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TURKEY'S SITUATION IN THE PRODUCTION AND TRADE OF MEDICINAL AROMATIC PLANTS IN THE WORLD

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Medicinal and aromatic plants that have many applications such as in food, medicine, cosmetics, or spices have been used for similar purposes since the beginning of human history. While some of these plants are collected from nature, some are cultivated and produced. Herbal medicinal products are getting worldwide importance due to their health benefits. However, a significant part of the plants used for treatment is collected from nature. One of the most important features of medicinal and aromatic plants are their use for therapeutic purposes. There is demand will increase due to increased interest of consumers in natural products, as they are considered safer and more cost-effective than synthetic drugs in many cases (Peet, 1999; Karik and Tunçtürk, 2019). Treatments with plant species known as traditional therapy, complementary therapy, natural therapy are used in many countries, especially in undeveloped countries (Demirezer, 2010; Yazici and Yilmaz, 2020). Medicinal and aromatic plants are usually used in dried form, as essential oil or as fresh plants. About half a million tons of dried medicinal and aromatic plants are traded each year internationally and worldwide. Besides, a considerable amount of medicinal and aromatic plants is sold in local (national) markets. According to the World Health Organization (WHO), traditional medicine; It is the whole of knowledge, skills and practices that can be explained or not based on theories, beliefs and experiences specific to different cultures, which are used in the prevention, diagnosis, improvement or treatment of physical and mental diseases (Acıbuca and Budak, 2018).

The use of plants for therapeutic purposes differs according to the development level of the countries. In developing countries, 80% of the population benefits from herbal products for therapeutic purposes. In some countries of regions such as Asia, Africa and the Middle East, this rate rises to 95%. In developed countries, this rate is less 40-50% in Germany, 42% in the USA, 48% in Australia and 49% in France. However, the most important trade centers of medicinal plants are also located in Germany, USA, Japan and England (Titz, 2004). There are 174 families, 1,251 genera and more than 12,000 species and subspecies taxa (subspecies and varieties) in the flora of Turkey, and it is also the gene center of many plants (Kırıcı, 2015). There are many taxa with medicinal and aromatic properties in these plants. Turkey, which has different climatic and ecological conditions, includes three phytogeographic regions: Europe-Siberia, Mediterranean and Iran-Turan. It also has topographic, geological, geomorphological and soil variations, varying elevation differences, and very different ecosystem types. All these features cause a rich plant diversity throughout the country. Despite this, some medicinal and aromatic plants and products are imported (Bayram et al., 2010; Bozkıran, 2015). Most of the medicinal and aromatic plants are provided by the method of collecting from the nature. Therefore, it makes it challenging to keep healthy statistical data in this regard (Başer, 1997; Yazici et. al., 2020). The growing demand for medicinal and herbal products is a national and international trend. Legal restrictions are imposed on the chemicals used in food preservation. Therefore, the need for essential oils obtained from plants that could be used as antioxidants and preservative is increasing. Unlike synthetic medicines, herbal products are safe with very few side effects which also helps to the market share grow (Kartal and Erdem, 2012; Yazici and Yilmaz, 2021). In recent years, interest and demand for natural products have increased instead of synthetic additives in food and medicine. Due to the fact that there are few numbers of researches in this area, therefore more data and information are needed in order to report the production and trade of medicinal aromatic plants in Turkey. Medicinal plants also play an essential role in the lives of rural people in Turkey. It is estimated that at least 1 000 of the species in Turkey are used in various ways as 400 of them are manufactured. The number of plant species collected from nature for commercial purposes in Turkey and sold in the domestic and foreign markets was given as 347 in a study, and the number of endemic species among them is 35. Around 200 natural plant species are sold in herbalists in the country. The number of natural plant species collected from nature and sold abroad is about 100. In other words, about 11% of traded species are endemic. According to the ethnobotanical studies carried out in various regions of our country, the local people use an average of 10-12% of the natural plant species grown around them for various purposes (Arslan, 2014). In this study, Turkey's medicinal and aromatic plant production and trade status were reviewed by scanning the data obtained from the International Trade Statistics (ITC), Food and Agriculture Organization (FAO) and Turkish Statistical Institute (TUIK) records.

