New Approaches and Applications in Agriculture

EDITOR:
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CONTENTS

PREFACE

New generation agricultural models are needed to meet the rapidly increasing needs of the consumption society. In a sense, the economically sustainable development and development of countries at local, regional and global scale can be achieved by revealing, developing, producing and implementing new inventions and innovative differences.

The preparation of plans and programs in the agricultural sector generally focuses on the resources needed for agriculture such as soil and water, as well as socio-economic factors such as investment potential, food chain economy and level of knowledge.

Within this period, it is vital to deliver the information to the target audience faster and efficiently to create society of knowledge and allow these Technologies to be applied and become wide spread. In increasing agricultural production, the selection and use of inputs such as water, fertilizer, seed, plant protection and mechanization is important, the more important it is to use the work and machine power that will ensure the application of these inputs in an appropriate and economical way. As in every field and every stage of crop production, developments in terms of mechanization in animal production have reached a promising level in using our country's agricultural potential more effectively. In this book section, studies on new approaches and applications in agriculture are included.

The studies presented in this book, will benefit the agriculture sector development and sustainability practitioners also will make a very important contribution to Turkey's agriculture.

Best regards
Assoc. Prof. Dr. Mehmet Fırat BARAN
EDITOR

CHAPTER 1

NEW TRENDS TO REDUCE SPRAY DRIFT

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INTRODUCTION

Due to the increasing chemical costs, insufficient biological efficacy and negative environmental impacts of the current spraying methods, and rising interest in precision farming, it is obliged to apply chemicals under controlled conditions. For that reason, researches aim to improve the application methodologies and to suggest alternative methods are done intensely (Celen and Aktas,2000).

It is suggested that in all pesticide applications, especially in insecticide and fungicide applications, droplet size must be smaller than 150 micrometers. However, smaller droplet size is more prone to drift and not all types of nozzles can generate that size of droplets. Because of that limitations, pesticide application becomes a challenge.

Spray drift means the movement and dislocation of the spray deposit outside of the target area due to unintended mistakes during the application. For instance, wind, droplet size, nozzle type, reflection, splash, etc. may cause spray drift (Figure.1).

Figure.1. Spray Drift

- Spray drift causes the lack of fatal dose and insufficient pest control. If one considers the apply the chemical again, that becomes an issue of time and source.
- Spray drift causes the waste of expensive chemicals.
- Spray drift may cause damage to the non-target environment. Friendly and joyful neighbors may not be that friendly after their crop, animals, or facility, or even themselves are affected by spray drift, and the one who is done spraying can be charged for the non-target damage.
- Environmental concern for the spray drift needs to be considered. Air and water quality is highly important. The more people move to the cities from the rural area, the more problems with their life quality occur.
- People are getting more interested in what is happening around them and how they are affected.

The problems we mentioned above are the reasons why spray drift is a current problem. New technologies and methodologies are developed day by day to overcome those problems. Producers are doing researches and developments on spray nozzles and sprayers continuously.

What are the Spray Nozzles?

The most common principle about the spraying is that larger spray droplets move through the ground easier than small droplets. Another fact in spraying application is, larger droplets are closer to each other. However, spraying applications with small droplets carry less AI and

due to the wing, temperature, or humidity, the droplets may drift. The ability to stick to the lower side of the leaf surface of small droplets are more than larger droplets. Also, smaller droplets are less susceptible to run-off from the leaf surface than larger ones (Celen, 2012). That fundamental principle has to be considered while designing new spraying equipment. Moreover, spray nozzle manufacturers benefit from those principles to reduce the drift potential of the spraying application. For that purpose, they have designed three different nozzle types (Figure.2).

Spraying nozzle makers have been developing nozzles that generate larger droplets with lower pressures (extended range flat fan nozzles) to minimize the spray drift for years. These kinds of nozzles can achieve a perfect spray deposit distribution with a wide angular range and 1-4 bar pressure range. They also reduce the smaller droplet number which can drift easily below 1 bar. They are suggested to use especially after-emerge herbicide and systemic pesticide applications.

Figure 2. Spray Nozzles to Reduce Spray Drift

Standard flat fan nozzles and extended range flat fan nozzles have one orifice that controls the spraying pattern and flow rate. The spray solution creates a deposit when it comes out from the orifice. When this deposit becomes unstable and breaks into pieces, the droplets occur. There is some factor that affects that liquid deposit, how it is created, how and when it begins breaking into pieces.

- The thickness of the liquid deposit helps to determine the droplet size created. The thicker the liquid deposit is the larger droplets are created.
- At the same pressure levels, similar to the standard and extended range flat fan nozzles, nozzles with a single and wide orifice can generate larger droplets
- The shape and angle of the orifice may affect droplet size. Consider two nozzles with 80 degrees of beam angle and 110 degrees of beam angle and the same orifice size of 2 mm. At the same application pressure, one generates a spray beam with 80 degrees and the other one generates a spray beam with 110 degrees. That is related to orifice shape. The nozzle with 110 degrees of beam angle has a longer and thinner orifice shape than the one with 80 degrees of beam angle.
- When the pressure drops in the spraying system, the beam angle decreases. This causes thicker liquid deposits and larger droplet generation. As opposite, when the pressure increases in the spraying system, the beam angle gets wider and this causes thinner liquid deposits and smaller droplet generation.

Another technique used to reduce spray drift is designing the spray nozzle with a “pre-orifice”. It reduces the exit pressure. These kinds of nozzles operate under 2-6 bar range and 80-110 degrees of spraying beam range. With the help of the pre-orifice, the number of the smaller droplets is reduced. That type of nozzles is named drift reduction flat-fan nozzles. Compared to extended range flat fan nozzles, they reduce the risk of spray drift by 50%. As an example, Delevan-Delta Inc. used this technique on their “Raindrop” low drift nozzles. By reducing the inner pressure, they have aimed to drift resistant droplets.

Droplets generated from the nozzles which have pre-orifices are smaller than the ones generated from the flat fan or extended flat fan nozzles and have less exit speed. The possibility of adherence to the leaf surface of the droplets generated by the nozzles with pre-orifices is higher than the ones generated by flat fan nozzles.

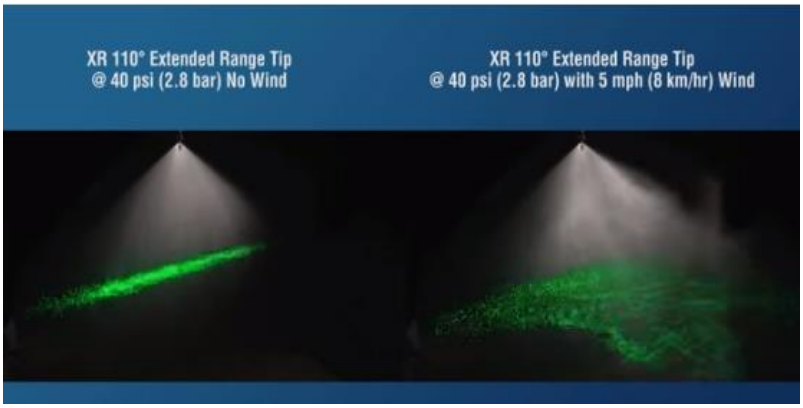

Figure 3. Spray Drift Caused by Wind (Teejet XR 110)

The pressure drop in the nozzles with pre-orifices requires a higher minimum pressure limit compared to flat fan nozzles with the same

orifice size. However, it depends on the application rates or working speed range. The reason for that is, nozzles with pre-orifices do not have an equivalent flow rate range in different operating pressures.

Since the entrance orifice is almost round rather than conical shape and the exit orifice is relatively wider, the possibility of clogging of nozzles with the pre-orifice is lower compared to flat fan nozzles.

Nozzles with pre-orifice and turbulence chamber are developed in late years. That nozzle design combines the pre-orifice construct with the turbulence chamber. The turbulence chamber absorbs the energy and reduces the exit pressure again. That does not exclusively generate coarser droplets, it promotes the homogeneity of the spray deposit structure as well.

Nozzles with the turbulence chamber appear in turbo flood nozzles and turbo flat fan nozzles. Turbo flat fan nozzles have better uniformity on the deposit structure in contrast to extended range flat fan nozzles or disparate drift reducing spray nozzles.

Furthermore, turbo flat fan nozzles decrease the percent of the drifted droplets in a wide range of pressure. Both turbo nozzles are designed to be used on the sprayer boom with a 50% overlap in the vertical direction.

Flood type nozzles generate a spray beam with a wide-angle. Changes in pressure affect the spray beam motive higher than extended range flat fan nozzles. Turbo flood nozzles generate larger droplets at low pressure, and smaller droplets compared to flat fan nozzles in equivalent

flow rates at high pressure. In contrast to extended range flat fan nozzles, non-target applications can be degraded by 50%. Also, turbo flood nozzles are suitable for herbicide and liquid fertilizer applications.

Air Assistance

Most of the farmers prefer using air-assisted sprayers for better coverage and reduced spray drift. The differences between air-assisted sprayers and conventional sprayers is an air fan, and air tunnels through the boom to generate an airstream close to the nozzles. The air tunnels are cylindrical and the diameter decreases from the fan to the exit. The air tunnel is made from intensively weaved and thick fabric or plastic swells when the fan starts to operate and becomes cylindrical. In addition to that, some of the air-assisted sprayers have air tunnels made from sheet metal. At the bottom of that cylindrical sheet metal, there are air outlets that are placed with a constant space between them. Sprayers used for the tall crops and especially fruit trees have a radial fan and nozzles placed around it.

Air assistance technology uses pneumatic systems for better atomization, movement, deposit, and penetration of the spray droplets. There are two types of air assisted sprayers:

1. Air curtains or air shield
2. Air atomizing nozzles

Figure 4. Air Assisted Sprayers

Using air curtains or air shields aims to increase pesticide efficacy, cover the lower side of the leaf surface better, provide better penetration in the plant canopy, have more sediment on the target surface, apply more pesticide on each unit area and degrade spray drift (Celen et al.,2016).

Air curtain or air shield have an external blowing system. The blower generates a fast air stream to blow and direct the spray droplets through the target surface. Also some sprayers have shields at the front and the back of the spray boom to keep the spray pattern inside the target direction. In addition to these, air assistance helps open the canopy and separate the leaves to penetrate the deposit all over the canopy.

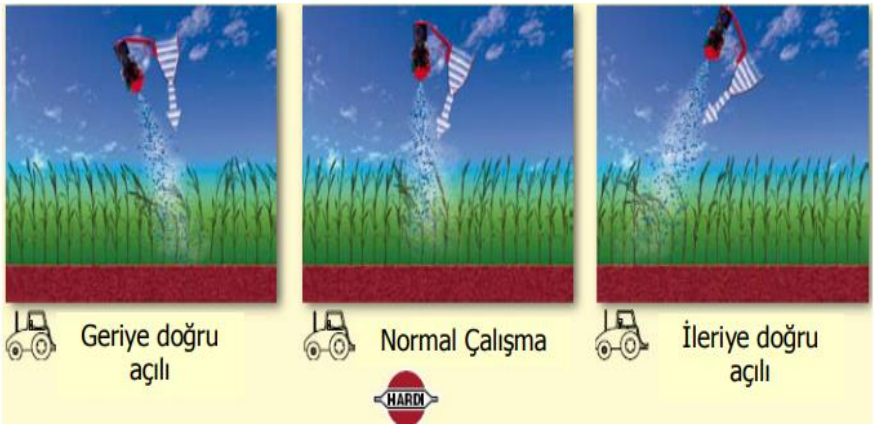

Figure 5. Working Principle of The Air Assisted Sprayer Made by Hardi

During insecticide and fungicide applications, it is important to cover and penetrate the lower and middle parts of the canopy. However, it is not necessary for herbicide applications. Researchers claimed that when air assisted sprayers apply spray deposit on the plant canopy, a lower potential of spray drift was observed. However, when it is applied on the bare soil, a higher potential of spray drift was observed. Plant canopy absorbs the additional energy generated by the air flux, but during the applications on the bare soil, increasing air velocity causes more potential of spray drift.

Another technique developed to reduce spray drift is air induction spray nozzles. In opposition to air curtains or air shields, the air assistance is not external on air induction nozzles, but inside of the nozzles. Single or double air inlets are placed on this type of nozzles. With the help of the air inlets, air comes inside the nozzle chamber and mixed with the spray liquid. When the droplets exit from the orifice of the nozzle, they

include air bubbles inside of them and they break into pieces when hit the target surface. That provides better coverage on the surface. Air and spray liquid, generate larger droplets when mixed and that reduces drift and provides more pesticide application per unit area (Celen,2016). The rate of the droplets generated by these nozzles is smaller than 50-100 microns are lower in the deposit structure compared to flat fan nozzles. In other words, the volume of the small droplets is smaller. Thus, the risk of spray drift of the spray deposit generated by air induction nozzles is lower than the ones generated by flat fan nozzles (Celen et al., 2019). For instance, a spray nozzle manufacturing company named Spraying Systems stated that while the rate of the droplets having drift potential generated by extended range flat fan nozzles is 34%, the rate of the droplets having drift potential generated by air induction nozzles is 12% (Anonymous, 2000).

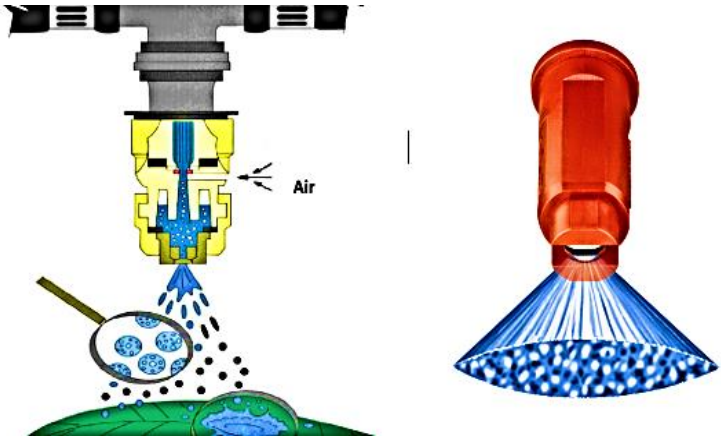

Figure 6. Air Induction Spray Nozzles (Anonymous, 2002)

Another technique developed to reduce drift is electrostatic spraying. Despite this is an old idea, lots of farmers are readopting this idea. However, field tests are still in progress to determine its possible to increase spraying efficacy and reducing spray drift.

On this technique, liquid spray droplets charged with static electricity, and those charged droplets generates an opposite charge on the leaf surface while approaching the surface. That opposite charge is generated by the electron transfer from the plant to the soil. Thus, an electrical attraction occurs between the charged droplets and the leaf surface and the droplets stick to the leaf (Law and Lane,1982). There are three techniques for charging applications:

1. Corona charging
2. Contact charging
3. Induction charging (Law, 1978; Marchant et al, 1985; Hussain and Kleisinger, 1992)

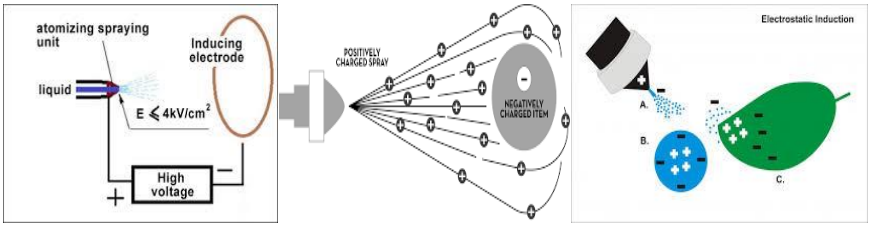

Figure 7. Fundamentals of Electrostatic Charging (Anonymous, 2018)

This approach called contact charging is different from the previous electrostatic system used an induction charge. In the induction charge

technique, the spray solution is charged while it is inside the nozzle. However, in the contact charge technique, the spray solution is filled in a charging chamber, it is charged with 40-50 kV voltage and moved through the boom and nozzles (Celen et al.,2009; Celen et al.,2020).

Electrostatic spraying increases the coverage on both the top and bottom side of the leaves. The charging quality is affected by the physical features of the spray nozzle, voltage, airflow rate, radius of the charging electrode, liquid flow rate, and distance between the electrode and the nozzle tip.

In that system, a ring electrode is a tool for charge induction. Electrodes charge the small droplets exits the nozzle orifice and are directed towards the plant. The electrical attraction force between the leaf surface and the spray droplets is 60 times bigger than the gravitational force. With the help of the force, the droplets mistargeting the leaf surface are directed towards the bottom side of the leaves, in opposite direction from the gravitational force. Researchers stated that electrostatic sprayers have 3.7 times better spray penetration and better coverage. Better coverage and penetration cause reduced usage of chemicals.

Due to the electrical force applied on the spray droplets additional to the gravitational force, the more pesticide is deposited on the leaf surface. That additional electrical force helps to reduce the drift effect of the wind. It causes a reduction in chemical losses and environmental pollution. Since the droplets with the same electrical charge (positive) repel each other, more uniform distribution on the leaf surface is

achieved. Because the electrically charged droplets follow the electrical field lines, the lower side of the leaf surface is covered with a sufficient amount of the pesticide as well as the upper side is done (Celen et al.,2017).

Although the benefits of electrostatic spraying mentioned above, it is not commonly preferred by the farmers due to its initial costs. However, environmental concerns and the pressure to reduce pesticide use forces the extensive usage of electrostatic spraying applications.

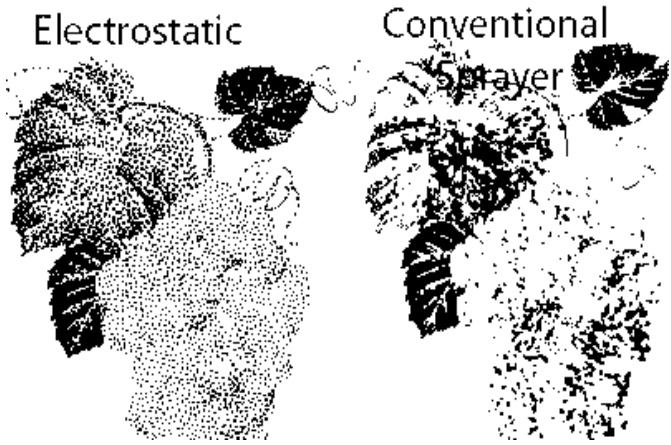

Figure 8. Effect of Electrostatic Charging on Deposit Distribution

RESULTS

Maximum 6.0% of the pesticide operation addresses the target organism, and the 94% of it addresses the non-target organisms and the ground in the agroecosystem or mixes into the water as chemical contaminants owing to drift and currents in the surrounding natural ecosystems.

Since almost all insecticides are not specific, they not only kill target organisms, but also affect other vertebrate and invertebrate organisms. The harshness of the damaging effects differs dependent on the type of insecticide and formulation, the type of operation and the type of farming land and production. Ramifications such as decreased reproductive potential, development of resistance to pesticides, deaths, imbalance in populations are seen.

Great numbers of researches in universities, research institutions, and industry are done to obtain maximum efficacy and minimum potential of risks of pesticides to operators and the environment by developing new methodologies and equipment. With the recent developments, making some changes to the existing equipment and bringing new systems into use are aimed to increase deposit efficacy, pesticide penetration, deposit on the bottom side of the leaves, and reduce the chemicals drift, thus reducing the chemical costs.

The efficacy of conventional methodology and equipment is highly low. Pesticides need to be applied efficiently to have better yield and quality. Thus, pesticides exposed to drift, chemical costs, and environmental pollution are reduced and sprayer deposits on the target surface, uniformity, and biological efficacy are increased.

The four elements that settle spray operation rates are sprayer pressure, nozzle orifice, ground speed, and the distance between the nozzles. Manufacturers and operators, the drift by as they solved the problem with technological changes, especially to the fine adjustment of the

pressure and flow rate are interested in and choose the right air assisted spray nozzle provided for each situation.

Drift can be degraded in several approaches, including decent use of the usual nozzles. Still, the novel "low-drift" nozzles mentioned in this publication further degrade the risk of propmting drift. They are more efficacious in reducing the number of fine droplets than what can be accomplished using the usual nozzles.

Despite the important development of pesticide application equipment in recent years, not all of them have got attention. The main reason for that is high initial costs and a lack of knowledge about those technologies. However, educating farmers about those technologies and selling highly efficient spraying technologies for reasonable prices may help the pesticide applications are done effectively.

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CHAPTER 2

DETERMINATION OF FRUIT AND TREE CHARACTERISTICS OF TRABZON PASTRIES (Diospyros kaki L.) GROWING AROUND THE SIIRT

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INTRODUCTION

Due to Turkey's geographical location and climatic conditions, it has created fruit growing potential in many areas. Therefore all temperate fruits in Turkey and some subtropical fruits, available in large quantities and can be raised at the highest quality (Kaska, 2003; Belliturk et al., 2019). Although Anatolia is the gene center of many fruit species grown in the world, it is also rich in fruit species and variety (Yarılgaç and Yıldız, 2001).

Persimmon (Diospyros kaki L.) is generally grown in subtropical climate zones. Persimmon, a fruit of Chinese origin, has more than 2000 varieties in this region. It has a history of 1300 years in Japan and 500 years in Korea. This genus has about 400 species, most of which are naturally found in tropical and subtropical climates, of which only 4 species are grown commercially. Diospyros lotus L., which belongs to the genus Diospyros, Diospyros oleifera Cheng. and Diospyros virginiana L. are species used as rootstock.

Although the tree height of the plant varies according to the varieties, it is a species that can rise up to 8 meters. Diospyros kaki L. type is not suitable for moist soil conditions, so other species are used as rootstock. It can form vertical, semi-vertical, and flat crown shapes. Root structure; Although the rootstock varies with the species, it consists of a taproot and a small number of hairy roots (Miller and Crocker, 1992). Leaf edges are straight, the middle vein is thick and the petiole is short. It is a species with simple leaves and its leaf shape is oval or pointed (Tuzcu, 1998). The leaves are 5-15 cm long and 5-10 cm wide.

Persimmon is a fruit species adapt to different regions in Turkey. Diospyros kaki, which is grown commercially, has been named as "Persimmon Dates" due to its entrance to our country from Trabzon. This fruit in Turkey "Heaven and palm fruit" is also known as. Modern enclosed gardens have been established in recent years in the production of persimmon. It is aimed to increase the consumption of this fruit type by producing varieties that are not bitter, especially those that are not bitter, the fruit flesh is hard, suitable for road and storage, and with dark orange-red color, which is seedless (Tuzcu & Yıldırım, 2000).

Kaki (Diospyros kaki L.) spread from China to Japan and later to other countries. Turkey persimmon cultivation despite the very long-standing need both production and marketing terms have not yet reached the desired level (Özcan, 2005).

Turkey, persimmon tree presence, on the rise at a higher rate than production, and despite his age fruiting about 75% of the available tree being the same rate of fruit production shows that there are several problems with yetiştiricilikl increasing. Low average yield, improper cultivation-related cultural processes, and also being scattered in the form of a single or a few trees in some commercially grown regions also have effects (Kaplankıran et al., 2004).

Although persimmon is a subtropical climate fruit, it has also adapted to warm temperate climate conditions. Persimmon can usually withstand up to -12 oC, some varieties can withstand up to -18 oC. For this reason, it can be grown in relatively cooler regions in our country,

especially in the Black Sea, Aegean, and Marmara Regions. Most of the persimmon varieties that shed their leaves in winter usually have a winter rest requirement of 200-400 hours under 7.2 oC. Non-bituminous varieties need more temperature sum than others. Flowering begins at the end of April in the Mediterranean region and in the second half of May in the Black Sea region. Varieties require a period of 140-160 days to ripen their fruits. Persimmons require high air humidity and the best quality fruits are obtained from humid regions. In places with low air humidity, good results can be obtained by irrigation (Tuzcu & Yıldırım, 2000).

The most suitable soils for persimmon are the soils rich in organic matter, medium heavy bodied, 6.5-7.0 pH, deep, and without drainage problems. However, it can be cultivated in different soil types from very light soils to very heavy soils. Since Diospyros kaki and Diospyros lotus, which are used as rootstocks in our country, bring many problems in moist soils, surface and subsoil drainage should be checked before establishing a garden and drainage should be done if necessary (Reich L., 1991).

Table 1. Chemical Composition of Persimmon Fruit (168 gr).

Food	Value
Water (g)	134.94
Calories (kcal)	118.00
Protein (g)	0.97
Fat (g)	0.32
Total Carbohydrate (mg)	31.23
Calcium (mg)	13.00
Phosphorus (mg)	29.00
Iron (mg)	0.25
Sodium (mg)	2.00
Potassium (mg)	270.00

Vitamin A (mg)	136.00
Vitamin E (mg)	1.23
Vitamin C (mg)	12.60

Looking at Table 1, potassium (279 mg), vitamin A (136 mg) and carbohydrate (118 kcal) are found in high concentrations in 168 gr persimmon fruit. It is also reported to be good for cardiovascular and digestive system diseases. It is used in anemia and vitamin deficiency because it contains vitamins A, B, and C. Thanks to its high fiber content, it prevents constipation by enabling the gastrointestinal system to work (Anonymous, 2019).

According to statistics around the world, the prominent countries in terms of persimmon production are China, the Republic of Korea, Japan, Brazil, Azerbaijan, Uzbekistan, and Italy. Israel, the US, New Zealand, Australia, Spain, Georgia, Egypt, Turkey, are among other important countries of Iran and Chile also made cultivation.In Table 2, persimmon production data on a country basis by years of FAO data are given (Anonymous, 2017).

Table 2. World Persimmon Production.

COUNTRIES	2012	2013	2014	2015	2016	2017
China	3.499.480	3.602.517	3.803.564	3.852.289	3.989.733	4.216.376
Korea	401.049	351.990	428.363	384.525	353.655	378.991
Spain	212.300	242.800	245.000	276.558	321.247	404.131
Japan	253.800	214.700	240.600	242.000	232.900	225.300
Brazil	158.241	173.169	182.290	192.327	161.052	180.800
Azerbaijan	140.082	143.106	140.405	146566	142920	147219
Uzbekistan	56.000	75.000	66.000	70.000	77.769	85.824
Italy	51.165	41.858	39.149	47.322	48.626	49.675
Turkey	**32.392**	**33.232**	**33.470**	**33.725**	**34.650**	**38.043**
Other	18.537	28.869	38.853	35.110	26.091	24.009
World	**4.823.046**	**4.907.241**	**5.217.694**	**5.280.422**	**5.388.643**	**5.750.368**

Persimmon foreign trade in the world According to the 2016 FAO data, the export amount was 494.034 tons and its value was 491.266.000 $, while the import amount was 445.394 tons and its value was 463.636.000 $ (Table 3). Also, the top five in exports are Spain, China, Azerbaijan, Uzbekistan, and Lithuania, respectively (Table 4).In Turkey, the export volume of 81 tons and worth $ 40, while the value of 48 tons is the number of imports was $ 49.The fluctuations in both exports and imports indicate that there is a volatile market (Anonymous, 2016).

Table 3. World Persimmon Export and Import Data.

	Export		Imports	
Years	**Amount (ton)**	**Value ($)**	**Amount (ton)**	**Value ($)**
2012	468.835	559.754.000	274.270	346.261.000
2013	624.496	796.520.000	322.920	425.636.000
2014	399.373	482.928.000	341.466	433.800.000
2015	464.539	479.091.000	400.808	437.391.000
2016	494.034	491.266.000	445.394	463.636.000

Table 4. Top Five Countries in the World in Export and Import.

Country	Export	Country	Imports
Spain	194.663	**Russian Federation**	111.520
China (+ Mainland)	111.417	**Kazakhstan**	514.12
Azerbaijan	832.33	**Germany**	412.46
Uzbekistan	619.21	**Vietnamese**	392.14
Lithuania	124.64	**Belarus**	227.05

palm trees of 2018. The number of Trabzon in Turkey, production and yield values are given in Table 5. (Anonymous, 2018). According to the data of 2018, 46.676 tons of persimmon were produced from 1.031.418 persimmon trees of the fruiting age. The yield per tree is 45 kg.

Although it is not known exactly when it was brought to our country, it has been cultivated for a long time. It is grown intensively in the Mediterranean region, especially in Hatay, Mersin, and Adana.

According to the data in 2018 shown in Table 6, on a provincial basis1st place in Adana (8.913 tons), 2nd place is Adıyaman (6.800 tons), 3rd place is Mersin (4.503 tons), 4th place in İzmir (4.163 tons) and The 5th is Denizli (3.478 tons) (Anonymous, 2018).

Table 5. Persimmon Statistics in Turkey.

Years	Number of Trees at Fruiting Age (Number)	The Number of Trees in Not Fruiting (Number)	Area of Bulk Orchards (Decares)	Yield (Kg / Fruiting (Tree)	Production Amount (Ton)
2011	800.898	197.141	20.900	35	28.295
2012	857.840	188.454	21.317	38	32.392
2013	883.235	172.778	22.642	38	33.232
2014	873.755	184.245	20.619	38	33.470
2015	860.177	197.067	20.789	39	33.725
2016	865.242	275.655	23.024	40	34.650
2017	883.449	303.467	23.932	43	38.043
2018	1.031.418	395.877	28.201	45	46.676

Table 6. Production amounts of important provinces in persimmon production for 2018.

Province	Production (tons)	Province	Production (tons)
Adana	8.913	**Gaziantep**	1.181
Adıyaman	6.800	**Sakarya**	1.011
Mersin	4.503	**Bursa**	1.364
Izmir	4.163	**Artvin**	739
Denizli	3.478	**Ordu**	782
Yalova	2.060	**Samsun**	1.141
Çanakkale	1.612	**Amasya**	626
Hatay	3.049	**Osmaniye**	688
Kahramanmaras	1.716	**Other provinces**	2.850

In terms of fruit characteristics, seedless and non-biting varieties are among the important commercial features, and bitter varieties are generally not preferred commercially. Among the bitter varieties, those with hard meat are important. The economic potential of the varieties with red color, hard flesh, seedless, and not bitter is extremely high (Tuzcu & Yıldırım, 2000).

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generally not preferred commercially. Among the bitter varieties, those with hard meat are important. The economic potential of the varieties with red color, hard flesh, seedless, and not bitter is extremely high (Tuzcu & Yıldırım, 2000).

In this study, it was aimed to determine the phenological, pomological, and morphological characteristics and breeding conditions of the persimmon varieties grown in the Siirt region, as well as to determine the high-quality genotypes in terms of fruit quality, and to prevent their extinction.

1. MATERIAL AND METHOD

1.1. Material

This research was conducted on the naturally grown persimmon genotypes in Siirt for two years in 2017-2018. The research material consisted of 25 persimmon genotypes taken from the gardens in Eruh district center of Siirt region, where the most intensive persimmon cultivation is carried out, and from the village of Pirinçli of Şirvan district. In this study, the phenological, pomological, morphological, and chemical properties of these genotypes were determined.

1.2. Method

In this study, the pomological, phenological, and morphological features of the persimmon types were examined and the pomological properties were averaged over two years. Some pomological and morphological definitions are made by UPOV (International Union for the Conservation of New Plant Varieties) (Anonymous, 2018).

1.2.1. Morphological and phenological features

The morphological characterization of the population consisting of 25 genotypes used in the study was carried out using the forms prepared by selecting the variables included in the 'International Union for the Conservation of New Plant Varieties '(UPOV) Persimmon descriptors' (Anonymous, 2018).

Table 7. Morphological Features and Explanations Examined in the Study.

Investigated feature	Explanation
Age of the tree	(year)
Habitus (growth pattern) of the tree	1 (vertical), 2 (semi-vertical), 3 (flat), 4 (drooping)
Crown height and width of the tree	(m)
The total yield of the tree	(kg)
Budburst	history
Blooming onset	history
In full bloom	history
End of flowering	history
Leaf shape	1 (oval), 2 (egg-like), 3 (opposite egg-like)
Leaf length	(mm)
Leaf width	(mm)
Leaf bottom shape	1 (narrow sharp), 2 (wide sharp), 3 (wide flat), 4 (round)
Leaf tip shape	1 (sharp), 2 (sharp), 3 (wide flat)
The beginning of the harvest	(history)
The time between full bloom and harvest (TÇG)	(day)
Fruit collection history	1 (early), 2 (middle), 3 (late)
Fruit weight	(g)
Fruit width	(mm)
Fruit size	(mm)
Fruit shape index (width / height)	rate
Fruit shape	1 (narrow oval), 2 (oval), 3 (round), 4 (flattened at the poles), 5 (angular at the poles), 6 (ovate), 7 (conical), 8 (short conical)
Fruit cross section	1 (round), 2 (angular round), 3 (square)
Fruit bottom shape	1 (pointed), 2 (blunt), 3 (round), 4 (flat), 5 (flattened)
Fruit volume	(cm3)
Fruit stem length	(mm)
Fruit stalk thickness	(mm)
Fruit skin color on my skin	1 (greenish-yellow), 2 (orange-yellow), 3 (orange), 4 (orange-red)
Crust color at maturity	1 (orange), 2 dark orange), 3 (orange red), 4 (red), 5 (brown)
Fruit shell structure	1 (high gloss), 2 (glossy), 3 (matt)
Fruit flesh color on my skin	1 (yellow), 2 (orange-yellow), 3 (orange), 4 (orange-red), 5 (brown-orange), 6 (brown)

Table 7. Morphological Features and Explanations Examined in the Study (continued).

Investigated feature	Explanation
Crust color on my skin	1 (yellow), 2 (orange-yellow), 3 (orange), 4 (orange-red), 5 (Brown-orange), 6 (brown)
Fruit flesh color at maturity	1 (yellow), 2 (orange yellow), 3 (orange), 4 (red orange), 5 (red), 6 (brown), 6 (dark brown)
Fruit skin color at maturity	1 (yellow), 2 (orange yellow), 3 (orange), 4 (red orange), 5 (red), 6 (brown), 6 (dark brown)
Presence of brown spots on fruit flesh	1 (absent), 2 (sometimes present-partially), 3 (present)
Number of seeds	Piece
Seed weight	(g)
Seed shape	1 (narrow elliptical), 2 (oval), 3 (flattened oval), 4 (elliptical), 5 (semi-triangular)
Fruit flesh color around the seed	1 (orange), 2 (brown), 3 (dark brown)
Maturation period	Those that mature before September 15 are very early; Between 16-30 September are early; The ones that mature between October 1-15 are mid-season; Those who come to my skin between October 16-30 are late and those who mature after November 1 are too late.
Total dry matter	(%)
SÇKM	(%)
Acid (TEA)	(%)
pH	(%)

Variables including forty-three different morphological, phenological, and pomological characteristics and explanations for these variables are presented in Table 7.

1.2.2. Statistical evaluation of genotypes

"Weighted Rating Method" was taken as reference in the analyzed genotypes. Statistical analyzes were evaluated using SPSS.

In weighted grading, the weighted total score of each genotype, the scores of the traits (feature) classes examined in each genotype will be multiplied by the relative scores, and the total score will be calculated,

and the highest scores are selected as the hopeful genotypes (Table 8). From fruits belonging to persimmon genotypes, in 2017 and 2018 harvest periods; Descriptive statistics of fruit weight (g), fruit length (mm), fruit width (mm), fruit volume (cm3), and soluble dry matter (Brix); Expressed as Mean and Standard Error. One-way analysis of variance was used to compare genotypes. Following the variance analysis, Duncan multiple comparison tests were used to identify different groups.

Table 8. Characteristics, Class Values, and Scores Based on Scaled Grading in the Evaluation of Persimmon Genotypes.

Fruit Quality Features	Relative Points	Groups	Class Values	Point
Fruit Weight (g)	30	Small	61.67-95.22	1
		Middle	95.23-128.78	5
		Large	128.79-162.34	7
		Too big	162.35-195.89	9
Skin Death Fruit Skin Color	20	Red		9
		Orange-red		7
		Orange		5
		Orange-yellow		3
		Greenish-yellow		1
Skin Death Flesh Color	20	Brown-Orange		9
		Orange Red		7
		Orange		5
		Orange Yellow		3
		Yellow		1
Number of Seeds (Piece)	15		0.00-0.97	9
			0.98-1.95	7
			1.96-2.93	5
			2.94-3.91	1
SÇKM (%)	15	Little	17-18.375	1
		Middle	18.376-19.751	5
		Good	19.752-21.127	7
		Very good	21.128-22.503	9
Total				**100**

2. RESULTS

This study was carried out in 2017-2018. Numerous persimmon seedlings that grow naturally in these regions have been scanned. In the study, 25 persimmon genotypes were examined; Pomological, morphological, chemical, and phenological examinations related to these genotypes were evaluated. The characteristics of the determined trees, such as the genotype number, the location, the owner of the place where it was taken, or the name of the neighborhood/village, and the information about the trees were recorded (Table 9).

Table 9. General Information About Determined Persimmon Varieties and Genotypes

No	Genotype	District	Owner of Place of Takeover or Name of Village / Neighborhood
1	56 ER 01	Eruh	Sarı gül Mahallesi
2	56 ER 02	Eruh	Sarı gül Mahallesi
3	56 ER 03	Eruh	Sarı gül Mahallesi
4	56 ER 04	Eruh	Sarı gül Mahallesi
5	56 ER 05	Eruh	Sarı gül Mahallesi
6	56 ER 06	Eruh	Selahattin Sevgin
7	56 ER 07	Eruh	İsmail Sevgin
8	56 ER 08	Eruh	Eruh TEDAŞ bahçesi
9	56 ER 09	Eruh	Eruh TEDAŞ bahçesi
10	56 ER 10	Eruh	Fatih Mah.
11	56 ER 11	Eruh	Fatih Mah.
12	56 ER 12	Eruh	Fatih Mah. / Sait Akça
13	56 ER 13	Eruh	Fatih Mah. /Dursun Usta
14	56 ER 14	Eruh	Fatih Mah. / Aydın Boz
15	56 ER 15	Eruh	Dih Mah. Eski Caddesi
16	56 ER 16	Eruh	Dih Mah. Eski Caddesi
17	56 ER 17	Eruh	Dih Mah. / Nusret Atabey
18	56 ER 18	Eruh	İsmail Erdemci
19	56 ER 19	Eruh	İsmail Erdemci
20	56 ŞV 01	Shirvan	Pirinçli köyü/ Mehmet Yıldırım
21	56 ŞV 02	Shirvan	Pirinçli köyü/ Mehmet Yıldırım
22	56 ŞV 03	Shirvan	Pirinçli köyü/ Mehmet Yıldırım
23	56 ŞV 04	Shirvan	Pirinçli köyü/ Mehmet Yıldırım
24	56 ŞV 05	Shirvan	Pirinçli köyü/ Mehmet Yıldırım
25	56 ŞV 06	Shirvan	Pirinçli köyü/ Mehmet Yıldırım

2.1. Morphological Characteristics of Genotypes

The 25 persimmon genotypes studied vary between the estimated ages of the trees in 2018, and the genotypes with these ages are 56 ER 19, 56 ER 12 and 56 ER 13, respectively (Table 10).

Table 10. Some Morphological Features of Persimmon Genotypes

Genotype	EAT	CH (m)	CW (m)	GST	GTT	TY (kg)
56 ER 01	10	3,4	2,22	Medium strong	Steep	60
56 ER 02	10	2,5	1,5	Medium strong	Splayed	65
56 ER 03	8	3,51	2,10	Medium strong	Steep	65
56 ER 04	10	2,5	1,60	Medium Strong	Splayed	40
56 ER 05	8	3,2	1,91	Medium strong	Half upright	55
56 ER 06	12	6,45	3,58	Medium strong	Steep	20
56 ER 07	6	3,5	2,21	Medium strong	Half upright	50
56 ER 08	13	5	3,90	Powerful	Splayed	60
56 ER 09	13	5,12	3,65	Powerful	Splayed	55
56 ER 10	4	2,21	1,65	Weak	Splayed	10
56 ER 11	6	3,2	2,7	Medium strong	Steep	30
56 ER 12	15	7,45	4,50	Powerful	Splayed	100
56 ER 13	15	6,3	3,80	Powerful	Splayed	75
56 ER 14	11	5,15	3,23	Powerful	Half upright	55
56 ER 15	4	2,95	1,91	Powerful	Half upright	20
56 ER 16	4	3,01	2,20	Powerful	Steep	20
56 ER 17	4	1,83	1,15	Weak	Steep	10
56 ER 18	5	3,5	2,65	Medium strong	Steep	45
56 ER 19	3	3,5	1,21	Weak	Steep	5
56 ŞV 01	12	7,51	5,12	Medium strong	Splayed	90
56 ŞV 02	10	7,69	5,21	Powerful	Splayed	100
56 ŞV 03	10	6,5	4,32	Powerful	Splayed	100
56 ŞV 04	6	5,25	4,05	Medium strong	Splayed	85
56 ŞV 05	10	5,5	2,22	Powerful	Splayed	110
56 ŞV 06	5	2,15	1,85	Medium Strong	Steep	15

EAT: Estimated Age of Tree**, CH:** Crown Height**, CW:** Crown Width, **GST:** Growth Strength of Tree**, GTT:** Growth Type of Tree**, TY:** Total Yield

Genotypes' crown height of 2018 trees varies between 1.83 m (56 ER 17) and 7.69 m (56 SV 02), while crown width is between 1.15 m (56

ER 17) and 5.21 m (56 SV 02). It was determined to be worth (Table 10).

Considering the growth forces of the genotypes according to the data of 2018, it was observed that 10 trees were strong, 11 trees were medium-strong, and 4 trees were weak (Table 10).

Growth patterns of the analyzed genotypes compared to 2018 were determined as 9 planted trees, 4 trees semi-upright and 12 trees flat (Table 10).

According to the data of 2018, the analyzed persimmon genotypes have been found to have a total yield of at least 5 kg (56 ER 19) and a maximum of 110 kg (56 SV 05) (Table 10).

2.2. Phenological Characteristics of Genotypes

According to the results of 2018 data of the researched persimmon genotypes, the bud burst date occurred between April 15-25. The first flowering date of these genotypes occurred between 10 May at the earliest and 19 April at the latest. Full bloom date is May 20th and the latest May 25th; The end of the flowering date was observed between May 26 at the earliest and June 2 at the latest. The period between full bloom and harvest was found to be between 168-177 days (Table 11).

Table 11. Some phenological characteristics of persimmon genotypes.

Genotypes	Bud explosion date	First Flowering Date	Full Flowering Date	End of Flowering Date	Harvest Date	TBFBH
56 ER 01	April 15	May 18	May 20	May 26	November 3	170
56 ER 02	April 15	May 19	May 26	June 1	November 3	168
56 ER 03	April 15	May 18	May 22	27 May	November 3	169
56 ER 04	April 15	May 18	May 21	28 May	November 3	169
56 ER 05	April 15	May 16	May 20	29 May	November 1	169
56 ER 06	April 20	May 17	May 24	30 May	November 1	168
56 ER 07	April 23	May 18	May 23	29 May	November 1	167
56 ER 08	April 22	May 16	May 23	27 May	November 5	173
56 ER 09	April 22	May 16	May 21	29 May	November 5	173
56 ER 10	April 17	May 10	May 22	26 May	November 1	175
56 ER 11	April 15	May 10	May 23	29 May	November 3	177
56 ER 12	April 20	May 17	May 23	29 May	November 3	170
56 ER 13	April 16	May 15	May 25	June 2	November 3	172
56 ER 14	April 15	May 12	May 22	27 May	November 5	177
56 ER 15	April 25	May 15	May 21	June 2	November 3	172
56 ER 16	April 19	May 12	May 21	28 May	November 3	175
56 ER 17	April 25	May 13	May 20	May 26	November 3	174
56 ER 18	April 20	May 12	May 24	May 30	November 3	175
56 ER 19	April 17	May 14	May 23	May 29	November 3	173
56 ŞV 01	April 20	May 19	May 25	May 30	November 4	169
56 ŞV 02	April 20	May 19	May 25	May 30	November 4	169
56 ŞV 03	April 20	May 19	May 25	May 30	November 4	169
56 ŞV 04	April 20	May 19	May 25	May 30	November 4	169
56 ŞV 05	April 20	May 19	May 25	May 30	November 4	169
56 ŞV 06	April 20	May 19	May 25	May 30	November 4	169

TBFBH: Time between full bloom and harvest.

2.3. Pomological Characteristics of Genotypes

The researched persimmon genotypes for the years 2017, 2018, and the average data and the lowest (↓), the highest (↑) are presented by plotting them on the Table (Tables 12-15).

Table 12. Fruit Characteristics of Persimmon Genotypes.

Genotypes	Fruit Weights (g)			Fruit Size (mm)			Fruit Width (mm)		
	2017	2018	0rt.	2017	2018	0rt.	2017	2018	Cover.
56 ER 01	177.88	135.9	156.89	65.38	61.93	63.66	59.55	56.28	55.71
56 ER 02	175.60	152.52	164.06	65.83	64.31	65.07	58.88	58.87	58.88
56 ER 03	167.72	146.59	157.15	65.08	63.56	64.32	59.80	57.66	58.73
56 ER 04	157.75	142.83	150.29	61.95	60.82	61.39	59.43	58.64	59.04
56 ER 05	195.18	**196.56 ↑**	**195.87 ↑**	**67.80 ↑**	67.05	**67.425 ↑**	**63.15 ↑**	**62.47 ↑**	**62.81 ↑**
56 ER 06	75.02	93.36	84.19	47.03	48.93	47.98	43.46	42.92	43.19
56 ER 07	177.22	136.68	156.95	66.33	60.23	63.28	60.56	55.71	58.14
56 ER 08	109.11	128.22	118.66	54.9	53.87	54.385	52.52	50.93	51.73
56 ER 09	74.07	104.77	89.42	48.15	46.39	47.27	45.92	43.85	44.885
56 ER 10	169.54	158.2	163.87	64.27	63.02	63.645	59.07	57.78	58.425
56 ER 11	96.34	114.65	105.49	53.12	51.11	52.115	51.3	50.14	50.72
56 ER 12	144.54	115.73	130.13	62.13	58.81	60.47	57.7	55.695	56.69
56 ER 13	169.93	131.5	150.71	64.8	60.81	62.81	62.75	55.225	61.48
56 ER 14	165.55	103.54	134.54	62.6	57.21	59.91	57.8	55.66	56.73
56 ER 15	73.03	91.27	82.15	47.6	46.36	46.98	45.42	45.91	45.67
56 ER 16	130.62	116.99	123.80	67	58.34	62.67	62.2	59.65	59.65
56 ER 17	136.97	113.88	125.42	58.45	56.83	57.64	57.32	56.21	56.77
56 ER 18	**68.92 ↓**	**54.43 ↓**	**61.67 ↓**	**39.05 ↓**	**40.9 ↓**	**39.975 ↓**	**35.6 ↓**	**37.56 ↓**	**36.58 ↓**
56 ER 19	107.08	93.55	100.31	53.75	53.6	53.675	51.7	51.66	51.68
56 ŞV 01	130.17	133.56	131.86	59.16	59.12	59.14	59.66	55.68	57.67
56 ŞV 02	129.68	104.19	116.93	61.3	56.90	59.1	59.26	56.98	58.12
56 ŞV 03	142.61	111.33	126.97	62.23	57.49	59.86	60.83	57.73	59.28
56 ŞV 04	153.51	141.14	147.32	67.03	60.03	63.53	63.8	61.61	62.705
56 ŞV 05	**195.17 ↑**	181.00	188.08	67.8	**67.57 ↑**	67.685	63.15	62.14	62.645
56 ŞV 06	128.08	123.42	125.75	58.6	59.48	59.04	55	51.09	53.045

Table 13. Fruit Properties of Persimmon Genotypes.