2. Findings and Discussion

2.1. Global Medicinal and Aromatic Plants Production and Trade

Production areas and quantities of a significant part of medicinal and aromatic plants in the world are given according to FAO (Food and Agriculture Organization) statistics. In terms of area, significant increases were observed between 2014 and 2019 (Fig1).

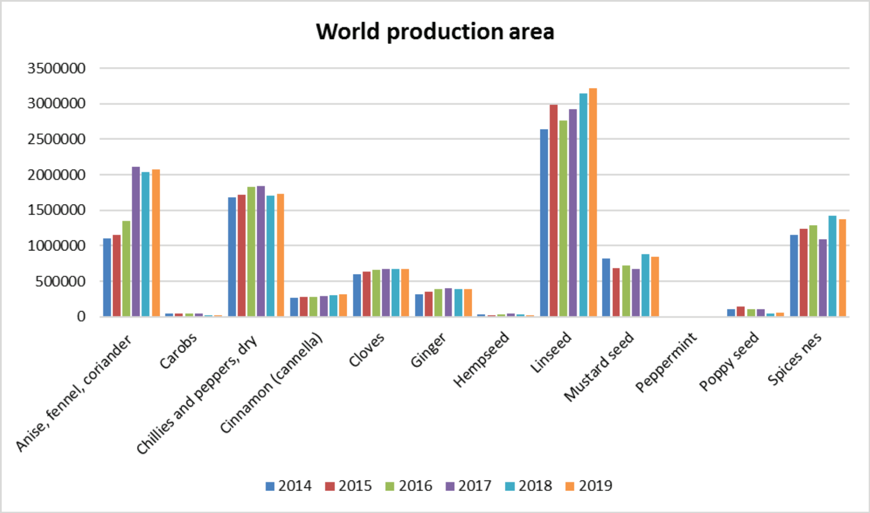

Fig 1. World production area of some medicinal and aromatic plants (ha) (FAO, 2019)

There is a general increase in the amount of production of medicinal and aromatic plants in the world between 2014 and 2019.

According to FAO data the medicinal and aromatic plants (chilies/ peppers dry, ginger, linseed, anise, fennel, coriander, and mustard seed) have highest production rate (Fig 2).

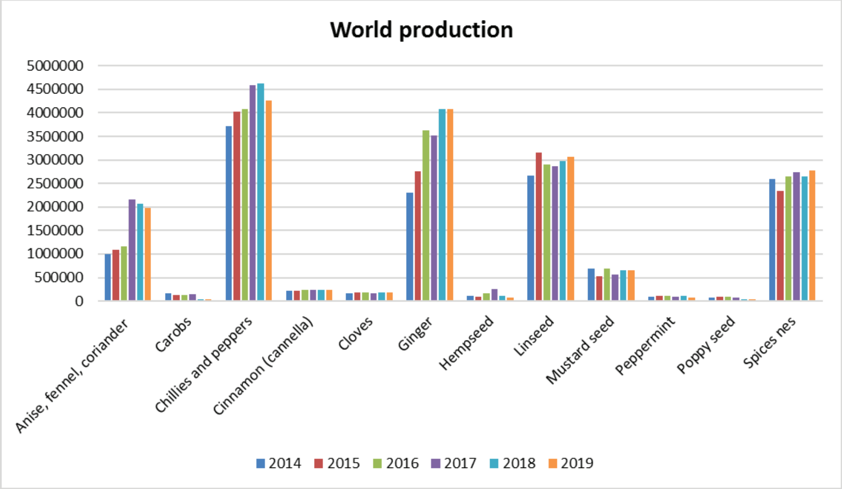

Fig 2. World production amount of some medicinal and aromatic plants (tons) (FAO, 2019)