Genotypes	Shape Index (U / G)			Volume (mL)			Density (g / mL)		
	2017	2018	0rt.	2017	2018	0rt.	2017	2018	Cover.
56 ER 01	1,09	1,10	1,09	146,50	115	130,75	1,21	1,18	1,20
56 ER 02	**1.11 ↑**	1,09	1,10	159,00	125	142	1,10	1,22	1,16
56 ER 03	1,08	1,10	1,009	152,67	115	133,83	1,09	1,27	1,18
56 ER 04	1,04	1,03	1,03	132,50	117,5	125	1,19	1,21	1,2
56 ER 05	1,07	1,07	1,07	**184,00 ↑**	**169,5 ↑**	**176,75 ↑**	1,06	1,15	1,11
56 ER 06	1,08	**1,14 ↑**	**1.11 ↑**	57,33	67,5	62,41	1,30	1,38	**1,34 ↑**
56 ER 07	1,09	1,08	1,08	148	114,5	131,25	1,19	1,19	1,19
56 ER 08	1,04	1,05	1,05	91,5	110	100,75	1,19	1,16	1,18
56 ER 09	1,04	1,05	1,05	52	95,5	73,75	1,42	1,09	1,26
56 ER 10	1,08	1,09	1,08	143,5	136	139,75	1,18	1,16	1,17
56 ER 11	1,03	1,01	1,02	84,5	99	91,75	1,14	1,15	1,15
56 ER 12	1,07	1,05	1,06	134	103,5	118,75	1,07	1,11	1,09
56 ER 13	1,03	1,009	1,02	146	100	123	1,16	1,31	1,24
56 ER 14	1,08	1,02	1,05	138	90	114	1,19	1,15	1,17
56 ER 15	1,04	1,009	1,02	**47 ↓**	**55 ↓**	**51 ↓**	1,55	**1,65 ↑**	1,6
56 ER 16	1,07	**0,97 ↓**	1,02	100	94	97	1,30	1,24	1,27
56 ER 17	1,01	1,01	1,01	110,5	79,5	95	1,23	1,43	1,33
56 ER 18	1,09	1,08	1,09	48	65	56,5	**1.43 ↑**	**0.83 ↓**	**1,13 ↓**
56 ER 19	1,03	1,03	1,03	89	77	83	1,20	1,21	1,21
56 ŞV 01	**0,99 ↓**	1,06	1,02	120,33	122,5	121,41	1,08	1,09	1,09
56 ŞV 02	1,03	0,99	1,01	119	82,5	100,75	1,08	1,26	1,17
56 ŞV 03	1,02	0,99	1,01	138	81	109,5	1,03	1,37	1,2
56 ŞV 04	1,05	**0,97 ↓**	1,01	151,6	108,5	130,05	**1,01 ↓**	1,30	1,16
56 ŞV 05	1,07	1,08	1,08	184	159	171,5	1,06	1,13	1,10
56 ŞV 06	1,06	1,16	**1.11 ↑**	114	95	104,5	1,12	1,29	1,21

The average number of seeds of the persimmon genotypes studied varied between 0.00 and 4.00 (56 ER 18). Seed shapes are generally elliptical and only one of these genotypes has a semi-flat shape. Seed colors were brown to dark brown (Table 13).

Table 14. Pomological Properties of Persimmon Genotypes.

Genotype	FS	FCS	FBS	NS (pieces)	SS (g)	SS	SC
56 ER 01	Round	Round	Flattened	0	0,00	-	-
56 ER 02	Conical	Angular Round	Round	0	0,00	-	-
56 ER 03	Round	Angular Round	Flattened	0	0,00	-	-
56 ER 04	Conical	Angular Round	Round	0	0,00	-	-
56 ER 05	Round	Angular Round	Round	0	0,00	-	-
56 ER 06	Round	Angular Round	Flat	1	0,543	Ellipse	Dark brown
56 ER 07	Oval	Angular Round	Mass	1,3	1,203	Ellipse	Brown
56 ER 08	Round	Angular Round	Round	0,3	0,52	Ellipse	Brown
56 ER 09	Round	Angular Round	Flat	0,3	0,44	Ellipse	Brown
56 ER 10	Conical	Angular Round	Flat	0	0,00	-	-
56 ER 11	Round	Angular Round	Flat	0	0,00	-	-
56 ER 12	Short Taper	Angular Round	Flattened	2,3	0,98	Ellipse	Brown
56 ER 13	Round	Angular Round	Flattened	0	0,00	-	-
56 ER 14	Round	Round	Round	0	0,00	-	-
56 ER 15	Round	Round	Round	1,5	0,661	Ellipse	Brown
56 ER 16	Oval	Angular Round	Flat	0,8	0,29	-	-
56 ER 17	Oval	Angular Round	Flat	3,4	1,63	Ellipse	Brown
56 ER 18	Narrow Oval	Angular Round	Mass	3,9	1,83	Half flat	Brown
56 ER 19	Conical	Angular Round	Round	1,1	0,76	Ellipse	Brown
56 ŞV 01	Round	Angular Round	Round	1,1	0,86	Ellipse	Dark brown
56 ŞV 02	Round	Angular Round	Flat	1,8	0,68	Ellipse	Dark brown
56 ŞV 03	Round	Angular Round	Flat	1,5	1,03	Ellipse	Dark brown
56 ŞV 04	Round	Angular Round	Round	3,1	0,71	Ellipse	Brown
56 ŞV 05	Round	Angular Round	Round	1,2	0,63	Ellipse	Dark brown
56 ŞV 06	Round	Round	Flat	2,6	1,22	Ellipse	Brown

FS: Fruit Shape**, FCS:** Fruit Cross Section**, FBS:** Fruit Bottom Shape**,**
NS: Number of Seeds, **SW:** Seed Weight, **SS:** Seed Shape**, SC:** Seed Color

Table 15. Pomological Properties of Persimmon Genotypes.

Genotype	My Skin Period		Maturity Period		FFCAS	PBSFF
	FSC	FFC	FSC	FFC		
56 ER 01	Orange-Yellow	Orange-Yellow	Red-Orange	Red-Orange	Orange	No
56 ER 02	Orange-Yellow	Orange-Yellow	Dark Orange	Orange	Orange	No
56 ER 03	Orange-Yellow	Yellow	Orange	Orange	Orange	No
56 ER 04	Greenish-Yellow	Yellow	Orange	Orange	Orange	No
56 ER 05	Orange	Orange-Yellow	Red-Orange	Red-Orange	Orange	No
56 ER 06	Greenish-Yellow	Yellow	Red-Orange	Orange	Brown	There is
56 ER 07	Greenish-Yellow	Yellow	Orange	Orange	Orange	There is
56 ER 08	Orange-Yellow	Yellow	Orange- Yellow	Orange	Orange	No
56 ER 09	Orange-Yellow	Orange-Yellow	Orange	Orange	Orange	No
56 ER 10	Orange-Yellow	Orange-Yellow	Red-Orange	Red-Orange	Orange	There is
56 ER 11	Orange-Yellow	Orange-Yellow	Red-Orange	Orange	Orange	No
56 ER 12	Greenish-Yellow	Yellow	Orange	Orange	Orange	Partially
56 ER 13	Orange-Yellow	Yellow	Orange	Orange-Yellow	Orange	No
56 ER 14	Orange-Yellow	Orange-Yellow	Orange	Red-Orange	Orange	No
56 ER 15	Orange	Orange-Yellow	Red-Orange	Orange	Orange	There is
56 ER 16	Orange-Yellow	Yellow	Orange	Orange	Orange	Partially
56 ER 17	Orange-Yellow	Yellow	Orange	Orange	Orange	Partially
56 ER 18	Orange-Yellow	Orange-Yellow	Red-Orange	Red-Orange	Orange	Partially
56 ER 19	Orange	Orange	Brown-Orange	Brown-Orange	Brown	There is
56 ŞV 01	Greenish-Yellow	Yellow	Orange-Yellow	Orange-Yellow	Orange-Yellow	There is
56 ŞV 02	Greenish-Yellow	Yellow	Orange	Orange	Orange	There is
56 ŞV 03	Orange	Orange	Red-Orange	Orange	Brown	There is
56 ŞV 04	Orange	Orange	Red-Orange	Red-Orange	Orange	Partially
56 ŞV 05	Greenish-Yellow	Yellow	Orange-Yellow	Orange-Yellow	Brown	Partially
56 ŞV 06	Orange-Yellow	Yellow	Red-Orange	Red-Orange	Orange	Partially

FSC: Fruit Skin Color**, FFC:** Fruit Flesh Color**, FFCAS:** Fruit Flesh Color Around the Seed**, PBSFF:** The Presence of Brown Spots in Fruit Flesh

2.4. Chemical Properties of Genotypes

The chemical properties of the researched persimmon genotypes for the years 2017 and 2018 and the average data and the lowest, the highest are presented in the Table (Table 16).

Table 16. Chemical Properties of Persimmon Genotypes.

Genotypes	Water-Soluble Dry Material (%)			Titratable acid Amount (%)			Dry Matter (%)			pH
	2017	2018	0rt.	2017	2018	0rt.	2017	2018	Cover.	%
56 ER 01	20	21	20,5	0,29	0,31	0,3	23,21	23,49	23,35	6,04
56 ER 02	**16 ↓**	19	17,5	0,41	**0.59 ↑**	**0.5 ↑**	22,31	24,32	23,315	6,24
56 ER 03	24	20	22	0,33	0,46	0,395	27,94	**26,17 ↑**	27,055	6,2
56 ER 04	19,9	16	17,95	0,22	0,57	0,395	25,15	23,60	24,375	6,4
56 ER 05	20,2	19	19,6	0,28	0,11	0,195	28	25,03	26,515	**6,74 ↑**
56 ER 06	**27 ↑**	18	**22,5 ↑**	0,32	0,4	0,36	14,92	23,44	19,18	6,32
56 ER 07	18	18	18	0,35	0,25	0,3	24,36	22,59	23,475	6,07
56 ER 08	19,2	20	19,6	**0.09 ↓**	**0,11 ↓**	**0,1 ↓**	**34,33 ↑**	25,92	**30,125 ↑**	6,15
56 ER 09	24	19	21,5	0,28	0,15	0,215	29,69	20,86	25,275	6,19
56 ER 10	19,9	19	19,45	0,23	0,49	0,36	13,59	23,29	18,44	5,86
56 ER 11	18,9	16	17,45	0,13	0,17	0,15	15,14	21,17	**18,155 ↓**	6
56 ER 12	18	16	**17 ↓**	0,26	0,37	0,315	23,54	**18,79 ↓**	21,165	6,05
56 ER 13	18	18	18	0,33	0,47	0,4	23,32	21,49	22,405	5,89
56 ER 14	22,5	19	20,75	0,34	0,39	0,365	27,21	23,35	25,28	6,09
56 ER 15	25,2	19	22,1	**0,51 ↑**	0,49	**0.5 ↑**	29,22	23,62	26,42	6,07
56 ER 16	23	17	20	0,25	0,33	0,29	30,97	20,81	25,89	**5,55 ↓**
56 ER 17	21,8	**15 ↓**	18,4	0,25	0,24	0,245	28,43	23,38	25,905	6,09
56 ER 18	21,4	19	20,2	0,33	0,24	0,285	25,59	21,93	23,76	6,37
56 ER 19	24	20	22	0,26	0,62	0,44	27,57	24,87	26,22	6,37
56 ŞV 01	18,5	21	19,75	0,33	0,38	0,355	24,98	23,14	24,06	6,16
56 ŞV 02	21,5	22	21,75	0,17	0,25	0,21	28,94	25,45	27,195	6,08
56 ŞV 03	20,5	22	21,25	0,31	0,46	0,385	28,37	26,15	27,26	6,19
56 ŞV 04	19,9	**23 ↑**	21,45	0,26	0,33	0,295	25,29	25,57	25,43	6,06
56 ŞV 05	16,1	19	17,55	0,51	0,49	**0.5 ↑**	27,11	22,14	24,625	6,03
56 ŞV 06	21,2	19	20,1	0,22	0,27	0,245	**10,61 ↓**	28,21	19,41	6,05

2.5. Selection of Persimmon Genotypes

The average of the two years of our study was taken as a basis and weighted grading was applied to the examined varieties to determine promising varieties on these results. Features based on weighted grading; fruit weight, bitterness, amount of water-soluble dry matter (SSC), fruit flesh color, and seed number at maturity. As a result of the weighted grading, the scoring ranged between 270 (56 ER 18) and 670 (56 ER 05) (Table 17 - Figure 1).

Table 17. The scores they got at the end of the weighted grading.

Genotypes	Fruit Weight (g)	Fruit Skin Color in the Maturity Period	Fruit flesh color in the maturity period	SSC (%)	Number of Seeds (pieces)	Total Score
56 ER 01	**270**	**60**	**60**	**105**	**135**	**630**
56 ER 02	270	60	60	15	135	540
56 ER 03	210	60	20	135	135	560
56 ER 04	210	20	20	15	135	400
56 ER 05	**270**	**100**	**60**	**105**	**135**	**670**
56 ER 06	30	20	20	135	105	310
56 ER 07	210	20	20	15	105	370
56 ER 08	150	60	20	105	135	470
56 ER 09	30	60	60	135	135	420
56 ER 10	**270**	**60**	**60**	**75**	**135**	**600**
56 ER 11	150	60	60	15	135	420
56 ER 12	210	20	20	15	75	340
56 ER 13	210	60	20	15	135	440
56 ER 14	**210**	**60**	**60**	**105**	**135**	**570**
56 ER 15	30	100	60	135	105	430
56 ER 16	150	60	20	105	135	470
56 ER 17	150	60	20	75	15	320
56 ER 18	30	60	60	105	15	270
56 ER 19	**150**	**100**	**100**	**135**	**105**	**590**
56 ŞV 01	210	20	20	75	105	430
56 ŞV 02	150	20	20	135	105	430
56 ŞV 03	**150**	**100**	**100**	**135**	**105**	**590**
56 ŞV 04	210	100	100	135	15	560
56 ŞV 05	270	20	20	15	105	430
56 ŞV 06	150	60	20	105	75	410

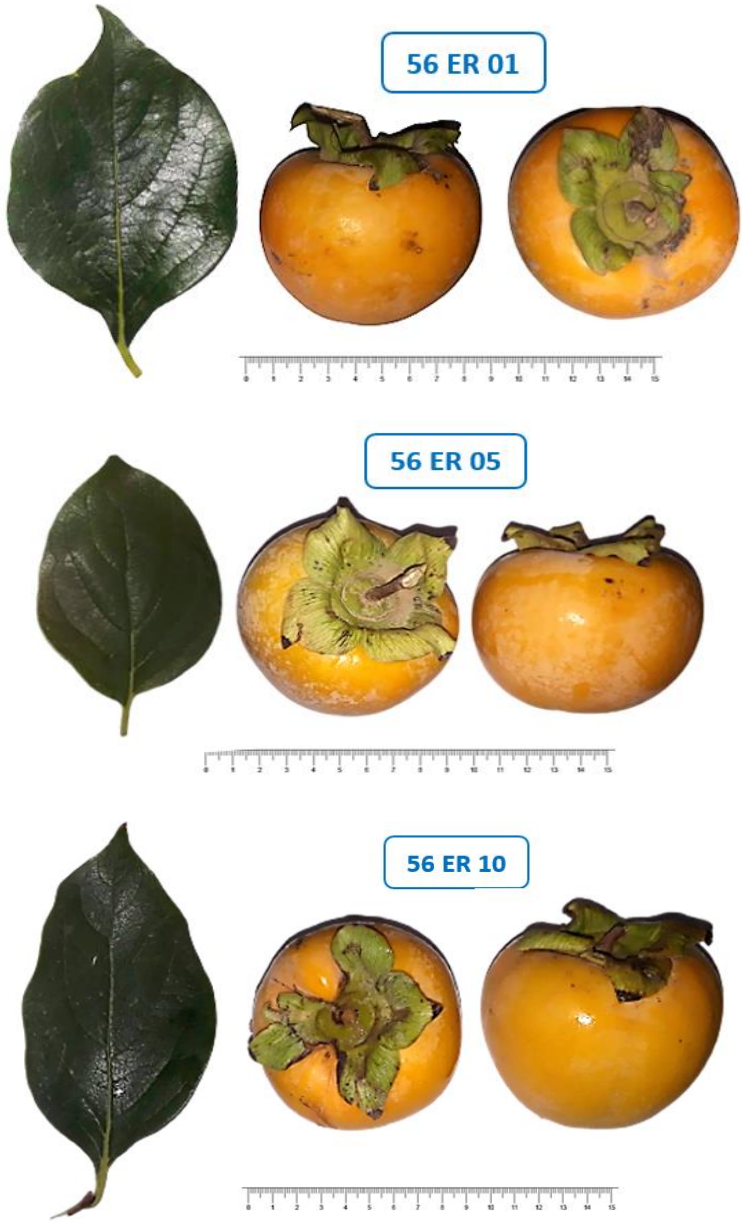

Figure 1. Prominent genotypes at the end of weighted grading.

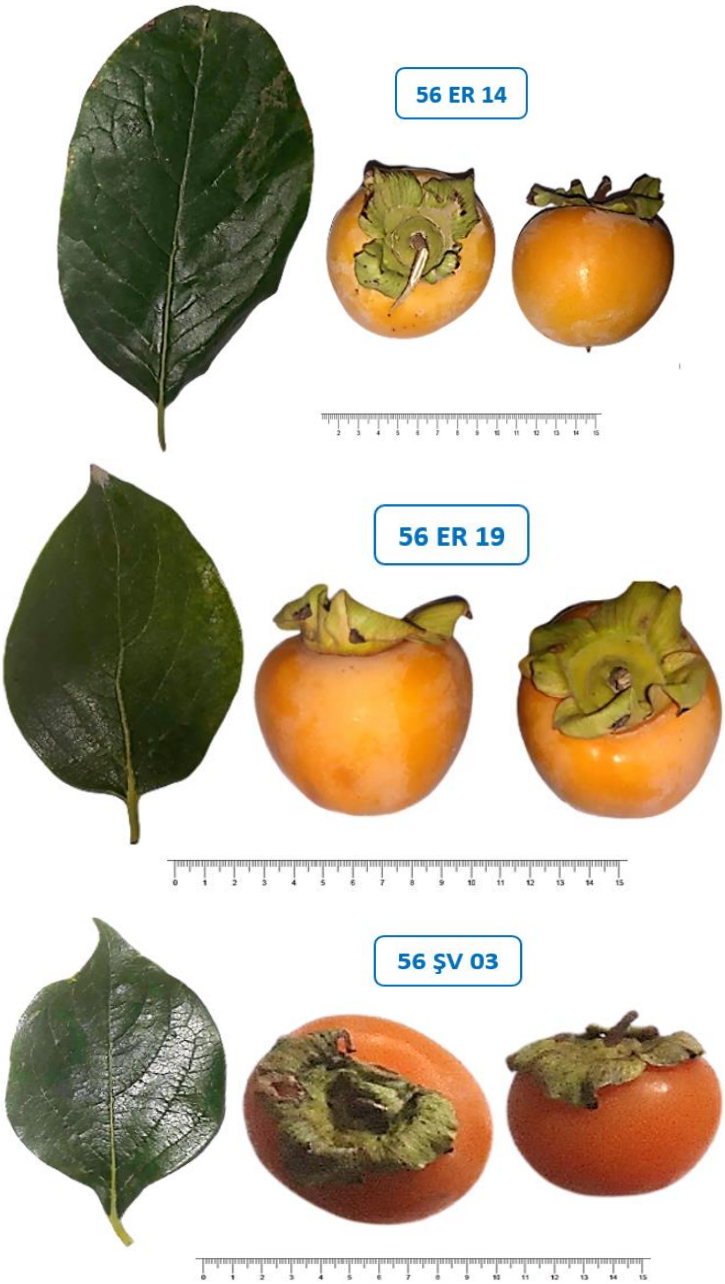

Figure 1. Prominent genotypes at the end of weighted grading (continued).

Descriptive statistics and comparison results of the genotypes included in the study for the characteristics mentioned are given in Table 18. As seen in the table, the differences between genotypes in terms of all traits were found to be statistically significant ($p<0.01$).

Table 18. Descriptive statistics and comparison results by genotypes for traits.

Genotype	Fruit weight	Fruit size	Fruit width	Fruit volume	SSC
	Mean ± S Error	**Mean ± S Error**	**Mean ± S Error**	**Mean ± S Error**	**Mean ± S Error**
56 ER 01	156.92 ± 7.19 bc	63.52 ± 0.69 bcd	57.92 ± 0.62 bcd	130.75 ± 8.37 bcde	20.35 ± 0.71 abcdef
56 ER 02	164.06 ± 3.60 b	65.08 ± 0.93 ab	58.87 ± 1.13 bcd	144.70 ± 5.68 b	17.50 ± 0.60 jk
56 ER 03	157.16 ± 2.73 bc	64.32 ± 0.25 abc	58.74 ± 0.58 bcd	134.90 ± 2.87 bcd	22.00 ± 0.68 abc
56 ER 04	150.29 ± 4.17 bc	61.39 ± 0.64 bcdef	59.04 ± 1.05 bcd	124.90 ± 5.45 cedf	17.93 ± 0.48 hijk
56 ER 05	194.90 ± 3.39 a	67.43 ± 0.96 a	62.81 ± 1.31 a	185.90 ± 7.48 a	19.60 ± 0.60 efghij
56 ER 06	82.30 ± 0.91 j	49.76 ± 2.53 jk	42.04 ± 1.54 h	63.10 ± 3.43 no	22.50 ± 1.00 a
56 ER 07	156.25 ± 1.05 bc	63.28 ± 0.88 bcd	58.14 ± 0.72 bcd	128.00 ± 1.52 cde	18.00 ± 0.82 ghijk
56 ER 08	118.87 ± 3.11 ef	55.91 ± 0.43 gh	51.73 ± 0.86 f	100.75 ± 4.55 ijk	19.60 ± 0.64 efghijk
56 ER 09	89.42 ± 3.05 ij	47.27 ± 1.35 k	44.89 ± 1.33 gh	73.75 ± 2.62 mn	21.70 ± 0.58 abcde
56 ER 10	163.87 ± 1.62 b	63.65 ± 0.79 bcd	58.43 ± 0.74 bcd	138.75 ± 2.44 bc	19.65 ± 0.73 defghij
56 ER 11	105.42 ± 2.37 gh	51.87 ± 1.25 ij	50.72 ± 0.79 f	91.70 ± 1.77 k	17.45 ± 0.56 jk
56 ER 12	130.14 ± 2.52def	60.47 ± 0.70 cdef	56.70 ± 0.26 cd	118.70 ± 5.26 defgh	16.80 ± 0.78 k
56 ER 13	150.72 ± 3.81 bc	62.81 ± 0.78 bcde	58.99 ± 0.43 bcd	123.00 ± 4.66 cdef	18.00 ± 0.32 ghijk
56 ER 14	At 134.55 ± 1.70	59.91 ± 0.40 def	56.73 ± 0.25 cd	114.00 ± 5.95 fghi	20.95 ± 1.07 abcde
56 ER 15	82.15 ± 4.45 j	47.06 ± 1.24 k	45.67 ± 0.71 g	51.00 ± 3.81 o	22.20 ± 0.62 ab
56 ER 16	123.81 ± 2.47 def	62.67 ± 0.59 bcdef	60.90 ± 1.06 ab	97.00 ± 8.12 jkl	20.00 ± 0.52 bcdefgh
56 ER 17	125.43 ± 9.23 def	57.64 ± 1.58 fg	At 55.98 ± 1.59	94.90 ± 4.65 jkl	18.40 ± 0.74 fghijk
56 ER 18	61.68 ± 4.98 k	39.98 ± 3.21 l	36.58 ± 3.21 i	57.10 ± 6.96 o	20.20 ± 0.38 bcdefgh
56 ER 19	100.32 ± 1.32 hi	53.68 ± 0.74 hi	51.68 ± 0.48 f	84.00 ± 1.27 lm	21.90 ± 0.63 abcd
56 ŞV 01	At 131.87 ± 7.78	58.87 ± 1.15 efg	56.50 ± 1.17 cd	121.30 ± 6.42 defg	19.75 ± 0.77 cdefgh
56 ŞV 02	116.94 ± 5.05fg	60.10 ± 0.79 def	57.66 ± 0.91 bcd	105.40 ± 6.47 ghijk	21.95 ± 0.69 abc
56 ŞV 03	126.97 ± 6.41 def	59.86 ± 0.72 def	57.84 ± 0.81 bcd	109.50 ± 3.89 fghij	21.45 ± 0.60 abcde
56 ŞV 04	147.33 ± 5.63 c	63.53 ± 1.44 bcd	60.39 ± 1.43 ab	130.10 ± 6.10 bcde	21.45 ± 0.84 abcde
56 ŞV 05	188.09 ± 6.00 a	67.69 ± 1.04 a	62.65 ± 1.04 a	171.50 ± 7.61 a	17.55 ± 0.32 ijk
56 ŞV 06	125.75 ± 3.73	59.04 ± 1.04 efg	53.05 ± 1.16 ef	104.50 ± 1.99 hijk	20.05 ± 0.67 bcdefgh
P values	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**

As seen in Table 18, the highest value in terms of fruit weight was observed in the genotype of 56 ER 05 with 194.9, while the lowest value was observed in 56 ER 18 with 61.68. Similarly, the highest value in

terms of fruit length was observed in the genotype of 67.69 and 56 ŞV 05, while the lowest value was observed in 39.98 and 56 ER 18.

3. DISCUSSION

According to the results of 2018 data of the researched persimmon genotypes, the bud burst date occurred between April 15-25. The first flowering date of these genotypes occurred between 10 May at the earliest and 19 April at the latest. Full bloom date is May 20th and the latest May 25th; The end of the flowering date was observed between May 26 at the earliest and June 2 at the latest. In previous studies, in the phenological observations of 44 persimmon types selected in the Black Sea Region between 2000 and 2004, the swelling of the eyes started from the beginning of March and continued until the fall of the leaves at the end of November (Akbulut et al., 2004).In his study on the persimmon collection parcel of the Faculty of Agriculture, Çukurova University, Horticulture, the first flowering dates were between 15-18 April. While the full blooming period occurred between 17-21 April, the flowering period occurred between 22 April and 28 April (Sağır, 2013).

It was observed that the persimmon genotypes we examined reached harvest maturity between 1-7 November. Kaplankıran et al. (2008) by determining the ripening dates of the varieties according to the number of days after full flowering; Those that mature before September 15 are very early; Between 16-30 September is early; The ones that mature between October 1-15 are mid-season; Those who came to my skin between 16-30 October were considered late and those who matured

after 1 November were considered too late. The genotypes in this study fall into the very late group according to this evaluation. Some researchers have done different studies to determine the persimmon fruit size. For example, Yamada et al. (1995b) observed that the cultivars in Japan (mid-November) matured a little later than the cultivars in China (early November). Wen (2003), in his research on 16 varieties brought from Japan with 11 local genotypes in Taiwan, found that the Jiro variety matured in early October, while the Fuyu variety matured in early November. Simkhada and Gemma (2005) observed in their study with the persimmon variety in India that the varieties ripen from the beginning of September to the end of October (Jiro-mid-September, Fuyu-early October). Stanciu et al. (2008), in their persimmon adaptation study conducted in Romania between 2003-2007, found that the earliest ripening matured between the varieties Hana Fuyu (September 22) and Sharon (November 7). Yıldız et al. (2004) determined that 117 persimmon types, which may have different characteristics in the province of Hatay and its districts, mature between 8 September and 28 November. Bulk et al. (2009) investigated the phenological and pomological characteristics of 10 different persimmon varieties in Dörtyol-Hatay between 2001-2007. Among these varieties, Amankaki started to mature later than other varieties in September and early October in Hachiya.

The average fruit weight of the studied genotypes varied between 195.87 g (56 ER 05) and 61.67 g (56 ER18). Some researchers have done different studies to determine the fruit weight of persimmon. For

example, Aksu (1995), 115-148.8 g, Collins et al. (1995) found that the Fuyu variety (182 g) and the O'Gosho variety (171 g). Yamada et al. (1995a) determined 152.0 g in the cultivar in Meixian (China) and 221.0 g in the cultivar in Akitsu (Japan). Iwasaki and Yoshida (1996), 139.7 g (Hiratanenashi) vs. 179.5 g (NishimuraWase), Kim and Ko (1997), 44-302 g, Mowat (2003a), 185-263 g, Mowat (2003b), New Zealand 25 weeks after full bloom 192-221 g, Wen (2003), 274 g (Fuyu) and 286 g (Jiro), Japanese varieties found that ranged from 185-388 g. Simkhada and Gemma (2005), (Fuyu) 250 g and (Jiro) 220 g, Zhou et al. (2011), bitter varieties (35.72-339.35 g), non-astringent varieties (24.44-152.76 g), Bratyemez and Ergenoğlu (2000), 300.99 g at eating death, Şeker et al. (2004), 23.10-265.02 g, Yıldız et al. (2004), 61.08 g and 293.27 g, Akbulut et al. (2004) found that it ranged between 109-293 g. Yeşiloğlu et al. (2004), the largest fruits were found in Fenni o (163.41 g) and Hachiya (150.89 g); The smallest fruits have found in Shokaku (133.36 g) values. Yıldız (2005), 58.60 g and 242.02 g, Ercişli (2008), 169 g, Çok et al. (2009), 251 g (Hana Fuyu) to 87 g (September), Özkahraman (1995), 189.49-310.93, Yılmaz (2011), 104.09-263.98 g. In terms of fruit weight, which is one of the important fruit quality criteria, our genotypes were above the average as the lowest values and slightly below the average as the highest values compared to the fruit weight values obtained in similar studies conducted in different regions of our country. In other words, the lower value of 61.67 g in our varieties increased to 192.00 g in the literature data (Mowat, 2003b); It has been determined that the highest value of 195.67 g in our varieties is 388.00

g in the literature (Wen, 2003). This situation is thought to be due to climatic and maintenance conditions.

The average fruit size of the examined persimmon genotypes was between 67.68 mm (56 ŞV 05) and 39.97 mm (56 ER 18). Some researchers have done different studies to determine the persimmon fruit size. For example, Zhou et al. (2011), with 31.90-75.60 mm in biting varieties and 28.20-53.10 mm in non-biting varieties, Özkahraman (1995), 59.25-71.14 mm, Sütyemez ve Ergenoğlu (2000), 63.5-82.3 mm, Yıldız (2005), 43.13 mm. Changes between 70.16 mm, Yılmaz (2011), 40.81 mm (Amankaki), and 75.62 mm (Hachiya) were found. Accordingly, it is seen that the fruit size results we determined in our study are close to the results of the literature.

In our study, the average fruit width varied between 62.81 mm (56 ER 05) and 36.58 mm (56 ER 18). Some researchers made different studies to determine the width of the fruit in persimmon. For example, Zhou et al. (2011) found that between 42.30-93.80 mm in the bitter varieties and 35.10-72.60 mm in non-biting varieties. Özkahraman (1995), 72.28-83.68 mm, Karadeniz and Cangi (2004), 3 weeks after full bloom 24.67 mm, Yıldız (2005), 25.98 mm and 78.84 mm, Yılmaz (2011), 59.26 mm (September) and 83.83 mm (The values between Hana Fuyu) have been found. When looking at the data in these studies, results were found close to the studies conducted in our genotypes in terms of fruit width.

The average fruit shape index of the examined persimmon genotypes ranged from 1.11 mm (56 ER 06 and 56 SV 06) to 1.009 mm (56 SV 03). Some researchers have done different studies to determine the

persimmon fruit shape index. For example, Kim and Ko (1997) reported that 31 different persimmon varieties of Japanese origin and 110 Korean origins have a fruit shape index of 0.6-1.5. Zhou et al. (2011) found that a total of 46 different persimmon dates, 32 bitters and 14 non-biters in China, varied from 0.66 to 1.19 in bitter varieties and from 0.66 to 0.87 in non-bituminous varieties. Yıldız et al. (2004) found the fruit shape index between 0.39 and 1.45, while in another study by Yıldız (2005) it found 0.39.Yılmaz (2011) found the values of 0.95 (Hachiya) and 1.50 (Jiro). It showed similar results with previous studies.

The average seed number of the researched genotypes varied between 0.00-3.9 (56 ER 18). In previous studies, Iwasaki and Yoshida (1996) found the average number of seeds between 0.0 (Hiratanenashi) and 6.2 (NishimuraWase), while Kim and Ko (1997) found it between 0.0-7.4. Akbulut et al. (2004), 3-6, Tangu et al. (2004) found the number of seeds in the range of 0.00 (Seedless Mardan and Persimmon Seedless) to 6.4 (Fuyu) in their research in the Marmara region. Yeşiloğlu et al. (2004), 0.27-2.36, Yıldız et al. (2004) found that between 0.00 and 9.30 pieces, Yıldız (2005), 0.00 and 6.28 pieces, Yılmaz (2011), 0.00 (Amankaki) and 3.65 pieces/fruit (Fuyu). According to this situation, it is seen that the results of the average number of seeds we determined in our study are close to the studies conducted in the maintenance.

The average amount of water-soluble matter of the investigated genotypes ranged from 17% (56 ER 12) to 22.5% (56 ER 06). Some researchers have done different studies to determine the persimmon

SSC. For example; Yamada et al. (1995a) found the amount of SSC in the variety in Meixian (China) 16.9% and 17.2% in the variety in Akitsu (Japan). Yamada et al. (1995b) identified cultivars in Akitsu (Japan) (16.8%) and cultivars in China (17.7%), while Iwasaki and Yoshida (1996) found 14.0% (NishimuraWase) and 19.2% (Tonewase) in their study in Japan. has found between.Kim and Ko (1997), 12.7-22.0%, Bi et al. (1999), Cilang, Fuyu and Chansilang varieties 14.23%, 13.85% and 15.27%, respectively, Mowat (2003b), 12.2-12.8%, Simkhada and Gemma (2005), 14.5% in Jiro variety, 16.0% in Fuyu variety, Zhou and arc. (2011), bitter varieties (from 11.11% to 21.15%) and non-biting varieties (from 13.19% to 24.76%), Özkahraman (1995), 14.83-18.83%, Üstün et al. (1997), 14-18.9%, Akbulut et al. (2004), 13.9-18.6%, Karadeniz and Cangi (2004), 18.45%, Tangu et al. (2004), 20.02% (Hachiya) and 15.34% (Moralı), Yeşiloğlu et al. (2004), the highest SÇKM; Hachiya (18.91%), Hana Fuyu (17.13%) and O'Gosho (17.12%); the lowest, Fenni o (16.47%) and Shokaku (16.60%), Yıldız et al. (2004), 7.20-23.40%, Yıldız (2005) showed a change of 7.70% and 22.60%. When we compare the amount of SSCM in our study with the literature, it is seen that the highest value is close to the average, while the lowest value is above the average. It is thought that this situation may have resulted from the time of harvest or the time until analysis.

The average titratable acid content of the studied genotypes ranged from 0.1% (56 ER 08) to 0.5% (56 ER 02, 56 ER 15, 56 SV 05).Some researchers have done different studies to determine the fruit weight of

persimmon. For example; Zhou et al. (2011) conducted a study on 46 different persimmon varieties, 32 bitters, and 14 non-biters in China. has found that it has changed much.Özkahraman (1995) found it between 0.1190-0.2006% in his study on persimmon in Ünye district of Ordu, while Üstün et al. (1997) found 0.06-0.014%. Akbulut et al. (2004) found it to be between 0.07-0.31 g / 100ml in his study in Samsun between 2000 and 2004. Karadeniz and Cangi (2004) found the acid value of TE 0.164% in their study on persimmon in Ordu between 1997-1998, while Yıldız (2005) determined it between 0.055% and 0.296%. Yılmaz (2011) found these values of 0.133% (Jiro) and 0.445% (Hachiya) persimmon varieties. Our results regarding TEA are similar to other results in the literature.

The total dry matter amount of the genotypes we investigated ranged from 30.125% (56 ER 08) to 18.155% (56 ER 11) (Table 4.2). Some researchers have done different studies to determine the total dry matter amount of persimmon. For example; Herrman (1994), 17-21%, Aksu et al. (1994), average values of bitter, bitter-seedless, and non-biting fruit types, respectively; 20.69%; 23.35; It detected 18.67. The results of our study have shown similar results to those in the literature.

The pH amounts of the investigated persimmon genotypes varied between 6.74 (56 ER 05) and 5.55 (56 ER 16). Some researchers have done different studies to determine the fruit weight of persimmon. For example; Üstün et al. (1997), the pH value varies between 5.90-6.42, Karadeniz, and Cangi (2004), pH 5.45, Yıldız (2005), pH 5.46, and 6.53. Our study results were found close to the results of the study.

4. CONCLUSION AND RECOMMENDATIONS

The data obtained from this study carried out in 2017-2018 to reveal the fruit and tree characteristics of the 25 persimmon genotypes that grow naturally in the village of Pirinçli in Siirt province Eruh district and Şirvan district were evaluated in general. Generally, these genotypes consist of trees located on the roadside, in the fields and gardens, and without cultural processes. Persimmon genotypes are grown here usually become eating after being softened after harvest.

The results of our study were similar to the results of previous studies. However, it is thought that the differences that have occurred may be due to ecological and genotypic differences, as well as the time of harvest or the time until analysis.

With this study carried out in Siirt conditions, it was aimed to determine the yield and pomological characteristics and some plant characteristics of persimmon genotypes that could adapt to the ecological conditions in the region. There is no persimmon cover garden in the Siirt region. Generally, it is aimed to give information about the existence and potential of persimmon and to close the literature gap on this subject.

It is important that the persimmon genotypes included in the research have a high tendency to parthenocarpy and they are preferred by producers and consumers thanks to this feature.

As a result of the evaluations made on the persimmon genotypes, which are cultivated in Siirt and its surroundings and considered as research material, the selection was made for the 56 ER 05 and 56 ER 01

genotypes, which received high scores based on fruit weight, fruit shell and flesh color, seed number and SSCM characteristics in the maturity period. It is superior in terms of other genotypes. While the determined genotypes can be used as a material in future breeding studies, they will also give an idea to growers to produce genotypes with good fruit characteristics.

Considering that the trees are generally grown in unprotected gardens to meet the fruit needs of the house, it is thought that the persimmon genotypes in the study cannot fully reveal their true morphological characteristics and the potential of the fruits, and these genotypes can yield more successful results if better maintenance conditions are established.

Persimmon trees did not differ in average yield each year. Therefore, periodicity was not observed in persimmon genotypes in the Siirt region.

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CHAPTER 3

ECOSYSTEM SERVICE

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INTRODUCTION

Agriculture is currently facing one of the greatest challenges of our time, namely the production of sufficient high-quality nutritious food, while reducing external reactive chemical inputs and minimizing disservices to the agroecosystem. Energy- and chemical-intensive conventional agriculture can contribute to high crop productivity, but with its excessive use of pesticides and chemical fertilizers, agricultural production practices have adverse environmental impacts by reducing biodiversity and efficiency, accelerating water pollution and eutrophication, and degrading soil health (Geiger et al., 2010; Bender et al., 2016, Celik and Baran, 2018).

Healthy and balanced soils provide the essential framework for the production of healthy food. The quality and production of food is dependent on reliable sources of essential nutrients, water, and root support for soil planning. A healthy soil, while reducing environmental impacts, can increase farm productivity and income (Vinayak and Islam 2017).

1. SERVICE of ECOSYSTEM

Agroecosystems supply us with food, forage, energy, food and pharmaceuticals and other essentials for human well-being. Natural ecosystem services, including pollination, diversity and bio-control, soil balancing, fertility and nutrient cycling, and hydrological services, are used for these systems. Preliminary evaluations have shown that the

value of these ecosystem services to agriculture is enormous and often underappreciated or ignored.

A variety of ecosystem services are manufactured by Agroecosystems, such as soil and water quality regulation, carbon sequestration, biodiversity support and cultural services. Depending on management practices, agriculture can be the source of numerous disservices, including loss of wildlife habitat, nutrient runoff, sedimentation of waterways, greenhouse gas emissions, and pesticide toxicity of humans and non-targeted species. In terms of spatial and temporal scales and reversibility, the tradeoffs which may occur between provisioning services and other ecosystem services and disservices should be assessed. The potential for 'win-win' scenarios increases as more efficient methods for valuing ecosystem services become available. Sustainable agricultural management practices are critical in all scenarios in order to realize the much-needed benefits of ecosystem services and to reduce disservices arising from agricultural activities. Agroecosystems are ecosystem service providers as well as consumers (Figure 1).

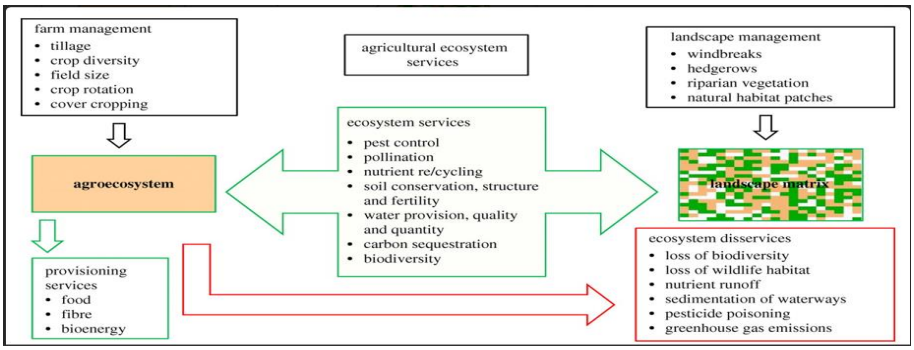

Figure-1. Impacts on the flow of ecosystem services and disservices to and from agro-ecosystems by farm management and landscape management (Power, 2010).

These systems are of human value, primarily for their provision of services, and these highly managed ecosystems are intended to provide us with food, forage, feed, fibre, energy and pharmaceutical products. Agroecosystems, in turn, rely heavily on a suite of ecosystem services provided by unmanaged, natural ecosystems. Support services include genetic biodiversity for use in livestock and breeding crops, soil formation and structure, cycling of fertility and nutrients, and provision of access to fresh water. Agriculture may be provided with regulatory services by pollinators and natural enemies who move from natural vegetation into agro-ecosystems. In active plant growth phases, natural ecosystems can clean their water and regulate its flow into agricultural systems, providing adequate amounts (Power, 2010).

1.1. Agriculture-flowing ecosystem services

The production of agricultural goods is highly dependent on the services provided to agricultural enterprises by various living and non-living components of natural ecosystems, but only recently have attempts been made to estimate the value of many of those services. Some services are quantified more easily than others, to the extent that they are vital to crop production or directly replace or complement purchased chemical inputs (Power, 2010).

1.1.1. Controlling biological pests

One of the important services often supported by natural ecosystems is bio-control in agro-ecosystems. The habitat and various food resources required for arthropod predators and parasitoids, insectivorous birds

and bats, and microbial pathogens are provided by non-crop habitats that act as natural enemies of farm animals and provide biological control services in agroecosystems (Tscharntke et al. 2005; Power, 2010). Such biological control systems can reduce the number of pathogens and reduce the need for pesticides (Power, 2010).

1.1.2. The Pollinating

Pollination is another significant agricultural ecosystem service provided by natural habitats in agricultural landscapes. Approximately 65% of plant species require insect and animal pollination, and an analysis of data from 200 countries showed that 75% of crop species of global importance for food production rely on animal pollination, primarily insect pollination (Klein et al. 2007; Power, 2010). More than 40 percent of the largest animal-pollinated crops depend on wild pollinators, often in addition to domesticated honeybees. Animal pollinated crops account for only 35-40 percent of the total volume of food crop production, but cereal crops do not typically depend on animal pollination (Power, 2010).

1.1.3. Quantity of water and quality

An essential ecological service provided by agro-ecosystems is the provision of sufficient quantities of fresh and clean water, and agriculture accounts for about 70 percent of global water use (FAO 2003). In natural ecosystems such as forests, perennial vegetation can control the capture, infiltration, retention and flow of water across the landscape. The plant community plays a central role in regulating water

flow by retaining soil, modifying soil structure and producing litter. Forest soils tend to have a higher infiltration rate than other soils, and while retaining base flows, forests tend to reduce peak flows and floods (Maes et al. 2009). Through hydraulic lift and vertical uplifting, deep rooting species can improve both water and nutrient availability to others in ecosystems. Furthermore, soil erosion rates are generally low, leading to good water quality. Except for this generalization, fast-growing forest planting may help to regulate groundwater recharge and flow, but they can reduce stream flow and salinize or acidify some soils (Jackson et al. 2005). The availability of water in agroecosystems depends not only on infiltration and flow, but also on the other type of ecosystem service, soil moisture retention capacity. While the world's supply of surface water and groundwater inputs to agriculture via irrigation is essential, 80% of the use of agricultural water comes from soil-storage rainfall (Molden, 2007; Power, 2010).

1.1.4. Structure and fertility of soil

Soil structure and fertility provide essential services to agroecosystems (Zhang et al. 2007; Power, 2010). Well-drained soils with a high content of organic matter are fundamental to the acquisition of nutrients by crops as well as the retention of water. Soil pore structure, organic matter aggregation and decomposition are affected by the activities of microbes and other invertebrates. Through decomposition of detritus and plant residues and by N-fixation, micro-organisms mediate nutrient availability. While conventional agricultural practices degrade soil structures and affect microbial communities, by reducing soil erosion

and runoff, sustainable management practices can protect the soil. By minimizing the loss of nutrients and keeping them available for crops, conservation measures can maintain soil fertility. Cover crops facilitate soil and nutrient retention between rotation cycles on the farm, while erosion and runoff between fields are reduced by hedgerows and riparian vegetation. The incorporation of crop residues can preserve organic soil matter, which helps to retain water and provide crops with nutrients. Together, these practices maintain a suite of soil-based agricultural ecosystem services (Power, 2010).

1.1.5. Landscape impacts on the provision of ecosystem services to agriculture

The delivery of agricultural ecosystem services depends heavily on the nature and structure of the landscape in which the agroecosystem is located. From structurally simple landscapes dominated by one or two cropping systems to complex mosaics of various cropping systems embedded in the matrix of natural habitats, agricultural landscapes span a continuum. Water delivery to agroecosystems depends on flow patterns throughout the landscape and can be affected by irrigation withdrawals and simplification of the landscape. Diversion to other uses in the landscape or watershed, such as domestic, industrial or energy consumption, also affects the provision of water. The movement of organisms across the agricultural landscape is crucial to both natural bio-control and pollination services, and the spatial structure of the landscape therefore strongly influences the magnitude of these services

to agricultural ecosystems (Tscharntke et al. 2005; Kremen et al. 2007; Power, 2010).

1.2. Ecosystem services and disservices from agriculture

Agroecosystems are essential sources of provisioning services and are readily measured using standard market analysis to measure the values of the products they provide (Power, 2010). Depending on their structure and management, a number of other services contribute to the agroecosystem (MEA 2005). Some of the same supporting services as described above may be provided by ecosystem processes and properties operating within agricultural systems. In addition, biodiversity can be supported by agricultural systems and carbon sequestration can be increased (Power 2010).

1.2.1. Agriculture's Ecosystem Disservices

Agriculture may contribute to the services of the ecosystem, but may also be a source of disservices (Dale & Polasky 2007; Zhang et al. 2007; Power 2010). But there is often a mismatch between the benefits accruing to the agricultural sector and the costs typically borne by society at different scales, from local communities affected by pesticides in drinking water to ordinary communities affected by global warming. There is a potential to reduce these negative environmental consequences of agricultural practices by linking these disservices more closely to agricultural activities through the incorporation of externalities into production costs.

1.2.1.1. Cycling and polluting nutrients:

The most essential nutrient for plant growth is nitrogen (N), but excess N adversely affects the environment, namely through leaching of nitrate (NO3) and emissions of nitrous oxide (N2O). Agricultural activity is recognized as one of the factors contributing to the contamination of groundwater by diffuse sources of NO3 (Ledoux et al., 2007) and N2O emissions are estimated to account for more than 75% of total global anthropogenic N2O emissions (Isermann, 1994; Stehfest & Bouwman, 2006; Marie et al., 2015).

Agriculture has profound implications for ecosystem biogeochemical cycles and nutrient availability (Vitousek et al. 1997; Galloway et al. 2004; Power 2010). In natural and agricultural ecosystems, the two nutrients which most restrict biological production are N and P. The concentration of reactive nitrogen and phosphorus in the biosphere was greatly increased by N and P fertilizers and had long-term negative effects on natural ecosystems (Vitousek et al. 1997; Power 2010) and public health. Approximately 20% of post-applied N fertilizers enter aquatic ecosystems and have an impact on the quality of ecosystems (Galloway et al. 2004; Bouwman et al. 2009; Power 2010).

Soil nutrient pools need to be managed to supply crops at the right time, while minimizing reactive nutrient losses, in order to maintain ecosystem services (Drinkwater & Snapp 2007; Power 2010). Plant and microbial assimilation of N is improved by management practices such as cover cropping or intercropping. Diversifying nutrient sources, legume cover crops for biological N fixation and P solubilizing

properties and diversifying crop rotations are additional management practices. The need for reactive nutrient applications in agriculture could be reduced by the integrated management of biogeochemical processes which regulate C-N-P cycling (Drinkwater & Snapp 2007; Power 2010).

Ecosystem disservices from agriculture, on the other hand, include applications of reactive cheicals that result in biodiversity loss and efficiency and contamination of surface and groundwater. In addition, agriculture modifies the plant community's species diversity and root structure, the accumulation of litter, the extent and timing of plant cover and the composition of the biotic community of the soil, all of which affect the infiltration of water and the retention of moisture. In any agricultural landscape, the intensity of agricultural production and management practices affects both the quantity and the quality of water.