There are serious problems in the world and in Turkey regarding the registration and trade of medicinal and aromatic plants. Many studies have been conducted in order to standardize and record the medicinal and aromatic plants market called "Black Market" in the world literature. International Trade Center (ITC) comes first among them (Temel et. al., 2018). While the world' import rate for anis, badian, fennel, coriander, cumin or caraway groups were 770.7 million in 2016, it was increased to 1.2 billion dollars for 2020. The USA, Germany and France are the leading countries for the import of this group of products. According to the world average import for 2020, Turkey ranked 7th with 38.8 million dollars in imports. In addition, Bulgaria was ranked 64th with an import of 1.8 million dollars (Table 1).

Table 1. World imports of anis, badian, fennel, coriander, cumin or caraway; juniper berries by countries and years ($ 1,000)

Country	2016	2017	2018	2019	2020
China	561	718	539	102.390	154.336
United States of America	81.033	82.405	83.199	83.823	97.135
India	77.682	67.143	60.991	67.093	82.355
Bangladesh	35.787	42.988	65.765	66.761	82.075
Germany	40.551	43.675	47.019	43.915	55.854
United Kingdom	31.975	37.019	37.534	38.334	42.610
Turkey	10.632	11.596	10.155	27.760	38.800
Egypt	33.806	32.842	42.455	37.473	36.674
United Arab Emirates	28.255	29.674	29.265	34.417	36.082

Table 1. World imports of anis, badian, fennel, coriander, cumin or caraway; juniper berries by countries and years ($ 1,000)-cont.

Country	2016	2017	2018	2019	2020
Malaysia	37.416	34.398	34.418	36.859	35.889
Saudi Arabia	26.839	28.312	29.627	33.878	33.418
Nepal	17.183	18.578	21.335	23.780	31.097
Bulgaria	1.886	2.164	2.837	1.562	1.751
Word	770.739	795.708	827.061	1.002.154	1.183.032

[*]ITC, 2021

According to the International Trade Center data, the export of anis, badian, fennel, coriander, cumin or caraway; juniper berries was 864.6 million in 2016 and was 1.2 billion dollars in 2020. This group is leading the countries exporting products, Brazil, Vietnam and India are among the leading countries in the export of the analyzed products, as Turkey takes 5th place with its 47.8 million dollars in exports. Also, Bulgaria takes 12th place with its 18.9 million dollars in exports (Table 2).

Table 2. World exports of anis, badian, fennel, coriander, cumin or caraway; juniper berries by countries and years ($ 1.000)

Country	2016	2017	2018	2019	2020
India	384.440	448.217	522.664	563.546	633.182
Syrian Arab Republic	105.066	119.742	74.173	72.666	68.707
China	20.905	29.008	50.807	49.108	63.476
Turkey	35.813	22.987	31.994	39.357	47.791
Viet Nam	16.772	27.275	26.667	46.624	46.327
Afghanistan	24.462	28.260	21.694	29.356	35.733
Egypt	22.592	19.396	27.462	31.797	32.445
Germany	19.304	23.050	23.583	23.257	28.824
Italy	22.145	16.871	19.095	21.546	26.694
Russian Federation	29.029	18.343	17.730	19.673	23.122
Spain	9.894	14.146	19.032	18.448	22.260
Bulgaria	11.551	9.249	11.304	17.356	18.942
Netherlands	16.136	16.442	14.408	14.104	16.637
Word	864.604	928.718	1.001.222	1.090.498	1.210.303

(ITC, 2021)

While the worldwide essential oils market value is expected to grow to $27 billion in 2022; Europe has the largest share in the global essential oils market. The global essential oil market share attributed to Europe is 50%, while the worldwide market value of organic essential oils is $4.38 billion (Statista, Essential Oils Market Share, 2020).