1.2.1.2. Greenhouse Gas Emissions

It is estimated that agricultural activities are responsible for 12-14 percent of global anthropogenic greenhouse gas emissions, not including land clearing emissions (US-EPA 2006; IPCC 2007). Land-use change is the second largest global source of CO2 emissions after fossil fuel combustion. Much of this shift is driven by the conversion of land use to agriculture, largely in developing countries. Conversion of natural ecosystems to highly managed agriculture decreases the soil carbon pool by 30-50 percent over 50-100 years in temperate regions and 50-75 percent over 20-50 years in the tropics (Lal 2008a), in addition to losses of above-ground carbon due to deforestation or other

land clearing (Sakin et al. 2018). Although very large CO2 fluxes are generated by agricultural systems to and from the atmosphere, the net flux appears to be small. However, both the magnitude of emissions and the relative significance of the various sources vary widely across the world's agricultural systems. Approximately 49 percent of global methane (CH4) anthropogenic emissions and 66 percent of global annual N2O emissions are attributed to agricultural practices of high input production (FAO 2003). Naturally, N2O emissions occur as part of the soil N cycle, but the application of N to crops can significantly increase the rate of emissions, especially when more N than can be absorbed by plants is applied. Through the use of inorganic fertilizers, the application of animal manure, the cultivation of nitrogen-fixing plants and the retention of residues from crops, N is added to soils.

1.2.1.3. Services for ecosystems from agriculture

Ecosystem services provided by agriculture can be significantly enhanced by on-farm management practices. Farmers routinely use inputs and practices to increase yields to manage higher provisioning services, but management practices can also improve other ecosystem services, such as pollination, bio-control, soil fertility and structure, water regulation and biodiversity support. Habitat management can provide the necessary resources for pollinators or natural enemies within the agro-ecosystem (Tscharntke et al. 2005). The important role of perennial vegetation in supporting biodiversity in general and beneficial organisms in particular has been identified in many studies (Perfecto & Vandermeer 2008). Evidence suggests that management

systems that emphasize crop diversity by using polycultures, cover crops, crop rotations, and agroforestry can often reduce the abundance of insect pests that specialize in a particular crop, while providing natural enemies with refuge and alternative prey (Andow 1991; Power 2010). Wild pollinators, including minimal pesticide use, no-till systems and crop rotations with mass-flowering crops, may benefit from similar practices. Greenhouse Gas Emission Mitigation (Power 2010).

Agricultural practices through a variety of processes can effectively reduce or compensate for greenhouse gas emissions (Drinkwater and Snapp 2007; Lal 2008a; Smith et al. 2008). Effective management of manure can reduce CH4 emissions from animal waste significantly. It can reduce CO2 emissions from agricultural production by replacing chemical N fertilizers with biological N fixation by legumes (Drinkwater & Snapp 2007; Power 2010). By increasing capacity for C uptake and storage in soils, i.e., agriculture can compensate for greenhouse gas emissions. C sequestration (Lal 2008 a,b; Power 2010). A balance between C loss from land-use conversion and land-management practices and C gain from plant growth and sequestration of decomposed plant residues in soils is the net flux of CO2 between the soil and the atmosphere. Soil conservation measures such as conservation tillage and no-till cultivation can in particular, conserve soil C, and crop rotations and crop cover can reduce subsurface C degradation. Water management and erosion control can generally assist in the maintenance of soil organic carbon (Lal 2008a). Thus, soil

carbon sequestration provides agriculture itself with additional ecosystem services by preserving soil structure and fertility, improving soil quality, increasing the efficiency of agronomic inputs, and improving water quality through pollutant filtration and denaturation (Lal 2008b; Smith et al. 2008). To achieve higher productivity and lower costs, many farmers have already adopted practices that retain soil C. However, soil carbon lost through conversion to agriculture can not be fully restored even by the use of soil conservation and restoration practices (Power 2010).

1.3. Soil Biodiversity Engineering for Ecosystem Sustainability

Strong interventions in natural processes are necessary to maximize benefits from ecosystems. It has become apparent that the 'green revolution' in developed countries has reached its limits for further yield increases (Mann, 1999) and the adverse effects of land management appear to exceed the earth's capacity (Steffen, 2015). Foley et al. (2011) emphasized that to meet the challenges of food security and environmental sustainability, agriculture requires novel and holistic approaches. A fresh approach based on integrating knowledge into the management of ecosystems on how biological systems and biodiversity work (Bender et al 2015). They need to go a step beyond generic relationships between biodiversity and function. A targeted approach to soil biological engineering is therefore required to improve the functioning and services of ecosystems (Bender et al 2015).

Management strategies must be applied at multiple scales to achieve maximum effects, from soil and plant community to plant genetic and rhizosphere microbiome management (Figure 2). These strategies can be categorized as untargeted strategies for improving general soil biodiversity and targeted manipulations of the composition of the soil community in order to specifically affect certain ecosystem processes that are beneficial over time for sustainable food production.

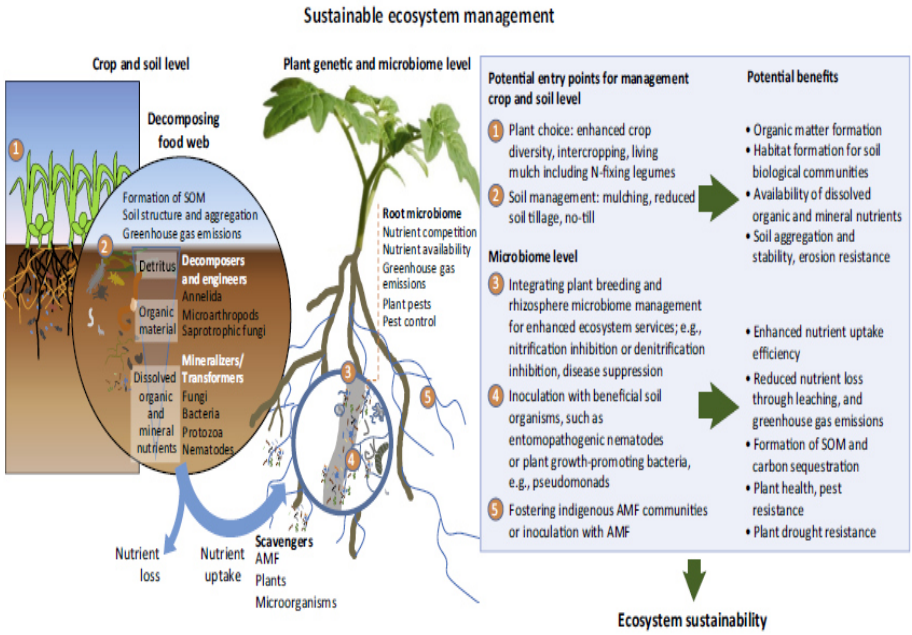

Figure-2. Summary of different approaches from a Soil Ecological Perspective for local ecosystem management. Entry points involve management of crops, soil, and microbiomes. Numbers in orange circles indicate possible ecosystem management entry points (Bender et al 2015).

2. CONCLUSIONS

Agricultural systems provide services to the ecosystem that are essential for human well-being. A range of other ecosystem services, including regulatory services and services that support provisioning, are also provided and consumed by them. Maximizing the provisioning of agroecosystem services may result in tradeoffs with other ecosystem services, but these tradeoffs can be substantially reduced or even eliminated by thoughtful management. The practices of agricultural management are key to the realization of the benefits of ecosystem services and the reduction of disservices arising from agricultural activities. In the face of climate change, these challenges will be magnified, but there have been several recent advances in our ability to estimate the value of different agricultural-related ecosystem services and to analyze the potential to minimize tradeoffs and maximize synergies. Future research will have to address these challenges in explicit spatial and temporal frameworks (Power, 2010).

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CHAPTER 4

THERMOGRAPHIC APPROACH IN PRECISION LIVESTOCK FARMING

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INTRODUCTION

Let's start to this chapter with a question What is Precision Livestock Farming in animal husbandry?

These are the procedures applied to protect and improve the production, health and welfare of the herd with continuous automated control and monitoring techniques. It is a livestock management system that predicts important events such as diseases before they happen and ensures that necessary measures are taken. This chapter is aimed to give information within the scope of novel technologies for animal husbandry applications in precision agriculture, especially related to the image technology based on thermography.

In recent years, there have been new expansions and developments in image processing systems, techniques and applications. One of the possibilities in these visual applications is that measurements can be made from the pictures taken. Machine vision applications made with electronic systems are increasingly used in the industrial field. Non-contact analysis of objects is more preferred than other methods because damage or change may occur on the object to be measured in contact.

Computer vision can be described as the process of revealing and evaluating the positions, dimensions or different features of the images or objects on the picture by an algorithmic program. Digital image analysis and image processing have some differences in practice. The main difference of the analysis process is that without obtaining a new

image as a result of the processes, classifications or measurements of the image are made, and statistics are produced about the image. In image analysis, the parameters of objects (shape, length, area, angle, grey-tone and colour values, etc.) are measured.

1. DIGITAL CAMERAS

Unlike film cameras that produce analog images, digital cameras are an electronic device with an optical element that converts image signals that can be processed in a computer environment into digital form. Digital cameras are widely used in close-up photogrammetry and computer image processing and analysis applications (measurement of architectural objects, close-range mapping, engineering applications and space industry, etc.). Digital cameras use CCD and CMOS detectors as the image recording plane. Thanks to these detectors, the image is recorded in digital form. And it also facilitates image processing operations on the image taken. From a photogrammetric perspective, digital cameras are called non-metric cameras, because the internal orientation elements are not known partially or completely and there are no frame marks on the image. Some systematic distortions that affect the metric quality of the images, such as lens distortion, receiver (sensor) plane deformation and electronic transfer errors, occur in these cameras. These errors need to be identified and corrected. In order to determine the measurement accuracy with a digital camera, distortion and other parameters should be taken into account in a broad sense. The reason why such cameras are widely preferred is that the images can be directly transferred to the computer environment (data storage

convenience-portability) and can be directly processed in the computer environment.

2. CAMERA CALIBRATION

In order to obtain three-dimensional information from photographs, i.e. two-dimensional images, certain conditions must be met. It is necessary to know some variables specific to each method (such as camera calibration variables or lighting conditions) in order to make three-dimensional measurements. In addition, most techniques require the same object to be viewed from at least two different angles.

Camera calibration process is performed to determine the internal geometric and optical characteristics of the camera and / or its 3-dimensional position and its angular position and metric potentials according to the specific coordinate system, to check and correct systematic errors in these systems. Calibration of a picture taking machine can also be expressed as the inverse of photogrammetric point determination. Photogrammetry is a science that aims to determine the shape, dimensions and position of the object in space by using one or more pictures. In the photogrammetric point determination, internal guiding elements are known and the coordinates of the object points are found. In calibration, the coordinates of the object points are known and there are internal guiding elements.

The lenses of the camera (camera) have some physical properties. The physical effects of lenses in projection are commonly referred to as distortion. The effect of distortion on the picture plane, which is the

picture coordinate system, is determined by camera calibration. In the cholinary (linearity) condition, the use of linear transformation parameters is provided and the distortion can be corrected by finding it with calibration. This distortion can be of two kinds.

Radial Distortion; If the image of an off-axis target is displaced radially either far or close from the main point, the image is radially distorted.

Tangential Distortion; Since all the elements of the lenses that make up the multi-lens system used in picture taking machines are not formed on the same line, the lens centres are not located on the same line and special attention should be paid to this during the fabrication phase. Deviation from the direction will cause a geometric displacement called tangent distortion in the picture.

There are a wide variety of camera calibration methods available in the literature. These can be listed as linear, nonlinear and multi-step techniques. The linear method is faster than others and also does not require iteration. But its accuracy is low because the camera model needs to be simplified (Taşdemir et al., 2009).

3. DIGITAL IMAGE PROCESSING

Digital image processing method; obtaining correct descriptive values, fast and being objective, saving people from tedious and time-consuming processes, being stable, effective and low-cost, being automatable of many processes requiring high cost labour, allowing the analysis of objects often without distortion, storing data in a way that

allows continuous and post-analysis. It can be said that it can be used as an alternative method with its advantages (Aktan, 2004a).

Today, appearance features are used as an important selection criterion in all countries where the breeding program is applied. One of the main tasks of animal breeding is to evaluate the appearance characteristics of animals. In order to achieve the desired improvement from body features, the method used to measure and evaluate these features should be practical, as objectively comparable as possible, fast and computer-assisted.

Many processes, which were difficult and time consuming until recently, have gained the characteristics of simple and less time-consuming applications with the help of developing especially computer-based technologies. Among these applications, Digital Image Process and Digital Image Analysis methods, which are based on space research, have started to take place in the field of animal husbandry as in many other fields in recent years.

The definition of Image Processing Systems is hardware and software combinations that enable the examination and evaluation of the object or objects of interest, such as colour and reflection, and geometric properties such as length, width and height.

The most powerful feature of advanced software is the colour and dimensional recognition of shapes. For shape analysis, especially in microscopic evaluation, certain objects can be marked with a mouse on the screen, one by one or automatically by overlaying. The registration

process includes measurements of diameter, circumference, area, width and length, and roundness and bending measurements. Position analysis includes the processes of determining the distance of a certain object or point on the image from another reference point, the settlement angle relative to this point or the horizontal / vertical settlement situation. Statistical analysis includes length, area, etc. on pixels or objects within a selected area of interest. It consists of determining average, standard deviation, minimum and maximum values for any measurement type, frequency analysis and histogram drawing. In this software, it is desirable to be able to take measurements in metric or inch measurement units with precision from micron to millimetre.

In parallel with the developments in computer technology, it has production period, storage and pre-consumption health and quality inspections, examination of growth and development, determination of morphological characteristics, evaluation, grading or standardization of animal products according to colour characteristics. It is also possible to use it in determining body development and growth by examining the dimensions and shape. If such a system is used, grouping animals according to their developmental status, making separate care and feeding practices for the grouped animals is not only necessary for business economics, but also for scientific studies examining the growth event (Cebeci et al., 1992). If there is sufficient contrast between the ground and the object of interest, it can be done automatically or manually. (Sezenler et al., 2009)

Two methods were used to take body measurements. In the first method, which is defined as the classical or traditional method, body measurements were taken using measurement tools known as a measuring stick, measuring calliper and measuring tape.

In the second method, the data were obtained by Digital Image Processing Method. Digital video camera was used for this purpose (Özder ve Önal, 2008; Önal et al. 2008). Within the scope of the method; 2 pieces of 5MW power, 532 nm, parallel to the focal point of the camera during shooting (wavelength) and green laser beam emitted. Laser wavelength and power have been selected in accordance with international standards and animal welfare standards. The distance between the two laser points has been fixed at 38 cm both at the origin and destination. In order to apply this method, the animals were passed through a narrow passage and continuous recording was made with a video camera.

After the video camera images are transferred to the computer, the most suitable photo images for each animal can be obtained using the Picture Motion Browser, © 2006 software. The photographs obtained were evaluated in the software of Microsystem Image Processing, © 2007, and body measurements were determined. All measurements are measured in cm (centimetres).

In the study conducted by Sezer et al. (2009), the measurement of egg shell color in Japanese quails with image processing technique, with the help of the program prepared using image processing techniques in the Delphi programming language, the average of all pixels belonging to

the area selected from the image was Red, Green and Blue (respectively R, G and B) band densities were determined. Red, Green and Blue values range from 0 to 255, with 0 being the darkest and 255 the lightest tone. These colours are collectible and their combinations produce 2563 different colours. Samples taken from two different regions from each image were examined. These values obtained from the RGB scale were converted to values between 0 and 1 by proportioning 256. Due to the high correlation between RGB values, Hue, Saturation and Lightness (H, S, and L, respectively) were converted to scale values using the following formulas (Foley et al., 1996).

Speckles on the light-coloured surface are the basis of the category classification. Therefore, the ratio of the light-coloured area to the examined area has been calculated. The software used can collectively separate the pixels between the two determined values from the background by scanning the pixels on the picture with the help of RGB based threshold technique. Pixels between threshold values were converted to a colour not found in the eggshell, then these pixels were counted. By proportioning the area of interest to all pixels in the area of interest, the ratio of the light-coloured area over the entire surface was obtained. Japanese quail egg shell colour and speck distribution are fairly constant in females, while females show a high variation.

In this study, colour measurement method of spotted eggs and determination of differences between individuals were investigated. The study shows that the relationships between egg shell colour and colour and other characteristics of the egg can be examined by image

processing technique. This promising differentiation of Japanese quails' eggs with only their colour characteristics also indicates that the differences between females can be made better by adding other egg characteristics to the analysis (Sezer et al. 2009).

In the research conducted by Bozkurt et al. (2006); The beef industry in the world applies research results aiming to benefit from different fattening systems in order to minimize the carcass fat ratio. For this reason, the most important point is the lack of system in classifying cattle according to optimum feeding and marketing groups and carcass qualities before slaughter. Especially in developing countries such as our country, the sale of cattle to the market in small groups as butchers poses an important problem.

For this reason, commercial classification of cattle for slaughtering should be done in slaughterhouses. It is important to know pre-slaughter weight and post-slaughter carcass weight and carcass quality in live animals, and this process takes a lot of time. In order to speed up such processes, some computer aided models and software programs based on these models are required. For this purpose, in this study, it was tried to estimate the live weight and carcass weight and some other carcass characteristics of animals for slaughter with the Digital Image Analysis method which is the latest technique.

In the study of Aktan (2004); It was aimed to determine some internal and external quality characteristics of eggs and their relationships by using digital image analysis in Japanese quail. Shelled egg area, egg width and length, total egg content, outer juicy white, inner dark white

and egg yolk spreading areas were determined from the numerical images of 72 eggs in shell and broken form obtained from an eight-month-old quail herd. In addition, it was tried to determine the color value of egg yolk in RGB color space. A wider variation was observed in terms of external juicy white spreading area and deviation of egg yolk from circular appearance (33.23% and 51.01%, respectively). Correlations were determined between egg weight and internal dark white and yolk spreading area at 0.489 and 0.796 ($P < 0.001$) levels, respectively. In the numerical color analysis of egg yolk, it was concluded that the color tone was determined by the R (red) and G (green) values.

The correlation coefficients calculated between these properties were also found to be statistically significant. it was observed that RGB components were significantly higher in females than males, possibly due to greater fat accumulation under the skin in females, whereas the red component in males did not change in quantity in the breast and abdominal skin area, whereas females were higher in the abdominal skin area. It was concluded that the colour differences between the bruises classified as visually predominantly red, predominantly purple and predominantly green were also significant in terms of the grayscale values of the RGB components, and therefore the differences could be defined numerically and the possible occurrence time and causes of the defined bruises could be predicted.

In the research conducted by Sabuncuoğlu (2006); Ultrasound is widely used in human and animal clinics for diagnosis and treatment. In

addition, studies have been carried out to evaluate the carcass characteristics of live animals with this device since the 1950s. These efforts aim to make progress in genetic breeding programs, meat production and breeding. In this study, some recent research results on ultrasonic imaging in animals raised for meat production are compiled.

Sezer et al. (2009); In terms of animal technology, the variation in eggshell colours is an important external quality feature that affects customer demand. In ecology and behaviour studies, it is important how birds can distinguish their nests and foreign eggs in their nests. In this study, the analysis of shell colour in Japanese quail eggs was made by numerical imaging method. In this method, two photographs of 222 eggs belonging to 15 females were taken with a digital camera and transferred to the computer for analysis. Red, Green and Blue (RGB-Red, Green, Blue) values in the whole of a large section taken from two separate regions of each picture and the ratio of dark coloured spots in the selected area were determined with the help of the threshold technique made on this base. RGB indicator values have been converted to Hue, Saturation and Lightness (HSL) values. Females differed in all traits ($P < 0.01$). The degree of repetition of these characters was determined to be between 0.58 and 0.85. When the distinctive function analysis was made using all of these features, it was found that egg discrimination was achieved among individuals with 78.3% success. The results obtained indicate that the ratio of egg colour and colour area can be used as an individual identity in distinguishing eggs. It is seen that the proposed method has a feature that can be used

in feeding, breeding and selection studies related to quail shell colour and shell colour.

4. LIMITATION OF THERMOGRAPHY

Regardless of the intended use, a number of factors affect the quality and usefulness of any thermogram. These factors can be divided into three categories: test material, environment, and image acquisition and processing. The variables in each of these categories can affect the thermographic image interpretation, so it is important to define and control them. Environmental factors that can affect a thermogram include ambient temperature and stability, air movement such as wind or draft, sunlight, rain, and other weather conditions. Wtermografihgen et al. (2011) identified potential uncertainties in thermogram production and designed a series of algorithms to obtain the most accurate measurements from thermographic images. Image processing improves when thermograms and technically skilled professionals combine. It is also important to develop and maintain a catalog of thermographic images of healthy animals under controlled conditions, to account for the normal variations of thermal patterns in each species.

Many studies have been conducted to investigate how individual animal factors may affect thermography results in healthy animals (Hellebrand et al. 2003; Loughin and Marino 2007). Skin color can also affect thermography readings, for example, black areas in black and white cattle are generally warmer than white areas (Hellebrand et al. 2007). 2003). Similarly, there is a temperature difference between the black and white stripes in zebras (Hellebrand et al. 2003). Black stripes are

warmer than white stripes during the day, possibly because black stripes absorb more solar energy.

However, black stripes are cooler than white stripes at night, which may be the result of differences in emissivity, or a surface releases a thermal energy between black and white stripes (Benesch and Hilsberg, 2003).

Environmental factors affect thermography readings, and some of the most common environmental factors affecting thermography readings are moisture and debris on the subject (Prohit, 2008). In livestock, thermography is frequently applied as a screening tool in field environments where animals are rarely clean and dry. Water or dirt on an animal's hair or skin affects its emissivity (Campbell and Norman, 1998). Wet environmental conditions limit the usefulness of thermography and can affect thermography readings. Church et al. (2014) used fans to investigate the effect of wind on thermography readings obtained from cattle eye. The thermography temperature reading was low at 7 km / h wind speed and even lower at 12 km / h wind speed. In another study, the researchers directed a fan to the distal part of the horses' right forelimb to determine the effect of wind speed on thermography temperature readings. The temperature of the right forelimbs decreased with wind speeds as low as 1.8 km / h and continued to decrease as wind speed increased (Westermann et al., 2013).

Still other researchers suggest that thermography may be the most useful technique for night testing, because the technology is based on the identification of temperature differences, and the temperature

difference between the object and its environment will be highest after sunset (McCafferty et al., 2011). Obviously, this recommendation would be most suitable for thermography performed in animals housed outdoors. Internal factors affecting circulation and thermoregulation also affect thermography temperature readings. The results of a study using thermography to determine the effect of various sedation protocols on superficial temperature regulation in dogs show that administration of medetomidine alone causes a decrease in peripheral skin temperatures (Vainionpää et al., 2013). Another important factor to be considered when interpreting thermographic images is the position of the thermography camera on the subject. In this study, a 17 ° 20 ° change in camera angle or 0.5-m increase in camera distance had no effect on thermography temperature readings. Changes in camera angles <30 ° with respect to the right angle are generally considered to have no effect on thermographic image interpretation; however, Watmough et al. (1970) reported that changes in camera angle with respect to the object significantly affect the emissivity and the detection of temperature measured by thermography.

In the study of Church et al. (2014), the effect of heat transfer and absorption by the intervening atmosphere became more pronounced in the study performed by increasing the thermography camera distance from 0.2 m to 2.0 m in increments of 0.2 m. Given the appropriate algorithm and input such as distance, humidity and ambient temperature, the effect of the environment on thermography temperature readings can be controlled. With the availability of

advanced cameras and software, thermographic images are easier to acquire and interpret. Infrared cameras are mobile and compact, and most newer models can wirelessly transfer images to a remote computer for immediate processing. Some camera models are equipped with audible and visual alerts that can draw the user's attention to a specific area of the subject under consideration, and further viewing and evaluation can be performed to ensure the most useful images to aid accurate diagnosis.

5. THERMOGRAPHY IN EARLY DISEASE DETECTION

Infrared thermography has the potential to be a useful screening method for detecting animals affected by any disease that causes pyroxia or localized inflammation. Infrared thermography can be very useful for use for wild animals that cannot be easily restricted, or for large groups of animals (for example, herds), as it is time consuming to obtain the body temperature of each creature by conventional means. While determining a pathognomonic thermal profile for a disease of one species is difficult, rapid determination of the presence of fever or inflammation can help identify the creature at high risk of becoming ill.

These creatures can then be isolated for additional diagnostic testing and treatment as needed. The following paragraphs describe the use of thermography to detect various diseases and physiological conditions.

Eye temperature measured using thermography is more effective than other areas such as nose, ear, body and hooves in detecting diarrhea in cattle. Similarly, studies with bovine respiratory diseases have clearly

shown that infrared values are much more effective (Schaefer et al., 2007). In such cases, it is possible to use thermography for non-contact and non-destructive detection of early stages of disease in living animals.

6. THERMOGRAPHY IN PREGNANCY

The use of thermography for pregnancy detection has been studied in several genres and has shown varying degrees of success. Infrared thermographic images were obtained from the left and right sides of both pregnant and non-pregnant mares and the evaluation of these images showed that there was a significant temperature difference. The reason for this temperature difference is believed to be due to implantation of the right or left uterine horn of the fetus, which increases local metabolic requirements and leads to an increase in blood flow and temperature detected by thermography (Bowers et al., 2009). Infrared thermography has been used to detect pregnancy in giraffes, zebras and black rhinos, and was used to detect the difference between pregnancy and false pregnancy in pandas (Hilsberg et al., 1997). In contrast, the results of studies involving dogs and cattle showed that thermography is not useful for pregnancy detection (Durrant et al., 2006).

This is probably the result of physiological characteristics unique to these species. Cows have a large, physiologically active rum that covers most of the left breast, possibly preventing temperature changes caused by pregnancy. In general, thermography appears to be useful in detecting pregnancy only in uniparous species and some ruminant

animals. Reproductive efficiency is vital for the livestock industry (Stelletta et al., 2012). Thermography has been used in mares to monitor the oestrus and to describe ovulation.

7. THERMOGRAPHY IN ANIMAL WELFARE

Various studies have been conducted in which thermography has been used to evaluate animal welfare, especially in subjects related to the detection of thermal changes (Ferreira et al. 2011). In horses, thermography-determined eye temperature correlates significantly with both saliva and plasma cortisol concentrations. In sheep, the thermography-determined eye temperature can accurately measure in response to stress 68. However, there are significant differences in the temperature response to stress between species. In another study, injection and operation sites in various horses were evaluated by thermography (Van hoogmoed and Snyder 2002).

8. THERMOGRAPHY IN PRODUCTION

In animal husbandry, well-being is often intertwined with production, and thermography is used for the detection of diseases as well as for the evaluation of treatments to which animals are exposed. Thermography results revealed that various milking machine teat liners were associated with an increase in udder temperature of dairy cows (Paulrud et al., 2005). The results of another study show that proper milking technique is associated with a detectable change in udder temperature (Poikalainen et al., 2016). Infrared thermography can also be used to evaluate meat quality before and after cutting (Schaefer et al., 1989; -

Nanni et al., 2007; Weschenfelder et al., 2013). However, more research is needed to better define how meat quality affects thermography. Feed conversion efficiency is an important parameter in livestock production; Typically, there is a positive correlation between the amount of weight produced per feed unit and economic return. Automatic, remote thermography is useful for serial monitoring of feed intake over time.

9. DISCUSSION AND CONCLUSION

Infrared thermography is a fast, non-contact and non-destructive method used to evaluate surface temperature in veterinary medicine with many diagnostic and screening applications. These properties allow thermography to complement existing methods for diagnosing disease, assessing well-being, or evaluating other conditions or characteristics. When it comes to thermal changes, physiological mechanisms increase and increasing energy expenditure rates increase. In this article, the use of thermography technology in the assessment of disease and welfare forms in animal production is reviewed and case reports on the use of this technology in experimental procedures for the assessment of stress in cattle and poultry are presented. Surface temperature is an important indicator of predicting diseases and physiological conditions of animals. Because infrared thermography is a safe method that can operate non-contact and non-destructively for evaluating surface temperature and its different consequences. For example, eye temperature measurements using thermography have been particularly promising and have become an important component.

Therefore, the advantages of thermographic approach in animal husbandry need to be understood by scientist and the further studies should be conducted with this technology.

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CHAPTER 5:

DEVELOPMENTS IN THE USE OF ELECTRONIC TECHNOLOGIES IN LIVESTOCK FARMING

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INTRODUCTION

Although the information technology has been out of the agriculture sector in our country for many years; In recent years, and especially in developed countries, with the development of information technologies, it has gone through an evolution that is sensitive to humans, plants, animals and the environment, prioritizing quality and productivity factors in production. Technologies called precision farming, which are considered as the continuation of the transition from manpower to animal power and then to tractor power in agricultural production, have also emerged with this evolution process. Considering sensitive agriculture, economy and environmental protection principles; It refers to the use of the developing technologies of the information age by integrating with agricultural production.

By analysing the information obtained in this study and the development of digital image analysis and sound analysis applications in precision agriculture in the following periods, it is thought that determining the level of our country in these applications can provide significant benefits in the evaluation of the country's economy and precision agriculture.

The world population has reached more than seven billion people today. Income levels of BRICS countries have increased significantly. As the world population continues to increase, there has been a trend towards urbanization as countries become richer and income levels have risen. As a result, consumption of animal products such as meat and milk has increased dramatically and will continue to increase day by day.

The sector, which adopts intensive livestock systems to fulfil this task, faces some problems on an industrial scale. Because in the past, farmers who had enough time to observe the health, welfare and production of their animals were under a very high workload due to the significant growth of farms and the increasing number of animals. Because of this situation, farmers cannot find enough time to monitor the health and welfare of their animals. In this case, it causes some disease and welfare problems, especially for animals, and even some disruptions in the organizational sense of farm management and sometimes huge economic losses.

As a result, it is not possible for farmers to continue intensive animal husbandry with traditional methods today and they should be supported with developing technology. Because, as a result of the increasing demand worldwide, more and more animal productions are taking place. In addition to that diseases and epidemics occur on a global scale as a result of the transfer of diseases from animal to animal and from animal to human during this production. Demand for sensitive livestock systems will increase day by day, not only to increase animal production, but also to contribute to reducing the spread of diseases and epidemics on a global scale by keeping the health and welfare of animals under better control.

Precision Livestock Farming (PLF) is a livestock management system that monitors the health, welfare and production of animals in real time and provides a more controlled farm management by informing farmers with instant alerts when necessary (Berckmans, 2004, 2013).

The purpose of this technique is not to replace farmers, veterinarians or zootechnicians, but to support them as they cannot monitor animals 24/7. Sensitive livestock technologies provide unlimited observation time because farmers get tired and sleepy, but computers and technological devices do not get tired and do not need rest.

Sensitive Animal Husbandry is developed by using the technology, which continuously monitors the animal production, health and welfare and its effects on the environment (24/7) using different modelling techniques. It is a livestock management system that predicts important events such as diseases before they happen and ensures that necessary measures are taken.

Sensitive livestock farming systems aim to provide a real time detection and management system. This system differs fundamentally from all other approaches that do not aim to increase the life of animals during evaluation period. It is good to define any issue when the animals arrive at the abattoir, but better than that is to anticipate the issue or disease before it occurs and prevent it from spreading to other animals. At this point, technology can help us. In the management model, which is carried out using the latest developments in technology and sensitive animal husbandry techniques, a real-time warning is provided when any problem occurs and the farmer can intervene immediately.

There is a need for algorithms working in real time that can predict or detect problems while animals are still in the breeding stage. Experts from different disciplines (veterinarians, physiologists, ethologists, engineers, ICT specialists, etc.) are needed to develop these systems.

Because living organisms have complex structure and they are individually different from each other, time dependent and dynamic.

When the primary goal is to establish an early warning system, the first point to be considered is to ensure that animals are monitored without disturbance and contact. Otherwise, animal behaviour will differ. Audio and image processing techniques, which are among the sensitive livestock sensor technologies, can be used to monitor the differences in animal behaviour in real time and to analyse them with relevant algorithms.

1. The Relationship Between Animal Health and Healthy Food

In order to meet intense requirement for animal products such as meat and milk, farmers have switched to intense animal husbandry and have turned to raising more animals. However, this has brought some management and health problems with it. It has become impossible for a farmer or keeper to do this due to the increasing number of animals, who previously knew each animal individually and constantly monitor them. Some animal diseases cannot be diagnosed early and the necessary precautions cannot be taken, on the national economy. The connection between health and welfare of animal and healthy animal foods is clear. When reached to the higher animal health and welfare; the hygiene and quality of meat and other animal foods will be higher.

Recent studies show that HHT systems increase milk yields, improve animal welfare and reduce livestock methane emissions by 30%. With automatic HHT techniques, operators are able to spend more time with

animals and manage larger herds by creating more free time for themselves, as they reduce the time they spend on routine work. In this way, an increase in productivity and a more docile behavior profile is observed in animals.

2. Lameness Detection with Image Processing

Lameness is a definition used for injuries in broilers (Rousing et al., 2000). The emergence of lameness reveals a strong relationship between growth and body weight (Vestergaard and Sanotra 1999; Kestin et al. 2001). Because, broiler chickens reach a slaughter weight of 2.5 kg at the age of 40-42 days due to genetic choices (Narinç et al., 2015). In contrast, conventional broiler chickens take three to four months to reach 2.5 kg (EEC, 1991). As a result of this rapid growth, broilers have a large body weight in a short time, while their skeletal systems cannot develop at the same rate and have difficulty in carrying their body weight (Corr et al.2003). As a result, this rapid growth causes abnormal gait pattern in broilers, higher body weight requires more than a partially growing skeletal system, and causes to anomalous walking behaviour (Corr et al.2003).

So much so, previous studies show that at least 90% of broilers have some degree of walking trouble and about 30% are severely lame. Beside lameness, broiler chickens are severely wrecked by skeletal ailments and economic losses due to these skeletal disorders can be quite high (Cook, 2000).

The first method for detecting walking problems is gait scoring based on observing and evaluated by a trained specialist (Kestin et al. 1992). In this assessment, the expert's assessment is based on parameters such as rolling, tremors, and limping.

However, the resistance to lie down test was developed by (Weeks et al. 2000). The main basis of this test is that broilers with leg problems can survive in shallow water for less time than healthy broilers. As a result of the tests they performed, they found a statistically high relationship between the lying / sitting delay times and walking scores ($P < 0.001$). However, performing this test in commercial broiler farms requires a very high cost and labour force, and since it is a fixed test method, it can only stay in the facility where it is established and cannot be moved to other farms.

Due to these negativities of the method, Berg and Sanotra (2003) made some changes in the lying / sitting delay test This mobile test method, developed by Berg and Sanotra (2003), also revealed a high relationship between walking score and lying / sitting delay time ($P < 0.001$). However, it is not possible in terms of time and workforce to take the chickens one by one in broiler chicken coops that have reached the level of 50 000 heads and to undergo lameness test with the method developed by Berg and Sanotra (2003).

In the same years, it was demonstrated by other researchers that the parameters that allow the recognition of gait anomalies can be determined by computer-assisted analysis (Reiter, 2002). Caplen et al. (2013) and Stover et al. (2015) tried to determine some foot kinematics

of broilers with three-dimensional image processing and pressure sensors. However, it has been shown that these computerized analysis methods have some disadvantages and it is not possible to carry out tests without removing especially the broiler chickens from their natural environment and it is not realistic to conduct individual experiments due to the increasing number of animals.

As a result, it is unlikely that lameness will not be detected early when these methods are used. In addition, it is clear that it is not feasible to be carried out for such a manual test on a large commercial farm with over 50,000 broilers.

Especially in large farms, the number of broilers that can reach 50,000 in a single shelter has made it necessary to use image processing technology to identify lame and sick chickens. Early detection systems equipped with 2D and 3D monitoring technologies together with image processing software provide very successful results in early detection of lameness in broilers.

Image analysis was used in many studies performed for this purpose (Aydin et al.2010, 2013, 2015; Aydin, 2017a & Aydin, 2017b). The mobility levels of thirty broiler chickens with different walking values were monitored with the developed algorithm and compared with the values determined by the experts (Aydin et al.2010).

In the study, it was found that there is a significant relationship between walking values determined by experts and mobility values determined by the system. In addition, chicks with a walking value of 3 were found

to be more active than other broilers. Chickens with a walking score of four and five were found to be less active than other chickens. In summary, the results of this study showed that the automatic camera surveillance system has a high potential for determining the activity levels directly related to the lameness of chickens, and especially chickens with walking values.

However, the main disadvantage of this study is that, unlike actual centres, chicks with different walking values are located in different areas. In this context, Aydin et al. (2013) determined in another study to determine the mobility of chickens and their use in the field. Unlike the study conducted in 2010, all chickens with different walking values were placed in the same area and their activities and area use were determined by image analysis techniques. For this reason, a colour detection system was designed and the required data were evaluated with this system. For technological reasons, only chickens with 0, 1, 2, 3 and 4 walking values were used in this study. As a result of the study, chickens with zero and three walking values took up more space and are more active than others.

Aydin et al. (2015) developed a new method using image processing to identify the problem of lameness in chickens, and the number of chicks sitting and sitting resistance was automatically calculated using an algorithm during their experiments. Some parameters such as the number of sitting of broilers and their resistance to sitting, such as x-y coordinates, speed, ridge surface area and direction of the broiler during the experiment were calculated.

Although the study achieved an accuracy of 83%, a high correlation was found between the number of sitting and walking score, and a negative correlation between the resistance to sitting and walking score of chickens. Due to the high correlation between broiler walking values and measured data and the strong relationship between system values and the reference method, Aydin et al. (2015) stated that this surveillance method developed has great potential in defining the problem of lameness in chickens.

2-D and 3-D systems have been used during the studies on the determination of collectivism in broiler chickens, and success has been achieved at different rates. For example, while the accuracy of lameness detection in the 3D system was 93%, it remained at 83% in the 2-dimensional system. However, both systems have their own advantages, disadvantages, and limitations. For example, 2-D systems require a lot of parameters to detect lameness and also require more time for analysis, whereas 3-D systems can detect lameness in a short time and with a single parameter, but they are more costly than 2-D systems.

Although both systems can detect lameness in broilers to a certain extent, an automatic system has not yet been developed that can distinguish all walking scores in broilers. Therefore, in future research, new parameters such as broilers' foot curves should be added to the novel systems. Because lameness detection in time is very important for farmers or veterinarians to take immediate action and prevent economic losses.

3. Feed Consumption Measurements by Sound Analysis

Feed is one of the most important inputs in broiler production, therefore feed efficiency is used as a primary tool in the evaluation of a broiler plant. For example, the diet of broilers has been studied by Kutlu and Forbes (2000). In another study, algorithms were developed to determine individual nutrition statistics of broilers, pecking behaviours obtained from sensitive scales were determined and compared with video observations (Gates & Xin, 2008).

However, in the same years, voice recording has been used as a different method in calculating the animals feed intake (Milone et al, 2012). For example, acoustic measurements and sound analysis were used for the first time to determine the actual feed consumption of broilers (Aydin et al., 2014).

Unlike previous studies, Aydin et al. (2014) installed a microphone to the feeder instead of a tape recorder attached to animals. The broiler, can be monitored completely automatic, non-contact and non-destructively. It is very important to determine the feed consumption of broiler chickens in a reliable and precise way, to determine feed waste, to monitor dynamic feeding behaviours, to calculate feeding time and to evaluate the health and well-being of chickens. More importantly, obtaining a precise feed consumption value is very effective in calculating the feed conversion ratio.

Aydin et al. (2014) revealed in their hypothesis that the real feed consumption of broiler chickens can be determined using pecking

sounds. For this reason, a sound analysis system has been invented to define the broilers pecking sounds. The correlation between pecking sounds and feed consumption of chickens was evaluated. The results show that the system can detect pecking noises with 94% success. Since the relationship between pecking noise and feed consumption (R2 = 0.985) is very high, the results revealed that the pecking sound detection method can be useful as to calculate chicken feed consumption. The main benefit of this method is that experiments can be performed continually (24/7), fully automatic and non-destructive way throughout the life of the chickens.

Aydin et al. (2015) prepared a test configuration in which many chickens ate at the same time, and the pecking sounds of all chickens were monitored. Then, the number of grams of feed the chickens ate in each pecking was tried to be determined based on the sound data. The results showed that pecking sounds could be detected with 86% accuracy. Compared to previous work, it has been demonstrated that several pecking occurs simultaneously as one reason for the decrease in accuracy and the algorithm recognizes them as a single pecking sound.

In the light of the results obtained, it was stated that although the accuracy rate of the developed algorithm decreased, many problems could be found with this advanced method. For example, many questions and problems can be identified immediately and necessary action can be taken, for example, how many times a day chickens feed, how long each feeding period takes, how much each feed or whether there is a problem in the feed line (Aydin et al. 2016).

A new algorithm has been developed to accurately determine the feeding behaviours of chickens (feeding size, feeding time, daily meals and feeding rate) at the group level with a real-time voice processing technology. It has been suggested by the researchers that the system should be developed and tested in commercial conditions (Aydin et al. 2016).

However, Aydin et al. (2014) received an international European Union patent numbered WO2014153626 A2 and entitled "Automated Monitoring of Animal Nutriement Ingestion" in 2014 and a United States patent in 2016 (US 2016/0050888 A1), with a private sector firm in Belgium as a result of the agreement made, R&D studies are continuing to improve the design of the new generation microphone feeders.

4. Effects of Lighting on Broiler Chickens

The importance of lighting for the management of modern broiler flocks is widely recognized. Therefore, the source, duration, intensity, and wavelength of the light become much more important for broiler performance in artificial lighting in fully controlled environment (Andrews and Zimmerman, 1990). While the duration and intensity of illumination in broiler flocks were important in the past, studies on different colours (Monochromatic illumination) have gained speed in recent years.

5. Early Warning System in Broiler Chicken Facilities

Automatic systems can be used to monitor the welfare and health of broilers. For example, feeder or drinking lines, light and air conditioning controls. The distribution index of chickens was calculated in the study, which aimed that the failure in any of these systems could be detected only by image processing technique, and an accuracy of 95% was achieved as a result of the analysis and modelling based on this (Kashiha et al 2013).

6. Determination of Some Features of Bovine Animals by Image Analysis

In parallel with the developments in computer technology, the use of (IPS) Image Processing Systems in the field of animal husbandry, health and quality inspections before the production period, storage and consumption, examination of growth and development, determination of morphological characteristics, evaluation, grading or standardization of animal products according to color characteristics focused on the subjects. It is also possible to use IPS in determining body development and growth by examining the dimensions and shape. If such a system is used, grouping animals according to their developmental status, making separate care and feeding practices for the grouped animals is not only necessary for business economics, but also for scientific studies examining the growth event. For example, within the scope of the study conducted by Onal et al. (2009), among animals, Wither Height (CY), Back Height (SY), Rump Height (SGRY), Rear Rump Height

(ASGRY), Chest Depth (GD), Body Length (VU) and Body Length (GU) measurements were obtained by IPS.

7. Reduction of Antibiotic Use in Animals with Voice Analysis

Another example of watching animals is on-line audio analysis. As a result, the energy characteristics and the sound produced in the sound signal produced during coughing will be different. In a study conducted by Guarino et al. (2004), this difference in the sound signal was detected and it was revealed that the antibiotic administered to animals could be reduced.

The change in body temperature, approximately BC. It has been recognized as an important indicator of the disease since 400, and since the thermometer was invented in the 17th century, the quantitative measurement of body temperature has been a standard in medical practice. Although thermography has been incorporated into many architectural and engineering professions it has led to industry-wide standardization, its use in medicine is still being discovered. Given the various potential uses of thermography in the medical field, several standards have been established for its use. Early diagnosis of febrile patients by thermography is advantageous because these patients can be isolated and treated, which controls disease transmission in a susceptible population. During severe acute respiratory syndrome and avian influenza epidemics in humans in the early 2000s, thermography was used to identify individuals with fever at airports, thereby preventing transmission of the disease by travel. Infrared thermography has also been used in veterinary medicine for many years. Because, over

the years, various laws have been enacted and the EU Annual Welfare Strategy, recently published by the World Organization for Animal Health. The thermography method is among the research methods that allow an objective and scientific evaluation of animal welfare conditions (Prohit, 2008).

Perhaps the most promising application of thermography in livestock is the early identification of an increase in body temperature that indicates the development of fever or local inflammation. Animals detected with abnormally elevated body temperature can be isolated, tested and treated. Due to its ease of use, high thermal resolution (depending on the detector used) and highly non-invasive usage possibilities, it has recently been seen that thermography has become a widely used technique as a diagnostic tool.

CONCLUSION

Turkey livestock industry, which competes with European producers in production, is unfortunately not at the same level in terms of the benefits of newly developed technologies. In this context, it is necessary to ensure that the technology is compatible with biology (agriculture) and to speed up sensitive research in agriculture for the broiler industry. Because our farmers, who have kept thousands of poultry, can no longer control the health, well-being and production of chickens using traditional methods.

For this reason, software such as image and sound analysis should be developed and presented to the farmers in our country. The most important feature of these developed methods can be defined as fully automatic and non-stop monitoring (24/7) and non-contact and non-destructive monitoring of the health and welfare of animals. Sensitive livestock technologies provide unlimited observation time because farmers get tired and sleep while computers and technological devices do not get tired and need no rest.

It is clear that sensitive livestock technologies will have a very important and positive impact on the work of farmers with intensive broiler production and can be particularly interesting for young farmers and farmer candidates. It is essential for sustainable intensive broiler production to develop these new technologies, which are not yet known and used by our farmers engaged in broiler chicken production, in line with the needs of our country's farmers. For this reason, sensitive animal husbandry techniques should be transformed into practice in order to further develop our country's livestock sector and to compete with other countries in the world.

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CHAPTER 6:

THE EFFECT OF APILLARNIL (MALE BEE LARVA) ON HUMAN NUTRITION, HEALTH SITE AND MEDICAL TREATMENT OF SOME DISEASES

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INTRODUCTION

Today, due to the changing and changing life conditions, the increase in diseases and varieties, insufficient food and nutrition, insufficiency in drug production, negative fluctuation in nutritional deficiencies worldwide, increasing population and consequently increasing protein-containing food need, etc. The search for a source and scientific researches made accordingly have gained momentum in our eyes. The need for food that develops due to the population increase in different countries of the world and the search for a food source and the solution of the problem that occurs in this context have forced people to evaluate the sources that can be an alternative food. For this purpose, the world's insects and insect products are consumed as a food product with a source of protein in many countries.

Honey bee products are among the insects in question and the products of honey bees have a conservative and nutritious effect in terms of human health. Made in scientific studies result apilarnil's (3-7 days old male bee larvae) have concluded that a high nutrient ratio, therefore human health, the protection of health and medically in some diseases has proven to be consumed with medical supportive treatment purposes. It is predicted that apilarnil is consumed for food purposes and it can be used in the medical treatment of some diseases, and the use of bee products for different medical purposes (apitherapy) is expected to become widespread (Mateescu, 2011; Topal et.al., 2018).

The high nutritional value of apilarnil and the increase in demand for apilarnil due to its use for medical complementary therapy paves the

way for the continuous supply and production of larvae. Therefore, it is of great importance to have a knowledge of the biochemical formation / structure and apitherapeutic importance / effect of drone larvae (apilarnilin). 3-7 days of drone larvae (apilarnil) contain very valuable nutrients in terms of human health and have the components of these nutrients, so many health problems such as triggering the formation of force in the body, cell regeneration, balancing and regulating fertility physiology, treatment of diseases that cause neuron damage. takes the role of medical complementary therapy in the solution.

WHAT IS APILARNIL?

Apilarnil is called the drones of the unfertilized egg (haploid (n)) by the queen bee in honeybees or by other workers / female bees in honeybees, and is usually scattered around the edges of the honeycombs, rarely in the middle or in the middle of the honeycombs, and is slightly more domed when glazed compared to other honeycomb eyes. It is the name given to the larval forms obtained from the haploid egg thrown into the honeycomb cells that appear to be large and obtained by collecting the 3-7-day-old larvae at this time interval before the comb glazing (Yücel et al., 2011).

Apilarnil is a biologically active / active bee product (Ilieşiu, 1991). The product is then filtered or lyophilized and used according to the purpose. Apilarnil was first discovered by Romanian scientist Nicolae Iliesiu. The Romanian scientist named Apilarnil. This component, which is obtained from 3-7 days old male bee larvae by lyophilization (freeze drying) method (apilarnil), has a wide use in the treatment of

some diseases in Romania. In the limited number of studies in the scientific literature, the chemical content of apilarnil has been tried to be determined and its content;

Water (65-75%)
Dry Matter (25-35%)
Protein and Amino Acids (12.9%)
Glucose (6-10%)
Fructose (3.16%)
Sucrose (0.03%)
Lipids (5-8%)
adipose soluble vitamins (A, D, E and K)
Water soluble vitamins (B group and C)
It has been found to be composed of minerals, hormones, xanthophyll, choline (37) and ash (2-3%).

SCIENTIFIC STUDIES ON THE CHEMICAL CONTENT OF APILLARNIL AND ITS IMPORTANCE FOR HUMAN HEALTH.

3-7 day old male bee larvae (apilarnil) contains all the essential amino acids in the basic structure of the protein due to "complete food" is considered within the class. Apilarnil can be consumed fresh after its harvest, paying attention to cold chain protection, and it can be consumed in a wide range of time by processes such as grinding, homogenization, filtration and lyophilization (Çakmak, 2015; Topal et.al., 2015).

If this process series is applied appropriately, it allows apilarnil to be used without losing the nutrients it contains and without requiring its preservation in the cold chain. If Apilarnil is not protected in the cold chain within half an hour when it is fresh after harvest, a significant amount of nutrient loss occurs.

The best preservation process that can be applied in the preservation of apilarnil is lyophilisation. Lyophilization is a preservation method called sublimation (turning the liquid contained in the material into a gas phase after it becomes solid), which is done to dry the material to be treated. Fresh apilarnil can be safely stored and consumed at (-15) 'C' for 1 year after harvest (Bruneau, 2015).

The quality of apilarnil is significantly influenced by production, cleaning, storage, storage and marketing conditions (Hasegawa et al., 1983; Höffel, 1983). Chemical nature or composition; The period when it is produced, the age of the larva collected, the flora of the area where the bee colony is located may differ due to the effect of many variable factors. In scientific studies, the total moisture, protein and lipid ratios are respectively; 65-70.97%, 6.61-12%, 3.44-8.38%. Total sugar, acidity, Ph level and ash ratio are respectively; 6-10%, 0.88-3.18%, 6.49, 2%. Sugar profiles, respectively, fructose, glucose, sucrose; It was stated to be around 0.11-0.60%, 3.40-6.74%, 0.00- 0.14% (Lowry et.al., 1951; Stângaciu, 1999; Camara et.al., 1996; Markopoulou et.al., 2002; Kutlu, 2008; Bărnuţiu, 2013; Balkanska et al., 2014; Aoşan, 2016; Mărgăoan et al., 2017).

Minerals of calcium, magnesium, phosphorus, iron, manganese, copper, zinc, sodium, potassium have been determined in apilarnil. Vitamin A, xanthophyll, beta-carotene, B1, B2 vitamin, trace level of vitamin B6, vitamin PP and choline were found (Aoşan, 2016).

It has been proven by scientific researches; It has been revealed that drone larvae (apilarnil) can be consumed in addition to health protection and medical treatment due to the high amount of nutrients they contain.

With these studies, it was aimed to increase the support opportunity in areas such as the preservation of health, the use of apitherapy, which is the science of the use of bee products for medical treatment, and the production of valuable food, due to the rich nutritional value of apilarnil components.

In a separate study, apilarnil chemical content; minerals (zinc, potassium, copper, calcium, sodium, iron, manganese and phosphorus), vitamins (PP, A, B1, beta carotene, vitamin B6 and choline) was detected. In addition, amino acids, which cannot be produced / synthesized by some animal organisms and which are essential for the functionality of vital activities, have been found in the basic structure of apilarnil. It contains high levels of phosphorus and potassium (10.4 - 8.0 g / kg) as well as trace elements such as iron, selenium, copper, manganese. Protein, amino acid, fatty acids and lipid content were measured as 9.4 / 100g, 7.9 / 100g, 4.0 / 100g, 4.7 / 100g, respectively. Basically, saturated fatty acid content consisting of stearic and palmitic acid is dominant (52%). It has a unique content with vitamin C,

selenium, choline, vitamin B groups and insoitol (Bărnuţi, 2013; Silici, 2019).

It has been reported that royal jelly, perga and apilarnil contain high levels of α-tocopherol and coenzyme Q10. It was determined that the a-tocopherol level was 16, 75.5 and 7.6 µg / g containing royal jelly, bee bread and apilarnil, respectively (Balkanska et al., 2014).

In a study to investigate the effect of apilarnil on neuron damage, experimental groups were formed by dividing 64 adult male Sprague-Dawley mice into 8 groups, and the effect of apilarnil on nerve damage and related mechanisms was measured. The animals were given apilarnil and lipopolysaccharide (LPS) and the levels of catalase, xanthine oxidase, testican.1, Proinflammatory cytokines (tumor necrosis factor), interleukin 1 beta, superoxide dismutase, interleukin 6 and malonialdehyde were measured in brain tissue. Texturally, examinations were made on the hippocampus and cortex tissues in all groups.

Apoptotic cell number was estimated using the TUNEL method to observe the effect of apilarnil on apoptosis. Purkinje cells were counted in the hippocampus to measure the protective effect of apilarnil on the hippocampus. Apilarnil has been found to reduce the decrease in SOD and CAT levels in the brain with sepsis and decrease the increase in MDA, XOD and testican-1 levels in the septic brain. It was observed that as the apilarnil dose increased, the number of degenerate neurons due to sepsis decreased, high proinflammatory cytokine levels (IL-6, TNF-α, IL-1β) caused by sepsis decreased, and it prevented apoptosis

due to sepsis in the brain. In the study; The effect of apilarnil against brain and nerve damage has shown that it has the potential to contribute to new therapeutic targets and it has been shown to prevent various neurological disorders (Hamamcı et.al., 2020).

In a scientific study performed on the liver interacting with lipopolysaccharide, 64 adult Sprague-Dawley mice were divided into eight groups for damage detection, and animal groups were formed. In the study, the experimental animals were given apilarnil and lipopolysaccharide, and the tissues obtained from the liver tissue interacted with lipopolysaccharide and apilarnil were obtained by using ELISA test and TUNEL method for histopathological evaluation. Catalase, malondialdehyde, superoxide dismutase, xanthine oxidase and testican 1 levels were measured. In immunohistochemical evaluation; Using Interleukin 6, Toll receptor 4, kappa as nuclear factor, Tumor necrosis factor alpha, Interleukin 1 beta, High Mobility Group Box Protein 1, and Inducible nitric oxide, the number of apoptotic cells was determined and Comet test was performed to detect DNA damage.

Histopathological examination revealed dilated blood vessels, inflammatory cell infiltration and hepatocyte damage in the pycnotic nuclei in liver tissues of the lipopolysaccharide group; It was found that tissue damage in the lipopolysaccharide + apilarnil group was significantly reduced compared to the lipopolysaccharide group, and the number of TUNEL positive cells observed in the lipopolysaccharide group increased in liver samples compared to those treated with control and apilarnil.

The number of TUNEL positive cells showed a statistically significant decrease in the lipopolysaccharide + apilarnil-treated groups compared to the lipopolysaccharide group. While an increase in malondialdehyde, xanthine oxidase and testican1 levels was observed in lipopolysaccharide treatment, a decrease in catalase levels of superoxide dismutase was observed. DNA damage has been reported to increase significantly.

It was found that lipopolysaccharide treatment increased the expression of High Mobility Group Box Protein 1, Interleukin 1 beta, nuclear factor kappa B, Tumor necrosis factor-alpha, Interleuki 6, Inducible nitric oxide, toll Like Receptor 4, and the lipopolysaccharide + apilarnil group decreased this increase. In this study, it was reported that toll Like Receptor 4, High Mobility Group Box Protein1 apilarnil, administered to mice, prevented liver damage caused by lipopolysaccharide by inhibiting kappa B signaling pathway as a nuclear factor. (Doğanyiğit et.al., 2020).

In a review, the first detection of Apilarnil in history, its use in the elderly with psychotic, neurodegenerative and sexual disorders in Romania after its detection and its content, respectively fatty acids and lipids, proteins), carbohydrates, water (3.5-8%, 9-%). 12, 6-12%, 65-75%) K, Na, Ca, Mg minerals (1-1.5%), essential amino acids (threonine, leucine, isoleucine, methionine) as well as testosterone, prolactin, progesterone and estradiol The richness of such sex hormones has been compiled. In addition, some chemicals and hormones defined in the lipid part of apilarnil can have an androgenic effect, Apilarnil can

increase androgen in patients with androgen deficiency syndrome, whether Apilarnil can be effective on androgen deficiency syndrome and the areas where it can be used, studies on Apilarnil in the literature have been compiled and have been interpreted (Erdem and Özkök, 2017).

Made In another study, collected from Turkey apilarnil examples of some percentage of the physico-chemical parameters (moisture, ash, total lipids, total protein and cholesterol) levels of certain hormones (estradiol and prolactin, progesterone and testosterone) and were investigated in terms of the characterization of certain fatty acids. The chemical composition of apilarnil is composed of mineral salts, vitamins, carbohydrates, lipids and amino acids. It is defined as 5.68, 13.25 and 2.28. In addition, the levels of testosterone and progesterone were recorded as high as 14.80 ± 0.05 ng / g and 14.40 ± 0.05 ng / g, and conjugated linoleic acid (52.62%) was identified as the main fatty acid component by gas chromatography. The effect of biostimulant on hypothalamus-pituitary-adrenal axis function, which has a direct effect on basic measures of gender function, has been determined, and detailed physicochemical characterization of apilarnil has been revealed in the study. According to the data obtained from the study, it has been reported that apilarnil can be seen as a significant natural resource due to its high level of biological properties (Yücel et.al., 2019).

Bărnuţiu, (2013) conducted a study on the determination of the chemical composition of apilarnil (drone larvae), moisture, ash, free

acidity, total protein and sugar content. The composition of apilarnil has been reported to be quite complex and is not detailed in the literature. In the study, seven apilarnil samples were analyzed and compared with the literature data on physico-chemical parameters, a basic preliminary study was presented for the quality of apilarnil that can be used as a food supplement or in other fields (Bărnuţiu, 2013).

Doğanyiğit et.al., (2019) in a study conducted on male rat subjects, the rats were divided into 8 groups in total and Apilarnil (increasing dose increase according to 0.2, 0.4 and 0.8 g / kg body weight), LPS-induced group (30 mg / kg body weight) increasing dose according to their weight) and LPS + Apilarnil (dose increasing by 0.2, 0.4 and 0.8 g / kg body weight). Apilarnil (increasing doses of 0.2, 0.4 and 0.8 g / kg, 1 ml orally given to rats). The DNA of the kidney cells was analyzed with the Komet method, the changes were compared with the control group, it was determined that the DNA damage increased in the LPS group when the LPS group was compared with the LPS + Apilarnil group. In LPS + Apilarnil group, DNA tail percentage, length and moment decreased significantly at the end of the application. In the study, when comparing the groups given variable and increasing doses of Apilarnil against LPS, it was concluded that the administration of high amounts / doses of Apilarnil was significantly protective (Doğanyiğit et.al., 2019).

CONCLUSIONS AND RECOMMENDATIONS

Our country, which is rich in vegetation, has a great potential in terms of the production of bee and bee products. This potential also affects

the chemical content and biological activity of bee products. Studies have revealed that apilarnil, a bee product, has the potential to shed light on scientific studies. The studies on apilarnil have started recently, the determination of its chemical content and the reduction of its effects on the newly started animal subjects to the tissue and cellular basis and the results have taken a promising path. Today's technology makes scientific research easier and minimizes the time to reach results. From this point of view, today's technology should be used and apilarnil, which is a bee product with bioactive properties, should not be limited to only chemical content, tissue and cellular researches, but scientific research should continue to obtain nutrients / drugs that can be used for human health.

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CHAPTER 7

ANHYDROUS AMMONIA APPLICATION

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INTRODUCTION

Nitrogen is one of the major plant nutrients applied to the soil to enhance crop growth. Anhydrous ammonia (NH3), the most concentrated nitrogeneous fertilizer. The commercial compound contains 81.5-82.5% nitrogen. Anhydrous ammonia (AA) is ammonia without water. This gives AA a strong affinity for water. Ammonia is a chemical substance. Therefore, it is considered as a dangerous substance.

Table 1 lists some of the important chemical and physical properties of Anhydrous ammonia.

Table 1: Physical and Chemical Properties of Anhydrous Ammonia

Physical form	Gas (liquid under pressure)
Chemical formula	NH_3
Color	Colorless gas and liquid
Odor	Strong
Boiling point	-33 C at 1 atm
Melting point	-78 ^{o}C
pH	App. 12.0 (neat)
Density	0.696 g L^{-1}

The physical properties of AA determine how it should be applied to the soil. AA must be injected directly into the soil and covered immediately to prevent ammonia gas escaping directly to the atmosphere.

There are parameters that need to be known in order to achieve high success in ammonia application.

These are;

- Features of storage and application equipment
- Amount and rate of the AA
- Depth of application
- Soil moisture
- Application Spacing
- Injection System
- Application time
- The anhydrous ammonia application equipment
- Risks and Protective Equipment for Anhydrous Ammonia

1. Features of Storage and Application Equipment

Due to its chemical properties, AA requires special storage and application equipment. It will stay in liquid form when stored under pressure. AA is often stored in liquid form in storage equipment and application equipment. When AA is released under pressure, it turns into gas form. Therefore, it should be injected under the soil. Hanna, (2001) reported that AA will create a tank pressure of about 8 kilograms per square centimeter at 21° C. These properties of AA, which create problems for the application and storage, also make it dangerous to use (Baker, 1993). Pressure changes depending on temperature.

The basic features that the equipment should have can be summarized as follows:

- All parts of storage and application equipment must be materials resistant to pressure and chemical properties of AA.

- It should have an injection unit that can apply AA under the soil. Because, gas losses are significant.
- Ammonia dose (kg da-1) to be applied should be adjustable.
- It must have level indicators and safety valves (Figure 1).
- Its tank must be of a pressure resistant structure.

The tank should generally be resistant to 10 bar pressure. Agriculture is one of the least dangerous areas of AA. Applications are carried out in the field. However, it is necessary to be very careful in use. Special protective clothing and masks should be used during the transportation, application and storage of AA.

Figure 1: Safety Valves

Safety is the most important factor in ammonia application. For emergencies, water must be kept on the equipment. If there is no transfer pump, AA transfer into the tank is usually done by pressure difference. In this case, the use of water is also required.

2. Amount and Rate of The Anhydrous Ammonia

The use of anhydrous ammonia in agriculture is increasing day by day. For example, AA has been reported to account for approximately 32% of the N fertilizers used in the USA (Terry & Kirby, 2006). Nowatzki (2011) reported that more anhydrous ammonia is used as fertilizer in North Dakota than any other source of nitrogen fertilizers.

While urea, ammonium nitrate and ammonium sulphate are used as nitrogen fertilizers in our country, there is no use of anhydrous ammonia. Nitrogen fertilizers and nitrogen content used in agriculture are given in Table 1. Urea contains 46% nitrogen and ammonium nitrate 26-33%, ammonium sulphate 21%. AA is used as a raw material in nitrogen fertilizer production. The reason why ammonia is not used as a nitrogen fertilizer source is the lack of necessary equipment and knowledge. Trials and researches are carried out for its use. Research has been conducted on anhydrous ammonia applications in wheat and sunflower. Tan et al. (2016) reported that AA has a positive effect on yield and yield parameters. They found the highest efficiency in the AA method when compared to the AA method and the traditional method.

Table 1: Nitrogenous Fertilizers Used In Agriculture

Fertilizer	Formula	N content (%)
Ammonia	NH3	82.2
Ammonium nitrate	NH_4NO_3	26-34
Ammonium sulphate	$(NH_4)_2SO_4$	21
Ammonium chloride	NH_4Cl	26
Urea	$(NH_2)_2CO$	46
Sodium nitrate	$NaNO_3$	16
Calcium cyanamide	$CaCN_2$	20.6
Calcium nitrate	$Ca(NO_3)_2$	15.5

Amount of the ammonia application is determined according to soil analysis results. However, farmers generally apply nitrogenous fertilizer much more than the soil needs. It is seen that in the traditional fertilization method, much more fertilizer is used per unit area (kg ha-1).

The amount and rate of the ammonia is related to application method, soil texture, and soil moisture.

The best part of ammonia application is that one fertilization is enough. The application is generally done a day or two before planting. When it is considered to apply AA with sowing, it is desirable to have a distance from the seeds.

3. Depth of Application

If the injection depth is small, the roots may be near or within the ammonia injection site. This could increase the potential for seed and seedling toxicity. Therefore, shallow injection can be problematic. So it is recommended that, AA should be made under the soil 15 to 20 cm depth with the injection system. If the injection depth decreases, the power requirements of the tractor may decrease and the application speed may increase. However, it should be known that gas losses will increase in this case. Thus, Nitrogen usage efficiency (NUE) also decreases. It should not be forgotten that AA application depth significantly affects nitrogen losses.

4. Soil Moisture

When the moisture and organic matter content in the soil is low, ammonia losses increase. If the soil is dry, AA will be difficult to hold in the soil and gas losses will increase. Therefore, moist soil should be preferred in AA applications. Soil moisture is also important in reducing gas losses. For a correct application and NUE, AA should not be injected into extremely wet, heavy soil. At the same time, it was seen that the effect of soil pH values on NUE was significant (Tan & Saglam, 2017).

5. Anhydrous Ammonia Application Spacing

Anhydrous ammonia application equipment commonly used in small grains is typically spaced between 38 and 50 cm. Maxwell et al. (1984) suggested that spacing up to 50 cm may be adequate for most situations but 30 cm may be more favorable in certain soils and conditions. In addition, they also noted the increasing sapacing did not negatively affect yield. Most of the studies reviewed indicate that the traditional 38 to 50 cm spacing is sufficient for wheat under normal conditions. Tan & Saglam (2017) also reported that 50 cm row spacing yielded successful results in sunflower and wheat agriculture.

Little work has been done on spacing in recent years as the theories and equipment available have not really changed in that time. There are also physical and economic considerations when evaluating spacing of AA application equipment. Narrower spacing requires more power per foot of applicator as you add more resistance from more row units.

6. Injection System

In AA application equipment, traditional blade type injection system is generally used as the injection system (Figure 2). With this unit, it is possible to inject ammonia 15-20 cm beneath the soil surface. Thus, maximum absorption by the soil is ensured.

Figure 2: Traditional Knife Injection Systems

Different types of AA application injection units have been investigated for no-tillage production systems. There are also injection systems that can perform high speed and shallow placement, especially developed for no-soil tillage production systems.

Compared to traditional knife applicators and disc applicators; it is slower, has higher power requirements, and creates significant soil disturbance. Stamper (2009) determined that; with the disc type applicator (Figure 3), there were statistically higher ammonia losses at all application times and high N application rates. When AA was applied at an 11cm depth with the disc type applicator, losses were significantly greater than when applied at depths of 20 cm with the

traditional knife applicators. The most preferred injection unit in AA applications is traditional knife injection systems.

Figure 3: Disc Type Applicator (Wyckoff 2009)

7. Application Time

AA is a nitrogenous fertilizer commonly used in grain production. It is preferred because of its positive effects on product yield parameters. The application time of ammonia also varies according to the planting time. It is the most common method to apply AA a day or two before planting. Leaf analysis has shown that wheat plant has the nitrogen it needs in all growth periods. It is also stated to be significantly important compared to other nitrogen fertilizer applications (Saglam & Tan, 2019).

8. The Anhydrous Ammonia Application Equipment

Application equipments can be of small (Figure 4a) and large capacity (Figure 4b). Both types of equipment can be used for the application. In Figure 5, it is seen that AA turns into gas form during application.

(a) (b)

Figure 4:a) The Anhydrous Ammonia Application Equipment-Small capasity, b) The Anhydrous Ammonia Application Equipment-Large capasity (Tan & Saglam, 2016)

Figure 5: Before Injected (Gas form of AA in contact with air)

The application is easy and very practical. The biggest advantage is that it is enough to make nitrogenous fertilization once. Two or three applications are made in other nitrogenous fertilizer forms. Therefore, AA application provides advantages in terms of fuel, labor, time and cost.

9. Risks and Protective Equipment for Anhydrous Ammonia

Wearing protective equipment reduces the chance of injury and accidents from ammonia release. When anhydrous ammonia is released into the atmosphere (0 psi) from compression in a storage tank (200 psi), it can be very dangerous. In this case, the temperature of anhydrous

ammonia drops suddenly and freezes. Human skin can be burned on contact.

- Due to the seriousness of exposure to anhydrous ammonia, personal protective equipments must be used.
- It should be convex type to increase the resistance against pressure.
- The working pressure of the tank must be resistant to at least 10 bar.

- There should be safety valves on the tank and should be checked frequently.
- Not all protective equipment and masks are enough. The mask and clothing should be in the form suitable for anhydrous ammonia (Figure 6).

Figure 6: Special Protective Clothing and Masks

Advantages and Disadvantages Between Anhydrous Ammonia Application and Conventional Application

The advantages and disadvantages between anhydrous ammonia application and conventional application are given in Table 2. As can be seen from Table 2, AA is advantageous in many areas compared to the conventional method.

Table 2: The Advantages and Disadvantages Between Anhydrous Ammonia Application (AA) and Traditional Application (TA)

.	AA	TA
Amount of fertilizer	☺	☹
Number of applications	☺	☹
Yield	☺	☹
Yield parameters	☺	☹
Work capacity	☺	☹
Field traffic	☺	☹
Cost	☺	☹
NUE	☺	☹
Environmental impact	☺	☹
Less fuel	☺	☹
Risks	☹	☺

NUE: Nitrogen Usage Efficiency

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CHAPTER 8

SILO MANAGEMENT

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INTRODUCTION

Forages, which have an important place in animal nutrition, are also important with their high nutrient-substance content. Therefore, they are the necessary feed source for husbandry businesses. Since it has high quality nutrient content among forages and has less quality and quantity losses during its production, silage becomes prominent. Especially the corn plant is the most used material in silage production due to its easy silage features. However, insufficient feed sources require the silage use of other materials and alternative products.

The gradual increase in silage production cause the rapid development of tools, equipment and technologies, which are used in this field. Silo management is becoming very important day by day.

1. Silo Management

It contains a process including the harvest of the materials to be silage making, compacting, closing, opening and consumption stages of the silo. In general sense, the most important point of silo management is the correct management of the silo process. Correct management of silage is important in obtaining quality silage. In addition to this, incomplete and bad management causes many problems such as poor quality silage and increase in the deterioration rate of the silo. Silo management consists of three phases. These are;

- Harvest
- Transport
- Silage stage.

Each phase should be planned and managed separately. Harvest should be ready in the number calculated by considering the working capacity of the machine together with the silage machine and the carrier equipment. Harvest should be made in the ideal maturity period and the size of material shredding should be adjusted. Since it is effective on the material, the type of the machine-shredding unit, the number of blades, and the wear level of blades are also important. Transport phase involves the process of moving shredded material between plantation and silo. The use of insufficient equipment means the transportation of material to silo with late intervals and it causes the silage machine to fail in efficient operation. This distance is important in determining the number of carrier equipment. Although the silage phase is under the influence of many factors, the biggest factor is related with the method of compacting process.

Factors affecting silo management in general are;

- Planning
- Tool and equipment availability,
- Distance between plantation and silo,
- Site selection,
- Operation conditions,
- Operation time,
- Silo sizes,
- Material,
- Compaction equipment,
- General structure of the business,

- We can list the educational status and experiences of the people performing the silo.

Planning is the most effective step in silo management. At this stage, many questions should be answered such as the procedures to be done regarding the silage making process, the tools and equipment used, the number of equipment and carriers, the site selection of the silo, silo capacity, harvest time, processes regarding the harvest, the materials to be used, and the number of people and employees who shall work in the process phases. Tools and machinery should be brought to suitable conditions for the planned day. The maintenance and repair works of the harvester and compaction equipment should be done in advance and they should work perfect on the harvest day.

By considering the distance between the silo and the plantation where the material is harvested, the number of equipment should be calculated in advance and the number of tools and machines calculated in harvest time should be ready in desired area for the correct management of silage. It is important for smooth operation of this process.

The plantation efficiency of the equipment used in unplanned silo management is low. Silage machines and round balers are machines with very low field efficiency. It is stated that this value range varies between 55-65% for silage machines and as 65-80% for round balers which work in plantation conditions. The main reason for the low plantation efficiency is the bad planning. Therefore, planning becomes very important in silage making. The effective operation of the machine

depends on good planning, having sufficient number of tools and equipment, and systematic management of the work.

$$Ef = \frac{Ta}{Ts} \qquad \text{(Eq.1)}$$

Where Ef is field efficiency ,%, Ta is actual working time (time between starting and ending work, h, and Ts is total daily working time, h (Ülger et al. 2002).

In case the field efficiency is high, it is possible to complete the operations in the most efficient and short time.

While the harvesting process continues in the plantation during silage making, the silo operation process continues in the silo. Therefore, the operation process in silage is under the effect of plantation work process. This may cause failure in materials to come into the silo with equal intervals. In addition, the distance between the plantation and the silo has an effect on the material arrival time into the silo.

Silo management scheme is given in Figure 1. As can be seen here, planning is the beginning of the management system. The number of equipment used for transportation and the calculation of the load carrying capacity of the equipment are also included in the planning. Transport plays an efficient role in the success of the silo making process. It is effective on the success rate.

The compaction process in silo management is determinant on the quality of the feed. When sufficient compaction is made, the material has low porosity and low permeability (Toruk et al. 2009), high density

(Sahin & Tan, 2019). The permeability varied in sunflower silage made at different maturity periods. While the highest permeability in sunflower silage was 0.0488 cm min -1 in the BL period (Black Line), which is the late harvest period, the lowest permeability was measured at 0.0072 cm min -1 in the sunflower silages (Beginning of Anthesis) made in the early harvest period (Toruk et al. 2009). Similarly, porosity increased with maturity period in sunflower silage. While it was calculated as 15% in the early period, it was calculated as 57% in the late period. This shows that it is effective on the compaction efficiency according to maturity periods in the material.

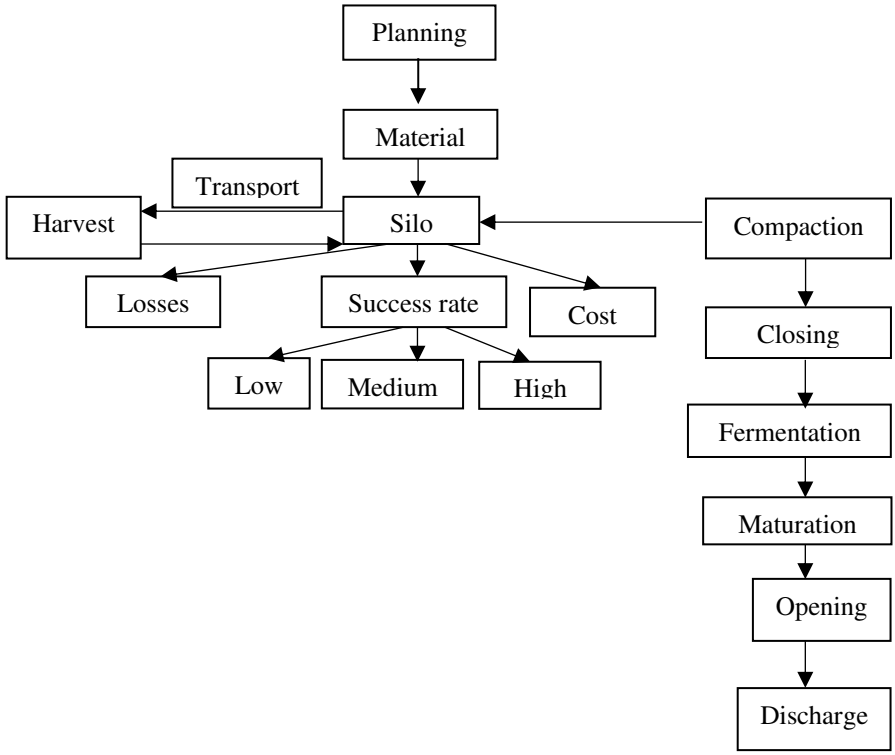


Figure 1. Silo Management Flow Chart

1.1. Compaction

It is the most effective phase of silo management. While the correct management of this phase provide high quality silage production, it also allows the use of the silo with high efficiency. This also provide the business to have economic feed expenses.

The success of silo management depends on the correct and sufficient compaction of the material. There are many parameters that affect the success of the compaction process.

These are;

- Weight of equipment (Ruppel, 1993; Ruppel, 1997; D'Amours & Savoie, 2005; Oelberg et al. 2005; Tan et al. 2018)
- Number of equipment,
- Tire type, (Roy et al. 2001; Muck et al. 2004)
- Tire pressure, (Roy et al. 2001; Muck et al. 2004)
- Single / double tire,
- Silo type, (Tan et al. 2018, Tan et al. 2019)
- Silo size,
- Layer thickness, (Muck & Holmes, 1999; Oelberg et al. 2005)
- Compaction area (tire contact area or pallet contact area),
- Compaction duration,
- Material type, (Roy et al. 2001; Holmes & Muck, 2004; Jones et al. 2004)
- Moisture content, (Roy et al. 2001; Holmes & Muck, 2000; Jones et al. 2004; Wang, 2012)

- Particle size, (Ruppel, 1993; Shaver, 1990; Shinners et al. 1994)
- Silage making technique, (Tan et al. 2018)
- The route which the compaction equipment passes (Odabaş, 2019),
- The number of passes on the route,
- The direction of the route ,
- The experience of the person using the equipment.

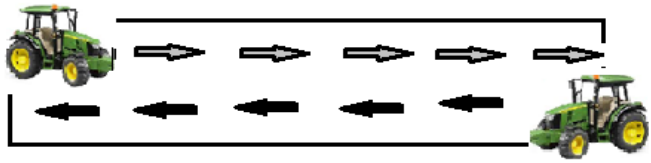
As can be seen here, there are many variable parameters in the compaction phase. These differences generally arise from many factors such as the manufacturer having different compacting equipment, different operator competencies and different training levels. In addition to variable parameters such as material type, moisture content (Roy et al. 2001; Holmes and Muck, 2004; Jones et al. 2004; Wang, 2012), harvest period, shape period, particle length (Ruppel, 1993; Shaver, 1990; Shinners et al. 1994), many variables such as the mass of the compaction equipment used, the number of equipment, tire types, tire pressure, compaction duration, applied compaction pressure, equal and adequate compaction process throughout the silo are the parameters depending on the compaction equipment and silage technique.

The location and position of the silo is also very important for the correct compaction process. Sufficient space should be allocated for the planned size silo especially in pile type silo making and the ground should be cleaned. In silos which are planned very close to the shelter or building, since the movement of the compaction equipment will be prevented, a sufficient and correct compaction process may not be done.

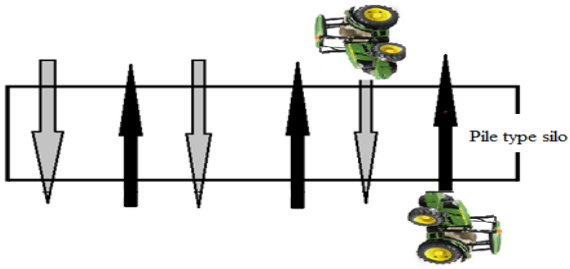
This situation may be one of the common problems in the making of ground pile silos, especially in small and medium-sized husbandry businesses. Compaction level is also insufficient in areas with movement restrictions. In addition, this situation causes a determinant effect on the route of the compaction equipment used for compaction purposes (Figure 2).

Compaction equipment route;

- Transverse route,
- Longitudinal route,
- Cross-longitudinal mixed route.



(a)



(b)

Figure 2. The Followed Route, a. Longitudinal, b. Transverse Route

The route selection applied by the compaction equipment can be selected and implemented in accordance with the silo management. The

equipment must follow the route on the silo both across the silo width and along the silo's length. The unidirectional compaction route generally causes the formation of insufficient compaction. As can be seen in Figure 3, the compaction equipment route is determined due to the wrong silo location selection. In addition, the compaction process applied in silo management cannot be performed efficiently due to silo location selection in an area which shall prevent the movement of equipment (Figure 3).

Figure 3. An Example With The Wrong Silo Location

Compaction equipment and its use are the most important parameters for achieving the desired compaction in the material. This process can be managed by using a tractor or a construction machine according to the business needs. Generally, an equipment in the center of the business is used but sometimes the equipment is supplied from outsources by renting in the businesses with large silo capacity. The level of compaction required in the material; mass of compaction equipment (Ruppel, 1993; Ruppel, 1997; D'Amours & Savoie, 2005; Oelberg et al. 2005), layer thickness (Muck & Holmes, 1999; Oelberg

et al. 2005), tire size, tire type, tire pressure vary depending on the efficiency of the force applied and time spent for compaction (Roy et al. 2001; Muck et al. 2004). Due to the existence of very different and many variable parameters, there are no general rules for silage and the compaction processes applied in the silo are mostly done at an inadequate level. Therefore, the material density in the silo varies considerably depending on the level of compaction (Muck & Holmes, 2000; D'Amour & Savoie, 2005; Visser, 2005; Craig & Roth, 2005; Oelberg et al. 2005; Tan et al. 2018). This situation causes regional spoilage of silage feeds.

Many studies have been made for determining the silo density in order to determine the compaction level. Because the density of the silage material gives the most basic information about the quality of the silage technique. Silage feeds with high density express that the silage technique with sufficient compaction level has been successfully applied.

1.2. Density of material

It is important to determine the density of the material. However, it is also the stage in which the density will be determined. We can mention these process steps as;

1. in silage phase,
2. in feeding phase (after silo opening).

We can learn the material density and have information about the feed quality in the calculation to be made after opening the silo but there is nothing to do.

If it is possible to determine in the silo phase, it may be possible to take measures to improve the silo density. In this way, it may be possible for the whole silo to be in high quality class and to be obtained without loss. Fundamentally, equation 2 is used in calculations. Additional systems have been developed for density measurements after opening in bunker silos.

The density of the silage was determined by taking the cylinder volume into consideration. The silage samples taken with the cylindrical container were then weighed (Eq.2). The volume and weight of the silage materials were then used to calculate the density of the silage in kg m -3 :

$$\rho = \frac{m}{v} \qquad \text{(Eq.2)}$$

where ρ is the ensiling material density, kg m -3 , m is the mass of the ensiling material filling, kg, and v is the cylinder volume, m -3 (Hoffmann et al., 2013; Wang, 2012).

Li et al. 2016 developed a penetrometer-based mapping system for determining the silage density in bunker silos by 2016. They stated that it is not only possible to determine the weakly effective compaction management but also it is possible to determine aerobic destruction risks of the materials with the system they developed. Figure 4 shows

the density measurement studies in a hand-held penetrometer and pile type silo (Sahin, 2019). Penetrometer method (M6) is the best method for fast and accurate measuring of density. If small farms do not have a penetrometer, Core sampling method may be recommended for density measurement (Sahin & Tan, 2019).

Norell et al (2013) used three different density calculation methods. They also reported that core sampling is the standard method for determining silage density and recommended for directly assessing silage density. They proposed the calculator method to estimate the average density and to evaluate alternative management strategies during the silo filling and packaging process. They did not recommend unless the storage structure has uniform silage faces in the third type of calculation method (the feed-out method).

Hoffmann and Geyer (2014) used the radiometric method for density scale during material silage. However, they stated that radiometric measurement method would provide economic benefit when the number of cows exceeds 135.

Figure 4. Penetrometer

The density of a silo on a commercial farm is variable (Ruppel et al.,1995). A high density of a silo can minimize the DM losses and reduce the costs of storage (Pitt, 1986). It is important to have a high density in a silo for two main reasons; the porosity of the silage and the capacity of the silo (Bolton and Holmes, 2006). According to research by Ruppel (1992), the dry matter loss of alfalfa silage was decreasing when the density was increased. A minimum dry matter density of 240 kg DM m -3 was recommended by Holmes and Muck (2004) as a reasonable density to attain and to reduce excessive losses of dry matter. To increase the density; tractor mass, compaction pressure, packing time, silage dept and the dry matter content of the silage are important. (Muck & Holmes, 2000; Tan et.al 2019). Density is also increased by increasing the moisture content (Holmes & Muck, 2007; Jones et al., 2004), compaction pressure and tractor mass.

Many studies have been conducted on density in bunker type silos: These are;

- The density of silage is higher in the bottom layer than in the top layer (Muck & Holmes, 2000; Visser, 2005; Craig & Roth, 2005; D'Amours & Savoie, 2005; Oelberg et al., 2005; Holmes & Muck, 2006). Similar results were also found in the pile type silo (Tan et al. 2018, Tan & Dalmıs, 2019).
- The density in the center of a silo is higher than next to the wall (Visser, 2005; Craig & Roth, 2005; D'Amours & Savoie, 2005; Oelberg et.al. , 2005).

- Reducing layer thickness before packing, increasing the weight of the packing tractor and the number of tractors can increase the dry matter density of the silage (Muck & Holmes, 2000; Visser, 2005; Craig & Roth, 2005; D'Amours & Savoie, 2005; Oelberg et al ., 2005).

1.3. Compaction pressure;

Knowing the compaction force applied to the material during the silo making means knowing the quality of the material in the silo. Therefore, it is important to know the compaction pressure. If the total pressure effectively applied during the silage phase is measured, the ideal compaction time can also be determined. In this way, the compaction process can be completed safely in the silo. However, providing adequate compaction in general terms is expressed with the density of the silage material and the density is generally measured after opening the silo. The pressure measurement system developed by us was used to determine the compaction level applied to the material during the silo making.

Measurement system

The measurement system has five units mainly (Fig 5). These are;

1. Pressure sensing tire globe
2. Hydraulic hose connection
3. Pressure sensors
4. Data recording and storage
5. Computer

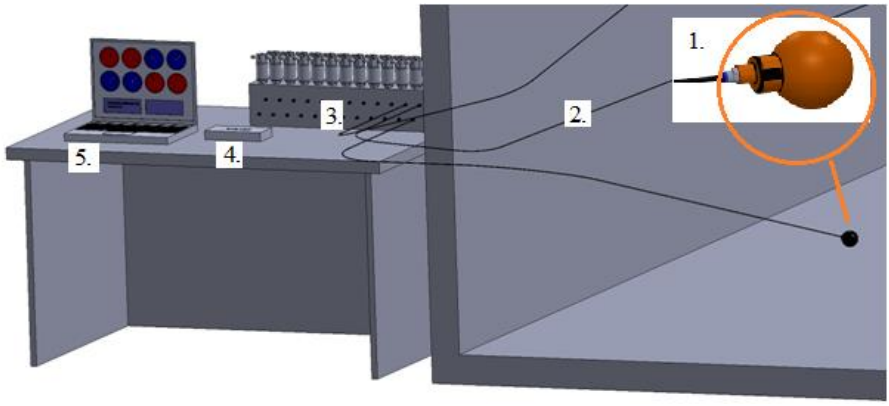


Figure 5. Pressure Measurement System (Tan et al. 2017)

1. Pressure sensing tire globes

Three-way tire globes are placed inside the pile poured into the silo as pressure sensors. The globes are connected to pressure sensors by hydraulic hoses. Thus, the force effecting the bulk material from all directions can be measured. Since the flexible globes (pressure sensors) are surrounded by silage, they are capable of transmitting the total pressure on them to the sensors regardless of direction. Similar pressure sensors were used in the measurement system developed by Turner & Raper (2001) to determine the compaction force in soils.

2. Hydraulic hoses

Hoses are in the form that they can withstand applications up to 10 bar pressure. These hoses are connected to pressure sensors with snap-on couplings. Pressure sensing tire globes were connected to pressure sensors via the hydraulic hoses. In this hydraulically operated system, water was used for pressure transmission (Turner & Raper, 2001).

3. Pressure sensors

Pressure sensors have a range to measure the force of the tractor and the work machine.

4. Data recording and storage

The data acquisition system is based on a graphical programming language NI LabVIEW software and NI Compact DAQ hardware modules.

5. Computer

Data are stored in a MS Excel file on the computer by using user interface created with NI Labview software.

Through the pressure measurement system, the compaction applied to the material in the silo can be determined and the compaction durations times can also be recorded. In this case, the duration spent by the compaction equipment at the positions related to the pressure sensing globes is determined. Figure 6 shows a schematic picture of the measurement works in a bunker type silo with pressure measurement system. Sensors provide the opportunity to make measurement by being placed in different layers in the silo, in the area close to the rear wall of the silo, in the middle of the silo or in different positions such as the front part of the silo.

Compaction pressure measurements were made both in bunker silos and pile type silos during the silage-making phase. In these studies

performed by us, the silo was examined by being divided into different regions and locations. It has been possible to measure the pressure inside the silo in both types of silo.

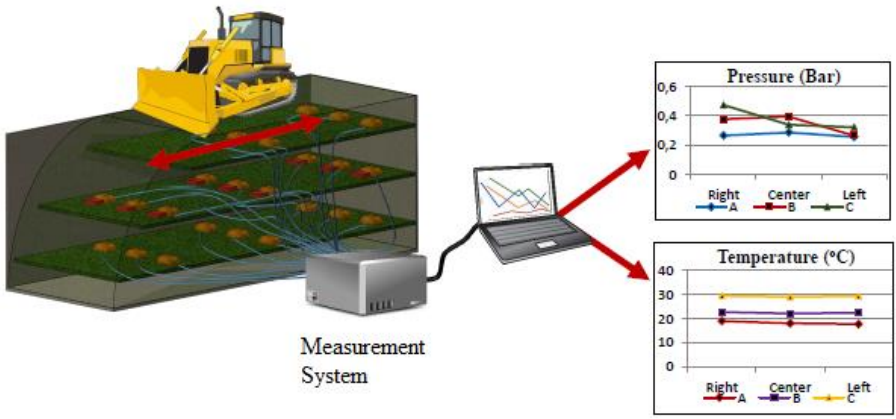


Figure 6.Compaction Pressure Measurements In The Bunker Silo

The highest compaction pressure measured in the bunker silo is 0.34 bar (Tan et al. 2017). Tan & Dalmıs (2019) reported that, the pressure measured in pile silo was 0.46 bar, which was higher than the value reported by Tan et al. (2017). Although average residual pressure was 0.33 bar, the maximum pressure measured instantaneously was 0.726 bar during the ensiling. Figure 7 shows a scatter diagram regarding the silage density, compaction pressure and duration spent for compaction when it is considered in terms of layers in silo.

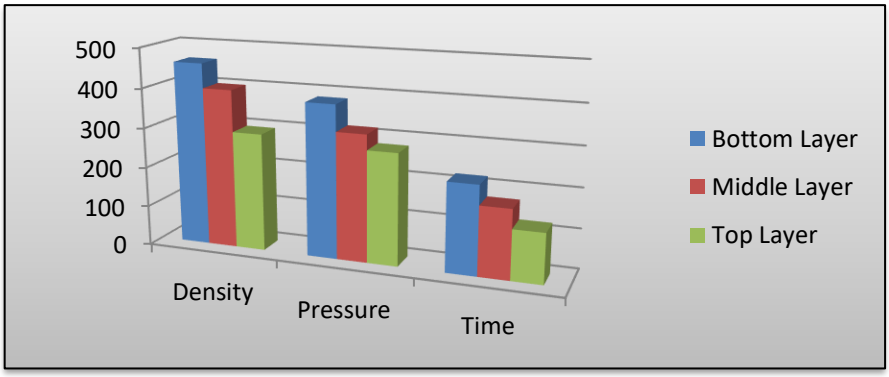


Figure 7. Silage Density, Compaction Pressure and Compaction Time In Bunker Silo (Tan et al. 2017)

As can be seen from Figure 6, there are large differences in compaction pressure, density and time between layers in the silo. On the other hand, it has similarly tended to increase or decrease. The silage density was high at the points where the compaction was high, or we can reach similar conclusions when we look in terms of compression times. However, compaction duration does not cause such high difference. However, if there is a difference of at least 25-30% in the period of time spent for compaction, it shows its efficiency. In order to avoid inequality in the distribution of the pressure determined in the material between the layers, our studies include situations in which layer thicknesses are equally shared.

1.4. Temperature

Quality of silage is related to the temperature of silage mass in the silo (Borreani & Tabacco, 2010; Jiang et al . 1987). Studies have shown that temperature is highly correlated with compaction pressure. As seen in

Figure 8, temperature values increased with increasing compression pressure at the measurement points (Tan et al. 2019).

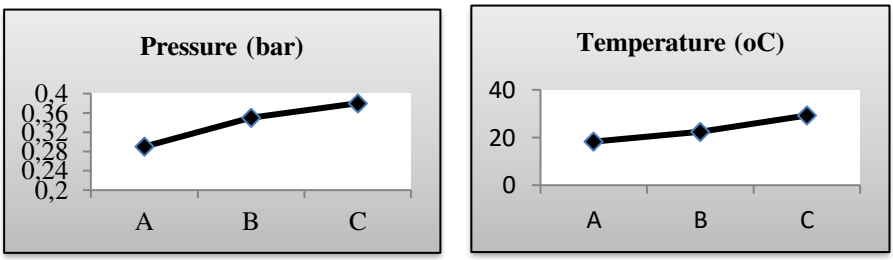


Figure 8. Compaction Pressure and Temperature

In Table 1, the effective parameters on silage quality in silo management are classified. It is seen here that there are many effective variable parameters. Therefore, silo management is very difficult.

Table 1. The Effective Parameters on Silage Quality In Silo Management

Equipment	Material	Silo	Livestock business	Operator
Type	Type	Type	Number of equipment	Experience
Number	Harvest period	Size	Number of employees	Information and skill
Mass	Dry matter (%)	Volume	Knowledge and experience	Application time
Technical specifications	Piece size	Location	Capacity	
Tire / track feature	Buffer capacity	Filling technique		
Number of tires	Crude protein content	Layer thickness		
Tire pressure	Carbohydrate content	Number of layers		
Tire / track contact area	WSC	Time		
Route		Dept		
Compaction press.				
		Silage		
	-	Compaction press.	✓	
	-	Porosity	✓	
	-	Permeability	✓	
	-	Density	✓	
	-	Temperature	✓	

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CHAPTER 9

ENVIRONMENT-FRIENDLY APPLICATIONS AFFECTING PLANT GROWTH AND YIELD IN AGRICULTURAL PRODUCTION

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INTRODUCTION

Agricultural production; it is to obtain a plant product using the seed, seedling and sapling. "Increasing productivity" in agricultural production has been one of the most important issues of the last 30 years. The expected increase in agricultural production is associated with meeting the food demand. It is clearly known that the concept of quality in agricultural production (Karaçal and Tüfenkçi, 2010) is important for environmentally-friendly production, together with the expression of productivity. It is important not only to grow plants highly yield, but also to grow plants healthy. With the emergence of agricultural problems, productivity in crop production has decreased. It has brought along irreversible errors. The yielding of the product and the quality of the products affect the factors such as fertilization, irrigation, planting-planting time, disease, pests and weed control. For example, fallow and crop rotation practices are used to protect soil fertility in regions with low rainfall. This situation will be reflected in the next production as yielding. Mono culture is the production method of the soil in which only certain depths of plant nutrients are used. If the stubble is not burned and the harvest residues are mixed with the soil in a suitable and appropriate time, it will bring organic matter and plant nutrients to the soil and ensure the sustainability of the soil and will positively affect the agricultural production. While soil tillage practices performed at the wrong time damage soil, farmers should also avoid the intensive machinery works.

Today, synthetic plant protection preparations used in chemical control are still the most preferred method by the farmers. Maximum and healthy yield can be obtained from plants by selecting and applying the correct methods of pest control. In recent years, the production of products in healthy production environments, environmentally friendly products, quality products, reliable food, etc. topics also stand out. In recent years, production in healthy environments, environmentally friendly products, quality products, reliable food, etc. topics stand out. However, organic (biological, ecological) agriculture, sustainable agriculture, biodynamic agriculture, good agricultural practices, alternative systems to conventional agriculture have emerged. In these systems, the principle of reliability has been adopted between producer and consumer. In this context, different soil tillage methods in environmentally friendly production have gained importance in order to protect soil fertility. These soil cultivation methods can be defined as, zero (0) soil tillage, number one (1) soil tillage and number two (2) soil tillage. 0 soil tillage is cultivation of the first 10-15cm depth of soil, number 1 soil tillage is cultivation of the 25-30cm depth of soil, number 2 soil tillage is cultivation of the 30cm and more depth of soil can be defined as. It is very important to prepare fertilization programs according to the cultivated plant and soil analysis without disturbing the soil pH balance in the implementation of these programs (Connelly, 2011). In addition, the use of organic fertilizers and renewable energy sources in plant production has gained importance in recent years. According to Akbaba (2003) and Özenç & Şen (2017), the use of organic fertilizers in plant production provides a continuous flow of

nutrients to the plants, while improving the soil structure in areas with insufficient and/or deficient nutrients, and also improving the permeability and water holding capacity to the soil. Researchers of the world have carried out experiments on different cultivars in order to prepare fertilization recipes with environmentally friendly practices. These scientific studies shed light on some of the problems of farmers. Studies were carried out about soil additives, organic fertilizers and/or encouraging plant growth practices were solved the recipe problems of the farmers. It has been observed that the use of microorganisms such as environmentally friendly bacteria, mycorrhiza fungi and algae in agricultural production as biological / ecological / organic fertilizers does not pose an environmental risk and revealed the importance of biological fertilizers. Biofertilizer was defined by Nguvu (2009). It is a living compound of microorganisms. These fertilizers can fix atmospheric nitrogen or solubilize phosphorus decompose organic materials. It is also oxidized Sulphur in the soil. Increasing success in researches on fertilizer applications originating from microorganisms is achieved by controlling the factors of soil moisture, soil organic matter, soil pH. Thus, it is predicted that biological fertilizer applications will continue to affect the natural ecosystem for years. Karaçal & Tüfenkçi, 2010 explained this by the fact that microorganisms develop their own activity in the nutrition of plants. In this context, the importance of environmentally friendly microorganisms (bacteria, fungi, algae, etc.) has emerged in plant growth and development.