Table 3. World exports of essential oils, whether or not terpeneless, incl. concretes and absolutes; resinoids; extracted oleoresins; concentrates of essential oils in fats, fixed oils, waxes or the like, obtained by enfleurage or maceration; terpenic by-products of the deterpenation of essential oils; aqueous distillates and aqueous solutions of essential oils by country and year ($ 1,000)

Country	2016	2017	2018	2019	2020
India	607.651	784.922	861.416	1.212.564	837.765
United States of America	634.744	729.610	799.983	788.842	803.523
France	396.924	471.256	522.032	460.229	478.641
China	468.392	354.559	469.176	349.893	305.138
Brazil	339.048	431.217	437.220	313.938	270.190
Indonesia	166.380	160.368	199.266	185.328	215.807
Germany	191.822	218.425	228.529	202.358	209.530
United Kingdom	218.628	276.951	244.039	210.808	205.290
Argentina	196.376	203.718	256.584	216.963	205.039
Spain	124.221	160.641	193.681	174.357	187.271
Italy	137.498	161.857	195.026	182.862	159.493
Netherlands	69.246	75.547	80.730	90.418	157.528
Bulgaria	66.572	103.480	119.279	86.950	96.000
Turkey	41.292	49.187	47.481	40.065	37.894
World	4.734.472	5.431.453	5.955.614	5.642.249	5.290.510

ITC, 2020

While the total exports of essential oils in the world were 4.7 billion dollars in 2016, it increased to 5.3 billion dollars in 2020. The leading exporting countries are India, USA, France and China. In 2020, Bulgaria takes 13th place in the essential oil exports, while Turkey takes 25th place with its 37.8 million dollars in imports (Table 3).

According to Table 4, the total imports of essential oils in the world increased from 4.6 billion dollars in 2016 to 5.2 billion dollars in 2020. The leading importing countries are USA, France, Germany, China and United Kingdom. Turkey takes 25th place with its 33.3 million dollars in imports. Also, Bulgaria takes 57th place in essential oil imports (Table 4). According to ITC data, there has been a significant increase in essential oil trade in the world.

India, USA, France, China and Germany lead the world in the trade of medicinal and aromatic plants. Turkey is taken place in the middle of the world ranking. In order to take a strong position in this sector in Turkey, where there are nearly 3500 endemic plants, it is necessary to encourage the identification of medicinal and aromatic plants and then their cultivation in accordance with the field of medicine and food.

Table 4. World imports of essential oils, whether or not terpeneless, incl. concretes and absolutes; resinoids; extracted oleoresins; concentrates of essential oils in fats, fixed oils, waxes or the like, obtained by enfleurage or maceration; terpenic by-products of the deterpenation of essential oils; aqueous distillates and aqueous solutions of essential oils by country and year ($ 1,000)

Country	2016	2017	2018	2019	2020
United States of America	1.064.404	1.269.412	1.377.070	1.094.928	1.057.545
France	387.450	443.385	519.362	443.055	410.945
Germany	353.055	413.639	441.629	380.443	362.754
China	189.931	204.299	250.003	263.938	273.212
United Kingdom	285.067	334.276	340.636	273.331	272.956
India	212.273	271.930	388.659	693.335	228.231
Ireland	131.473	140.384	159.844	190.089	214.629
Netherlands	111.184	151.841	189.011	185.256	198.968
Japan	174.952	179.780	208.745	206.699	175.995
Singapore	150.639	169.678	188.235	172.909	154.152
Spain	125.396	147.362	158.091	135.641	149.779
Switzerland	137.908	158.486	172.696	155.384	145.965
Indonesia	129.440	136.213	211.109	167.376	145.799
Mexico	99.020	104.116	112.821	115.377	124.564
Turkey	27.398	36.394	33.546	32.457	33.314
Bulgaria	4.341	6.143	7.122	5.802	6.266
World	4.627.929	5.405.416	6.097.214	5.987.026	5.240.871

(ITC, 2020)