In this section, the use of bacteria, mycorrhiza fungi and algae in agricultural production and the effects of these used microorganisms on the yield, quality and plant nutrient uptake will be explained through current and scientific studies. First of all, in terms of its benefits to plants; Plant Growth Promoting Root Bacterias' (PGPR), nitrogen fixing organisms, then the results of mycorrhiza fungi. Lastly Spirulina applications will be explained with scientific data.

1. PGPR Applications

In recent years, PGPR bacteria isolates have been used in different plants as biological control elements (Yıldız et al., 2012 and Şevik, 2010). PGPRs have started to be used in agriculture in terms of increasing the yield and mobilizing the nutrients in the soil and carrying them to the plant. Microorganisms in the soil form a dense population in the part defined as "rhizosphere". Bacteria are the most living organisms in the soil. PGPRs are soil bacteria found in the root environment and / or root surface habitat. These bacteria, which are named as Rhizobacteria, can colonize (Van Loon et. al.,1998) the roots in natural microflora by stimulating plant growth in the rhizosphere habitat, which they determine by their nature, with direct and indirect action mechanisms (İmriz et al., 2014). Nitrogen binding of bacteria promoting growth and development (Şahin et al., 2004), phosphorus uptake (Egamberdiyeva and Höflich, 2004), auxin (Jeon et al., 2003; Aslantaş et al., 2007; Sabır, 2013), cytokine (Timmusk et al., 1999; García de Salamone et al., 2001), the production of herbal hormones such as gibberellin (Gutiérrez-Mañero et al., 2001) and ethylene (Glick

et al., 1995), nutrients and some. They encourage plant growth by mechanisms of action such as increasing the intake of minerals, supporting root development, increasing enzyme activity in the plant, and increasing yield (Dejordjevic et. al., 1987 and Ferreira et. al., 1987 and İmriz et. al., 2014). According to Prasad et. al., 2019, PGPRs' have different modes which are biofertilizer, phtostimulators, biopesticide and bioremidators. PGPRs, defined as biofertilizers, act in a different mechanism. These are phosphate solubilization PGPRs' (Vansuyt et. al., 2007), siderophosphores production PGPRs' (Yazdani et. al., 2009), exopolysaccharides production PGPRs' (Sandhya et. al., 2009) and biofixation of atmospheric nitrogen PGPRs' (Weyens et. al., 2010). Nitrogen is the fourthly important element for plant dry mass (Prased et. al., 2019). PGPR can fix the atmospheric N and it can convert to available for plants. Solubilization and mineralization of phosphorus by phosphate solubilizing bacteria is an important trait that can be achieved by PGPR (Prased et. al., 2019). A study was about the effect of phosphate solubilization microorganisms (PSM) and PGPR on corn cultivation (Yazdani et. al., 2009) PSM and PGPR applications were added to conventional application and these applications increased ear weight, row number and grain number per row and yield when compared with control. They also reported that PGPR applications reduce fertilization costs and reduce greenhouse gas emission. Khosravi et. al. (2018) were reported co-application of PGPR, vermicompost and triple super phosphate significantly decreased shoot dry matter, which may be due to the P toxic levels in the plant aerial parts in calcareous soil. They also reported using these biological fertilizers instead of

chemical P fertilizers can reduce costs and environmental hazards. In a similar study (Xiaohui et. al., 2017) tomato was cultivated in calcareous soil to determine the effects of plant growth-promoting rhizobacteria and N source on plant growth and N and P uptake. In this study, inoculation with PGPR increased shoot dry weight and shoot N uptake for the same N rate and N source and effect of PGPR varied and was influenced by many factors such as N source, N rate, and soil fertility. Goyal et. al. (2019) were examined the effect of PGPR applications on greenhouse strawberry cultivation. As PGPR strains, Pseudomonas sp. strain MHA75, Bacillus sp. strain RCA3 and Bacillus sp. strain SYB101 were used alone and combinations in this study. Application of PGPRs' were increased plant growth, yield and fruit quality of strawberry. According to the results of the study, they reported that root-inoculated PGPR applications increase growth and yield and that PGPR applications in strawberry cultivation have a potential. Artyszak and Gozdowski examined the effects of PGPRs on soil properties, root yield and technological quality in the sugar beet plant in 2020 in Poland. In this study, Mineral N fertilization of sugar beet was reduced by 30% without decreasing the biological sugar yield and pure sugar yield and Penergetic-K and Penergetic P have achieved an increase as a result of the use of growth activators and preparations containing bacteria. Also, it was reported that high sugar yield can be obtained by environmentally friendly technologies. The use of PGPRs have not only contributed to the plant and sustainability, but also contributed to the transfer of nutrients to the plant leaves while decreasing productivity under stress conditions (Dayan, 2018). Although there are still a limited number of

researches in Turkey, I believe that the use of PGPR contributes to plant production, reduces chemical control, can be developed into different formulations and its applicability in different ecologies will increase and these preparations will gain an important share in environmentally friendly production.

1.1. Mycorrhiza Fungi

It is known that mycorrhiza fungi, one of the environmentally friendly microorganisms, have an effect on increasing the phosphorus solubility. Mycorrhiza fungi play an important role in maintaining the balance of the soil ecosystem (Sandal Erzurumlu and Erman Kara, 2017). The symbiotic life-forming system between microorganisms and plants, that is, mycorrhizal life, is present in almost all terrestrial plants (Almaca, 2014). After the researchers who stated that the symbiotic relationship between plant and microorganism in nature is provided by mycorrhiza fungi, the use of mycorrhiza mushrooms in agriculture facilitates the use of mycorrhiza fungi as a preparation in organic and environmentally friendly production. High rate of root colonization occurs in plant roots due to mycorrhiza inoculation (Mışraklı et al., 2020). It has been stated that the structure of the spores of the mycorrhiza fungi and their morphological and physiological structures within the root are taxonomically different (Sieverding et. al., 1991; Bagyaraj, 1991; Almaca, 2014). Mycorrhiza fungi contribute to plant growth, the intake of nutrients from the soil and the plant growing environment. Mycorrhiza applications in vegetables have been tried for many years (1995) in the Eastern Mediterranean region (Ortaş, 2010) in Turkey.

The preparations were produced and certified by different companies in order to increase plant growth and productivity in organic agriculture have been tried by researchers in different regions of Turkey. The importance of using mycorrhiza in organic agricultural production has emerged. The effects of this application on plant growth under stress conditions, open field or greenhouse conditions, as well as its contribution to the intake of nutrients in the soil and plant growing environment have been investigated. It has been announced that the use of mycorrhiza in the agricultural field will increase soil fertility, plant product quality, reduce input costs, reduce profitability and agricultural-based environmental pollution (Sandal Erzurumlu and Erman Kara, 2017). It has been explained that the application of mycorrhiza to plant roots due to its root development feature in vegetable cultivation in areas where water is limited, efficiency can be achieved to meet the optimum water need (Akın et. al., 2020). The relationship between mycorrhizal fungi, pathogens and mycorrhiza is among the basic principles of biological control and is involved in stimulating competition host resistance (Biçici, 2011). It has been determined by many researchers that there is a chance to combat important soil pathogens in the rhizosphere by stimulating plant resistance mechanisms with mycorrhiza applications (Çetinkaya, 2008). The use of mycorrhiza has an important place in plant nutrition, it is effective in taking many elements, especially P and Zn, into the plant. Mycorrhiza fungi may not affect plant growth much when they are fixed in plant roots in case of lack or insufficiency of nutrient elements in the soil. It has been stated that the intake of nutrients

present in the soil increases thanks to the mycorrhizal hyphae and the effect of mycorrhiza on the intake of mobile nutrients such as N and K (Bieleski, 1973; Almaca,2014). Ortaş (2012) stated that when arbuscular mycorrhiza fungus (AMF) is infected, it contributes to the intake of many nutrients such as phosphorus (P), copper (Cu) and zinc (Zn) to the host plant. Smith and Read (2008) explained that mycorrhiza fungi contribute to plant growth and increase plant resistance under stress conditions. AMF play an important role in improving the adaptation to biotic and abiotic plant stresses and increasing plant growth and yield (Diagne et. al., 2020). In another study, it was explained that AMF 'has a positive effect on plant growth under stress conditions (Begüm, 2019). Çetinkaya and Dur (2010) were found that mycorrhiza fungi have an effect on the yield and quality parameters of the corn plant under field conditions. When Özeren et al. (2019) examined the effect of mycorrhiza and planting system on tomato yield and quality, they found differences between the results, but statistically the results were not different from each other, but Al-Karaki, 2006, Saka, 2012, Baum et al., 2015, Bona et al., 2017 and Ulusu and Yavuzaslanoğlu, 2017 were stated in their studies that mycorrhiza applications significantly affect the yield and quality parameters of tomatoes.

Sabri et al. (2020) were reported as a result of study that in cucumber cultivation, the application of mycorrhiza to the plant roots, better development of the plant roots, more use of the water in the effective root zone, and significant increases in yield. In the same study, it was

determined that applying mycorrhiza in cases where water is limited provides a significant increase in efficiency, while they stated that 25% more product is obtained with mycorrhiza application when ⅔ of the optimum water need is met.

In another recent study, it was reported that the application of mycorrhiza in saplings of Meyer lemon variety did not affect the rootstock diameter, shoot diameter and shoot length in terms of plant growth, but did affect the chlorophyll amount in the leaf and leaf area index values among other parameters (Mışraklı ve ark., 2020). In the same study, it was determined that microorganisms (Mycorrhiza and PGPR) applied individually or in combinations have been limited the activities of other microorganisms in the rhizosphere. Çiylez et al. (2018) used mycorrhiza and PGPRs, which have proven useful in various studies.

Glomus fasciculatum among the mycorrhiza species, Agrobacterium A18 among the rhizobacterium strains, find that it has a positive effect on strawberry cultivation, they recommend that these two beneficial microorganisms can be used together in strawberry growing.

It has summarized in this section that with mycorrhizal colonization, mycorrhiza fungi, as a true extension of the root system, enter the places where the roots cannot enter and ensure that the plant nutrients and water can be taken by the plant. There is a beneficial relationship between the mycorrhiza fungi in the roots and the plant. Mycorrhiza fungi can increase vegetative yield, root structure and plant growth,

biomass, fruit number, leaf and surface area. In addition, it can reduce the demand for the use of synthetic chemical fertilizers as in PGPRs, and protects the plant in stress conditions (lack of water and saline soils).

In the light of researches and published studies, it is seen that mycorrhiza applications are used both as commercial preparations and produced under laboratory conditions in environmentally friendly plant production.

1.3. *Spirulina* spp. Applications

For the last 15 years, it has been known that water and marine plant extracts provide useful inputs used in agriculture. Research is being conducted on how it affects plants and their benefits.

In researches, algae seeds contain indole acetic acid (IAA) and indole butyric acid (IBA) from growth-promoting hormones, Iron (Fe), Zinc (Zn), Copper (Cu), Cobalt (Co), Molybdenum (Mo), it has been reported to contain growth regulators such as Manganese (Mn) and Nickel (Ni) as well as vitamins and amino acids (Crouch and Staden, 1992), auxins, gibberellins and cytokinins (Özenç and Şen, 2017). Today, ready-to-use powder and liquid algae extract products from the soil or the leaves of the plant are produced and used as an environmentally friendly-biological fertilizer, sometimes pure and sometimes with additives. Spirulina is a micro-organism which is edible and it can be naturally grown in alkaline lakes of tropical and sub-

tropical regions (Khaing et al., 2009). Spirulina is a microscopic blue-green algae (algae) species that lives in water, a type of cyanobacteria.

Spirulina is naturally found in some lakes, mainly in Ethiopia, Kenya, Tanzania, Chad, Botswana. In Turkey, attention was drawn to the nutritional properties and production of Spirulina approximately 25 years ago (Cirik, 1989) and Spirulina was produced in pools for the first time in cooperation with Ege University-Industry. Spirulina is a blue-green algae and unicellular microorganism mostly produced in pools as a food supplement in Turkey. It is rich in chlorophyll and similar to plants, it gets its energy from the sun. Since the nutritional elements, vitamins and minerals contained in Spirulina are natural, they do not cause any accumulation in the human body and are disposable (Richmond, 2004). Although it is not very difficult to grow Spirulina in Turkey, it is developed in alkaline lakes with high pH value and in large outdoor pools under absolutely controlled conditions.

It is applied by re-diluting the powdered form of Spirulina produced in pools after drying in agriculture and adding it to the plant growing medium (Bayram, 2014; Khaing Khaing, 2009; Yee, 2009; Özenç and Şen 2017). Some researchers have also carried out experiments by applying algae to leaves and roots (Craige, 2011).

Researches on plant growth, nutrient content and productivity applications of Spirulina are still being carried out in the world and in Turkey. Although these studies are limited in terms of plant growth, productivity and nutrient intake, positive effects of using Spirulina have been determined in their results.

In melon cultivation study was carried out in Adıyaman, the highest main stem diameter, main stem length, root-stem-leaf fresh weight, stem dry weight and plant dry weight values were determined as a result of biomass measurements. In the same study, Spirulina applied parcels gave good results on highly fruit number and regular fruit harvest (Bayram, 2014).

Yee et al. (2009) studied the effect of spirulina on growth and yield in Brassica campestris L. Cv. Indian Mustard (Mon -nyin) cultivation. They compared different doses of Spirulina with control application (no Spirulina applied) in this study. As a result of this study, they found that 3 gL-1 Spirulina application gave the best results in plant height, yield and fruit number compared to the control, also it was announced that Myanmar Spirulina could be used as a natural biological fertilizer in Indian Mustard cultivation.

Khaing et al. (2009) investigated the effects of Spirulina on germination, growth and productivity in the cultivation of Phaseolus lunatus L. (Lima Bean). 5 different doses (1g/l, 2g/l, 3g/l, 4g/l ve 5g/l) were compared with control application (no Spirulina application). They obtained the highest germination (%92) from 4g/l application. Researchers observed the same application (4g/l) as the highest application in mean shoot length, mean plant height, mean leaf area and efficiency according to the control and other doses. Thus, Spirulina was a successful application in lima bean cultivation with this study. Win Naing Oo also applied Spirulina to rice and wheat in 2008 and found

that 2gl/l application gave the best results in germination and shoot growth.

Dayan et al. (2018) determined no statistically significant difference on yield parameter with other applications when they used Spirulina instead of growing plants, either alone or by mixing it with organic fertilizers in their snack squash studies. However, Spirulina application was observed as the second important application in lipid content.

As a result, Spirulina application is among the microorganisms that contribute to agricultural production and promote plant growth as an organic fertilizer. Spirulina application could be tested as an effective environmentally friendly fertilizer on different species in new studies under different ecologies. When Spirulina is been certified as organic fertilizers, usage of Spirulina will be widespread.

The use of microorganisms in Organic Agriculture, which is an environmentally friendly agricultural production method, is clearly stated in the regulation. Not only in organic farming practices, but also in sustainable agriculture, biodynamic farming, good agricultural practices, etc. It is also an effective and important source of biological fertilizers in applications. It has been clearly demonstrated that these practices contribute to the quality and yielding concepts sought in plants as well as soil fertility. It is important to address the ecological balance not only with known wrong industrialization or by choosing the right food, but also with agricultural production holistically. It has been observed that PGPRs and mycorrhiza fungi, which are among the environmentally friendly microorganism groups, are the most current

researches. The effects of PGPRs on plant growth and development, on the transport of nutrients in the plant growing medium to the plant leaves, on yielding issues have been explained through studies. The resistance mechanisms developed by PGPRs against diseases are also important in environmentally friendly production.

It has been determined that mycorrhiza stimulate plant resistance mechanisms under stress conditions and also contribute to the intake of other nutrients, especially P and Zn, with studies. It has been observed that studies on plant growth and quality parameters of Spirulina, which is limited in number, should be increased.

At the end of this section, it is important to apply environmentally friendly practices that regulate plant growth and development in different plant species in terms of ecosystem balance, as well as not polluting the soil and the environment. Studies on this subject need to be carried out in different plant groups and ecosystems and expanded.

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CHAPTER 10:

SHIGELLOSIS AND SIGNIFICANCE IN TERMS OF PUBLIC HEALTH

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INTRODUCTION

Shigella bacteria are the primary causative agents of shigellosis or bacillary dysentery disease. This genus of bacteria was first discovered by a Japanese scientist, Kiyoshi Shiga (Binet & Lampel, 2013; Halkman, 2019). Bacilliform bacteria, a member of Enterobacteriaceae family, are gram negative, immobile, facultative anaerobic, catalase positive, oxidase negative, able to ferment carbohydrates, non H2S producing and 1–3 x 0.7–1.0 µm in size (Strockbine & Maurelli, 2005). It is estimated that annually at least 600.000 people died from this disease (Erol, 2007). Disease incidence is quite high not only in undeveloped countries, but also in developed countries. Especially in undeveloped countries, shigella bacteria increase disease severity or have greater lethal effect on children under 5 years of age, elderly over 65 years of age and individuals with a weakened immune system. Shigella infection is typically by fecal-oral means or direct contact from one person to another (Erol, 2007; Halkman, 2019). Another means of infection is passive infection through the consumption of contaminated water and foodstuffs. Among the shigella species, S. dysenteria is the most dangerous one and the others pose a moderate risk on human health (Karapınar & Aktuğ Gönül, 2015). S. dysenteria produces shiga toxin and the others produce shiga-like toxins. Because of reproduction ability between 10 - 45°C, shigella bacteria have both mesophilic and psychrophilic characteristics (Erol, 2007; Halkman, 2019; Karapınar & Aktuğ Gönül, 2015). Therefore, bacteria could survive in several cold-stored foodstuffs. Besides the foods stored at improper storage

temperatures, bacteria are also encountered in cold-stored foods and consumption of these foods may result in serious infection and poisoning in humans.

General characteristics of shigella species:

These bacteria, a member of Enterobacteriaceae family, have gram negative, immobile, bacillus, 1–3 x 0.7–1.0 µm in size, asperous, acapsular, facultative anaerobe, catalase positive, oxidase negative, able to ferment carbohydrates and non H2S producing characteristics. Genetic and biochemical characteristics of shigella species are similar with the E. coli. Among the shigella species, S. dysenteria has the greatest pathogenicity (Binet & Lampel,2013). Growth temperatures range between 10 and 45°C with an optimum reproduction temperature of 37°C. Bacteria are known to be inactive at temperatures close to pasteurization temperature (at 63°C for 5 minutes). On the other hand, although a broad range of pH (5.0 – 9.0) is required for reproduction, the best reproduction is achieved at a pH of between 6 – 8. Also, bacteria were reported to survive at 5% salt concentration (Erol, 2007; Karapınar & Aktuğ Gönül, 2015). Since the bacteria are facultative anaerobe, they have a broad range of oxidation-reduction potential (between +386 and -745) (Hentges, 1969). At least 4x107 cell should exist for shiga toxin production (O'brien & Holmes, 1987). Minimum infectious dose (MID) for shigellosis is generally around 200. Although the MED value for S. dysenteria is 10, the value should be between 102-104 cfu/g for the other species (Erol, 2007).

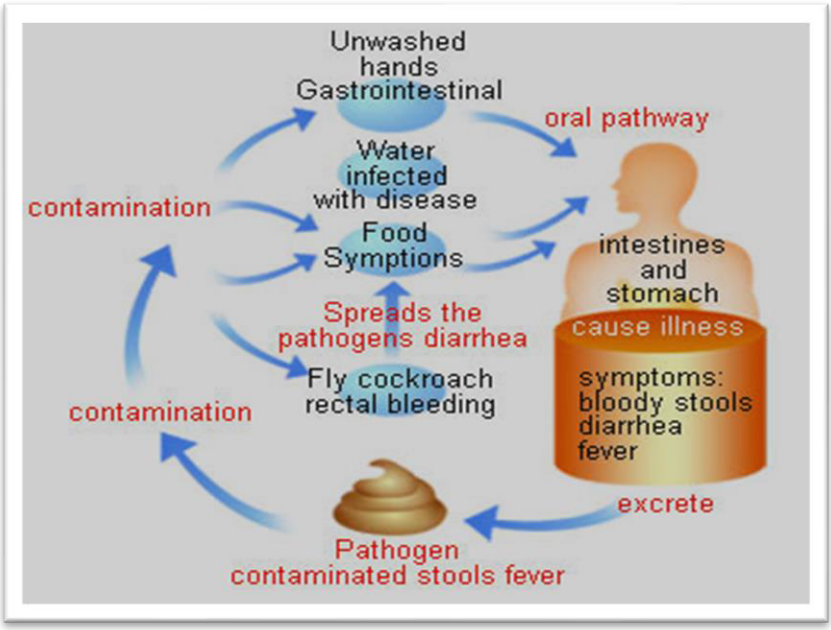

Figure 1: Means of contamination for shigella species (Anonymous, 2020).

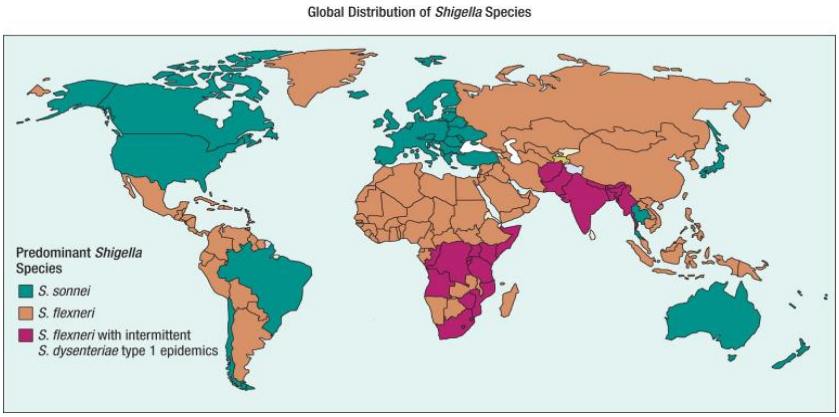

Figure 2: Global distribution of shigella species (Bennish & Ahmed, 2020)

Shigella species in waters:

Drinking and domestic waters constitute the most important source of infection for shigellosis originated from shigella species. Chouhan (2015) indicated that shigella species are encountered in all natural drinking water resources and 91.6% of processed spring waters.

Ibrahim (2017) conducted a study in Galadze region of Iraq and isolated shigella species from 20% of drinking waters and 80% of domestic waters and identified S. dysenteria in drinking waters and S. dysenteria in 4 domestic water samples, S. flexneri in tow samples and S. sonnei and S. boydii in one sample each. Number of cells of shigella species was reported as between 22 - 1650 cfu/g.

Crockett et al. (1996) conducted an experimental study investigated number of cells in shigellosis and reported an incidence of epidemic at 95% confidence in case of 10.5-12 cells in waters and 344 cells in foods. These numbers were considered significant in risk assessments for S. dysenteria and S. flexneri.

Taneja and Mewara (2016) conducted a study on epidemiology of shigellosis and indicated shigellosis as the primary reason of diarrhea, reported high morbidity and mortality and pointed out that sufficient sanitation and safe water supply played as significant role in epidemiology of shigellosis disease.

Makintubee et al. (1987) investigated swimming-related shigellosis-induced diarrhea based on the complaints of stomachache, fever, nausea and bloody-mucous stools and diagnosed swimming-related disease in

38 of 44 people (86%). Researchers reported that disease incidence was not observed in non-swimmers and typical symptoms were encountered in 16.66% of walkers around the water, 20% of the ones submerged into water but not swallowed and 61.81% of the ones submerged into water and swallowed. In this way, researchers suggested that swimming might constitute a potential source of shigellosis and the other enteric diseases.

Ugbogu et al. (2006) isolated Salmonella-Shigella species from home flies in Nigeria and reported that shigella species were encountered in all of 34 flies collected from water pool and salmonella species were encountered in 21 of them (61.7%). Researchers indicated the significance of vectors in spread and transfer of the disease and pointed out the need for insecticide and sanitation treatments in waste repositories.

However, Çetinkaya et al. (2007) conducted a study on drinking waters of Bursa province of Turkey and reported that Salmonella and Shigella species were not encountered in drinking waters supplied from artesian wells.

Because of all these issues, it is recommended that local authorities should disinfect especially drinking waters and domestic waters (used for washing and cleaning) against shigellosis.

Shigella species in meat and meat products:

Animal drinking waters should possess the quality characteristics at least as much as human drinking waters and such an issue plays an

important role in prevention of the production of shigella and the other pathogen microorganisms. Besides the microbiological characteristics of carcasses, disease agents may be encountered through the contaminations from the waters used in meat processing and staffs working in meat processing (Hallaç, 2004). Thusly, Rahimi et al. (2017) conducted a study about the existence of S. dysenteria and S. flexneri in meat and meat products served in factory and local markets of İsfahan region of Iran and antibiotic resistance of these species. Researchers reported the incidence of shigella species in 80 beef samples, 50 hamburger meat samples, 50 roasting beef samples, 40 sausage and 40 salami samples from the local markets respectively as 8.75, 6, 4, 0 and 2.5%; reported the incidence of Shigella spp. in meat, ground beef and final products respectively as 40, 20, 10% in one factory and respectively as 40, 10, 10% in the other factory. Significant differences were reported in Shigella spp. incidence of meat and meat products ($p<0.05$). But, the differences in shigella incidence of sausage and salami were not found to be significant. Incidence of shigella in poultry meat dough of 3 different factories was respectively reported as 28.57, 20 and 0% and significant differences were observed in disease agent frequency of the factories. Researchers indicated that S. dysenteria and S. flexneri were isolated from meat and meat products sold in markets; S. dysenteria was dominantly identified in roasting beef and salami samples; S. dysenteria was identified in all mortadella salami dough and S. flexneri was identified almost half of German sausage dough. It was reported that Shigella species exhibited quite a high resistance against gentamicin (100%), tetracycline (92.30%) and

ampicillin (84.61%), but were found to be sensitive against ofloxacin (23.07%), co-trimoxazole (23.07%) and imipenem (7.69%).

Ahmed and Shimamoto (2014) conducted a study in Egypt on 1600 meat and dairy samples and reported Salmonella, E. coli and Shigella species as among the most important food-originated diseases and epidemics. Shigella species were identified in 16 meat samples (2.0%); in species level, S. flexneri was identified in one sample (1.4%), S. sonnei in 3 samples (0.4%), S. dysenteria in 2 samples (0.25%). Researchers reported that Shigella species were identified mostly in fresh meat samples (9 samples) and pointed out that hygiene and treatments played an important role in prevention of diseases.

Munir et al. (2014) analyzed 849 samples (661 poultry carcass and organs, 168 eggs, 20 poultry meat containing mayonnaise and shawarma) collected from Khartoum region of the Sudan and identified shigella species in 20 poult meat samples (3.03%), in egg shell and constituents of 8 samples (4.76%) and in one sample of poultry meat products (5.00%). Apart from Shigella, several other pathogens were identified in poultry products and indicated that such pathogens posed serious risks on public health, there was a need for further epidemiological studies and such threats should be eliminated through eradication of pathogens.

Ibrahim (2017) conducted a study in Galadze region of Iraq and isolated shigella species from factory-made raw poultry meat (30%), traditionally produced poultry meat (20%), chicken shawarma (50%) and meat shawarma (40%) samples. While only S. dysenteria was

identified in traditional raw poultry meats, more than one shigella species were identified in the other meat-originated samples. The S. dysenteria was the most dominant species identified in meat samples. Number of shigella species was between 40 – 1630 cfu/g in raw poultry meats and between 80 - 710 cfu/g in cooked meat samples.

Shigella species in dairy products:

As it was in several diseases, milk and dairy products may be a source of contamination for shigellosis disease in cases where proper hygiene rules were not followed. Ahmed and Shimamoto (2014) identified Shigella species in 11 dairy samples (1.4%). In species level, S. flexneri was identified in 7 milk samples (0.9%) and S. sonnei in 4 samples (0.5%). Shigella species were mostly identified in square cheese samples (7). Researchers indicated that hygiene and treatments played a great role in prevention of the disease.

Ibrahim (2017) invesitaged home-made dairy products served for consumption in Galadze region of Iraq and identified S. sonnei in 10% home-made yoghurts and S. flexneri in 10% of home-made ayrans. Number of Shigellosis disease agents varied between 180-590 cfu/g. Stuff, tools and equipment or process water were the primary sources of contamination.

Garcı´a-Fulgueiras et al. (2001) conducted a case screening study about gastroenteritis related to consumption of pasteurized milk cheeses and screened the epidemic encountered in November 1995 influencing 200 people and identified the disease agent as S. sonnei and the source as

fresh cheeses made of pasteurized raw milk. Contamination to these cheeses mostly came from the personnel working in food processing department. The S. sonnei was not identified in stools of more than 20 of 123 patients. Freshly consumed cheese was included in 3 types of meal consumed ($p < 0.001$). Researchers pointed out that hygiene rules should be followed in all stages of cheese production, consumption and sale of raw or non-pasteurized cheeses should not be allowed.

The measures to be taken against shigellosis in milk and dairy products could be summarized as: quality drinking water supply to animals; take care of feed hygiene; regular health checks of animal caretakers; staff hygiene from milking to final product; proper disinfection of tool-equipment.

Shigella species in sea products:

Sewage waters or untreated wastewater effluents are the primary reasons of pollution in seas and sea products. These waters or wastes influence sea creatures.

Vantarakis et al. (2000) conducted a study in Greece and indicated that instead of conventional methods, more reliable PCR techniques should be used in identification of Salmonella and Shigella in mussels for food safety.

Obaidat and Bani Salman (2017) analyzed 330 commercial fish samples imported from Egypt, Yemen and India and isolated Salmonella from 64 samples and Shigella from 61 samples. Researchers reported antibiotic resistance as 79% for Salmonella isolates and 98% for

Shigella species. Shigella species had the greatest resistance against tetracycline, amoxicillin–clavulanic acid, cephalothin, streptomycin and ampicillin and the least sensitive against gentamicin and ciprofloxacin. Researchers indicated that 14 Salmonella and 42 Shigella species isolated were found to be resistant against antibiotics, thus such resistance may prolong the therapy duration of diseased individuals or may turn the disease into an uncurable one.

Shigella species in fruit – vegetables:

Ignorance or negligence of hygine and sanitatino rules during the harvest, storage and processing of fruits may result in emergence of shigellosis and several diseases.

Lennox et al. (2015) conducted a study in Nigeria about the existence of Salmonella and Shigella species in fruits and reported the average number of Salmonella and Shigella species respectively as 1.10x104 and 2.4x105 cfu/g. Such numbers were found to be quite high; the greatest incidence of Salmonella spp. (77%) and Shigella spp. (57%) was observed in water leaf (a kind of forest plant consumed in Nigeria) surfaces, incidence was 33% in squash and no-incidence was observed in carrot. Researchers pointed out that cross-contamination of these raw or insufficient heat-treated foodstuffs and resultant consumptions pose serious threats on public health through emergence of food-induced diseases.

Kapperud et al. (1995) investigated the epidemics encountered in several European countries including Norway, Sweden and the United

Kingdom between May – June 1994 and Shigella sonnei was reported to be responsible for majority of these epidemics. Researchers indicated that Shigella sonnei resulted in shigellosis in 97.9% (46/47) of raw-consumed lettuces and 97.1% (34/35) of head lettuces ($p<0.0001$). It was also reported that shigella species were responsible for antibiotic resistance developed in thousands of people in Norway.

Agle et al. (2005) investigated the reasons of epidemic encountered 72 hours after a dinner in a restaurant in Chicago in March 1999 through fever and acute diarrhea and indicated the primary reason as the bean salad. Researchers analyzed the stools of the patients with disease complaints and identified the disease agent of S. boydii 18. The disease agent was able to develop throughout the shelf life of bean salad, survived at 4°C, not reproduced, but doubled at 23°C until the 2nd day, then rapidly decreased. Researchers pointed out significance of storage and shelf life conditions in prevention of food-induced pathogens.

Rahman and Noor (2012) indicated that fecal coliform, E. coli, S. aureus-like several pathogens existed in salads and vegetables consumed in Bangladesh and these foodstuffs including cucumber, lettuce and tomatoes posed significant risks on public health.

Shigella species in various foodstuffs:

Warren et al. (2006) indicated that Shigellosis was the 3rd most reported disease in 2002. Researchers asserted that disease was encountered mostly through contaminated foodstuffs because of insufficient personnel hygiene. Shigella disease agent was reported to

be identified in acid-resistant and salt tolerant fruit and vegetables, low-pH foods, take-home foods, modified or vacuumed foods and it was reported that disease agent improved survival in cold (refrigerator conditions). Conventional, immunological and molecular microbiological methods are employed in disease agent identification. Problems are encountered in conventional method because of the lack of appropriate selective broth, there is a since commercial test kit in immunological tests, thus more developed and reliable PCR techniques are recommended for identification of disease agents.

Ibrahim (2017) conducted a study in Galadze region of Iraq and isolated Shigella species 50% from raw village eggs and 10% from boiled village eggs, identified only S. sonnei in boiled eggs, S. dysenteria in 2 of positively identified raw eggs and identified the other shigella species in each one of remaining samples. Number of cells of shigella species were reported as between 2 – 100 cfu/g in boiled eggs and between 490 - 1630 cfu/g in raw eggs.

Cetinkaya et al. (2008) conducted a study in Bursa province of Turkey to investigate Salmonella and Shigella species in various foodstuffs and food industry employees. Researchers were able to identify Salmonella infantis only in 2 of 416 samples, but they were not able to identify Shigella species.

Muleta and Ashenafi (2001) taken 30 samples from 5 groups of foods (150 samples in total) sold in streets and identified S. flexneri in 3 (10%) macaroni samples and these species were resistant against 5 different antibiotics. As compared to sandwich eggs, Shigella flexneri

development was quite high in macaroni. Researchers pointed out that foods sold in streets were seriously contaminated, pose serious risks on public health, thus should not be kept under improper conditions for long durations.

Shigella species in humans:

Koehler et al. (2006) conducted a study on enteric pathogens in children under 5 years of age between the years 1996-98 and reported that shigella was the most common (38%) in children of 1-4 years age group and shigella infections had the second place (45%) in June-September period after Campylobacter infections (46%). Researchers pointed out that strategies should be determined for the control and prevention of the disease in children especially through elimination of enteric pathogens.

Mead et al. (1999) investigated food-related disease and mortalities in the USA and reported 448.240 Shigella spp. originated cases. Of these cases, 1476 were epidemic, food-originated contamination ratio was 20%, ratio of in-patients was 0.139 and case-mortality ratio was 0.0016. Of 448.240 cases, 89.648 were food-originated and the ratio in total food-originated diseases was 0.6%; of 6231 hospital records, 1246 were food-originated and the ratio in total food-originated hospital records was 2%; of 70 shigella-originated mortalities, 14% were food-originated and the ratio of shigellosis-originated mortality in total mortalities was 0.8%.

Miller et al. (2005) linked together S. sonnei-originated pneumonia in poorly nourished children, humans with weakened immune system, patients infected with *human immunodeficiency virus* (HIV) and individuals with chronic diseases.

Alcoba-Flórez et al. (2005) conducted a study in Spain about food-originated diarrhea encountered in a hotel and identified S. sonnei in 14 (50%) of 28 tourists. Disease symptoms were identified as stomachache and diarrhea in all 14 of them, vomiting in 5, fever in 2 and excessive water loss-induced renal failure in 1 of them. Researchers indicated that risk of pandemic could be reduced through prioritized food safety measures, regular chlorination, monitoring and inspection of wastewater and drinking water facilities.

Von Seidlein et al. (2006) indicated that disease symptoms resulted in watery diarrhea, fever, stomachache, dysuria and bloody diarrhea-like serious complications and disease severity could vary with the infection agent. Researchers also asserted that antibotic treatment might be used to reduce disease severity.

Emch et al. (2008) investigated the case in a hospital of Bangladesh and indicated that almost half of the cases were Shigellosis. Researchers investigated various variables of the randomly selected patients for 3 years and identified 161 S. dysenteria 1 and 225 S. flexneri cases. Both bacteria were mostly identified in children under two years of age and it was followed by 2 – 5 years old age group. S. dysenteria exhibited changes with time, but S. flexneri not. S. dysenteria cases were mainly attributed to aseptic toilets around the markets and bazaars, but S.

flexneri was common in flood control regions. It was pointed out that S. dysenteria was related to hygiene and sanitation and S. flexneri was rather related to environmental sources.

Fight against shigellosis:

Waste repositories should be treated with insecticides to prevent the spread of the disease since the disease spreads through vectors (Bidawid et al.,1978; Ugbogu et al., 2006).

Selma et al. (2007) conducted a study about the effects of ozone treatments on S. sonnei species in cut lettuce and waters and reported that 5 ppm ozone treatment was more effective in cut lettuce than the other treatments and significant reductions were achieved in number of S. sonnei in waters with increasing ozone concentrations and treatment durations in waters ($p < 0.05$).

Soffer et al. (2017) indicated that lytic Bacteriophage (ShigaShield™) significantly reduced the Shigella sonnei contamination in water and foods by about 90% ($p<0.05$), thus could be used against Shigellosis.

Mirzaei et al. (2018) conducted a study about the efficacy of Lactobacillus species isolated from traditional yoghurt culture and milk against Shigella species and reported that 6 lactic acid bacteria isolated from milk had an inhibitor effect against 12 Shigella species and concluded that lactobacillus species isolated from traditional yoghurt and milk could be used against S. flexneri and S. sonne.

Murdoch et al. (2012) investigated lethal impact of 405 nm UV treatments on some pathogens and reported that S. sonnei exhibited 5 log reduction (99.3%) in liquid medium in 2.5 minutes, 64.4% reduction in 15th minute, 93.3% in 30th minute and 99.3% in 45th minute. Significant differences were observed in bactericidal effect of UV light treatments based on light exposure duration and intensity ($p<0.05$). Researchers indicated that 405 nm UV light could reliably be used in prevention of surface contaminations in food and health sectors.

Raiden et al. (2003) investigated the effects of detergents at 22 and 40°C on removal of Salmonella and Shigella species from the surfaces of fresh products and reported that detergents reduced number of Salmonella-Shigella species in tomato, strawberry and lettuce more as compared to water. All detergents were found to be more effective in removal of bacteria at 40°C ($p <0.05$) and removal rates significantly varied with the type of product, detergent and temperature parameters ($p<0.0001$).

Warren et al. (2007) investigated the survival rate of five types of Shigella sonnei cocktails on smooth tomato surfaces, potato salads and raw ground beef. For this purpose, since S. sonnei species were resistant to rifampicin, antibiotic was supplemented into the samples for better identification and tomato samples were stored at 13°C/85% RH and potato salad and ground beef samples were stored at 2.5°C and 8.0°C temperatures. Assessments were made with the use of the most probable number (MPN) technique. Researchers reported that numbers significantly decreased on tomato surfaces and S. sonnei was not

identified in two days, but numbers in potato salad and ground beef samples throughout the shelf life at 2.5°C and 8.0°C did not decrease and maintained survival rates. Researchers also indicated that temperature did not have significant effects on S. sonnei species.

Simango and Rukure (1992) conducted a study on survival of enteric pathogens in traditional fermented foods and inoculated one unfermented and 2 fermented food groups with 106-107cfu/ml Salmonella, Shigella, Campylobacter, Aeromonas spp. and E. coli. Researchers indicated that Aeromonas and Campylobacter were not identified in traditional fermented foods 20 minutes after inoculation, Salmonella was not identified 4 hours after inoculation, but identified Shigella and E. coli species resistant to low pH of fermented foods. Number of these surviving species distinctively decreased 24 hours after inoculation. It was concluded that since fermented foods had lethal or inhibitor effect on pathogens, they played an important role in prevention of enteric pathogen bacteria.

Bennish and Ahmed (2020) indicated that Shigellosis was frequent encountered especially in poor countries with insufficient hygiene conditions and disease spreaded mostly through fecal-oral means. It was also reported that disease agent generally exhibited resistance against antibiotics, but antibiotic treatments provided significant benefits in individuals with dysentery symptoms. Ciprofloxacin and azithromycin were mostly preferred in treatment of the disease. Researchers pointed out that an effective vaccine should be developed since antibiotics might be insufficient in disease treatment.

Islam et al. (2001) investigated the survival of Shigella dysenteria type 1 on some materials. Researchers were not able to count the disease agents with conventional methods, but encountered disease agents with PCR and fluorescent antibody technique even 5 days after inoculation. Disease agent was the least encountered on plastic (1.5 hours), glass (2 hours), aluminum (2 hours), wood (3 hours) and fabric (4 hours) surfaces. It was asserted that decreasing moistures during drying did not have significant effects on survival of S. dysenteria. Researchers also pointed out that surface of home appliances might frequently be contaminated with S. dysenteria and result in emergence of shigellosis in developing countries like Bangladesh with insufficient hygiene conditions.

Zaika and Phillips (2004) indicated that temperature, pH, salt content and additives were effective in maintenance of survival and reproduction of shigella species in foods and reported increasing survival rates for S. flexneri with decreasing temperatures, salt or NaCl concentrations and increasing pH levels.

Hentges (1969) investigated the effects of 14 different coliform group of bacteria isolated from human feces on development of S. flexneri and reported that none of the coliform group bacteria produced antibiotics against S. flexneri, but formic acid and acetic acid formed in mixed cultures inhibited S. flexneri. However, S. flexneri could not be identified since it was either in still or death phase.

Nyachuba (2010) indicated that food-originated diseases have recently increased, posed serious risks on public health and resulted in

significant economic losses, thus pointed out the significance of hygiene conditions throughout the entire production phases from the farm to tables. It was indicated that shigellosis was the third most common food-originated disease after Salmonella and Campylobacter. For prevention of such diseases, the best pathogen control strategy should be determined based on biology, impact mechanism, ecology and spread of food-originated pathogens and comprehensive research is needed about new pathogens emerged, their evolutions and disease mechanisms.

Sutherland and Varnam (2002) indicated that Shigellosis was common in countries with poor hygiene standards, but the cases in countries with well hygiene conditions were mostly related to tourists. Besides hygiene education, handwash training provided to children may aid in prevention of the disease. In terms of public health, Shigellosis prevalence was food-originated rather than water. Apart from infections, Shigella species have toxin formation abilities. S. dysenteria type 1 was reported to be the greatest producer of shiga toxin with a weight of 70 kDa. Besides, S. flexneri and S. sonnei have an ability to produce shiga-like toxins at low levels. The foodstuffs used as a tool in Shigella infections include various salads, tuna salad, lettuce, milk, fresh cheese, cooked rice, spaghetti, shrimp cocktail, potato salad, potato puree, chocolate pudding and boiled apple. In disease control, direct control procedures should be applied against human-originated contaminations. Researchers asserted that since the disease spreaded from person to person, it was hard to control and thus food-originated

shigellosis should be controlled through applying HACCP-like food safety systems in production of especially raw-consumed risky foodstuffs, processed foods should be produced with the use of modern technological systems under sufficient hygiene conditions. Especially the leaved-vegetables may contain large quantities of disease agent and pass the disease easily when consumed raw, thus disinfectants without any risks on human health should be used to eliminate the disease agent. In countries with endemic Shigella infections, improved standards, hygiene and clean water supply may alleviate the problem. It was estimated that increasing climate change trends reduced water resources and aggravated disease-related problems and increased the level of endemic infections. Such a case will then result in increases in the incidence of the other important pathogens as well as Shigella and accordingly increase the spread of the disease between the tourists and local people. Deterioration in hygiene conditions in salad material-producing countries may increase incidence of food-originated diseases.

CONCLUSION

Shigella species pose serious risks on public health. To prevent the spread of the disease, hygiene rules should be applied throughout all stages of food production and some kind of preventive measures should be taken.

Primarily, quality of domestic waters should be brought to drinking water quality, drinking waters should periodically be chlorinated and subjected to UV and ozone treatments to prevent disease incidences.

Raw or insufficiently heat-treated leaved-vegetables should be treated with proper disinfectants, should be waited for long durations and stored under proper temperatures and relative humidity.

In production and consumption processes, people should pass through routine health checks, routine analyses should be performed for disease incidence in foodstuffs, tools and equipment used in production processes should be disinfected, producers and consumers should be trained about food and personnel hygiene and the other relevant measures should be taken for prevention and guarantee of consumer health. With such measures to be taken, apart from bacillary dysentery, several other pathogens could also be prevented.

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CHAPTER 11

SUSTAINABILITY OF SOIL ORGANIC MATTER

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INTRODUCTION

Since the green revolution, agricultural lands have been exposed to more intensive cultivation and chemical inputs to ensure the nutrition requirements of the increasing human population. The rapid decrease of nutrients in agricultural lands in many developing and developed countries has reached alarming levels. Although chemical fertilizers rapidly promote plant growth and crop yield, they have extremely destructive effects on the soil structure (Wu et al., 2020: 9568).

Initially, whereas it was thought only related to environmental pollution, chemical fertilizer was found to be closely related to global warming and climate change towards the 21st century (Meyer et al., 2018: 34). The structure, condition and importance of soils for a sustainable life come up at this point. Because the carbon (C) stock in the atmosphere is kept in organic matter and directly affects the reduction of global warming (Guan et al., 2018: 224). Also, the soil is not only important for global warming. As a result of the physical, chemical and biological degradation of agricultural lands, there is a danger of approaching an age when the requirements of the increasing human population cannot be ensured (Nair, 2020: 165). Such that, after the breakdown of aggregate structures and destruction of organic matter in the soil, agricultural land faces the danger of erosion. Intensive use of chemical fertilizers and pesticides in the last quarter-century is one of the factors that accelerate this process (Massah & Azadegan, 2016: 44). It is stated that heavy metal toxicity threatens agricultural areas in addition to chemical inputs due to the rapid increase in industrialization

Dere, 2019: 108). Therefore, preserving and increasing the soil organic matter content is of great importance in terms of recycling plant nutrients, improving soil productivity and a healthy environment.

1. The Role of Soil Organic Matter and Organic Carbon Stock

Although the organic matter is generally composed of plant-based wastes, it also accumulates as a result of the resolve of animal and microbial wastes. The organic material in the soil can be in a dissolved or particulate form. Although the most common soil organic matter's main material consists of residual leaves and roots, microorganisms play the most important role (Sokol, Kuebbing, Karlsen-Ayala, & Bradford, 2018: 233). The soil organic matter (SOM) plays an active role in general C retention, nitrogen (N) mineralization, aggregation, promoting plant growth and nutrient adsorption (Hoffland, Kuyper, Comans, & Creamer, 2020: 455). The components of the OM in the soil are composed of two basic components which are active (easily soluble) and stable organic fractions (Watanabe et al., 2019: 319). Fresh and soluble residues from the active part of the OM and their decompositions realize very fast (Goidts, Wasemael, & Crucifix, 2009: 723). While the active carbon forms the basis of soil chemical and physical properties, the stable fraction resists decomposition as it is physically and chemically protected. Dissolved OM constitutes less than 2% of the total organic matter in the soil (Von Lützow et al., 2007: 2183). During the aggregate formation, the stable part of the OM is kept by the aggregates and prevented from being consumed by microorganisms. Therefore, it is effective in cation exchange capacity

and soil color. As the stable fraction dissolves very slowly, its impact on soil fertility is not as high as the active fraction. However, humic substances (humic acid, fulvic acid and humin) difficultly dissolve and decompose into small molecules due to their stable structure (Tan, 1994: 304). These materials can not be separated by natural processes constitute a substantial part of the OM and have great importance in terms of soil fertility and the sustainability of microbial activity in the soil (Robertson et al., 2014: 404; Belliturk et al., 2019: 251).