2.2. Medicinal and Aromatic Plants Production and Trade in Turkey

Around 900 medicinal plant cultures are obtained worldwide for commercial purposes, and the number of cultivated plants is minimal (Arslan et.al., 2015). There is no special classification of medicinal and aromatic plants in the statistical data published by the Turkish Statistical Institute (TUIK). Some of them are included in the classification of industrial plants, the oilseeds class, spices, and some are classified as vegetables. Table 5 shows the production areas and quantities of these plants. According to the provided information, approximately 14 kinds of plants are included in the medicinal and aromatic plants group and are cultivated in 273.421 ha area. Today, the medical and aromatic plant production area has increased by 40% compared to previous years. Again, it has been observed that the yield of some plants increased per unit area. While new plants have entered the cultivation culture, the cultivation of some ancient plants has either decreased or ended. Poppy, cumin, and sesame are plants that have been cultivated since ancient times. Later, plants such as thyme, anise, fennel, fenugreek, red pepper, tea, black seed, mint, lavender, salvia, capers, echinacea, lemon balm, cumin, chamomile, basil, coriander, and nettle, were cultivated. Production of ginger, saffron, turmeric "curcuma", thyme, bay leaves, curry and other spices had $ 136 million revenue in 2020 (Table 6). There have been increases and decreases in exports over the years. Coffee is, therefore, a plant that made ecological agriculture in Turkey, while exports consist of coffee obtained through imports. Pepper exports increased from 7.3 million dollars in 2015 to 17.7 million dollars in 2020. Fennel export data has started to be given in anise records in recent years. Seeds of anise, badian, fennel, coriander, cumin, or caraway decreased from $ 31.9 million in 2018 to $ 47.7 million in 2020 (Table 6). Black pepper, carob, licorice, mint, green tea, sumac, linden, coriander, clover, rosemary, vanilla, black seed, fenugreek, cinnamon, clove, ginger, flax, hemp, turmeric, saffron, cardamom, nutmeg, chicory, moth grass, vermouth grass are other plants that are exported.

Table 5. Cultivation area and production amount of medicinal and aromatic plants in Turkey

	2005		2010		2015		2019	
Crops	ha	ton	ha	ton	ha	ton	ha	ton
Cumin	25.800	14.300	17.124	12.587	27.024	16.897	32.188	20.245
Sesame	42.450	26.00	31.8.24	23.460	28.088	18.530	24.860	16.893
Anise	16.500	9.500	18.645	13.992	13.811	9.050	23.917	17.589
Poppy (capsule)	25.335	12.403	51.897	33.555	61.591	30.730	67.736	27.288
Fennel	-	-	-	-	1.551	1.461	3.385	4.655
Fenugreek								
Lavandula	-	-	-	-	321.8	400	1.190	1.462
Melissa	-	-	-	-	51.2	242	20.9	93.0
Black cumin	-	-	-	-	468.1	425	3.708	3.603
Sage	-	-	-	-	53.6	80	560.2	1.233
Coriander	-	-	-	-	15.0	11.0	15.5	12.0
Mint		7.750		11.772		14.945		16.011
Red pepper	78.000	45.000	104.00	186.272	11.288	204.131	11.940	240.656
Thyme	-	-	85.351	11.190	10.486	12.992	15.707	17.965
Total	188.085	88.953	218.552	292.828	153.839	309.894	273.421	367.705

(TUIK, 2020)

Table 6. List of products exported by Turkey ($ 1.000)

	2015	2016	2017	2018	2019	2020
Ginger, saffron, turmeric “curcuma”1 thyme, bay leaves, curry, and other spices	106.714	113.613	109.656	113.700	118.415	136.087
Seeds of anis, badian, fennel, coriander, cumin or caraway, juniper berries	-	35.813	22.987	31.994	39.357	47.791
Tea, whether or not flavoured	23.614	28.585	24.966	13.090	16.110	17.835
Pepper of the genus Piper	7.311	7.887	9.097	8.896	14.125	17.782
Vanilla	257	315	213	396	1.264	1.404
Cinnamon and cinnamon-tree flowers	164	203	189	265	733	1.552
Nutmeg, mace and cardamoms	119	91	109	144	1.395	3.517
Cloves, whole fruit cloves and stems	110	151	172	104	535	665
Mate	0	7	245	16	53	157

(ITC, 2020)

Turkey's list of imported medicinal and aromatic plants are given in Table 7. In Turkey, plants such as cinnamon, turmeric, cloves, ginger, black pepper, henna, vanilla, coconut, and ginseng are not grown. Some medicinal and aromatic plants are imported due to lack of production, some for lower cost, and some for re-export.

Table 7. List of products imported by Turkey ($ 1.000)

	2015	2016	2017	2018	2019	2020
Tea, whether or not flavoured	17.015	41.089	59.929	38.911	40.851	44.366
Pepper of the genus Piper	10.698	12.710	32.676	12.009	29.612	21.649
Ginger, saffron, turmeric "curcuma", thyme, bay leave, curry and other spices	14.348	14.494	16.112	13.719	18.513	22.018
Anis, badian, fennel, coriander, cumin or caraway	7.430	10.632	11.596	10.155	27.760	38.800
Cinnamon and cinnamon-tree flowers	1.265	2.083	3.396	1.901	3.741	4.956
Nutmeg, mace and cardamoms	588	774	1.109	929	2.132	4.237
Cloves, whole fruit, cloves and stems	594	353	726	483	1.186	1.842
Vanilla	318	181	180	60	267	342

(ITC, 2020)

Turkey's essential oil exports by years to important countries are given in Figure 3. France, USA, Germany, United Kingdom and Switzerland are the most important countries. Accordingly, it can be stated that a very important part of our exports of essential oils are directed to European Union countries.

It is seen that there are fluctuations in total essential oil export values. It can be said that these fluctuations are mostly caused by the increases and decreases in rose oil and stearoptenes.

Although the importing countries vary according to the years, our essential oils imports are made from India, Germany, France, USA and China in 2020 (Figure 4).

Rose oil constitutes a large part of essential oil production and export. Rose oil and rose concrete are exported with the same Customs Tariff Statistics Position (GTİP) number. Turkey is one of the leading countries in the world in rose oil production. Rose oil exports account for approximately 36% of essential oil exports (Temel et.al., 2018).

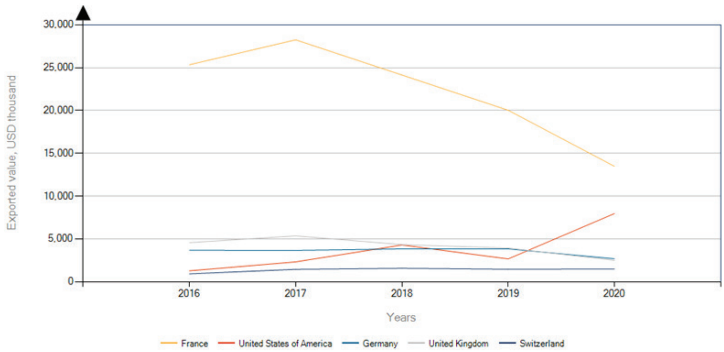

Fig 3. List of importing markets for a product exported by Turkey ($ 1.000) (ITC, 2020)

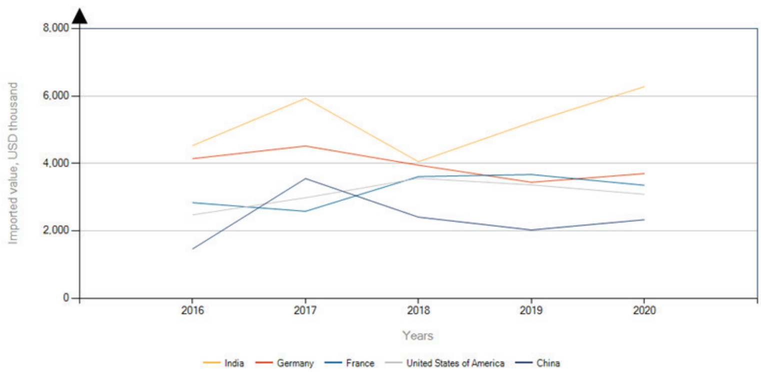

Fig 4. List of supplying markets for a product imported by Turkey ($ 1.000) (ITC, 2020)