One of the vital factors that negatively affect agricultural production in arid and semi-arid regions is low soil fertility. The organic carbon ratio in the soil is low due to the rapid mineralization of the OM (Palm et al., 2001: 27). Soil organic carbon (SOC) refers to carbon fixed in organic matter. The degradation of SOC balance is expressed as the tendency of the organic carbon stock in the soil to resist a decrease (Doetterl et al., 2016: 102). Disruption of the SOC balance is accepted as one of the most accurate indicators of global climate change and global warming (Panagos, Liedekerke, Jones, & Montanarella, 2012: 329). Because the carbon stock in the soil is 2-3 times higher than the atmosphere, and the most fundamental factor that determines how much CO2 will be transferred from the soil to the atmosphere due to global warming is the rate of degradation of the OM (Davidson, Trumbore, & Amundson, 2000: 789). Approximately 50% of the terrestrial organic carbon pool is found in the upper 100 cm layer of the soil (Lal, 2004: 1623). The SOC, a key element of the continuous carbon cycle between the atmosphere, seas and lands, also plays a critical role in the formation of

soil structure, infiltration and storage of water, and protection of soil health and fertility (Yang, Li, Yang, Li, & Zhang, 2020: 103199). Sustainability of the SOC balance is possible by gaining is higher than losing carbon emitted in the form of leakage, erosion and gas from the soil.

2. The Role of Organic Matter on Soil Productivity

The soil productivity is evaluated with 3 basic traits as physical, chemical and biological. Although some qualitative observations are used, quantitative ones such as and modern chemical methods are often required to determine the soil quality. The application of organic matter, which has a vital role, has both direct and indirect effects on soil fertility. Organic materials also contain nutrients in various proportions depending on the substrate material and contribute to the soil during dissolution (Ferreras et al., 2006: 635). It provides rapid aggregation which is expressed as a key role in soil structure and fertility (Guo et al., 2019: 1029). It also plays a substantial role in chemical processes such as balancing soil pH and increasing cation exchange (Graber, Singh, Hanler, & Lehmann, 2017: 74). Besides, unconscious chemical fertilization causes groundwater and environmental pollution, therefore, poses a threat to the health of all life (Savci, 2012: 287) and causes a great economic loss. Therefore, it is emphasized that the importance of organic fertilizers has increased even more.

2.1. The Role of Organic Material on Soil Physical Properties

The soil's physical traits focus on structure, swelling, compression, retention and conductivity of water and nutrients, porosity, aeration, and plasticity. The OM is very porous and larger in volume than soil. Therefore, the presence or absence of the OM in the soil is of critical importance for aeration in the soil (Inan, Badairy, Inan, & Al Zahrani, 2018: 39).

The structure, which expresses the soil structure, is a parameter that expresses the bonding of soil particles to each other and is extremely important for soil health and productivity. While forming soil structure, sand and silt particles are bound to each other with colloids such as clay and organic matter to form micro-aggregates, and macroaggregates as a result of their binding to each other (Yılmaz, Alagöz, & Öktüren, 2005: 78). Many researchers stated that conservation or rise of soil aggregation is depending on the SOM (Bu et al., 2020: 106681). Therefore, the reduction of organic mineral in the soil maximizes the erosion risk.

After gaining the OM into the soil, O2 and CO2 gases increase due to rapid mineralization. Thus, more of the soil meshes fill with air and improve the aeration (Epstein & Kohnke, 1957: 585). Another effect of increased porosity is related to the absorbed water in the soil. Therefore, with the increase of the OM in the soil, the number of macro and micropores in the soil increases by bonding soil particles to each other or creating suitable living conditions for soil organisms (Nath, 2014: 1419). Thus, the water holding capacity that refers to the maximum

amount of water that can be kept in the pores without leaking, of the soil increases. The adsorption of water realizes in the pores between the soil particles (Huff-Lonergan & Lonergan, 2005: 194).

According to the report published by the UK Ministry of Environment, Food and Rural Affairs (DEFRA), three key points threatening agricultural production and soil productivity are soil erosion, reduction of organic matter and soil compaction (2009). Some factors such as heavy agricultural machinery, unconscious tillage practices, soil moisture, irrigation methods play a critical role in the compaction of soils (Wang, Wu, & Meng, 2004: 009). Soil compaction leads to the denaturation of aggregate structure and porosity. Soil compaction also causes reduce water infiltration (Soane, 1990: 179) and negatively affects soil biological properties (Beylich et al., 2010: 133). As another result of soil compaction, root growth in plants is inhibited (Correa, Postma, Watt, & Wojciechowski, 2019: 6019) and therefore soil fertility decreases. Shah et al. (2017: 10056) stated that soils that have low organic material are more sensitive to compaction compared with soils of higher ones. It has been determined that the structural stability of the topsoil has increased resistance to compaction due to the increase of organic matter content in the soil (Batey, 2009: 335). The main role of the OM on soil compaction is to adhere to soil particles (especially clay particles) and bind them together, therefore, create resistance (Shah et al., 2017). Although it is not as effective as organic matter in the lower layers of the soil, the organic residues on the surface are also helpful for preventing soil compaction. The theory behind the anti-

compaction effect of organic matter is associated with the presence of residues on the soil surface, which is an important feature of the protected tillage system. These residues are thought to allow the formation of voids in the soil by absorbing the pressure exerted by the high axle load caused by heavy agricultural machinery (Hamza & Anderson, 2005: 121).

2.2. The Role of Organic Material on Soil Chemical Properties

Soil chemical properties are a complex phenomenon in which a series of chemical reactions proceed in a certain balance. Soil chemistry, which includes many extremely substantial properties such as pH, electrical conductivity, cation exchange on soil quality, has also direct interaction with soil physical and biological properties (Tale & Ingole, 2015: 57).

Soil pH is the most important chemical property that determines many factors such as the concentration and absorption of dissolved substances, cation exchange, and nutrition uptake (Akpoveta, Osakwe, Okoh, & Otuya, 2010: 57). Because all organism in the soil has an optimum pH range to maintain its life at an optimum level. The pH refers to the degree of acidity of the soil solution and is the logarithm of the concentration of H+ ions (Schofield & Taylor, 1955: 164). So, whereas pH has a positive correlation with alkalinity, it has a negative correlation with acidity. pH is an important indicator regarding the presence and balance of nutrients in the soil (Kinyangi, 2007: 1). McDonald et al. (2017) determined that the dissolved micronutrient concentration in soils with low pH value is higher than in alkaline soils.

In addition, pH is a significant indicator of cation exchange capacity and the SOM (Foth & Ellis, 1996). Therefore, plant growth is negatively affected by low or high pH values due to the disturbance of the ion balance (Kumar, Iver, & Agarwal, 2011: 52). The availability of soluble nutrition varies depending on soil pH.

The most important effect of the OM on soil pH is to contribute to the balancing of pH. The SOM provides anions for H+ binding. Thus, it allows the soil solution to approach neutral in acidic or alkaline soil (McCauley, Jones, Olson-Rutz, 2017: 1). When the OM starts to decompose, it secrets many amounts of anions and cations in the soil. Since there are generally more anions in the plant, soil pH increases slightly in the first few weeks of dissolution. Especially as a result of dissolution caused by plant residues with high nitrogen content, this increase in soil pH at the beginning contributes to the retention of toxic elements such as aluminum and manganese in the root zone (Xiao, Yu, & Xu, 2014: 1513). However, after a while, the microorganism population in the soil causes mineralize by breaking down the ammonium that leads to an increase in the pH. The nitrification of ammonium starts at the end of the microbial activities and chemical process. As a result of the conversion of ammonium to nitrate, the pH of the environment decreases. If the nitrate in the environment is washed away, the soil pH drops more.

The primary factor preventing nutrition loss from the soil is the cation exchange capacity. The cation exchange capacity refers to the total amount of cations that can be held by electrostatic forces in the soil at

a certain pH level. In simpler terms, it is a measure of the areas in the soil where anions can be connected. Therefore, there is a direct relationship between soil fertility and cation exchange capacity. Soils with high cation exchange capacity are more productive and suitable for agricultural production compared to low ones (Graber et al., 2017). In soils with low cation exchange capacity, the attachment of cationic nutrients becomes difficult, it moves away from the effective root zone. For this reason, the efficiency of the fertilizers significantly decreases. This situation leads to both failure to provide nutrient support to the plant requirements and to experience economic losses. As a result of the decomposition of the OM, the pH of the soil solution is balanced and the soil cation exchange capacity increases (Leng, Huang, Li, & Zhou, 2019: 210). Besides, the availability of cationic nutrients tends to decrease continuously due to decreased solubility in alkaline soils and leakage or erosion losses in acidic soils. Therefore, the presence of the OM has a positive effect both directly and indirectly in terms of benefiting from nutrients in the soil.

2.3. The Role of Organic Material on Soil Biological Properties

Soil biology is considered a very important part of soil quality and is becoming more and more important in modern agriculture. Current studies in agriculture indicate that more reliance should be placed on the self-regulating processes of the soil (Brussaard, De Ruiter, & Brown, 2007: 233). While it is thought that physical and chemical properties are important to soil quality, it has been accepted that soil biota is the main determining factor (Ritz et al., 2009: 1212). Biota

plays a key role in fauna and flora, plant nutrition, preservation of the structure, protection of water and carbon stock, suppression of disease and harmful factors, and product yield processes (Kibblewhite, Ritz, & Swift, 2008: 363; Dere et al., 2019). Besides, soil biology is more susceptible to change in parallel with changes in soil, unlike soil physical and chemical properties that change rather slowly (Xing et al., 2020: 154). The main reason for this situation is that living organisms constitute the basis of soil biology and there are continuous change, transformation and reproduction events (D'Hose et al., 2018: 18). Not only microorganisms but also plant roots and earthworms have an impact on soil biological properties (Tsunoda & van Dam, 2017: 58; Poirier, Roumet, & Munson, 2018: 246). Therefore, soil biology is an extremely complex and important phenomenon.

The organic C concentration in the soil changes as a result of the carbon exchange between the soil and the atmosphere. With the exclusion of erosion losses, organic matter from the soil occurs only in the form of CO2 as a product of microbial activity. In order to minimize the C mineralization rate in the soil, it is possible to manage microbial metabolism by increasing the organic C input by increasing the C storage in the soil (Ladd, Jocteur-Monrozier, & Amato, 1992: 359; Soysal, Çığ, & Erman, 2020: 178). Although heterotrophic microorganisms are the main reason for the release of humus and organic carbon through the breakdown of organic material, the last product is the main food source for these microorganisms. For this

reason, C mineralization is less in soils with low organic C concentration than higher ones (De'Hose et al., 2018: 18).

3. Conservation and Increasing Ways of Soil Organic Matter

All plant and animal residues and their organic decomposition products in and on the soil are called the SOM. It is the process of biochemical decomposition of complex organic matter by microorganisms, therefore, the formation of CO2, H2O and mineral nutrients (Mg, Fe, N, S, etc.). The transformation of nitrogen, which is bound in organic form in plant substances, into ammonium cation (NH4+) in this way is called nitrogen mineralization (Hart, Stark, Davidson, & Firestone, 1994: 985). The SOM both contains non-metal (C, H, O, N, S, P) and metal (Ca, Mg, K, Na, Cu, Mn, Zn, Al, Fe) substances in chemical composition. However, the chemical structure of the organic composition is very complex. Major components are cellulose (20-50%), hemicellulose (10-30%), lignins (10-30%), tannin, colored substances, cutin, suberin, oils and waxes (1-8%), proteins (1-15%) (Six et al., 2020: 607). The ratio of the OM in the soil persistently changes depending on microbial activity (Soysal & Erman, 2020: 649). With the continuation of vegetative production, the mineral matter in the soil is exploited and the number of minerals coming from the OM in the soil decreases. It is possible to measure the net organic carbon amount in the soil with the following equation (Magdoff & Weil, 2004: 45):

Net organic C change = C gains – C losses

The deterioration of balance will cause a decrease in the amount of OM in the soil. The amount of SOM primarily forms the basis of life in the soil. To maintain fertility in the soil, it is necessary to ensure that the organic material level is always sufficient.

3.1. Composting and Vermicomposting of Organic Residues

Composting refers to microbial degradation of organic material including aerobic respiration that leads to passing a thermophilic stage and eliminate harmful microorganisms (Onwosi et al., 2017: 140). Composting is defined as a controlled microbial aerobic decomposition process with the formation of stabilized organic materials that can be used as a soil amendment and/or organic fertilizer (Sarangi & Lama, 2013: 420). Composting is one of the most effective methods of recycling organic waste in sustainability agriculture (Raj and Antil, 2011: 2868). It is aimed by composting to convert degradable organic substances into a biologically stable material, destroy pathogens and weed seeds, have maximum nutrient content (Tchobanoglous, Theisen, & Vigil, 1993: 872). Plant wastes or all kinds of plant-based residues generated during agricultural production are recycled by mixing them into the soil if they do not contain diseases and pests. These residues become a compost product as a result of the fermentation process through composting and are recycled by mixing with the soil.

Farm manure is the most common organic material used by composting in the world. Several researchers have reported that cow manure is an effective source of organic material (Pergola et al., 2018: 3969). Although not as common as farm manure, poultry manure is also

a rich material with high nitrogen content and has positive effects on plant growth and crop yield if used in appropriate doses (Uçar & Erman, 2020: 96). In the evaluation of fruits and vegetables in plant production, it is important for the sustainability of soil fertility to use organic wastes after fruit juice, vegetable residues and tomato paste production in factories, and to bring them to agriculture. It has been determined by many studies that plant or agro-industrial wastes generated in the fruit juice industry can be used successfully in agriculture (Soares, Quina, Reis, & Quinta-Ferreira, 2017: 80). It has been determined that these wastes can be used as a source of the OM and plant nutrients by applying them directly to the soil and can also be used as a growing medium with mixtures in certain proportions (Gutierrez et al., 2017: 387). One of the factors that will make it practical to use compost is the cost of compost. For this reason, it is important to obtain compost from local materials. Vegetables, fruit factories, wine and breweries, tomato paste factories, meat, milk and egg processing facilities, sugar factories, potato processing factories, etc. The remaining wastes in the facilities are used in composting (Russ & Meyer-Pittroff, 2004: 57). It was concluded that some organic residues (hazelnut slag, wood shavings, waste mushroom compost and household waste compost), which are abundant and do not have any beneficial usage, can be composted and used as a growing medium in ornamental plant cultivation (Öztekin, 2018). Ekinci, Dursun, Kotan, & Güneş (2016: 24) reported that chemical fertilizer was reduced by 50% and 4 different bacteria applications positively affected tulip production. It was concluded that the compost consisting of a mixture of tomato waste, melon waste, olive

mill waste and sheep manure creates a growing environment resistant to salinity and alkalinity (El Hasini et al., 2020: 21). Tarıq et al. (2012: 378) stated that adding composts made using agricultural and urban wastes to the growing environment provides the best production amount and cheap pot environment for Dahlia hortensis 'Figaro' plant. The 34% of the compost produced in Italy is sold as humus in garden centers, 62% replaces mineral fertilizers in agriculture, and the remaining 4% is used in soil improvement (Rigamonti, Grosso, & Giugliano, 2010: 1652).

The process of vermicomposting, in which the composting process is made by some special earthworms and a final product with high OM content, which is also known as vermicast, has been gaining increasing interest in the last quarter-century. Vermicompost is rich material in nutrition, humic and phenolic substances, vitamins, antioxidants, and various hormones (Joseph, 2019). The selection of worm species used in the production of vermicompost is an extremely critical step, and the selection of species with high performance in terms of adaptation to environmental conditions and productivity is important for the quality and efficiency of the final product (Şahin and Ceritoglu, 2020: 15). Moreover, in the vermicomposting process, where almost any organic material can be transformed into a rich resource, the content of the substrate material(s) used significantly affects the content of the obtained vermicompost (Ceritoglu, Şahin, & Erman, 2018: 607). Vermicompost includes higher levels of macro- (nitrogen, phosphorus, potassium, calcium and magnesium) and micro-nutrients (iron, zinc,

copper and manganese) compared with other organic applications. Many researchers stated that appropriate doses of vermicompost have a promoting effect on wheat (Mahmoud, Mahmoud, & Doaa, 2015: 157), lettuce (Demir, 2019: 2151), Paddy (Dhanuja, Saxena, Abbasi, & Abbasi, 2019: 797), chickpea (Uçar, 2019: 116), lentil (Ceritoglu and Erman, 2020: 158), lettuce and tomato (Arancon, Owens, & Converse, 2019: 2447) and potato (Kumar, Svihani, & Singh, 2020: 1454).

3.2. Effect of Green Fertilization on Organic Matter Content

Green fertilization is the mixing of legume (especially) or non-legume plants into the soil during flowering or some stages of vegetative development. With green fertilization, the amount of nitrogen and other mineral nutrients in the soil is increased for the next crop, and the SOC is improved. Legume plants such as vetch, broad bean, soybean, alfalfa, lentil are substantial for green fertilization (Bıçakçı & Açıkbaş, 2018: 180) due to fixing the free nitrogen from the air to root nodules and intense microbial activity in the rhizosphere (Romania & Casals, 2019; 546). Another feature that makes legume plants valuable as green fertilization material is that they are organic sources with a low C:N ratio due to their high nitrogen content (Aulakh, Khera, Doran, & Bronson, 2001: 375). Low C:N ratio enables to faster breakdown of the OM, therefore, increase soil nutrient composition and contribute to soil organic C stock and microbial activity (Wu et al., 2017: 429). Although it is not as effective as legume plants, some species that are not green legumes are also used as green fertilizers. However, the use of non-legume species as green fertilization is generally considered as mixed

cultivation (Kim et al., 2011; Seydoşoğlu, 2020: 2136). The species evaluated as green fertilizer are listed in Table 1.

Table 1. Commonly used plant species as green fertilizer

Legumes	Non-legumes
Alfalfa (Gao et al., 2016: 36981)	Rye (Kim et al., 2011)
Broad bean (Lizhi, 1988)	Oat (Janninck, Liebman, & Merrick, 1996)
Vetch (Snyder et al., 2016: 2015)	Barley (Yoon, Kim, & Lee, 2019: 70)
Pea (Janninck, Liebman, & Merrick, 1996)	Millet (Donatti et al., 2017: 665)
Grasspea (Lazanyi, 2000: 28)	Rape (Williams-Woodward, Pfleger, Fritz, & Allmaras, 1997: 43)
Clover (Snyder et al., 2016: 2015)	
Forage pea (Biederbeck et al., 1993: 1035)	

Duman et al. (2013: 9) reported that green fertilization with vetch increased pepper yield. Faria, Soares, & Leao (2004: 641) stated that green fertilization improves the chemical properties of the 0-10 cm top layer of the soil. Nazmus et al. (2013: 1901) reported that the total yield of corn and rice, and the amount of the SOM increased depending on green fertilization. Cavigelli & Thien (2003: 1186) reported that the availability of phosphorus in the soil increased by green fertilization. Garcia-Franco, Albaladejo, Almagro, & Martinez-Mena (2015: 66) found that green fertilization increased soil aggregate stability and SOM content.

3.3. Effect of Conversation Tillage Methods on Soil Organic Carbon

Tillage methods are examined in two groups as conventional and conservation methods. Conventional tillage increases soil compaction, fragmentation of aggregate structure, rapid mineralization of the SOM and soil erosion (Rusu, 2014: 42). Studies have revealed that there is an average of 150 tons ha^{-} of soil loss per year in the world due to wrong tillage practices (Iocola et al., 2017: 96). In the protective tillage system, pre-plant or crop residues are left on the field surface. Although decreases in total crop yield can be seen with reduced-tillage methods, it is known to help reduce the negative effects that occur as a result of intensive tillage (Van den Putte et al., 2010: 231).

Conservation tillages, reduced - tillage or no-tillage, lead to enhance soil productivity (Xue et al., 2018: 1555). No-tillage and straw incorporation into soil improves the SOC in arable lands around the World. Besides, straw incorporation is used as the main technique of SOC input onto lands. The amount of C input determines SOC stocks in topsoils (Virto, Barré, Burlot, & Chenu, 2012: 17).

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CHAPTER 12

EVALUATION OF PRODUCTIVITY STATUS OF DRY FARMING SOILS IN MARDIN PLAIN USING GEOGRAPHICAL INFORMATION SYSTEM ANALYSES

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INTRODUCTION

Soil fertility is among the most basic criteria for obtaining quality and abundant products in agricultural production. The physical and chemical properties of soils, the scarcity or abundance of plant nutrients are important factors affecting the yield and quality of agricultural products, and the nutrient concentrations in soils can be determined by soil analysis. In addition, depending on the physical and chemical properties of the soil, knowing the relationships between these properties and the nutrients in the soil is important in terms of providing the highest benefit of fertilisation for the plants to be grown according to the land conditions (Taban et al., 2004; Başaran and Okant, 2005; Tümsavaş and Aksoy, 2008). The product yield and quality of the grown plants are closely related to the nutrient content of the soils to meet the needs of the plants (Zengin et al., 2003; Belliturk et al., 2019). The formation of agricultural lands is the only resource that takes thousands of years, and cannot be produced or renewed. The sustainability of soils, though, is possible by examining and monitoring soil resources as adequately as possible and defining the characteristics of agricultural areas better (Özyazıcı et al., 2016).

Mardin province has lands that can be processed very easily in terms of agriculture with high yield values in the Mardin plain, where important cereal products are grown in our country, which has a high agricultural potential in the Southeastern Anatolia Region (Eren, 2019). The climate of Mardin is similar to the Mediterranean climate; summers are hot and dry, while winters are rainy and cold. In the winter season, snowfalls

are seen in mountainous areas from time to time, while less and non-permanent snowfalls are seen in the plain (Mercan and Arpağ 2020). In this study, it was aimed to determine the fertility status, physical and chemical properties of soils taken from two different depths in some dry farming villages in the province of Mardin.

MATERIAL AND METHOD

In the study, SRTM data and soil maps of the General Directorate of Rural Services (Anonymous, 1997) were used to create maps of the study area. Maps were digitised using "Global Mapper 18" and "ArcGIS 10.3" programs. From these maps created; aspect, slope and digital elevation maps were drawn. A database was created in GIS for all maps drawn. Thematic maps such as land use map, classification of agricultural lands, large soil groups and land use capability were created from the data. In 2019, soil material was collected from 10 different villages of Mardin province (Yukarı Azıklı, Göllü, Çiftlik, Gökçe, Ortaköy, Yolbaşı, Emirli, Ilıcak, Kumlu and Çınarcık) and from each land; a total of 60 soil samples were taken from 3 different points at 0-30 and 30-60 cm depth according to the principles stated by Jackson (1958) to represent the land. Sampled villages are shown in Figure 1; and GPS coordinates of the samples are included in Table 1. Soil samples taken from the fields, plant residues and stones were crushed with a wooden mallet and passed through a 2 mm sieve, and then made ready for physical and chemical analysis. In soil samples, organic matter was modified by Bouyoucous hydrometer method (Bouyoucous 1951), pH saturation sludge according to Jackson (1958), % salt

saturation sludge according to Richard (1954); and it was determined with the Walkley Black method as reported by Walkley and Black (1934). Available P (Olsen et al., 1954); available K, according to Richards (1954); and the useful Fe, Cu, Zn and Mn were determined by DTPA as reported by Lindsay and Norvell (1978).

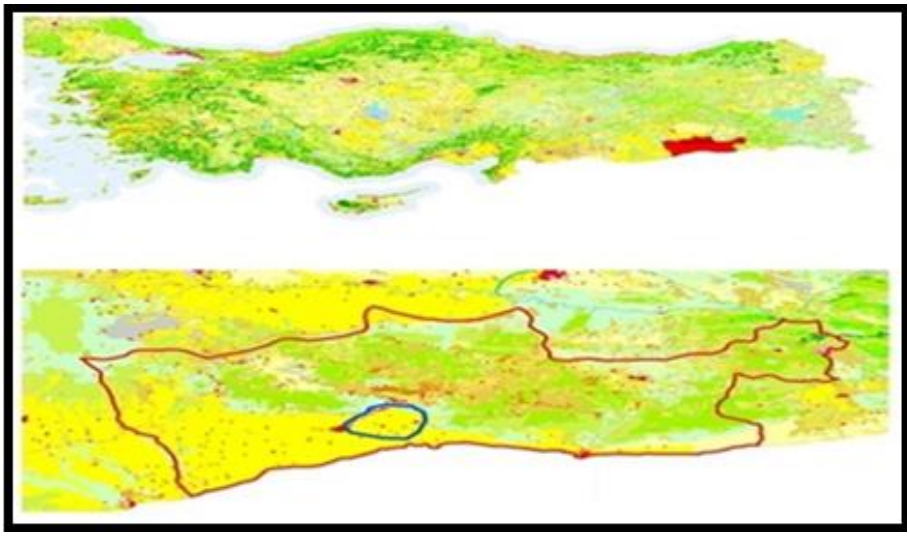

Figure 1. Location map of the study area

Table 1. GPS coordinates of soil samples

Villages	Coordinates (UTM, m)	
Yukarı azıklı	648612	4126128
Göllü	652088	4123562
Çiftlik	653071	4127968
Gökçe	650341	4118041
Ortaköy	657734	4120296
Yolbaşı	657870	4125365
Emirli	650105	4114633
Ilıcak	643884	4116133
Kumlu	653083	4114760
Çınarcık	642987	4119847

RESULTS AND DISCUSSION

The altitude of the sampling sites from different villages is between 503-554 metres in Kumlu, Eymirli, Ilıcak, Çınarçık and Gökçe villages, 555-599 metres in Ortaköy and Göllü villages, 600-659 metres in Yolbaşı and Yukarıazıklı villages; with the highest study area determined varying between 660-740 metres in Çiftlik Village. It was determined that the slope of Çitlik and Yolbaşı villages varied between 7.4-13%, and between 0.0-1.1% in the other sampled areas (Figure 2).

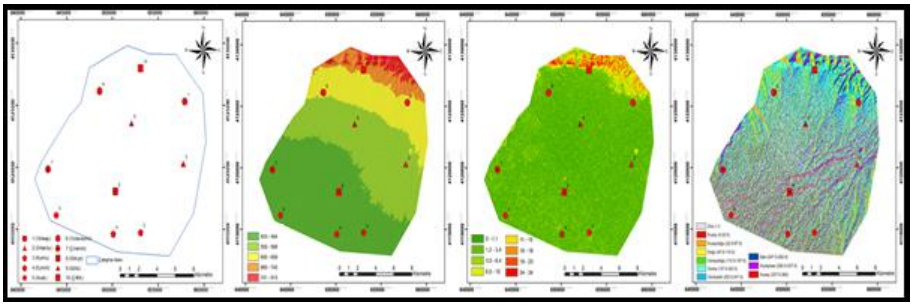

Figure 2. Village names, elevation, slope and aspect maps of the study area

In the sampled areas, Çiftlik village's soils seem to be close to the brown forest soils group; and it has been determined that Yolbaşı, Ortaköy, Yukarıazıklı and Göllü villages are in the other areas group, while Kumlu, Eymirli, Ilıcak, Çınarcık and Gökçe villages are in the reddish brown soil group. When the land use capability maps are examined, Yolbaşı and Çiftlik village soils are in 3rd class; soils in Ortaköy and Çınarcık are in 2nd class; and Kumlu, Eymirli, Ilıcak, Yukarıazıklı, Gökçe and Göllü village soils are determined to be 1st class (Figure 3). Among the soil types in Mardin, two different soil types can be

mentioned; the first is brown forest soils covering 46.65%, and the second is dry agricultural areas that make up 22.68%. 16.48% of the lands in Mardin is first class, 9.73% is 2nd class, and 2.68% is 3rd class, which can be evaluated as fertile land (Mercan and Arpağ 2020).

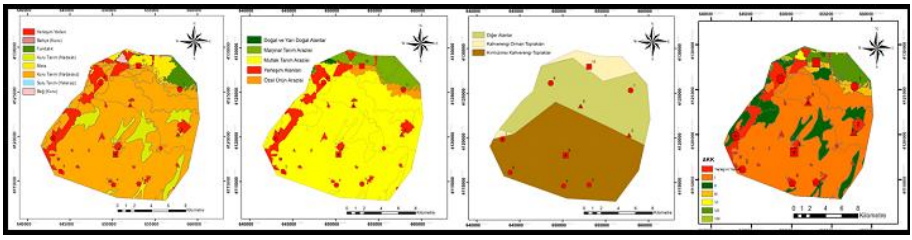

Figure 3. Land use, land classification, land use capability and major soil groups maps of the study area

The pH values of the soils range between 7.36-8.08 and the average pH was determined as 7.70. When classified according to the limit values reported by Kellogg (1952), it was determined that 55% of the soil pH was "slightly alkaline" and 45% was "neutral". When the sampled lands are classified according to the limit values reported by Tüzüner (1990) in terms of salt, it is determined that they are in the "salt free" class, the soils vary between 0.10-0.35% and the average is 0.23%. Organic matter contents vary between 0.54-2.38%, and the average was determined to be 1.39%. When classified according to the limit values reported by Ülgen and Yurtsever (1995), it was determined that the organic matter content of 65% of the soils is in the "low", 20% in the "very little" and 15% in the "middle" class. It has been determined that 70% of the soils are in the "clay-loam" and 30% are in the "loam" class according to their constituent classes (Tables 2 and 3).

In a study conducted by Eren (2019) on soil fertility in some villages of Kızıltepe district of Mardin, it was reported that approximately 67.4% of the soils were at "low" and 32.6% were at "moderate" level in terms of organic matter amounts. It has been stated that the total salt (%) amounts of the village soils used in the study are in the "salt-free" class. As a result of the analysis performed on 25523 soil samples of the South East Anatolia Region, it was stated that 47.5% of the soils has "clay-loam" structure (Güçdemir 2006).

Table 2. In soil samples, pH, salt, organic matter and constituent classes

Villages	Depth (cm)	pH	%					Texture class
			Salt	O.M.	Sand	Silt	Clay	
Yukarı azıklı	0-30	7.41	0.11	1.26	35.21	28.12	36.67	CL
	30-60	7.30	0.19	0.54	38.28	29.01	32.71	CL
Göllü	0-30	7.36	0.18	2.38	39.15	31.13	29.72	CL
	30-60	7.76	0.23	1.25	42.18	35.71	22.11	L
Çiftlik	0-30	7.41	0.10	1.78	41.32	30.26	28.42	CL
	30-60	7.96	0.13	1.06	44.22	35.91	19.87	L
Gökçe	0-30	7.52	0.18	2.04	37.15	30.73	32.12	CL
	30-60	7.93	0.25	1.29	37.97	39.09	22.94	L
Ortaköy	0-30	7.49	0.14	2.26	36.17	31.74	32.09	CL
	30-60	8.01	0.19	1.45	38.57	39.98	21.45	L
Yolbaşı	0-30	7.51	0.30	1.74	39.10	29.54	31.36	CL
	30-60	7.82	0.32	1.02	22.36	41.15	36.49	CL
Emirli	0-30	7.48	0.34	1.45	33.15	37.25	29.60	CL
	30-60	7.25	0.35	0.73	40.79	26.87	32.34	CL
Ilıcak	0-30	7.58	0.15	1.56	39.36	29.75	30.89	CL
	30-60	8.08	0.30	0.84	38.10	43.46	18.44	L
Kumlu	0-30	7.44	0.29	1.89	29.15	39.38	31.47	CL
	30-60	7.97	0.33	1.17	40.22	34.85	24.93	L
Çınarcık	0-30	7.41	0.21	1.37	28.36	35.36	36.28	CL
	30-60	7.94	0.22	0.65	41.17	28.85	29.98	CL
	Min.	7.36	0.10	0.54	28.36	26.87	18.44	
	Means	7.70	0.23	1.39	37.10	33.91	28.99	
	Max.	8.08	0.35	2.38	44.22	43.46	36.67	

Table 3. PH of soil samples, salt, organic matter, constituent classes and sample numbers

Physical and chemical analysis	Limit values	Class	Number of samples	References
pH	<4.5	Very strongly acid	-	(Kellogg, 1952)
	4.5-5.5	Strongly acid	-	
	5.5-6.5	Moderately acid	-	
	6.5-7.5	Neutral	9	
	7.5-8.5	Slightly alkaline	11	
	>8.5	Strongly alkaline	-	
% Salt	0-1,5	Non-saline	20	(Tüzüner, 1990)
	1.5-3.5	Very slightly saline	-	
	3.5-6.5	Slightly saline	-	
	> 6.5	Strongly saline	-	
% O.M.	<1.0	Very little	4	(Ülgen and Yurtsever, 1995)
	1.0-2.0	Little	13	
	2.0-3.0	Middle	3	
	3.0-4.0	Sufficient	-	
	>4.0	High	-	
Texture		C	-	(Bouyoucus, 1952)
		CL	14	
		L	6	
		LS	-	
		SCL	-	
		SL	-	

The macro and micro-element concentrations of soils vary between P 8.13-44.3 mg kg^{-1} and 45% (8.0-25 mg P kg^{-1}) is "sufficient", while 25% (25-80 mg P kg^{-1})'is "high"; and K ranges between 432-734 mg kg^{-1} and it has been determined to be generally "high" in terms of K. Zinc ranges from 0.18-0.56 mg kg^{-1}; 5% (<0.2 mg kg^{-1}) is "very little" and 95% (0.2-0.7 mg kg^{-1}) is "little"; it varied between 2.69-5.26 mg kg^{-1}in terms of Mn; 55% (<4 mg kg^{-1}) is "very little" and 45% (4.0-14 mg kg^{-1}) is "little" (Table 4 and 5). In the study conducted by Eren (2019), in 86 soil samples taken from some villages where wheat farming is carried out, 52.3% of the soils are low, 30.2% are medium,

and 9.3% are high in terms of P_2O_5, while 5.8% very low and 2.3%, it was determined to be very high. He stated that the K_2O amounts of soil samples are very high. In order to determine the general condition of the extractable soil in terms of Fe, Cu, Zn and Mn in Turkey, as a result of the analysis of 1511 soil samples taken to represent the country lands; it was stated that 49.83% Zn deficiency, 26.87% Fe deficiency, and 0.70% Mn deficiency was observed, while deficiency in the Cu element was not observed.

Table 4. P, K, Zn, Mn, Fe and Cu concentrations of soil samples.

Villages	Depth (cm)	mg kg^{-1}					
		P	K	Zn	Mn	Fe	Cu
Yukarı azıklı	0-30	12.7	523	0.33	5.07	19.9	0.61
	30-60	11.7	486	0.26	5.01	15.5	0.45
Göllü	0-30	13.3	518	0.24	5.26	20.7	0.54
	30-60	8.13	495	0.25	5.12	16.2	0.36
Çiftlik	0-30	15.4	639	0.39	3.42	12.9	0.46
	30-60	9.38	607	0.22	3.56	19.2	0.48
Gökçe	0-30	16.0	677	0.47	3.53	13.4	0.69
	30-60	9.75	638	0.36	2.69	11.6	0.65
Ortaköy	0-30	46.1	691	0.35	3.59	13.7	0.53
	30-60	28.1	657	0.26	2.74	10.8	0.34
Yolbaşı	0-30	44.3	727	0.38	3.72	14.1	0.49
	30-60	27.0	692	0.21	2.81	14.3	0.31
Emirli	0-30	21.3	589	0.43	3.91	14.9	1.05
	30-60	13.0	561	0.31	2.95	9.8	0.67
Ilıcak	0-30	21.5	453	0.56	4.01	15.4	0.65
	30-60	13.1	432	0.32	4.02	12.0	0.41
Kumlu	0-30	25.6	643	0.42	4.13	16.0	0.57
	30-60	15.6	629	0.18	4.12	13.2	0.58
Çınarcık	0-30	24.6	734	0.46	4.09	15.7	0.51
	30-60	15.0	543	0.33	3.95	15.4	0.32
	Min.	8.13	432	0.18	2.69	9.80	0.31
	Means	19.6	597	0.34	3.89	14.7	0.53
	Max.	44.3	734	0.56	5.26	20.7	1.05

Table 5. Classification of soil samples in terms of some macro and micro elements and sample number

Chemical analysis	Limit values	Class	Number of samples	References
P (mg kg^{-1})	< 2.5	Very low	-	(Sillanpää, 1990)
	2.5-8.0	Low	-	
	8.0-25	sufficient	15	
	25-80	High	5	
	> 80	Very high	-	
K (mg kg^{-1})	< 50	Very low	-	(Sillanpää, 1990)
	50-140	Low	-	
	140-370	sufficient	-	
	370-1000	High	20	
	> 1000	Very high	-	
Zn (mg kg^{-1})	< 0.2	Very low	1	(Lindsay and Norvell, 1978)
	0.2-0.7	Low	19	
	0.7-2.4	sufficient	-	
	2.4-8.0	High	-	
	> 8.0	Very high	-	
Mn (mg kg^{-1})	< 4	Very low	11	
	4.0-14	Low	9	
	14-50	sufficient	-	
	50-170	High	-	
	> 170	Very high	-	
Fe (mg kg^{-1})	< 2.5	Few	-	
	2.5-4.5	middle	-	
	> 4.5	High	20	
Cu (mg kg^{-1})	< 0.2	Few	-	
	> 0.2	sufficient	20	

RESULTS

As a result, when Mardin province is classified according to the adequacy of some dry farmed soils in terms of nutrients and productivity; it is in the "salt-free" class, soils varied between 0.10-0.35%, the average being 0.23%, soils were generally low in terms of organic matter, and the average pH values were determined as 7.70. It

has been determined that 65% of the organic matter contents are in "little", 20% in "very little" and 15% in "middle" class. Some macro and micro element concentrations, 45% of soils are sufficient in terms of P amount and 25% is high; in terms of K, it was determined to be generally high. It has been determined that 5% of zinc is "very little" and 95% is "little", and 55% of Mn is "a little" and 45% is "a little". No deficiency in terms of Fe and Cu was detected in soil samples.

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CHAPTER 13

ORGANIC SUBSTANCES APPLICATION TO ENHANCE ABIOTIC STRESS TOLERANCE IN PLANTS

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INTRODUCTION

Abiotic stress are the most important factors that prevent agricultural production. Plants experience stress when they do not adapt to their environment (Büyük et al., 2012). There are abiotic and biotic stress sources that cause stress in plants. While abiotic stress consist of drought, temperature, radiation, flood, machinery, electricity, magnetic field, wind, air pollution, allelochemicals, nutrients (inorganic substances), pesticides, toxins, salts and soil pH, biotic stress result from competition, allelopathy, symbiosis, human destruction, disease factors and insects (Dere & Daşgan, 2019).

Abiotic stress creates negative effects on plant growth and development and causes yield loss. Due to the high input cost of chemicals used to reduce the negative effects caused by biotic and abiotic stress, sufficient chemicals cannot be used (Khan et al., 2017; Bulgari et al., 2019). In addition, physical, chemical and biological structure of soils are adversely affected by the use of intensive chemical fertilizers to prevent yield losses (Çelik & Baran, 2018). Due to these problems in the use of chemicals, tendency to use organic matter has started.

Organic substances, which can be used as an alternative to chemical fertilizers, have features such as increasing the effect of microorganisms and increasing soil fertility. The effects of organic substances on plants are long duration (Bulgari et al., 2019; Fattah, 2019). Organic substances also have an effect on regulating the effect of chemical fertilizers and increasing their usefulness. This feature is effective in regulating the imbalance in the yield (Yan & Gong, 2010).

In addition, organic substances have an important effect on nitrogen availability and improving soil structure, protecting water availability and increasing the organic matter of the soil (Khan et al., 2017). There are many beneficial substances and beneficial microorganisms in organic substances. Some of these beneficial substances are macro and micronutrients, indole acidic acid (IAA), gibberellic acid (GA) and vitamins (Sreenivasa et al., 2010). Due to their positive effects on the soil, they increase the yield of the product. It is effective in improving the soil-water-plant relationship, increasing the porosity and increasing the soil-water connection. With the effect of these, organic substances are effective in increasing plant growth and water use (Fattah, 2019).

Recently, due to several properties of organic substances, it has been used against abiotic stress factors. In order to ensure productivity and sustainability in vegetative production, the organic matter content and nutrient content of the soil must use at a sufficient level. Organic fertilizers, which are included in organic substances used against abiotic stress factors in agricultural production, have many features. In agricultural production, organic substances such as cattle, sheep, goats, horses, chickens, pigeons, bats, geese, ducks, worms, seaweed manure, slampe, tea waste, zeolite, leonardite, humic acid, fulvic acid, mycorrhizas and bacteria are used (Uçar, 2019, Uçar, 2020). While the general characteristics of organic fertilizers are given above, organic fertilizers used as extensive are given below.

Approaches to Improve Abiotic Stress Tolearnce in Plants

Chicken Manure

The usıng of chicken manure as an organic fertilizer is ımportant to enhance the productıvıtyof soil and crop. In order to prevent the deterioration of agricultural soils, different organic fertilizers are used, one of which is chicken manure. There are important nutritional elements such as nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), zinc (Zn) and copper (Cu) in the content of chicken manure. It is known that the nutritional content of chickens changes according to their breeding techniques (Mızrak, 2016). Chicken manure contains 62% H_2O, 38% dry matter, 1.7% N, 1.6% P_2O_5, 0.90% K_2O and 2.00% CaO (Aygün & Acar, 2004). In the study according to AlTaey, 2017, it was reported that poultry manure can be used to reduce the negative effect of abiotic stress factor.

Bat Manure

Bat manure has a soil enhancing effect like other organic fertilizers. Its total nitrogen ratio is 2-6%, usable phosphoric acid 1.5-10% and soluble potassium 1.5-10% (Sikazwe & Waele, 2004). The presence of micronutrients besides primary and secondary macronutrients in bat fertilizers is important for plant growth. It was stated that the bat manure contains 3.5-9% Ca, 1.5-8% Mg, 0.4-0.8% Mn, 0.2-0.5% Cu, 0.5-1.3% Fe and 0.2-0.4% Zn nutrients. It has been stated that bat manure has a regulating effect on calcareous soils due to its pH value (4-5, 6) and provides nutrient intake and improvement of the rhizosphere

environment (Sikazwe & Waele, 2004; Sridhar et al., 2006). Bat manure has a positive effect on the porosity, ventilation, filtering and water holding capacity of the soil. Bat manure is harder to wash out of the soil than chemical fertilizer and has a more sustainable effect (Sothearen et al., 2014). Bat manure has the feature of increasing microbial activity and creating a suitable biological environment for plants due to the live bacteria in its content. It facilitates the intake of phosphorus and nitrogen. Its dark color provides the heat required for microorganism activities in the soil and promotes plant growth by accelerating the passage of nutrients to the plants. It is effective in increasing tolerance to erosion and drought due to its positive effect on soil aggregation. In cases where the soil is acidic, it prevents toxicity in plants by absorbing aluminum. It has a positive effect on root growth and quality of products also has a useful effect on tolerance to abiotic and biotic stress in trees (Karagöz, 2014). In the water stress according to Tascı & Dinler 2013, it was stated that bat manure had a protective effect.

Humic Acid

Humic substances are known as organic carbon basin. It is formed as a result of biological and chemical transformations of plant and animal residues in the soil (Canellas et al., 2015). Humic acid refers to humus materials (Hayes, 2006). The use of humic acid in clayey, loam and compacted soils creates a soft and permeable structure because humic acid gives the soil a soft and easily cultivable feature. Seed germination rate increases as it increases the respiration and water holding capacity

of the soil. In addition, humic acid reduces the evaporation of water in the soil. This feature is very important for arid regions (Akıncı, 2017). These substances play a role in the nitrogen, carbon cycle and growth regulation, transport of heavy metals in plants (Tangahu et al., 2011). It can be easily taken by plants due to its low molecular weight. It prevents the removal of elements in the root zone and triggers the uptake of these elements. It regulates the pH that is most suitable for plant development. Product yield can increase by 10-30% with humic acid application. It plays an active role in plant growth and development by acting as hormone-like molecules (Nardi et al. 2002). Humic acid is used as activator fertilizer in organic or ecological agriculture. It plays an important role in the mineral balance of the soil, yield and quality (Pılanalı et al., 2001). It is important for soil fertility because humic substances check biological and chemical events in the rhizosphere (Trevisan et al., 2009). It has been stated in studies that humic substances increase cell membrane permeability, stem cell size, photosynthesis and respiratory efficiency, and oxygen and phosphorus intake (Turkmen et al., 2004).

There are studies showing that it has protective properties in plants against abiotic stress conditions. Studies have shown that leaf water content, antioxidant ability, root and stem growth (Zhang & Ervin 2008; Van Oosten et al., 2017), photosynthesis and stomata opening mechanism (Russell et al. 2006), H-ATPase activity in roots (Leonard & Hodges, 1973), Nitrogen metabolism (Colla et al., 2014), nitrate transport (Jindo et al., 2012), redox homeostasis (Tognetti et al., 2012),

nitric oxide (NO) biosynthesis (Zandonadi et al., 2010), enzyme synthesis (Siddiqui et al., 2011), hormones (Huang et al., 2013), and retrotransposon activity (Shah et al., 2018).

It was reported that, several studies have been ınvestıgated on usıng of humic acid against abiotic stress factors , such as drought (Fu Jiu et al., 1995), water stress (García et al., 2012), salinity (Akıncı, 2017; Turhan, 2019; Bulut, 2020; Tunçtürk et al., 2020), heavy metal (Çelik et al., 2010; Akıncı & Öngel, 2011; Büyükkeskin & Akıncı, 2011), and other abiotic stresses (Çelik et al., 2012). It has been reported as a result of the mentıon studies that humic acid application could be used to mıtıgate abiotic stress factors effects.

Fulvic Acid

Fulvic acids are a family of natural compounds, organic acids and components of humus. Fulvic acids have a high content of carboxyl groups. Fulvic acids have higher solubility due to their high acidic and low molecular weight (Engin & Cöcen, 2012). Fulvic acids can pass through biological membranes due to their small molecular size. It has a high cation exchange capacity and this provides the ability to absorb more cations. In addition, fulvic acids have chelating properties. Fulvic acids are known to contribute positively to the transport and usefulness of microelements due to their properties (Bocanegra et al., 2006). Fulvic acids are known to have positive effects on photosynthesis, respiration rate, intercellular CO2 concentration, proline, plant physiology, plant growth and stress tolerance (Anjum et al., 2011).

There are several studies on humic acid applications against abiotic stress factors such as drought (Anjum et al., 2011; Lotfia et al., 2015; Sun et al., 2020), water stress (Anjum et al., 2011), salinity (Seckın Dinler et al., 2016), heavy metal (Shahid et al., 2012; Wang et al., 2019), and other abiotic stresses (Seckın Dınler et al., 2016; Zhao et al., 2019) and it has been observed that products with humic acid + fulvic acid content are more studied than products containing only fulvic acid.

Mycorrhizae

Mycorrhizae known as the relationships between plant roots and fungi in the soil. Useful soil microorganisms for soil fertility and healthy plant growth are mycorrhiza fungi. Mycorrhizal fungi do not harm plants. Mycorrhizal fungi live by settling on the root surface of plant roots, root tissues, cell and intercellular spaces. Mycorrhizal fungi form a dense fungal cover and hyphae and thus provide access to places where plant roots cannot reach (Chen et al., 2018). Since they continue a symbiotic life for plants, their place in agricultural production is increasing day by day (Sandal Erzurumlu & Erman Kara, 2014). Mycorrhizal fungi act as bridges in the transport of nutrients from the soil to the roots. Mycorrhizae contribute to plant growth by affecting physiological and morphological changes in plant roots, changes in the mycorrhizosphere and competition. It provides resistance against soil nematodes and fungal pathogens (Yıldız, 2009; Sandal Erzurumlu & Erman Kara, 2014). Mycorrhizae have positive effects in alleviating the negative effects of abiotic stress and increasing water and nutrient intake. Mycorrhizae have important effects on the uptake of elements with low

availability in the soil (Ortaş et al., 1999). Mycorrhizaes make positive effects on the nutrition of plants by providing / increasing the solubility of the nutrients in the root area with benefits such as lowering the pH in the root area, secretion of chelators, production of special ion-carrier proteins. Mycorrhizae penetrate the symbiosis with the roots, increase the root area of the plant with their hyphae and thus increase the accessibility to nutrients (Akman, 2017). Mycorrhizae, which increase the root surface area, encourage plants to increase their nutrient and water uptake from the soil. This situation positively affects growth and development. With the effect of mycorrhizae on plants, it increases resistance to lack of water and reduces the need for water and nutrients (Davies, 2000).

It ımproves the tolerance of mycorrhizal fungi under stress conditions. It has been stated that the mycorrhiza fungi, which increase the root surface area, can increase the water and nutrient intake power 5-7 times in the environment with this effect, and this will make a significant contribution to the solution of drought stress. The excess of mycorrhizae in the root regions increases the resistance to arid conditions. Mycorrhizal fungi regulate the plant water relationship, provide healthy and strong root formation, and provide resistance to pathogens (Sandal Erzurumlu & Erman Kara, 2014). In areas where abiotic stress conditions (drought, salinity, heavy metal accumulation) are observed, mycorrhiza shows more active activity (Miransari et al., 2007; Gholamhoseini et al., 2013; Bozkurt, 2018).