Conclusion and recommendations

In this study, the general situation of the trade of medicinal and aromatic plants in the world and in Turkey is discussed.

1. Countries can develop their foreign trade with more frequent bilateral relations. While Turkey has an important place in exporting some medicinal and aromatic plants, it is an importer in some of them. These products should be exported by applying processes such as diversification, differentiation, packaging, and standardization. Turkey, which is rich in medicinal and aromatic plant species, should market these products to other countries in a more effective, planned, and profitable way through foreign trade.

2. One of the most important problems in research on medicinal and aromatic plants is that the production and trade figures of the products in question cannot be reached exactly.

3. It would be beneficial to organize national and international databases in such a way that the production and trade figures of these plants can be accessed, and to regulate international standard trade classification codes, especially for products that have an important place in foreign trade.

4. In Turkey, the production amount is low (products with high foreign trade value) and it is necessary to increase the possibilities of increasing their production.

5. Medicinal-aromatic plants grown under culture conditions should be supported.

6. The source of medicinal plants sold (domestic, imported, collected from nature, culture, purpose of use, shape, etc.) should be determined.

7. The cultivation of medicinal plants should be considered in good agricultural practices for spices.

8. Medicinal plant species cultivated or newly purchased must have the properties in the pharmacopeias of that country or the recipient countries, and spice plants must have the necessary properties.

9. In addition to the export of medicinal aromatic plants as raw drugs, the production and export of processed products should be encouraged and necessary support should be provided.

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Chapter 2

EFFECT OF CALCIUM DEFICIENCY ON BLOSSOM-END ROT DISEASE IN TOMATO

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INTRODUCTION

Tomato, which is one of the important vegetables in human nutrition, is one of the most produced, consumed and traded agricultural products in the world. In addition to being consumed fresh, it has various uses in the food industry such as frozen, tomato paste, sauce, ketchup, tomato juice, pickles, tomato puree, peeled tomatoes, sliced, diced, dried, canned and jam (AbdElrazig et al., 2018). Tomato is considered an important crop that needs to be grown and commercialized both because of direct human nutrition and providing raw materials to the sector. However, the fact that the price of tomato crop received by the producer is low and the price paid by the consumer is high, is an ongoing phenomenon in both segments. Although the total amount of vegetable production in Turkey varies according to years, tomato constitutes approximately 50% of the total vegetable export. Tomato, which is one of the most processed vegetables in the food industry, is used as a raw material in the fruit and vegetable processing industry and all sub-branches of this industry (Keskin and Gül, 2004). Various biotic and abiotic stress factors cause significant losses by limiting tomato yield and quality. Blossom-end rot (BER) is an important factor that significantly reduces tomato quality and destroys the economic value of the product (Ho ve ark., 1993; Saure, 2001; Djangsou et al., 2019; Macedo et al., 2021). The aim of this study is to provide an understanding of the causes of BER disease, which causes significant damage in tomato agriculture, and the methods to be applied.