There are several investigations on mycorrhiza applications against abiotic stress factors such as drought (Aroca et al., 2007; Bozkurt, 2018), water stress (Kohler et al., 2007; Farahani et al., 2008), salinity (Koc et al., 2016; Satir et al., 2016; Abdulhadi et al., 2017; Altunlu, 2019), heavy metal (Mohammad & Mittra, 2013), and other abiotic stresses (Aroca et al., 2007; Maboko et al., 2013).

Bacteria

Bacteria belong to genus *Acetobacter, Acinetobacter, Achromobacter, Aereobacter, Agrobacterium, Alcaligenes, Artrobacter, Azospirillum, Azotobacter, Bacillus, Burkholderia, Clostridium, Enterobacter, Erwinia, Flavobacterum, Klebsasiella, Microccoontia* and *Plebsiella* (Çakmakçı, 2005). Bacteria are microbial inoculants and among the agricultural inputs, those containing live microorganisms are biological fertilizers (Vessey, 2003; Ceritoğlu & Erman, 2019). Useful bacteria, fungi, mycorrhiza fungi are included in the biostimulants. These microorganisms are obtained from soil, plant residues, water and composted organic fertilizers. Plant growth promoting rhizobacteria (PGPR) and plant growth promoting bacteria (PGPB) have been isolated from the plant root environment. P and K mineralization of the soil, N fixation and enrichment in terms of nutrients are the effects of bio fertilizers, and they also stimulate plant growth with plant growth regulators (Backer et al., 2018; Rouphael & Colla, 2020).

PGPRs have a positive effect on plant development, and this effect derives from their ability to dissolve phosphorus and heavy metals, produce hormones, increase water and mineral intake, encourage root

growth, and increase enzyme activity in the plant (Backer et al., 2018; Rouphael & Colla, 2020). Studies on detoxification of heavy metals related to rhizobacteria, degradation of pesticides, salinity tolerance, biological control of plant diseases and pests, increasing the efficiency of the use of plant nutrients and minerals, producing phytohormone and enzyme have intensified (Gurfinkel & Perticari, 2000; Çakmakçı et al., 2008; Bayrak & Ökmen, 2014).

Bacteria can be applied to the soil, seed and different plant regions. It is known that when applied, it increases positively the nutrient uptake, root area, root biomass and plant nutrient removal capacity from the soil (Vessey, 2003). Increase in plant nutrient solubility, asymbiotic N fixation, increase in siderophore production and Fe uptake, and the production of volatile organic compounds are the result of the work of microorganisms as activators. PGPR have a positive effect on production of IAA and cytokine in the plant structure, encouragement of gibberellic acid, nutrient uptake, and a decrease in the demand for chemical fertilizers (Eşitken et al., 2003; Eşitken et al., 2006; Orhan et al., 2006; Aslantas et al., 2007).

Various studies have been conducted to determine the effect of bacterial applications in alleviating the negative effects of abiotic stress. There are studies on bacterial applications against abiotic stress factors such as drought (Figueiredoa et al., 2008), water stress (Mayaka et al., 2004; Kohler et al., 2007), salinity (Koc et al., 2016; Riaz et al., 2019), heavy metal (Burd et al., 2000; Farwell et al., 2006), and other abiotic stresses (Çakmakçı et al., 2006; Farwell et al., 2007).

Vermicompost

In Turkey and in the world, efforts to increase the awareness of organic agriculture and to promote sustainable agricultural production have come to an important point. In parallel with this approach, organic wastes have started to be used and converted into quality products in a short time (Bellitürk, 2018). In this form of evaluation, worm composts are obtained by composting organic wastes using worms. The products obtained by passing through the digestive system of worms are called vermicompost, vermikest or kest (Edwards & Bohlen, 1996). Vermicompost production is an application that supports sustainability in agricultural production. It is important for the utilization of solid wastes and residues caused by rapid population growth and industrialization and to prevent environmental pollution (Şimşek-Erşahin, 2007). The organic content of vermicompost is produced using solids from cattle, sheep, horses, rabbit droppings, chicken and fish waste, pruning and harvest residues in vegetable and fruit production areas, grass, kitchen waste, paper waste, forest product waste (Ceritoğlu et al., 2019). Our country is rich in these organic wastes. The production of vermicompost using these organic materials and its use in agricultural production will provide great benefits to the economy and the environment, as well as reducing the dependence on chemical fertilizers. Soil improvement has become important due to the pollution in agricultural lands and the decrease in organic matter content (Bellitürk, 2016; Kuş, 2019). By using vermicompost, which contains around 40% total organic matter, the pollution and low organic matter

content will be prevented. Vermicompost, an organic fertilizer with an average of 1.5-2% nitrogen, 2.5-4.1% phosphorus and 1.4-9.2% potassium, which does not contain harmful microorganisms, increases the agricultural production potential (Bellitürk, 2016). It is known that vermicompost has a positive effect on the physical, chemical and biological properties of the soil, and because of this effect, it enables high efficiency and quality in plant cultivation (Jat & Ahlawat, 2006; Alam et al., 2007; Ali et al., 2007; Singh et al., 2008; Rangarajan et al., 2008). Allopbophora caliginosa worm species are widely found in the soil. Due to its granular structure, it helps to regulate the soil structure as well as increasing the aeration and water holding capacity of the soil. They contain a large number of bacteria that can compete with harmful bacteria in the soil. This situation increases the resistance of the plant. It has no toxic effect (Özer & Elibüyük, 2016). It has superior properties as it contains more nutrients and more amounts compared to standard compost products. It has features such as its porous structure, high aeration and water holding capacity. Vermicomposts preserve their nutrient content longer in the growing environment. It does not contain any pathogens or chemicals harmful to human health. Another important feature is that it provides water saving since it has a water holding capacity of 2-3 times its own weight. With this feature, its usability in water stress studies is important (Hosseinzadeh et al., 2016; Kıran, 2019; Teke, 2019).

Seaweed

Seaweed has been used in agricultural production in recent years. Brown seaweed (*Phaeophyta*) are fertilizer raw materials mostly used in fertilizer production. Although *Ascophyllum nodosum* is the most commonly used species, the *Sargassum, Macrocystis, Fucus, Laminaria* and *Ecklonia* types of algae are also widely used. Seaweed extracts are used extensively in greenhouse vegetable growing, fruit and ornamental plants. Seaweed extracts also have important beneficial effects on seed germination, seedling formation, rooting, flowering, fruit and crop yield, shelf life and resistance to diseases and pests. It has effects that increase chlorophyll content, leaf texture and strong root formation. Seaweed can be applied to soil, plant roots and leaves and are ultimately biostimulants that are effective on vegetables, trees, flowering plants and grains (Nabti et al., 2016; Bat, 2019). It has been reported that seaweed application is effective in regulating plant growth, increasing yield and quality in organic agriculture, increasing resistance to diseases and pests and improving the structure of the soil (Yazıcı & Kaynak, 2001; Bat, 2019).

There are researched on the use of seaweed in abiotic stress. There are studies on seaweed applications against abiotic stress factors such as drought (Santaniello et al., 2017; Shukla et al., 2018; Bat et al., 2020), water stress (Neily et al., 2010; Kaoaua et al., 2013), salinity (Jithesh et al., 2012), heavy metal (Wu et al., 2009), and other abiotic stresses (Rayirath et al., 2009; Sangha et al., 2010; Fan et al., 2011; Bischof & Rautenberger, 2012).

Biochar

Biochar is called carbon-rich material obtained by burning organic biomass in an airless or low air environment. It has been known that biochar has been applied to the soil for many years (Glaser et al., 2001). Biochar has important effects such as binding CO_2 in the atmosphere to the soil, reducing gas emission and providing positive effects on soil properties. Biochar is used as a soil regulator due to its effects that increase soil fertility and regulate the soil (Lehmann et al., 2011; Mounirou, 2019). Biochar has similar effects to organic fertilizers. Biochar, which is rich in nutrients, has many features that increase the water holding capacity and cation exchange capacity of the soil and regulate the soil pH (Gunes et al., 2014; Inal et al., 2015). It has an effect on increasing the cation exchange capacity and preventing the washing of nutrients. In addition, depending on the biochar used, its changes properties such as changing the pH of the soil and increasing the water holding capacity of the soil change (Lehmann et al., 2006; Kolb et al., 2009; Jeffrey et al., 2011; Mounirou, 2019). The increase in the water capacity of the soil in biochar application is related to the increase in organic matter in the soil (Lehmann, 2007). The increase in pH, EC and organic matter with P, K, Na and Zn available in the soil changes according to the use of biochar. There is also a study showing that N, K, Ca and Zn content, dry matter and peroxidase enzyme activity in plant leaves increased in biochar application (Majeed, 2014). It is also stated that biochar has effects on yield (Yamato et al., 2006; Chan et al., 2008; Deenik et al., 2010; Schulz & Glaser, 2012; Mounirou, 2019).

There are several studies on the effect of biochar used with abiotic stress application. There are studies on biochar applications against abiotic stress factors such as drought (Kamman et al., 2011), salinity (Sadegh-Zadeh et al., 2018), heavy metal (Salmani et al., 2014). It has been reported as a result of studies that biochar application can be used against abiotic stress factors (Karami et al., 2011; Gunes et al., 2014; Si, 2018).

Zeolite

Zeolites are aluminum silicates in crystalline form, containing alkaline earth cations, and easily and abundantly. It is characterized by its cation exchange properties, water loss and gain properties, and there is no significant change in its structure (Ayan, 2001; Zahedi et al., 2012; Soltys et al., 2020). Due to the gaps in the zeolite minerals, the input and output of liquid and gas molecules are very easy (Ayan, 2001). It realizes the increase in efficiency by providing an increase in this nutrient and water substance. It has been stated that the zeolite contains exchangeable metallic ions and water molecules, the zeolite retains the water in the presence of water, and releases the water held in the zeolite in dry conditions (Ayan, 2001; Çakıcıoğlu-Özkan & Becer, 2019, Soltys et al., 2020). This situation has an effect on preventing root rot in areas with excessive water accumulation and reducing the formation of fungal diseases in the presence of long-term high humidity. The use of zeolite in arid areas protects the plant for a while. Zeolites have a moisture absorption feature and due to this feature, they can absorb and retain moisture even in low humidity conditions (Zahedi et al., 2012;

Soltys et al., 2020). It has been reported that when zeolite is mixed with soil, it is effective in preventing the washing of plant nutrients and improving the water regime (Ayan, 2001; Nakhli et al., 2017; Soltys et al., 2020). Zeolites are important in reducing the washing out of nitrogen fertilizers (Ayan, 2001; Soltys et al., 2020). It reduces ammonium poisoning by taking ammonium into its structure at levels where ammonium can have toxic effects (Ayan, 2001; Soltys et al., 2020). Natural zeolites with high ion exchange and absorption capacity are used as drug carriers (Ayan, 2001; Wang & Peng, 2010). Zeolite is important for the effective uptake of ammonium in plants. It can be used to reduce the use of fertilizers and the pollution of fertilizers to the environment. It has been stated that it affects P and NH_4^+ uptake in plants, it is important in reducing the use of pesticides and the damage of the plant against the toxic effect of fertilizer (Ayan, 2001). Zeolite is rich in Na ions. Therefore, it has been reported that it makes the soil alkaline and also causes osmotic problems (Ayan, 2001; Wang & Peng, 2010). Besides, it is effective in regulating the pH of acidic soils. It has an important feature as a soil regulatory (Ayan, 2001). There are studies on the use of zeolite against abiotic stress factors (Zahedi et al., 2009; Zahedi & Moghadam, 2011; Zahedi et al., 2012; Nozari et al., 2013).

Leonardite

Leonardite is a source of humic acid. The organic material stratified in lakes and marshes as a result of decomposition and humification of the material (living wastes) under high pressure, temperature and anaerobic (without oxygen) conditions of ancient times plant and animal remains

is called leonardite (Özkan, 2007; Kolay et al., 2016). It is known that humic acids have many benefits for the soil. It is very important in providing the nutrients, macro and micro elements, vitamins and amino acids that are absolutely essential for plants by absorbing the plant nutrients at the highest rate. Leonardite is separated from the soil due to its content. Lenordite has high amounts of phosphorus (P_2O_5), calcium carbonate, Fe, Mn, Cu, Zn, poor in potassium, low toxic element content and neutral pH (Engin & Cöcen, 2012). There are studies on the use of lonardite in abiotic stress. There are studies on leonardite applications against abiotic stress factors such as drought (Kaya et al., 2020), salinity (Kiyas, 2020) and other abiotic stresses (Aguirre et al., 2009; Kaya et al., 2020).

Conclusions and Future Prospects

Abiotic stress factors are an important problem causing efficiency and quality losses. The use of chemicals in reducing the negative effects of abiotic stress factors on plants and plant growing environments both pollutes agricultural soils and harms nature. Hence, using organic substances, which can be used as an alternative to chemical fertilizers, have features such as improving the ımpact of microorganisms and soil fertility. Applications of organic substances produce an important role in nitrogen availability and improving soil structure, protecting water availability and improvıng the organic matter of the soil. One of the important strategies in agricultural production is the use of organic substances to mitigate the effects of abiotic stresses in agricultural production. It is an important phenomenon to determine effective,

sustainable practices that do not harm agricultural lands, nature and people in order to prevent these problems experienced today, where the negative effects of abiotic stress factors in agricultural production are increasing day by day. With the increase of awareness on sustainable agriculture in recent years, the use of organic substances in agricultural production has become widespread. Accordıngly, knowing organic substances used against abiotic stress factors and using these substances against abiotic stress factors is an important step in preventing problems in agricultural production for sustainable agriculture.

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CHAPTER 14

AGRICULTURE FRIENDLY BIO FERTILISERS IN WASTE MANAGEMENT: VERMICOMPOST and BIOCHAR

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INTRODUCTION

We are going through a period of global outbreak and the economies of nations are quite vulnerable and changes are observed in settlement and production patterns. Therefore, the most prominent issues of our nation to concentrate on are climate crisis and food safety. The accelerated use of eco-friendly good agricultural practises has emphasized the necessity of preserving sustainable natural assets. Preservation of these natural assets and an eco-friendly and economic approach in agricultural production has increased the importance of soil improvement materials.

Use of eco-fertilisers ensure quality and yield increase in agricultural production and they are becoming more and more common due to their significant benefits on environment and healthy living. Furthermore, eco-fertilisers also play an important role in solving the environmental issues arising from organic waste and residues created by rapid industrial growth and population increase. For these reasons, vermicompost (worm castings), bio-char is one of the more prominent organic based eco-fertilisers to improve sustainable and organic agriculture models as it can reduce the use of chemical fertiliser and pesticides. Scientific data that proves urgent solution is needed for waste management emphasize that eco-fertilisers need to be produced and used in agricultural-landscape areas as reaching a solution is particularly important in agricultural terms. Furthermore, bio-fertilisers, basic components of good agricultural practises, play a vital role in ensuring long term soil fertility and sustainability. We are going through a global process where the importance and awareness of waste

management is increasing and two of the bio-fertilisers, vermicompost and bio-char, have been assessed in terms of soil quality and environmental factors in this study.

1. VERMICOMPOST

With the purpose of maintaining modern life, natural resources are being fast depleted, nature is being damaged, and high levels of consumption lead to great amounts of waste and environmental pollution as well as other ecologic issues, all of which makes it necessary to use natural resources an optimum level. With regards to the existing agricultural areas in Turkey, wrong practises, extreme use of chemicals and other similar habits cause a reduction, even extinction, in the amount of organic matter and other beneficial nutrients in soil. Hence, agricultural production is lowered in terms of yield and quality, leading to reduced revenues for producers and increased maintenance costs for landscape areas. Accordingly, traditional agriculture is shifting towards "intense-input farming" model and ecologic system is being harmed. Furthermore, the amount of waste per person is being increased and increased organic wastes in particular lead to environmental problems. One of the popular and alternative methods of converting waste into bio-fertiliser as an agricultural input is the production of worm fertiliser. Vermicompost is the product acquired by composting organic wastes by using soil worms (Figure 1). Vermicompost is a good organic fertiliser and an eco-friendly production material that can be easily used in organic agriculture. Vermi means "worm" in Latin and together with the word compost it becomes "vermicompost or worm

compost" and it is becoming more and more familiar in fertilization terminology (Bellitürk and Goldmann Benardete, 2020).

Chemical fertilisers appeared following industry-based production processes and its misuse or overuse causes deterioration in soil quality over time and organic matter diminishes or becomes extinct, harming the living structure in soil. There is no doubt that soil analysis results must be observed when using chemical fertilizers and they also must be used only when necessary and by observing expert views to have product yield. However, this currently has no impact on increasing the quality of existing soil.

Figure 1. Vermicompost Sample.

Therefore, agricultural inputs such as compost, vermicompost that is produced by making use of all types of herbal and animal wastes should

be used for soil improvement and fertilization in agricultural areas and they can also be used for arranging landscape areas with great benefits.

According to some studies, vermicompost is an important and key agricultural input and a good soil improver and eco-fertilizer to bring soils back to their former condition and to ensure high fertility, to yield good quality agricultural products, to clean soil, to increase fertility, to create long-lasting grass and landscape areas and to ensure sustainability of ecosystem, (Bellitürk, 2016; Açıkbaş and Bellitürk, 2016; Bellitürk, 2018; Shrestha et al., 2019; Bellitürk and Özkan, 2019; Bellitürk et al., 2020; Rehman et al., 2020).

When applied, vermicompost improves the structure of soil helps it gain better physical properties. It increases the infiltration power and water-holding capacity of soil. In soils applied with vermicompost the amount of irrigation water and the number of irrigations will be decreased and therefore drought will not be a general issue and economic savings can be made from irrigation. According to Bellitürk (2016); vermicompost is a reliable organic fertiliser due to its slow-release characteristic and the physical, chemical, biologic and microbiologic improvements it makes in the soils it is used.

In Thrace Region, vermicompost is being used both for agricultural purposes and for landscaping. Some of the main reasons for this are worm fertiliser's water holding capacity in soil, providing plants with beneficial nutrients and increasing yield, reviving beneficial microorganism activities and increasing amount of organic matter, providing resistance against diseases and extending the shelf life of

products (Bellitürk, 2018a). Worm fertiliser is highly important in preventing environmental pollution, creating employment and taking measures against food shortage through sustainable agriculture (Bellitürk, 2017).

Vermicomposting is also defined as organic waste being converted into bio-fertilisers by worms and this technology is being widely used in organic solid waste management nowadays (Manyuchi et al., 2013). The most common 6 worm species used in converting organic wastes to vermicompost are respectively as follows; *Eisenia fetida* (a similar species to *Eisenia andrei*) living in warm climates, *Dendrobaena veneta* and *Lumbricus rubellus* and the tropical *Eudrilus eugeniae, Perinoyx excavatus* and *Perionyx hawayana*. Other soil worms are also used for vermicompost production but they are not as common as those 6 (Edwards, 2004). Every soil worm on earth has the ability to compost organic matters. Worms used to produce worm fertiliser are generally epigeic species. Excrement of endogeic worms are not preferred to produce vermicompost as they live deep underground (soil) (Lee, 1985). In addition, soil worms can also be used as baits and therefore is a potentially important market for fishing, domestic aviculture and frog and chicken farms.

1.1. Food Enjoyed by Worms

Coffee grounds (sediment), teabags, chopped vegetables and fruits, cereals such as oat, rye, corn, green leaves, animal excrements (horse, sheep, goat, rabbit, camel, cow, chicken, deer, duck, turkey, bull, pig etc.), forest waste (pine, cedar, spruce mulch or finely graded sawdust),

lightly graded egg shell, paper and carton, sugar factory wastes, fresh and dry leaves, fruit and vegetable pulps-green and outer skins of some fruits, coconut shell, groundnut shell, bran are among food items of worms (Bellitürk and Goldmann Benardete, 2020). Animal excrement can be used directly and on its own for feeding worms. However, a diet consisting mainly of poultry excrement can cause some problems in vermicompost production.

1.2. Things Which Should Not Be Eaten by Worms

Meat and dairy products, fish, bone, cheese, cooked pea and chickpea, rice, pasta, cooked potato, mown grass, foreign seeds and grass, roadside grass, diseased herbal waste, dog and cat excrement, citrus fruit, onion-garlic waste, chili pepper waste, waste with oil and salt other organic waste with heavy metal content should not be fed to worms (Bellitürk and Goldmann Benardete, 2020).

1.3. Common Systems Used for Producing Vermicompost

These are open (cluster) system, bed, box, windrow, container systems. Small-sized enterprises are usually known as open (cluster/batch) systems and they are the enterprise models preferred by new starters. Medium-sized enterprises are those where non-professional harvest systems are being used in both open and closed environments. Larger-sized enterprises are known as enterprises keeping modern-technologic production systems advised and supported by the Ministry of Agriculture and Forestry. The harvest system preferred by most of the larger-sized enterprises in Turkey is “Rivo Harvest Systems” developed

by “Riverm Ltd. Company” operating in Tekirdağ/Turkey (Figure 2). Regardless of the size of the enterprise, there is a possibility of growth and this makes vermiculture entrepreneurship attractive in Turkey (Bellitürk and Goldmann Benardete, 2020).

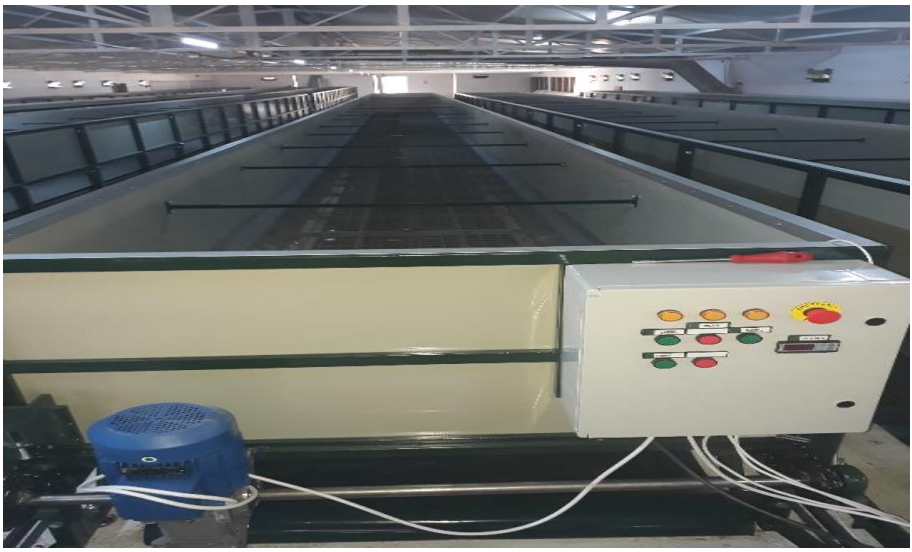

Figure 2. Vermicompost production mechanism with continuous flow reactor system (RHS).

Some of the analysis values of vermicompost with different characteristics and produced by using various organic wastes are provided collectively in Table 1. As Table 1 indicates, the characteristics of vermicompost varies according to the type of the waste fed to worms but regardless of this variation many wastes can be turned into a good organic fertiliser by vermicomposting. In terms of organic matter, the ratio in vermicompost’s produced from various animal and plant wastes ranges between 30,03% and 47,86%, which once again indicates the importance of this fertiliser.

Table 1. Chemical analysis results of some vermicompost's with different characteristics.

Chemical content	Vermicompost				
	Produced from Cattle Manure (Arancon ve Edwards, 2011)	Produced from Food+ Garden Waste (Lange, 2005)	Produced from Ground Paper Waste (Bellitürk ve ark., 2015)	Produced from Olive Pruning Waste (Bellitürk ve ark., 2014)	Hazelnut Outer Shell (%50)+ Cattle Manure (%50) Produced from Wastes (Soytürk, 2020).
N, %	1,90	1,81	1,11	1,86	0,76
P, %	4,70	1,01	0,14	0,23	0,083
K, %	1,40	1,04	0,32	1,74	0,40
Ca, ppm	23,25	0,27	25,82	41500,00	4855,28
Fe, ppm	3454,00	1440,00	-	15451,91	290,78
Mg, ppm	5802,00	2100,00	0,33	5400,00	1108,54
Mn, ppm	160,00	346,00	131,50	585,73	46,39
Zn, ppm	516,00	387,20	48,80	69,75	24,37
Org. Mad. %	-	30,30	39,00	47,86	37,23

2. BIO-CHAR (BC)

There is a need to increase the endurance of towns and agricultural areas against climate change/crisis, hence the fragility of agricultural lands needs to be reduced, the endangered food-access needs to be secured and accessible clean energy needs to be supported. Considering the conditions that the World and Turkey are in, there is an imminent necessity to rapidly establish environment and agriculture friendly energy source management plans in our country. In this sense, the importance and necessity of bio-mass, one of the sustainable energy sources is increasing on a daily basis. Agricultural product waste, or

bio-masses, is thermally processed through pyrolysis in an environment with or without oxygen and this leads to a side product of bio-char rich in carbon. The foremost objective of this side product is to catch and store atmospheric carbon. Bio-char, due to its organic-based characteristics, is mainly expected to reduce unnecessary use of chemical fertilisers and increase fertility in agriculture (Verheijen et al., 2010).

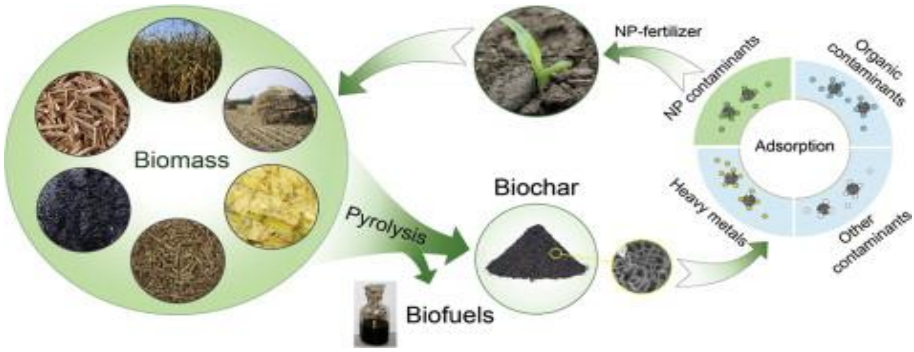

Figure 3. Conversion process of biomass to bio-char (Tan et al., 2015)

Bio-char (BC) is a carbonated organic material produced from carbon (C) based raw material under oxygen-free conditions. Bio-char is produced to bind carbon to soil and to maintain and improve the physical, chemical and biologic characteristics of soil (Lehmann and Joseph, 2009; Brassard et al., 2019). Pyrolysis is defined as the action to thermally process raw materials under oxygen-free conditions and separate the chemical compounds of organic matters. Furthermore, pyrolysis occurs naturally in high temperatures between 300- 1000°C (Bruun et al., 2017). The characteristics of bio-char depend on the materials used during production and the pyrolysis conditions.

Chemical compound of bio-char has a heterogeneous structure. Chemical compound of bio-char includes stable C, variable C and ash (Wijitkosum and Jiwnok, 2019). The C-holding levels of bio-chars produced in higher temperatures are higher than the bio-chars produced in lower temperatures (Novak et al., 2009). Water holding capacity, content of volatile compound, ash content, pH, pore size, volume weight and specific surface area are the most important quality parameters of bio-char used in agricultural practises (Mu and Wang, 2019).

2.1. The Effect of Bio-Char on Soil Characteristics

Bio-char defines the effect/efficiency of the physical, chemical and biologic characteristics of soil on soil functions. Bio-char provides important data about the process and functions of soil characteristics. It also provides information on the scope of bio-char's interaction level in soil and the time-changes inside the soil system to understand the improvement of soil and the contribution it makes to protect the soil from negative effects.

The important characteristic effect of bio-char on soil is the fact that it has high surface area and porosity level (Major et al., 2009). It is also a suitable adsorbent to hold nutrients and water molecules. This creates a good environment for the bio-char microorganisms to develop. It has an active duty that increases water and nutrient intake to plants so the plant and soil microorganisms can be fed.

Scientific research conducted on vertisol soils have concluded that bio-char plays an active role in carbon holding capacity, soil fertility and soil protection or improvement (Verheijen et al., 2010; Çelik et al., 2019b). Bio-char can contribute to different mechanisms of immobile materials. When applied as a healer, bio-char increases the pH value and reduces the mobility of materials (Igalavithana et al., 2017). When bio-char is applied to soil, negative loads in soil complex increase. This way, the free metal ions in soil solution are reduced due to the electrostatic attraction between positively charged metal ions and negative charges on bio-char surface (Peng et al., 2011; Sakin and Yanardag, 2019).

It has been observed that when bio-char is applied to fine textured soils, there is an improvement in soil structure or soil aggregation (Demir, 2018). The effects of bio-char practises on the physical characteristic of soil can be listed as aggregation, processability, shrinking-swelling and permeability. Surface areas of bio-chars are generally at a higher level than soils with sand and clay textures. As a result of this, bio-chars lead to an increased specific surface area of soils when used as soil additive (Ding et al., 2016).

Bio-char is a rich source of carbon, phosphor, magnesium, calcium and sometimes nitrogen. For hundreds of years bio-char is being mixed with soil. In global terms, bio-char is being used for soil reclamation, improving soil fertility and mitigate environmental problems. Bio-char is known for its ability to increase soil nutrient level, water holding capacity, microbial activity, agricultural productivity and to contribute

production through biomass wastes. High levels of bio-char additions in tropical areas helped higher levels of phosphor (P), potassium (K), calcium (Ca), zinc (Zn) and copper (Cu) intake by plants (Jeguirim et al., 2019; Tomczyk et al., 2020). Chemical surface characteristics of bio-char defines cations such as Ca or Mg and the possibility to hold nutrients. In addition, bio-char can make it easier to release N, S and P.

2.2. Improving Soil Characteristics and Combatting Climate Change

When word spread that bio-chars should be used and considered as soil improver and organic carbon source in agricultural practises, several studies have been conducted around the world on the issue. However, these studies were mostly concentrated in tropical or high-moisture areas. General conclusions of those studies were that use of bio-char prevents nutrients from being washed-off from soil, increases Cation Change Capacity, changes pH value in accordance to the material used for producing bio-char and increases water holding capacity and the biologic activity of soil.

The areas in a semi-arid climate zone in Turkey and in the world have soils with low soil organic matter level and high lime content and soil quality level drops rapidly. Carbon that is released through the separation of organic matter becomes oxidized and increases CO_2 emission to the atmosphere. This not only harms soil structure but it also leads to inevitable changes in climate due to the greenhouse gasses released to atmosphere. Separation of organic carbon is seen as the reason behind climate change and to stop this and keep more organic

carbon in soil, use of soil-improvement and agriculture friendly materials such as bio-char is important to ensure sustainable soil management (Sakin, 2012; Ortaş, 2018; Celik and Akca, 2018; Celik et al., 2019a).

It has been observed that as a result of using bio-char in agricultural areas, organic carbon in soil is separated slower and the organic matter content of soil is increased, emission of various greenhouses such as CO_2 and N_2O is reduced, helping to prevent global warming, and improvements are made to soil characteristics. With such improvement effects on environment and soil-regulation capacity in herbal production, bio-chars are considered to be important organic technology products making use of organic wastes not be

Figure 4. Application and uses of biochar (http://www.biochar-industry.com/biochar/)

used in a different economic way (Celik et al., 2019b). It is believed that bio-char can store carbon in soil for hundreds or even thousands of years (Lehmann, 2007). It has been reported if bio-char materials are used in agriculture, rather than for energy purposes, they can reduce greenhouse gas emission anywhere from 12% to 84% (Lehmann, 2007).

Using bio-char as a soil additive increases the fertility of agricultural soil and it has also been recommended as a method of reducing anthropogenic climate change (Woolf, 2008). Some studies suggest that there is no evidence regarding any changes in product yield or quality

in short term (Jay, 2015), therefore there is a need for long term studies with recurring bio-char implementations in commercial productions.

One of the other possible environmental contribution of bio-char is the reduction of nitrate filtering (Singh et al., 2010), however nitrate has a high solubility and pH plays an important role. In this sense, previous studies have observed adsorption of pollutants such as and Cu from soil and reduced gas emissions (nitrous oxide and methane) from soil (Beesley et al., 2010).

2.3. The Effects of Bio-Char on Soil Quality

Soil quality is defined as, "the capacity of a certain type of soil to function within natural or managed ecosystem limits, sustain plant and animal productivity, preserve or improve water and air quality and support human health and settlement" (Karlen et al., 1997). In arid and semi-arid climates organic matter is highly important for the quality of any type of soil (Celik and Baran, 2018). Significant efforts are required to improve the organic matter levels of soil in arid and semi-arid areas. Soil organic matter of arid soils need to be improved and also innovative methods that do not compete with water need to be developed for herbal production. In this context, one of the most effective methods is to convert locally available waste bio-mass materials into bio-char to be implemented to soil (Zhang et al., 2016).

Bio-char is a material considered to be the most important soil quality parameter and the soil carbon and soil organic matter level it contains has an impact on soil quality, fertility, production, continuity and

environmental protection. Soil quality is a highly important criteria in terms of soil functioning and usage. Several studies have been conducted to prove that applying bio-char to soil has important effects on various soil quality parameters.

Soil quality is measured in accordance to land-use planning by using soil quality indexes that include physical, chemical, biologic, mineralogical and micro-morphological parameters of soil (Doran and Parkin, 1994; Akça et al., 2010). Soil quality is an indicator that helps to assess and protect the current status of soil assets and ensure sustainable soil management (Karlen et al., 2008).

Physical, chemical, biologic, mineralogical and micro-morphological characteristics of soil are assessed holistically and all these characteristics have varying levels of impact of the behavioural attitude of soil, which in turn define the general quality of soil. During the past 25 years assessments to define soil quality parameters were based on the content of some physical and chemical characteristics possessed by soil. Using such limited quantity of parameters does not make it possible to have healthy data and interpretation regarding soil quality.

Agricultural sustainability and soil quality are closely related. Therefore, the functions of soil organic matter are also important for sustainable agriculture and soil quality. Regular addition of bio-fertiliser has a great impact on soil organic matter. Through optimum land use in agricultural practises, it is aimed to increase the chemical fertility and quality of soil by applying different bio-chars to soil (Lal and Kimble, 1997; Sarı, 2018).

To ensure wider use and benefit from soil improver and eco-friendly bio-fertilisers, there is a need to conduct further studies the behaviour of soil characteristics and their inter-relations, and their roles on the functions of degraded and unused soil. Furthermore, internationally accepted standard methods and reference values should be used by establishing a sufficient database between the scientists working on this matter. When the established/to be established quality, parameters are taken into consideration holistically with the chemical, physical, biologic, mineralogical and micro-morphological characteristics of soil, this will provide sub-data for future studies on soil quality.

CONCLUSION

Rather than being an organic fertiliser on its own, vermicompost is a good soil improver and an eco-friendly and economic material that makes culture plants resistant against disease. Vermicompost technology has a significant relevance to make use of waste and use them as agricultural input through recycling.

Despite the fact that several academic studies have been conducted recently in Turkey regarding the importance of both the production of vermicompost and its use in agricultural and landscape areas, the desired level has unfortunately not been reached in implementing this fertiliser. Currently the organic matter content of our agricultural soil has been reduced to below 1% and therefore it is now even more important to have a widespread use of bio-fertilisers. It is also important to eliminate the bureaucratic obstacles in front of the fertiliser production process and to support the related projects. In addition,

further academic studies are required on the recycling of organic waste and on the several benefits they offer. Increasing the amount of incentives offered to producers using organic and organo-mineral fertiliser is one of the quick solutions to ensure wider use of this fertiliser in the upcoming years.

The world population is expected to increase in the next centuries. This situation is an indicator of the decrease in land and other natural assets. For this reason, necessary measures should be taken to protect the soils and increase their quality. One of the most effective ways of this is possible with the use of agriculturally friendly biochar.

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CHAPTER 15

THE SITUATION OF CEREALS CULTIVATION IN THE WORLD AND TURKEY

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INTRODUCTION

Poaceae (*Gramineae*) family has 400 genuses and 4500 species, and 10 genuses are cultivated economically (Gençtan et al., 2010). The cereal genuses that have economic importance are as follows; wheat (*Triticum*), barley (*Hordeum*), maize (*Zea*), oats (*Avena*), rye (*Secale*), paddy (*Oryza*), triticale (*Triticale*), sorghum (*Sorghum*), proso millet (*Panicum*), foxtail millet (*Seteria*) and canary seed (*Phalaris*). Cereals are divided into two groups as cool climate cereals and warm climate cereals according to their temperature requirements. Wheat, barley, rye, oats, triticale are in the cool climate cereals group. Maize, paddy, sorghum, proso millet, foxtail millet and canary seed are in the group of hot climate cereals (Geçit and İkincikarakaya, 2011).

Covering many crop types, cereals show a wide variety of species, varieties and ecotypes. Therefore, cereals were able to find wider areas of adaptation compared to other cultivated plants, and spread from the equator to the poles, from low plains to high plateaus. The reason why cereals, especially cool climates cereals, are widely grown is that their adaptability is very high and they can be grown in a wide range of climatic and soil conditions (Söğüt, 2017; Soysal ve ark., 2020).

Cereals are the most cultivated field crops in the world. Cereals cultivation is carried out in 728 million hectares of the 1.5 billion hectares of agricultural land in the world. In Turkey, the total cereals production area (10.871.307 ha) in the year 2018 constitutes of 1.5% of the world grain production areas (FAO, 2020). In 2019, 34.401.704 tons of cereals were produced in an area of 10.772.160 ha. The vast

majority of the total cereals production is in Central Anatolia Region in Turkey, followed by Marmara, Mediterranean, Southeast Anatolia, Aegean, Black Sea and Eastern Anatolia Region. (TUIK, 2020).

Cereals which are easy to store and transport, are an economical food source that does not deteriorate quickly, is easily available, and is used in human and animal nutrition as an energy source (Soysal and Ülker, 2019a). 55-65% of the daily energy need in the world is provided by cereal products. The share of plant-based foodstuffs in meeting the protein need is 77%, 66% of which is provided by cereals and cereal products, 50% of which is unique to bread (Şanlıer, 2013). When these values are compared with developed countries with high living standards; it is seen that the share of herbal foodstuffs and cereal products in terms of providing both calories and protein in our country is quite high (Erbaş Köse and Mut, 2018).

Herbal based foods; it is consumed in higher amounts, especially in countries and societies that are lagging behind in technology, since they are cheaper and easier to grow, provide, transport, store and process than animal ones (Kün, 1988; Aktaş, 2010; Gökçe and Kotan, 2016). Wheat and paddy are mostly used as food in human nutrition, while barley, maize, rye, oats, sorghum and millet are mostly used as animal feed.

There are different consumption types of cereals; flour, pasta, bulgur, starch, etc., the most prominent among them is bread. Among the cereal flours, those that have the feature of making bread are wheat and rye flour (Kalkan and Özarık, 2017). Wheat bread contains 8-12% protein,

1-5% fat, 1-2% minerals as well as carbohydrates and is a nutrient source especially rich in B group vitamins (Baysal, 2007). In addition, oil can be extracted from cereals or it can be used in the production of glucose or alcohol. Wheat is the most grown cereal among these agricultural products that provide high energy with its abundant starch-containing grains (Sonkurt, 2018; Soysal ve Ülker, 2019b).

THE SITUATION OF CEREALS CULTIVATION IN THE WORLD

Cereals cultivation is carried out in 728 million hectares of the 1.5 billion hectares of agricultural land in the world. The total cereal production area in Turkey is the part of 1.5% of world cereal production areas (FAO, 2020). According to the production area of the cereals produced in the world in 2018 are wheat (214.291.888 ha), maize (193.733.568 ha), paddy (167.132.623 ha), barley (47.928.609 ha), sorghum (42.143.146 ha) , millet (33.560.087 ha), oats (9.846.085 ha), rye (4.117.396 ha), triticale (3.809.192 ha) and canary seed (205.322 ha).

Table 1. The production area, production quantity and yield values of wheat, barley and rye in the last 5 years in the world (FAO, 2020)

	Wheat			Barley			Rye		
Years	**Production area (ha)**	**Production quantity (tons)**	**Yield (kg/da)**	**Production area (ha)**	**Production quantity (tons)**	**Yield (kg/da)**	**Production area (ha)**	**Production quantity (tons)**	**Yield (kg/da)**
2014	219.750.589	728.730.126	332	49.759.004	145.091.156	292	5.250.562	15.201.560	290
2015	223.476.466	741.643.258	332	49.618.452	147.748.880	298	4.693.267	13.755.849	293
2016	219.096.587	748.392.150	342	48.190.505	145.906.773	303	4.48.7480	13.386.551	298
2017	218.424.864	773.476.524	354	48.165.251	149.141.292	310	4.485.029	13.817.724	308
2018	214.291.888	734.045.174	343	47.928.609	141.423.028	295	4.117.396	11.273.579	274

Wheat production areas in the world decreased from 219.750.589 hectares to 214.291.888 hectares. Production quantity increased from 728.730.126 tons to 734.045.174 tons. Despite the decrease in the production areas, the increase in the production quantity is explained by the increase in productivity. In the last 5 years, wheat yield in the world has increased from 332 kg/da to 343 kg/da (Table 1). When ranked in terms of production areas, the countries producing the most wheat in the world are India, Russia and China. China is ahead of India and Russia in terms of wheat yield, but it ranks 3rd due to its lower production area (Table 4).

Barley was grown in an area of 49.759.004 ha in the world in 2018. Barley production has decreased by approximately 4 million tons in the last 5 years. Production quantity has also decreased due to a decrease of approximately 2 million ha of production areas (Table 1). The most barley producing countries are Russia, Australia and Turkey. Barley yield was higher than yield of the other two countries, but ranks 3rd in Turkey due to production area being less (Table 4).

Table 2. Production area, production quantity and yield values of oats, triticale and maize in the last 5 years in the world (FAO, 2020)

	Oats			Triticale			Maize		
Years	**Production area (ha)**	**Production quantity (ton)**	**Yield (kg/da)**	**Production area (ha)**	**Production quantity (ton)**	**Yield (kg/da)**	**Production area (ha)**	**Production quantity (ton)**	**Yield (kg/da)**
2014	9.546.933	22.826.108	239	4.123.523	16.982.007	412	185.736.210	1.039.226.655	560
2015	9.919.280	23.327.168	235	4.559.733	16.968.111	372	190.575.736	1.052.127.378	552
2016	9.494.056	23.657.105	249	4.230.430	15.535.409	367	195.604.568	1.126.990.585	576
2017	10.161.935	26.118.296	257	4.132.275	15.515.704	375	197.465.862	1.164.400.832	590
2018	9.846.085	23.051.204	234	3.809.192	12.802.592	336	193.733.568	1.147.621.938	592

In 2018, rye was cultivated on an area of 5.250.562 ha in the world. Rye yield, production area and quantity have decreased in the last 5 years in the world (Table 1). Major rye producing countries are Russia, Poland and Germany. Although the yield of rye in Russia is lower than the yields of other countries, the production area is higher (Table 4).

In the last 5 years, around 10 million ha of oats have been produced in the world. There has been no significant change over the years in terms of production area, quantity and yield values (Table 2).Major oat producing countries are Russia, Canada and Australia (Table 4).

Triticale production in the world has decreased from 4.123.523 hectares to 3.809.192 hectares in the last 5 years. Production quantity decreased by 4 million tons. The yield of triticale has decreased over the years (Table 2).The countries with the most triticale production are Poland, Belarus and China. Approximately 34% of the triticale cultivated areas in the world are in Poland (Table 4).

Table 3. Production area, production quantity and yield values of paddy, sorghum and millet in the last 5 years in the world (FAO, 2020)

	Paddy			Sorghum			Millet		
Years	**Production area (ha)**	**Production quantity (tons)**	**Yield (kg/da)**	**Production area (ha)**	**Production quantity (tons)**	**Yield (kg/da)**	**Production area (ha)**	**Production quantity (tons)**	**Yield (kg/da)**
2014	164.291.421	742.454.148	452	44.643.058	68.277.810	153	32.214.021	28.417.591	88
2015	162.630.402	745.905.437	459	42.064.949	66.002.575	157	29.579.078	28.209.639	95
2016	162.981.535	751.885.117	461	46.131.027	63.660.983	138	31.645.267	27.705.316	88
2017	166.082.745	769.829.121	464	41.563.622	57.727.910	139	31.508.009	28.369.607	90
2018	167.132.623	782.000.147	468	42.143.146	59.342.103	141	33.560.087	31.019.370	92

Maize ranks 2nd in terms of production area and 1st in terms of production quantity in the world. In the last 5 years, the production area has increased by 8 million ha, the production quantity 108 million tons and the yield by 30 kg/da (Table 2). Major maize producing countries are China, USA and Brazil. China ranks first in terms of production area and USA in terms of production quantity (Table 4).

After maize, the most cultivated warm climate cereal is rice. In the last 5 years, paddy production areas have increased 3 million ha, production quantity 40 million tons and yield 16 kg/da (Table 3). India, China and Indonesia are the most rice growing countries. India ranks first in terms of production area and China ranks first in terms of production quantity (Table 4).

Sorghum production in the world in 2018 is 42.143.146 hectares. Production area has decreased by 2.5 million hectares in the last 5 years. Production quantity decreased from 68.277.810 tons to 59.342.103 tons (Table 3). The countries producing the most sorghum are Sudan, Nigeria and India. Sudan ranks first in terms of production area and Nigeria in terms of production quantity (Table 4).

Table 4. Production area, production quantity and yield values of the countries with the most cereal cultivation in 2018 (FAO, 2020)

	Countries	Production area (ha)	Production quantity (tons)	Yield (kg/da)
Wheat	India	29.580.000	99.700.000	337
	Russia	26.472.051	72.136.149	273
	China	24.266.190	131.440.500	542
Barley	Russia	7.873.944	16.991.907	216
	Australia	4.124.158	9.253.852	224
	Turkey	2.601.207	7.000.000	269
Rye	Russia	956.095	1.916.056	200
	Poland	893.962	2.166.884	242
	Germany	523.000	2.201.400	421
Oats	Russia	2.729.162	4.719.324	173
	Canada	1.004.900	3.436.000	342
	Australia	874.136	1.227.837	140
Triticale	Poland	1.287.969	4.085.669	317
	Belarus	429.035	1.014.640	236
	China	382.218	773.536	202
Maize	China	42.130.050	257.173.900	610
	USA	33.079.360	392.450.840	1.186
	Brazil	16.121.147	82.288.298	510
Paddy	India	44.500.000	172.580.000	388
	China	30.189.450	212.129.000	703
	Indonesia	15.995.000	83.037.000	519
Sorghum	Sudan	7.108.000	4.800.000	97
	Nigeria	6.125.132	6.862.343	112
	India	4.960.000	4.953.000	70
Millet	India	9.107.000	11.640.000	128
	Niger	7.033.751	3.856.344	55
	Sudan	3.753.000	2.647.000	71
Canary seed	Thailand	90.113	36.179	40
	Kanada	84.700	117.800	139
	Argentina	14.495	22.278	154

Millet production area in the world in 2018 is 33.560.087 ha, production quantity is 31.019.370 tonnes and yield is 90 kg/da. In the last 5 years, millet production area has increased by approximately 1.5 million ha and the production quantity has increased by 2.6 million tonnes (Table 3). Major millet producing countries are India, Niger and Sudan. India ranks first in terms of production area and quantity (Table 4).

Table 5. Production area, production quantity and yield values of canary seed in the last 5 years in the world and Turkey (FAO, 2020; TUİK, 2020)

Canary seed (World)				Canary seed (Turkey)			
Years	**Production area (ha)**	**Production quantity (tons)**	**Yield (kg/da)**	**Years**	**Production area (ha)**	**Production quantity (tons)**	**Yield (kg/da)**
2014	232.472	235.133	101	**2015**	239	390	163
2015	255.923	229.569	90	**2016**	399	670	168
2016	217.389	219.956	101	**2017**	574	922	161
2017	242.042	242.190	100	**2018**	737	1.228	167
2018	205.322	192.896	94	**2019**	2.066	3.839	185

Canary seed is the least cultivated cereal in the world. 192.896 tons of canary seed was grown on 205.322 hectares of land in the world in 2018. In the last 5 years, world canary seed production area, quantity and yield have decreased (Table 5). The countries producing the most canary seed are Thailand, Canada and Argentina (Table 4).

THE SITUATION OF CEREALS CULTIVATION IN TURKEY

According to the production area of the cereals produced in Turkey in 2018 are wheat (6.846.327 ha), barley (2.869.072 ha), maize (638.829 ha), paddy (126.419 ha), rye (112.164 ha), oats (109.823 ha), triticale

(64.101 ha), canary seed (2.066 ha), millet (1.762 ha) ve sorghum (0.7 ha)'dur (TUİK, 2020).

Wheat is the most cultivated cereal in Turkey (TUİK, 2020). The production area, which was 7.846.481 hectares in 2015, decreased to 6.846.327 hectares in 2019 (Table 6). Wheat cultivation is carried out in all regions in Turkey. The provinces where the most wheat is grown in terms of production area are Konya, Ankara and Diyarbakır, respectively (Table 9).

Barley is 2th among cereals cultivated in Turkey. An important change in terms of production area and quantity in the last 5 years has not been. 8 million tons of barley has been produced on an area of approximately 3 million hectares (Table 6). Barley, like wheat, is grown in all regions of Turkey. The provinces with the highest production are Konya, Ankara and Şanlıurfa (Table 9).

Maize production in Turkey ranks 3rd after wheat and barley. In 2019, 6 million tons of maize were grown on 638.829 hectares. Maize production values were close to each other over the years (Table 7). The provinces with the highest maize production are respectively Konya, Şanlıurfa and Mardin (Table 9).

310.000 tons of rye was grown on 112.164 hectares of land in Turkey in 2019. Rye production values are close to each other in the last 5 years (Table 6).Niğde, Kayseri and Konya are the provinces where the most rye is grown (Table 9).

Table 6. Production area, production quantity and yield values of wheat, barley and rye in the last 5 years in Turkey (TUİK, 2020)

	Wheat			Barley			Rye		
Years	**Production area (ha)**	**Production quantity (tons)**	**Yield (kg/da)**	**Production area (ha)**	**Production quantity (tons)**	**Yield (kg/da)**	**Production area (ha)**	**Production quantity (tons)**	**Yield (kg/da)**
2015	7.846.481	22.600.000	288	2.774.726	8.000.000	288	111.969	330.000	295
2016	7.609.868	20.600.000	271	2.700.023	6.700.000	248	114.016	300.000	263
2017	7.662.273	21.500.000	281	2.418.312	7.100.000	294	101.011	320.000	317
2018	7.288.622	20.000.000	274	2.601.207	7.000.000	269	110.902	320.000	289
2019	6.846.327	19.000.000	278	2.869.072	7.600.000	265	112.164	310.000	276

Oat is a genus of cereal whose production area and quantity have increased in the last 5 years. In 2019, 265.000 tons of oats were grown on 109.823 hectares of the land (Table 7). Ardahan, Ankara and Konya are the provinces where the most oats are grown (Table 9).

Table 7. Production area, production quantity and yield values of oats, triticale and maize in the last 5 years in Turkey (TUİK, 2020)

	Oats			Triticale			Maize		
Years	**Production area (ha)**	**Production quantity (tons)**	**Yield (kg/da)**	**Production area (ha)**	**Production quantity (tons)**	**Yield (kg/da)**	**Production area (ha)**	**Production quantity (tons)**	**Yield (kg/da)**
2015	103.449	250.000	242	37.185	125.000	336	686.169	6.400.000	933
2016	99.381	225.000	226	37.621	125.000	332	679.537	6.400.000	942
2017	112.855	250.000	222	45.601	150.000	329	637.726	5.900.000	925
2018	105.802	260.000	246	50.280	170.000	338	591.544	5.700.000	964
2019	109.823	265.000	241	64.101	215.090	336	638.829	6.000.000	939

The production area and quantity of triticale has nearly doubled in the last 5 years. Triticale production, which was 125.000 tons in 2015, increased to 215,000 tons in 2019 (Table 7). The provinces where the most triticale are grown in terms of production area are Çorum, Sivas and Muğla (Table 9).

Canary seed production has increased steadily in the last 5 years. The production area, which was 239 ha in 2015, increased to 2.066 hectares in 2019. Production quantity has increased approximately 10 times (Table 5). The provinces where the most canary seeds are grown are Konya, Eskişehir and Tekirdağ, respectively, according to production area sizes (Table 9).

Table 8. Production area, production quantity and yield values of paddy, sorghum and millet in the last 5 years in Turkey (TUİK, 2020)

	Paddy			Sorghum			Millet		
Years	**Production area (ha)**	**Production quantity (tons)**	**Yield (kg/da)**	**Production area (ha)**	**Production quantity (tons)**	**Yield (kg/da)**	**Production area (ha)**	**Production quantity (tons)**	**Yield (kg/da)**
2015	115.856	920.000	794	1	4	400	2.651	6.219	235
2016	116.056	920.000	793	0.5	3	600	2.307	5.327	231
2017	109.505	900.000	822	0.6	3	500	2.173	4.737	218
2018	120.137	940.000	782	0.6	3	500	2.075	4.397	212
2019	126.419	1.000.000	791	0.7	4	571	1.762	4.765	270

In 2019, 1 million tons of paddy was produced on 126.419 ha area. Production area and quantity increased by 80.000 tons in the last 5 years. There was no significant difference between yield values (Table 8). Respectively, Edirne, Samsun and Balıkesir are the provinces with the most paddy production areas.

Millet production area and quantity have decreased over the years. The provinces where the most millet is grown are Muğla, Diyarbakır and Kahramanmaraş, respectively. The least cultivated cereal is sorghum. In 2019, 4 tons of sorghum was grown in an area of 0.7 ha in Muğla, and its yield is 571 kg/da (Table 9).

Table 9. Production area, production quantity and yield values of cereals in Turkey in 2019 (TUİK, 2020)

	Provinces	Production area (ha)	Production quantity (tons)	Yield (kg/da)
Wheat	Konya	621.536	1.886.131	301
	Ankara	416.301	1.053.032	254
	Diyarbakır	313.165	1.030.268	332
Barley	Konya	342.045	1.006.617	356
	Ankara	238.437	638.470	268
	Şanlıurfa	186.178	387.507	208
Rye	Niğde	17.225	48.515	282
	Kayseri	13.029	38.262	294
	Konya	11.709	34.429	294
Oats	Ardahan	14.147	22.389	158
	Ankara	10.221	28.093	275
	Konya	8.795	20.269	230
Triticale	Çorum	16.968	57.608	340
	Sivas	4.822	13.140	273
	Muğla	3.862	17.340	449
Maize	Konya	124.535	1.345.064	1.080
	Şanlıurfa	46.591	354.710	761
	Mardin	44.442	421.130	948
Paddy	Edirne	51.261	431.658	842
	Samsun	18.436	137.069	743
	Balıkesir	15.860	118.620	748
Millet	Muğla	653	2.041	313
	Diyarbakır	384	734	191
	Kahramanmaraş	300	900	300
Canary seed	Konya	1.134	2.107	186
	Eskişehir	928	1.726	186
	Tekirdağ	4	6	150
Sorghum	Muğla	0.7	4	571

CONCLUSION

With increase in the world population, demand for food has increased. It is inevitable to take necessary measures to increase production quantity of cereals, which have importance in human and animal nutrition. Increasing the yield and quality per unit area in crop production is the primary goal in agricultural production. Improving cultivation techniques such as tillage, fertilization, disease and pest control is very important in increasing yield and quality in cereal production. Production quantity and quality can be increased by using high quality, productive, disease-resistant seeds that are suitable for the ecological conditions of growing region. Certified seed breeding should be encouraged.

Agricultural enterprises are shrinking as agricultural land is shared through inheritance. This situation causes decrease in agricultural areas. Land consolidation should be accelerated. It is also an important problem that farmers leave their land fallow or turn to different fields of work due to high input costs. Lands left empty should be utilized by growing cereal. Reducing input costs will be beneficial for farmers to use their production preferences for cereals. In addition to reducing costs, increasing the marketability of products is also effective in increasing cereal production. As of 2020, cereal purchasing has started by Turkey Sugar Factories Inc. and a new opportunity has been given to farmers to market their products. Increasing such opportunities and purchases is of great importance in increasing cereal cultivation.

Imports should not be made during the harvest period and farmers should be encouraged to enter the market effectively. In this way, market opportunities of domestic products will not be restricted. The economic income of the farmers will increase and the sustainability of cereal production will be ensured. The consultancy of agricultural engineers who can guide farmers is great important in ensuring the sustainability of agricultural production and natural resources. It is thought that cereal cultivation can be increased by taking this measures and practices.

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CHAPTER 16

PHYSICO-CHEMICALPROPERTIES OF PERSIMMON (Diospyros kaki L.) IN SİİRT PROVINCE

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INTRODUCTION

Diospyros kaki L. known as persimmon (Trabzon Hurmasi local name) in our country, is a plant belonging to the Ebenaceae family of the Ebenales team. The Ebenaceae family is divided into three subgenera, Euclea, Lissocarpa and Diospyros (Onur, 1990). While the Euclea genus is produced in the regions of the Arabian Peninsula, the African continent and Madagascar, the Lissocarpa genus can be grown in a wide area on the South American continent. Persimmon is evaluated in the Diospyros genus, and there are approximately 400 species belonging to this genus (Yonemori et al., 2000). It is stated in the literature that most of these species are plants that can remain green throughout the year and are grown in tropical and subtropical regions. Some species can be grown in regions with a warm and temperate climate (Iwanami et al., 2002). Today, with the development of the conscious consumer concept, the trend of feeding with natural, organic foods is increasing gradually in developed countries, especially in high economic countries. For this reason, persimmon, which is a fruit that prevents cancer, has high fibre content, low-calorie content, does not increase bad cholesterol, but helps it to fall, is rich in terms of high vitamin C content and mineral substances (Kaplankıran, 2010). As a matter of fact, persimmon cultivation has increasing importance in the world. In the world in 2000, 2,300,000 tons of production took place in an area of approximately 300,000 hectares. The production of this species has increased approximately 2.5 times in the last 40 years (Bellini &Giordani, 2002). Persimmon fruit is a nutrient-rich in content. It is a nutrient that has important benefits for human health due to its abundant

vitamin A, carbohydrate, vitamins and minerals. In addition, it contains vitamin C, beta carotene and water-soluble fibres. There are also various vitamins, minerals, antioxidants and flavonoids in the leaves of persimmon. The measurement, collection, identification, classification and evaluation studies of genetic riches are of great importance for the efficient use of genotypes. In order to be among the countries that have a say in the production and foreign trade of persimmon, it is very important to determine the varieties with the quality characteristics demanded abroad and to evaluate the genetic resources. In the production of persimmon in the world, the tendency for varieties that do not change and do not have a brownish (bitter) is increased with the formation of seeds after pollination of fruit flesh. Therefore, genetic improvement studies are carried out for these purposes. For this reason, these studies are of great importance in terms of determining the varieties in the collection parcel especially in this respect and providing material for future breeding studies (Yeşiloğlu et al., 2017). In this study, the physicochemical properties of the persimmon genotypes collected from different regions of the province of Siirt, located in the Southeastern Anatolia Region, and the differences between these properties using various parameters (sugar analysis, malic and citric acid, total protein composition, total carotenoid, gallic acid analysis, micro-macro nutrients, vitamin c, total flavonoid content, total phenolic compound analysis, antioxidant determination) were tried to be determined. With the data to be obtained, the mentioned characteristics of persimmon genotypes that can be grown in our region will be determined, and in this sense, the gap in the literature will be tried to be

filled, and these data will present an idea for the researchers who will work on persimmon.

1. MATERIALS AND METHODS

1.1. Material

This study was carried out on the persimmon genotypes naturally composed of seeds in Siirt province in 2018. The material of the study consisted of persimmon genotypes in villages and hamlets of Eruh and Şirvan district of Siirt region, on the roadside, in the garden and the fields. As a result of the observations made, the presence of persimmon was determined mostly in these regions. The types to be sampled are determined by examining the persimmon cultivation areas and numbered before harvest. In this study, it was aimed to determine the physicochemical properties of persimmon genotypes grown in Siirt region.

1.2. Methods

1.2.1. Organic acid analysis

25 mM potassium phosphate buffer pH: 2.4 orthophosphoric acids were used as a solvent system, and solvent. 2 grams of the dried and powdered sample was taken into a 50 mL falcon tube and diluted by adding 20 mL (25 mM potassium phosphate buffer pH: 2.4 with orthophosphoric acid). Then, it was vialed with the help of 0.22 PVDF filter and analyzed in HPLC Device (Shimadzu, Kyoto, Japan).

1.2.2. Sugar analysis

Two grams of weighed dried persimmon sample was taken into a 50 mL falcon tube and 18 mL of solvent (Methanol: Water) was added. After being left in a water bath at 70 ^{o}C for 1 hour, it was centrifuged at 5000 rpm for 25 minutes at 25 ^{o}C. Samples taken with Viale 0,22 polyvinylidene Fluoride (PVDF) filter were analyzed according to TS 13359 method using HPLC device.

1.2.3. Determination of antioxidant activity

Total antioxidant activity was determined by Miller and Rice-Evans (1996). Trolox equivalent antioxidant capacity method (TEAC). This method is a result of the oxidation of ABTS (2,2'-azinobis- (3-ethyl benzothiazoline-6-sulfonic acid)) on the ABTS • + radical solution. It is based on the principle of determining the colour of the + radical at a wavelength of 600–750 nm. The amount of ABTS spent as a result of the reaction was calculated as the Trolox equivalent, and the results are expressed as the "TEAC value" (Trolox equivalent antioxidant capacity).

1.2.4. Macro and micro element determination

For the analysis of plant nutrients, leaf and fruit samples were first cleaned in tap water, then 0.1% detergent, then again in tap water, and finally washed thoroughly with distilled water. The washed samples were dried at 65-70 0C for 48 hours until they reached constant weight and then ground. The amount of N in the samples prepared in this way

was determined using the N-protein analyzer under the Dumaş method, while the P, Ca, Mg, Zn, Fe, Cu, Mn and K levels were determined using the ICP-MS (inductively coupled plasma-mass spectroscopy method.

1.2.5. Determination of total carotenoid amount

The total carotenoid amount was determined according to the method developed by Rodriguez&Amaya (2001). The method is based on direct absorbance measurement after extraction using acetone and petroleum ether. In order to express the total amount of carotenoids from different carotenoids, absorbance measurements were made at 445 nm, 450 nm and 462 nm wavelengths and total carotenoid amounts were calculated according to the following equation.

2.RESULTS AND DISCUSSION

2.1. Determination of antioxidant activity

Measurements were performed on standard Trolox 1,5 standard Trolox 5 and standard Trolox 9, and the average results for Eruh were found as 0,201467, 0,191133, 0,169467 Eq / ml, respectively. At the same time, the average results for Şirvan were obtained as 0,192733, 0,149367, 0,144133 Eq / ml. When the results obtained are analyzed, it is observed that the measurement results made in Eruh are ahead of Şirvan, although the difference between them does are not significant (Table 1).

Table 1. Persimmon antioxidant activity results (Eq / ml)

	Mean
Eruh1,5µl	0,201467±0,012559
Eruh 5 µl	0,191133±0,00722
Eruh 9 µl	0,169467±0,00215
Şirvan1,5µl	0,192733±0,010289
Şirvan 5 µl	0,149367±0,014953
Şirvan9µl	0,144133±0,012404

2.1. GenotiplerinMorfolojikÖzellikleri

Yıldız and Kaplankıran (2011) found that the fruits in eating maturity, antioxidant capacity was higher than other varieties in Eylül genotype with 5.88 µmol Trolox equivalent / g TA in the FRAP method and 6.94 µmol Trolox equivalent / g TA in the TEAC method. Jung et al. (2005) showed that the antioxidant capacity of different persimmon fruits in Korea is 91% with DPPH method and 88% with Beta-carotene-linoleate method, Chen et al. (2008) stated that Mopan variety in China is 23.575 and 22.597 µmol / Trolox equivalent / g, respectively by ABTS and DPPH methods, whereas 18 types obtained from Ercisli et al. (2008) by selection from the Black Sea region, They reported that it varied between 51.7% and 91.6% according to the methods of Carotene, butylated hydroxyanisole and BHT (β-Carotene, butylated hydroxytoluene). In previous studies by Lamien-Meda et al. (2008) about the Diospyros species in West Africa, (Burkina Faso), antioxidant capacity was found near the 65.0 mmol/kg in D. mespiliformis. According to FRAP method, (Soobrattee et al., 2008) found that in

Mauritius (community of islands in the Indian Ocean) (D. neraudii, D. revaughanii, D. tesselleria and D. mellanida) found that they varied between 818-989 mmol/kg according to the FRAP method and 396-696 mmol/kg according to the TEAC method. In the abovementioned studies, the researchers emphasized that persimmons have a high antioxidant capacity. Soobrattee et al. (2008) evaluated endemic species belonging to Rubiaceae, Ebenaceae, Celastraceae, Erythroxylaceae and Sterculiaceae families in Mauritius region of Africa in terms of polyphenol contents and antioxidant potentials. In-plant research, it was determined that antioxidant activity using TEAC and FRAP methods, was mainly due to total phenolic and proanthocyanidin content, and there was a weak correlation with gallic acid content. As a result of the study, it is stated that endemic species belonging to the Diospyros genus are rich sources of phenolic antioxidants. In antioxidant activity studies using the DPPH method, the results differed significantly from different geographical regions. As a result of the study, it was stated that there is a correlation between antioxidant activity and antioxidative compounds. Cesari et al. (2013) reported that antioxidant activity investigated using DPPH, ABTS and ORAC methods in a study in which Diospyros bipindensis species were evaluated in terms of their anti-inflammatory, antibacterial and antioxidant characteristics. While none of the isolated compounds showed radical scavenging activity, it was reported that dichloromethane extracts showed high antioxidative activity as a result of orac analysis.

Khan et al. (2016) evaluated the antioxidant activities and free radical scavenging activities of cancer and free radical cleansing activities of Diospyros blancoi species leaves, root shells and stem shells using spectrophotometric methods. It was found that the extracts obtained from the shell of the trunk had the highest antioxidative activity and iron-reducing activity. As a result of the radical scavenging activity using the DPPH method, it was determined that the body shell extracts had 95.760 ± 0.343 and 67.460 ± 2.641% swept activities with Ic50 values of 3.10 ± 0.17 and 50.00 ± 3.11, respectively. As a result of the study, it has been reported that extracts obtained from the root bark have the highest ant oxidative and radical scavenging activity and moderate anti-cancer activity. It is stated that the anti-cancer activity of the plant may be partly due to the phenolic content and free radical scavenging activity of the plant.

2.2. Total phenolic compound analysis

Since the phenolic compounds in the analyzed samples are the determinant group in antioxidant activity, the total phenolic substance and total flavonoid amount, which is the subgroup of these compounds, were analyzed. In the total phenolic substance determination (TFM) analysis, the total phenolic substance amount of the samples is presented as gallic acid equivalent (GAE). For this purpose, primarily the gallic acid calibration curve was drawn. The ethanolic solution of gallic acid was prepared, and gallic acid solution in the concentration range of 10-50 mg/ml was used to draw the calibration curve (Table 2). Gallic acid calibration curve (Table 2). The total phenolic average of

the samples was found to be 16,208µg / µL ± 1,541 Eruh, 13,42µg / µL ± 0,719 in gallic acid (Table 2)

Table 2. Content of gallic acid in genotypes

Sample Name	1. Measuring	2. Measuring	3. Measuring	Mean Abs	Calculation in Gallic Acid
Şirvan	0,0662	0,0617	0,0657	0,0649±0,0019	16,208µgGallikAcid/µL ±1,541
Eruh	0,0612	0,0589	0,0601	0,0601±0,0012	13,42µg Gallik Acid/µL±0,719

When the total phenolic substance amount measurement results of the samples are analyzed, it is seen that the total amount of phenolic substance of the persimmon fruit sample taken from Şirvan region is higher than the persimmon fruit sample taken from Eruh. As a result of the results found in this study, it was determined that the difference in phenolic substance content of the samples taken from the Eruh and Şirvan region was not statistically significant. Kuzucu&Kaynaş (2004) found 0.17-0.24mg / 100g. Yildiz&Kaplankiran (2011) stated that the total amount of phenolic substances in fruits during the eating period was 131.3 mg / 100 g TA. During the harvest period, (Gorinstein et al., 2001) in Israel. (2001) reported that the amount of phenolic substance of Triumph variety is 102.0 mg / 100 g. They determined that persimmon types were significantly higher than apple species in terms of Na, K, Mg, Ca, Fe and Mn concentrations, p-coumaric acid, gallic acid, total phenol and soluble-insoluble nutrient content. Jung et al. (2005) compared the total phenolic and antioxidant capacities of fresh and dried persimmon fruits. It was stated that both phenolic substance

amounts and antioxidant capacities of fresh fruits are higher than dried fruits, but this difference is not statistically significant. The antioxidant capacity determined by the beta-carotene-linoleate method was determined to be 91% in fresh fruits, 88% in dried fruits, 88% and 84%, respectively, with the DPPH method. Yaqub et al. (2016) conducted a study on the chemistry and functionality of the bioactive components of persimmon. Based on their extensive research, they concluded that the main phenolic compounds found in persimmon are ferulic acid, p-coumaric acid and gallic acid. Rashwan et al. (2017) have identified the most basic phenolic compound in the fruit of persimmon and Tomatillo as pyrogallol. They found that the pyrogallol content in persimmon was 731.0 mg / 100g, and in Tomatillo it was 173.56 mg / 100g. In addition, they found that catechin in persimmon and benzoic acid in Tomatillo fruit are other remarkable phenolic compounds. The differences between the studies may depend on the solvent used for extraction or may vary depending on the composition of the compounds that show antioxidant properties in plants.

2.3. Total flavonoid determination

To find the total flavonoid amount in persimmon fruit taken from Eruh and Şirvan region, after drawing the routine mg/ml calibration curve, the absorbance of sample concentrations was determined to be read in this calibration curve. Total flavonoid substance analysis was calculated using the routine mg/ml calibration equation and 0.5391 mg routine/ml for Eruh and 0.5833 mg routine/ml for Şirvan. Three parallel repeats were made and averaged (Table 3).

Table 3. Total flavonoid measurement results of the samples (mg/ml)

	Absorbance			Mean
Eruh 5 µL	0,6320	0,5266	0,5716	0,5767±0,052887
Şirvan 5 µL	0,7391	0,7172	0,3387	0,5983±0,225116

In a study by Pretorius et al. (2003), Eucleacrispa subsp. was evaluated for biochemical content. Upon isolation, purification and identification of antibacterial compounds from crisp, they also identified five flavonoids as catechine, epicatechin, gallocatechin, hyperoside and quercetin, which show antimicrobial activity as separate compounds from the ethyl-acetate fraction. They found that epicatechin and hyperosidine had the highest activity in inhibiting the development of M. catarrhalis (-), Streptococcus pneumonia (+) and Haemophilus influenza (-). The fact that the flavonoids they isolated generally had less activity than the whole ethyl acetate fraction showed that these components were in synergy. Soobrattee et al. (2008) evaluated endemic species belonging to Rubiaceae, Ebenaceae, Celastraceae, Erythroxylaceae and Sterculiaceae families in Mauritius region of Africa in terms of polyphenol contents and antioxidant potentials. It has the highest flavonoid content of Coffea macrocarpa species (18 ± 0.7 mg / g). As a result of the study, it is stated that endemic species belonging to the Diospyros genus are rich sources of phenolic antioxidants. Khan et al. (2016) evaluated the antioxidant activities and free radical scavenging activities of polyphenol contents using spectrophotometric methods in a study comparing cancer and free radical cleansing activities of the leaves, root and trunk shells of Diospyros blancoi species. It has been stated that the extracts obtained

from the root bark have higher phenolic content in gallic acid and flavonoid contents in catechin compared to other extracts.

2.4. Determination of total carotenoid amount

Carotenoid amounts were calculated using four fixed carotenoids using a constant coefficient. The total carotenoid average was found to be 3.178 µg / g for Eruh and 6.959 µg / g for Şirvan (Table 4).

Table 4. Carotenoid amounts of persimmon samples (µg / g)

	Mean
Eruh total carotenoid microgram / gram	3,178±0,378
Şirvan total carotenoid microgram / gram	6,959±0,172

When the carotenoid averages of the fruit samples collected from Şirvan and Eruh are examined, it is seen that the carotenoid average of the fruit samples collected from the Şirvan region is higher than the carotenoid average of the fruit samples collected from Eruh. Butt et al. (2015), shown in their study, it was revealed that persimmon is rich in some bioactive molecules such as proanthocyanidins, carotenoids, tannins, ono avonoids, anthocyanidin and catechins, and it is able to treat damages that may occur due to oxidative stress and strengthen the immune system. Khokhlov&Plugatar (2015), identified the beta carotene content of fruits ranged from 1.91-6.33 mg per 100 grams of fresh fruit. Yaqub et al. (2016) stated that the main phenolic compounds found in persimmon are ferulic acid, p-coumaric acid and gallic acid. They also stated that β-Cryptoxanthin, lycopene, β-carotene, zeaxanthin and lutein are important carotenoids with antioxidant

potential. They listed the main benefits of persimmon as follows: They are important for preventing the oxidation of low-density lipoproteins that protect the beta cells of the pancreas, and stated that it would help reduce damage caused by cardiovascular diseases, cancer, diabetes discomfort and chronic alcohol consumption. When our results are compared with other studies in the literature, our results are in line with other results. However, when the study material is evaluated in itself, the differences can be attributed to the variety of differences, or to the differences between the locations where the samples are collected (annual precipitation, soil structure, temperature, etc.).

2.5. Macro and micro element determination

Analysis results of macro and microelements of fruit samples taken from Şirvan and Eruh regions are given. Considering the results given in the table, there is no significant difference between the elements of Cu, Mg, P, Zn, N, while it is observed that the samples taken from Şirvan region are lower in terms of Fe, Ca and K element values, while it is higher in terms of Mn. When the% value of the average protein is analyzed, it is seen that the samples taken from the Eruh region show an excess of 1% compared to the samples taken from the Şirvan region.

Table 5. Macro and micro nutrients of persimmon

Code	Cu	Fe	Mg	Mn	P
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Şirvan-5	1,119	8,628	499,583	13,846	57,264
Şirvan-5	1,209	8,767	520,039	14,264	41,817
Şirvan-5	1,157	8,350	497,704	13,220	47,175
Eruh-2	1,603	25,287	472,675	4,755	51,630
Eruh-2	1,618	26,268	489,810	4,604	47,403
Eruh-2	1,601	25,136	463,995	4,755	29,816
Code	**Zn**	**Ca**	**K**	**N**	**Protein**
	(mg/kg)	(mg/kg)	(mg/kg)	(%)	(%)
Şirvan-5	1,344	83,357	10814,375	0,629	3,933
Şirvan-5	1,367	145,853	10906,742	0,603	3,766
Şirvan-5	1,309	145,853	10814,375	0,585	3,658
Eruh-2	2,420	226,313	14253,457	0,770	4,810
Eruh-2	2,351	226,313	14253,457	0,727	4,544
Eruh-2	2,312	294,686	14143,531	0,759	4,742

As a result of the 3 measurements made in the study, the average of macro and microelements in Şirvan region is Cu 1,161, Fe 8,581, Mg 505,775, Mn 13,776, P 46,752, Zn 1,34, Ca 125,021, K 10845,164 in percent N 0,605, Protein 3,785. found to be. In the Eruh region, averages of macro and microelements were found in mg / kg Cu 1,607, Fe 25,563, Mg 475,493, Mn 4,704, P 42,949, Zn 2,347, Ca 249,104, K 14216,815 and N 0,752 and Protein 4,689 (Table 5).

Duckworth (2013) found calcium 10, iron 0.4 mg / 100g. Herrman (1994) found calcium 6-20, magnesium 8-11, phosphorus 20, iron 0.1-0.5, potassium 130-210 mg / 100g. Gorinstein et al. (2001) determined that persimmon types are significantly higher than apple types in terms of Na, K, Mg, Ca, Fe and Mn concentrations as a result of comparing the nutrients contained in persimmon and apple in Israel. On the other hand, the content of Cu and Zn of apples is higher than that of

persimmon. All of the nutrient contents analyzed and stated above in fruits were higher in both the persimmon and apple peels than in the fruit meat parts. In his study, Khokhlov&Plugatar (2015) identified the mineral elements in the fruit content as potassium, magnesium, iron, zinc and copper.

Mir-Marqués et al. (2015) conducted research to determine the mineral profile of 167 fruit samples collected from persimmon genotypes grown in different regions of Spain. Inductively coupled plasma optical emission spectroscopy (ICP-OES) and inductively coupled mass spectrometry (ICP-MS) methods were used to determine the mineral profiles of fruit samples. The daily consumption of 200-400 g of persimmon is 1 to 10% of the calcium needed by the body, 1 to 30% of copper and potassium, 1 to 15% of iron and magnesium, 1% of sodium, and He stated that he met around 4% of his zinc needs. (Rashwan et al., 2017) As a result of the comparison of persimmon and tomatillo fruits in his study, iron was determined as the dominant microelement in both fruit samples. It was determined that persimmon is richer than Tomatillo fruits in terms of vitamin K content. The difference of our studies may be due to the differences in the maturity time of the studies performed before us and the differences in the method or device used when considering the differences between the studies conducted before us and the differences of the studies we have done.

2.6. Sugar analysis

Samples collected from Eruh and Şirvan regions were analyzed in terms of sugar content (fructose, glucose, sucrose and maltose content. Although three fruits were randomly selected from 1 tree in each region, three parallel iterations were made, and the regions were compared. Two grams of dried persimmon samples are used in the laboratory analyzes. The sample was obtained by adding 50 ml of the sample to the solution, adding 18 mL of 3: 7 (Methanol: Water) solvent, then putting to wait in a water bath at 70 ^{o}C for 1 hour and then centrifuging at 5000 rpm at 25 ^{o}C for 5 minutes. The highest content in terms of sugar content is fructose, followed by glucose and sucrose and maltose. While the total average of fructose, glucose, sucrose, maltose sugar content of the fruits in Şirvan is 92476,5968 ppm, this number is 80725,3162 ppm in the samples taken from Eruh. As a result of the study, three parallel samples of fruit samples taken from Şirvan region were made and averaged. Averages of fructose 212402,752 ppm, glucose 145062,252 ppm, sucrose 11994,491 ppm, maltose 446,892 ppm were determined (Table 6). As a result of this study, it was determined that the sugar consisted mainly of fructose and glucose, and the value of maltose and sucrose was very low.

Table 6. Sugar analysis results of fruit samples taken from Sirvan (ppm)

	Fructose	**Glucose**	**Sucrose**	**Maltose**
Şirvan 1.Measuring	212279,780	145051,743	12021,800	439,481
Şirvan 2.Measuring	212722,725	145297,039	11990,275	365,165
Şirvan 3.Measuring	212205,751	144837,975	11971,399	536,029
Average	212402,752	145062,252	11994,491	446,892

Table 7. Sugar analysis results of fruit samples taken from Eruh (ppm)

	Fructose	Glucose	Sucrose	Maltose
Eruh 1. Measuring	202466,671	108530,842	11484,447	310,201
Eruh 2. Measuring	202070,378	108851,782	11613,66	311,931
Eruh 3. Measuring	202211,324	109091,067	11436,278	325,214
Average	202249,458	108824,564	11511,462	315,782

As a result of the study, three parallel iterations of fruit samples taken from the Eruh region were made and averaged. As a result of 3 measurements in fruit samples taken from the Eruh region, their average was obtained as fructose 202249,458 ppm, glucose 108824,564 ppm, sucrose 11511,462 ppm, maltose 315,782 ppm (Table 7). We can say that the results we obtained persimmon growing in Şirvan are more aromatic compared to persimmon grown in Eruh.

The fact that 80% of the total sugar is reductor sugar can ensure that the fruit is sweeter than other fruits, creates a unique aroma and is an easy-to-use energy source Herrman (1994). when we compare the results with those available in the literature. It is found that total sugar as g / 100g 13-15. Kuzucu&Kaynaş (2004) reveal that the rate of Brix in fruits and total sugar content are almost the same and acceptable for consumption during all harvest periods. Yildiz&Kaplankiran (2011) stated that the dominant sugars in the fruits of persimmon varieties and genotypes are glucose (7.14%) and fructose (7.02%), while the amount of sucrose (0.07%) is at very low levels. Senter et al. (1991) conducted a study to determine the amount of sugar and volatile acid components during the ripening of persimmon. The glucose content of the persimmon analyzed in the study indicated that 17,62-24,42 g, fructose

contents were between 14,23-22,16 g and sucrose contents between 6,83-21,97 g. Daood et al. (1992) conducted a study to separate and identify sugars in persimmon fruits using isocratic conditions using high-performance liquid chromatography (HPLC). In the evaluation made in terms of soluble sugars, the main sugars found in the fruit were found to contain glucose, fructose and an unspecified oligosaccharide.

2.7. Organic acid analysis

The importance of organic acids in plant nutrition is gradually increasing. The higher the sugar-acid coefficient in the product, the sweeter the taste. Organic acids are contained more in fruits than vegetables. While fruits have an average of 0.5-1.5% organic acid, vegetables have a rate of 0.1-0.7%. Considering these developments, in order to determine the organic acid amounts in persimmon fruit, fruit samples were taken from Siirt districts, and organic acids in these fruit samples were measured in 3 replicates with HPLC instrument. As a result of the analysis, as a result of organic acid analysis in fruit samples, tartaric acid, malic acid, ascorbic acid, acetic acid and citric acid were determined. Of the organic acids, malic acid was found as the dominant organic acid. Many researchers have identified dominant organic acid as malic acid in persimmon fruit.

As a result of statistical analysis, the amount of tartaric acid in the persimmon fruit taken from the Eruh region was determined as 119,019 ppm, malic acid 3542,058 ppm, ascorbic acid t22,073 ppm, acetic acid 4809,502 ppm, citric acid 1760,5526 ppm. In the fruit samples taken

from Şirvan region, tartaric acid was found to be 101,716 ppm, malic acid 3420,846 ppm, ascorbic acid 24,47966 ppm, acetic acid3357,561 ppm, and citric acid 1310,686 ppm on average (Table 8).

Table 8. Organic acid amounts in persimmon fruit samples (ppm fresh weight)

	Tartaric acid	Malic acid	Ascorbic Acid	Acetic acid	Citric acid	Total
Eruh1.Measuring	69,739	3602,630	21,477	4744,251	651,268	9089,366
Eruh2. Measuring	67,908	3533,865	21,963	4812,112	2293,998	10729,846
Eruh3. Measuring	219,410	3489,679	22,780	4872,144	2336,392	10940,405
Şirvan1. Measuring	174,673	3442,203	24,685	3333,750	1309,346	8284,656
Şirvan2. Measuring	65,886	3410,553	24,906	3312,689	1327,282	8141,316
Şirvan3. Measuring	64,589	3409,782	23,848	3246,244	1295,432	8039,895

Duckworth (2013) found ascorbic acid as 9-15 mg / 100g. Herrman (1994) found ascorbic acid as 20-50 mg / 100g. Günhan (1998) determined the average of the ascorbic acid content of the fruit samples used in his study to be lower compared to the previous studies in the literature; It was stated that the reason for this could be due to the different types of fruit or harvest periods.Kuzucu&Kaynaş (2004) stated that the nutritional content will be negatively affected due to excess softening and decreased ascorbic acid value in overripe fruits. In a study by Daood et al. (1992), it is stated that malic, isocitric, citric, ascorbic, fumaric and gallic acids are detected by HPLC method, and malic acid is the most dominant among these organic acids. As a result of the research, it has been reported that the metabolic processes towards the full ripening stage cause significant loss of organic acid in the fruit. Yordanov (2011) investigated Hyakume and Hiratenanashi genotypes of persimmon. The dry matter content of both genotypes varied slightly from the harvest period to physiological maturation period. Conversely, a decrease in the vitamin C content of two

genotypes was observed during the physiological maturation stage. In addition, the acid contents of the examined fruit were found to be quite low.

2.8. Essential fatty acid analysis

As a result of the analyzes carried out, the persimmon samples obtained from Eruh and Şirvan regions generally encountered the same types of essential fatty acids. In this sense, there was no difference between regions. The result of analysis was showed in Table 9.

Table 9. Essential fatty acid analysis

RT (Retention time)	Eruh	Şirvan
14.78	Dodecane	Dodecane
16.48	Pentadecane	Pentadecane
18.81	Pentadecane	Octadecane
25.18	Heptadecane	Eicosane (CAS)
31.84	Hexadecane	Eicosane (CAS)
53.83	Hexadecanoic acid, methyl ester	Hexadecanoic acid, methyl ester
56.65	Phenol, 2,4-bis(1,1-dime thylethyl)-Phenol	Phenol, 2,4-bis (1,1-dimethylethyl) -Phenol
60.59	Phenol, 3-pentadactyl-Phenol	9-Octadecenoic acid (Z)-, methyl ester (CAS)
63.40	15,15'-Bi-1,4,7, 10,13-pentaoxa cyclohexadecane	8,11-Octadecad enoic acid, methyl ester
76.96	Phenol, 3-pentadecyl-Phenol	(2S,2'S)-2,2'-Bi s[1,4,7,10,13-pentaoxacyclopen tadecane]
90.62	Phenol, 3-pentadecyl-Phenol	Phenol, 3-pentadecyl-Phenol

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CHAPTER 17:

PASSIVE SOLAR ENERGY USE IN BUILDINGS

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INTRODUCTION

The rapid increase in population density and industrialization, energy demand has increased. When energy was achieved in various ways, is in permanent damage to the environment. Environmentally damaging energy production causes global warming, which is a big problem today. Solar energy in a sustainable manner, produces energy without harming the environment. Solar energy production provides more reliable, cost-effective and long-lasting systems. Energy-efficient building design with solar energy production in architecture, provides a sustainability life and better than the other energy productions for human health and comfort (1).

The aim of this research, is to examine benefit of solar energy to reduced global warming and to explain some parameters about how can design an energy-efficient building.

After this research, people can understand usefulness of ecological architecture for global warming of the world. This research provide to be sensıtıve to the environment.

This research explains solar energy source.

İn the second chapter; solar energy sources are discussed .

İn the third chapter; passİve solar energy systems are discussed.

İn the fourth chapter; parameters of buıldıngs that heated with passive system design is discussed.

İn the fifth chapter; conclusion is discussed.

1. SOLAR ENERGY

15% of radiant energy emitted by the sun every day, is reflected back into space. The other 30% is spent for the production of rainfall in the atmosphere. In a limited number of radiant energy, are absorbed by plants, land, and sea. The continuity of the sun lighting and heating feature, makes solar, a sustainable-renewable energy source. Therefore, obtaining energy from the sun is a very smart solution, for to meet the energy requirements in architecture. Solar energy in architecture, is usually used for heating, cooling and electricity production of interior space (2). The use of solar energy is made in two ways in the architecture: passive solar energy use, active solar energy use.

1.Passive Solar Energy Use: is an architectural design and solution, according to climatic data and the orientation of the building on the land. In buildings, the south orientation large glass areas and, the system's performance enhancing materials are used to save energy. Passive solar energy used in architecture provides solar heating (space heating), water heating and solar cooling (3).

2.Active Solar Energy Use: is a mechanical solutions with photovoltaic PV and solar panels. Active solar energy using provide solar electricity with PV and solar power systems (3).

2. PASSIVE SOLAR ENERGY SYSTEMS

Passive solar energy systems, in architecture, provides to get heat and light in a healthy way from solar energy; for this solar powered systems using correctly in architecture, is very important. Passive solar energy

systems are used in buildings, should be provided temperature control, so as not to damage the material. Passive solar energy systems are analyzed in two groups as follows: (4, 5).

a. Passive solar heating systems.

b. Natural cooling systems.

Passive solar heating systems depend on three functions: collection, storage, distribution. Passive solar energy systems provides minimum heat gain in the summer, maximum heat gain in the winter.

Passive solar heating system types can be listed as follows: (6).

a. Direct Gain Systems

b. Indirect Gain Systems (Thermal storage wall, Roof Pool, Integrated Greenhouse System.)

c. Separated (Isolated) Gain Systems

a. DIRECT GAIN SYSTEMS

Direct gain system is collected the solar energy at first, then the energy is turned into heat and stored. System is based on this principle; solar radiation that corresponding to the large glass area, is directed to the south facade of the building and heat rays pass to interior is provided by the physical properties of the glass. Sunlight that passing through the south-oriented large glass area, is translated to the heat energy stored by walls, floors or roofs during the day. These storage elements, return this energy, at night, to interior by convection (Figure 1). Heat gain is

minimized, during the summer months, by the shaded such as roller shutters, roller blinds, vertical and horizontal sun breakers (7, 8).

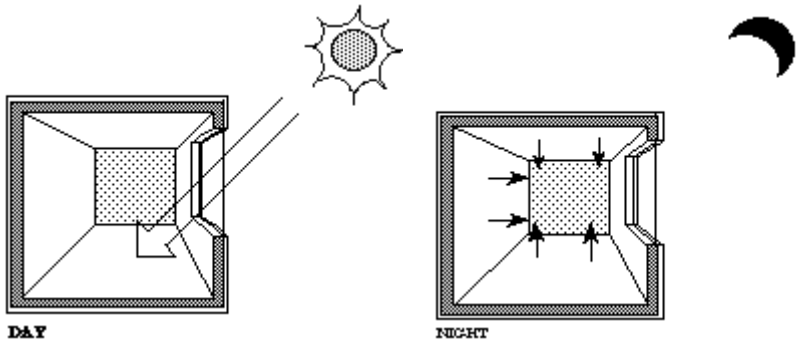

Figure 1: Thermal mass in the interior absorbs the sunlight and radiates the heat at night (7).

b.INDIRECT GAIN SYSTEMS

Indirect gain systems, in contrast to the direct gain system, solar energy is collected and stored outside of the volume and then, the stored energy is transmitted to the interior with natural convection way. There are various types of indirect gain system, three of them are as follows: (7, 8).

- Thermal storage walls.
- Roof Pools.
- İntegrated Greenhouse Systems.

Thermal Storage Walls (Trombe Wall)

For this system, a glass and, a wall that have the capacity to store are necessary. There is a gap between the wall and the glass that directed to the south side. Solar energy, is converted into heat energy in this gap and interior is heated with convection.

Interior heating is performed by convection, with this way; cold air that comes from the gap that bottom of the storage wall, began to be heat energy in the air gap that between the wall and glass, by time, and turns back to interior from the gap that top of the storage wall (7, 8); (Figure 2).

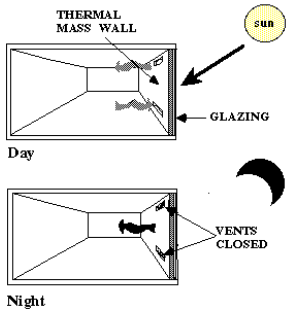

Figure 2: Thermal Mass Wall or Trombe Wall Day and Night Operation (7).

Rooftop Pools

This system, is a thermal storage system like 'trombe wall'. Plastic bags filled with water in the pool, that placed on the roof of the house, stored the heat energy directly, for giving back to the building at night. Also collapsible shutters were put on top of the roof. The shutters are opened during the day in winter but at night must be closed for to avoid heat from going out (7, 8); (Figure 3).

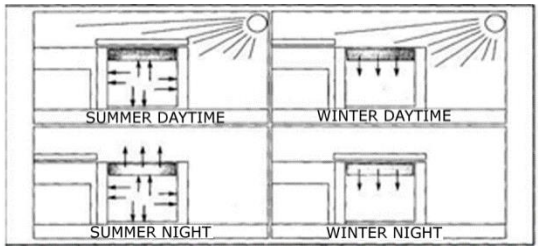

Figure 3: Rooftop pool system (10).

Integrated Greenhouse Systems

Integrated greenhouse system, is an example using a combination of direct and indirect gain system. Greenhouse is directly heated by the sun's rays. The principle of operation of the system shows numerous similarities with trombe wall. Basically, the stored solar radiation, is converted into heat in the greenhouse that oriented south and than, all or part of this heat is transferred to the interior by the walls (7, 8); (Figure 4).

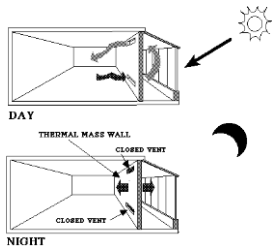

Figure 4: Day and Night Operation of a İntegrated Greenhouse Systems (7).

c. SEPARATED (ISOLATED) GAIN SYSTEMS

In this system, solar energy is collected and stored outside of living volume, because the heat is stored underground by a collector and the collector surface and the thermal reservoir is arranged to be under the building. This system is designed to minimize heat loss, so isolated has been manufactured. The heat storage material are used in the blocks of gravel or rock. Water or air is used as the heat transfer fluid. This system is more suitable for sloping site (7, 8); (Figure 5).

Figure 5: Gain was sperated system (10).

Maximum benefit from the sun, depends on the location of the building city's, on the world. For example, if the building in the northern hemisphere, the southern facade is more efficient. But while in the southern hemisphere, the northern façade is more efficient. For example, for Cyprus and Turkey, the south facade isthe best and some of the building parameters are as follows: (9).

3. PARAMETERS OF BUILDINGS HEATED with PASSIVE SYSTEM DESIGN

Passive solar energy systems can operate in an efficient manner and at an optimum level in order to benefit from solar energy in the construction of buildings, there are some rules that must be followed. These rules are described in this section. Energy-conserving buildings in order to benefit from solar energy at optimum levels must comply with the following specifications. These features are as follows: (9, 10).

- Placing Premises.
- Shape and Direction of the Building.
- Placing of Functional Spaces.

Placing Premises

During the winter months, by the time the sun between the hours of 9:00 am and 15:00 approximately 90% of solar energy is utilized. Therefore, the maximum of these times will be benefited from solar energy. In figure 6, different structure forms and locations are given. Here, optimal utilization of solar energy in form and position of the building is C-type (9, 10); (figure 6).

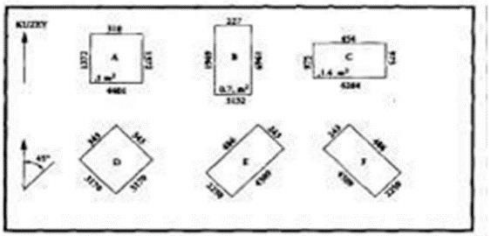

Figure 6: Location of buildings and relationship between solar energy and building (10).

Shape and Direction of the Building

The large window areas of the building that placed east-west direction, must designed to always face the south, to collect; the solar energy in winter. Therefore, the optimum shape of the building provides, minimum heat gain in the summer and maximum heat gain in the winter (9, 10).

Placing of Functional Spaces

The most important functions of the house; the living room and bedroom as well as the more time passed, when placed along the direction of the south, a large proportion of heating and lighting needs

are to be met. On the north facade of the volumes needs less heat than in the southern facade volume. Therefore, on the north side garage, laundry room, bathroom and hallway are placed in the volumes, that required as a minimum heating and lighting (9,10); (Fig. 7).

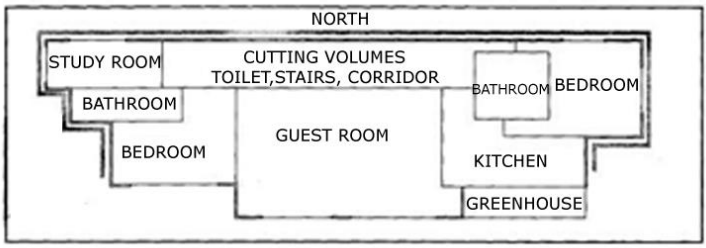

Figure 7: An example for volumes to be placed (10).

Determination of Window Area

One of the most important factors affecting of building energy consumption are size and placement of window forms. Diverted south to a building, in order to benefit from solar energy at it's optimal level greatly to the south side of the building (max.) window areas, the eastern and western facades medium (middle) window area is required to placed. To minimize heat loss in winter on the north side of the small (min.)window areas must be placed (9, 10); (Figure 8).

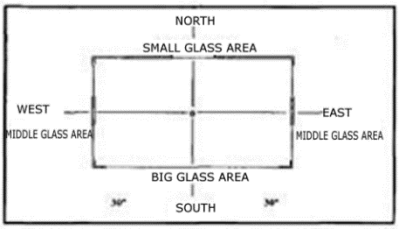

Figure 8: Layout of wındows (10).

4. CONCLUSION

Energy demand is expected to be significantly increased, in the next 40-50 years, depending on population growth and industrialization. In architecture, to meet the need for energy without harming the environment, in a sustainable manner should be focused on alternative energy sources. The use of solar energy in the world economy, especially in terms of architecture will provide energy savings and reducing global warming, will affect human health and comfort in a positive direction. Passive building design, also offers the user a more comfortable life (11, 12).

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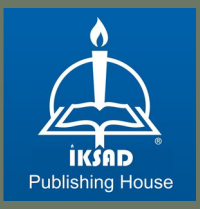

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