1. Production, Consumption and Nutritional Content of Tomato (Lycopersicon esculentum Mill.)

Tomato (Lycopersicon esculentum Mill.), belonging to the Solanaceae family, is one of the most produced, consumed and traded vegetables in the world and plays a very important role in human nutrition. In the world tomato production as of 2019, China ranks first with a production of 62.8 million tons, India ranks second with 19 million tons of production, and Turkey ranks third with 12.8 million tons. China, which ranks first in tomato production in the world, meets 35% of the total world tomato production (FAO, 2021). Although tomato can be grown in many countries of the world due to its wide adaptability, Turkey is an important country for tomato production with favorable climatic conditions (Keskin, 2013). In Turkey, tomato ranks first among vegetable cultivation areas in terms of cultivation area. Among the vegetables produced, tomato is followed by zucchini (snack), dry onions and green beans. According to 2019 data published in Turkey, vegetable gardens are cultivated on an area of approximately 7.9 million decares, and the tomato cultivation area constitutes 2.10% of the total cultivated area and 20.95% of the total vegetable planting area (TUIK, 2020).

Tomato fruit consists of carotenoids, lipids, organic acids (citric acid and malic acid), 93-95% water, alcohol-insoluble solids (proteins, cellulose, pectin, polysaccharides), 5-7% inorganic compounds (Petro-Turza, 1986; Minoia et al., 2010). Tomato is a rich source of minerals, vitamins, organic acids, essential amino acids and dietary fiber. It is also a rich source of vitamin A, vitamin C and potassium minerals, and contains minerals such as iron and phosphorus. Tomato is low in calories and fat, and are a good source of cholesterol-free dietary fiber (Kabelka et al., 2004). Due to its unique nutritional value (lycopene, beta carotene, flavonoids), tomato is considered a protective plant. Especially in recent years, the popularity of lycopene has increased due to its anti-oxidative activities and anti-cancer functions (Raiola et al., 2014). Lycopene in the fruit is the main carotenoid that causes the characteristic red color of tomato, which is used in the treatment of various chronic human diseases such as cancer, cardiovascular diseases, osteoporosis and diabetes. The red pigment (lycopene) found in tomato is considered the world's most powerful natural antioxidant (Shankar ve ark., 2013).

2. Role of Calcium in Plant, Morphology, Physiology and Metabolism

The ratio of Ca content in higher plants in dry matter is about 0.5%. Due to the limited mobility of calcium, its transport between tissues increases depending on the level of water uptake. Calcium molecules are transferred from the root to the upper leaves by transpiration and water uptake in plants. Plants need more nutrients in the greenhouse than in the open field. Ca, B and Ca/B ratio are important for the usefulness of these elements (Çakmak and Romheld, 1997; Ishii et al., 2001). Calcium is required for structural roles in cell walls and membranes as the +2 valent cation (Ca^{2+}), as a counter-cation for inorganic and organic anions in the vacuole, and as an intracellular messenger in the cytosol (Marschner, 1995). In addition to its role in cell structure, calcium plays a role in the regulation of physiological functions. In particular, it ensures the adequate formation of the cell wall and prevents disease factors from entering the plant body.

Calcium is taken up by the roots from the soil solution and transported to the shoot through the xylem. It can travel from the root either through the cytoplasm of cells bound by plasmodesmata (symplast) or through spaces between cells, the relative contribution of apoplastic and symplastic pathways to Ca delivery to the xylem is unknown (White, 2001). The extremely low Ca^{2+} levels in the phloem stem have been hypothesized to be a result of Ca accumulation in the cells surrounding the phloem. As a result of the low Ca^{2+} in the phloem, the Ca content of all plant organs is relatively low, provided largely by the phloem sap with nutrients (Mengel and Kirkby, 2001).

Although calcium is present in the soil, it may not be beneficial to plants under certain conditions. In particular, calcium fertilizers dissolved with phosphorus cause precipitation, salinity and water uptake problems by plants and cause great problems in calcium uptake in plants. Even if there is calcium in the soil, it cannot be recycled for fruit in some plants and causes deficiency symptoms (Karaman et al., 2012). Calcium deficiency causes blossom end rot, so the yield may decrease significantly (Karaman et al., 2012). Symptoms of Calcium (Ca^{2+}) deficiency in fruit begin with cell plasmolysis (tissue formation), and the water-soaked appearance of flower tip tissues eventually turns dark brown as the cells die (Suzuki et al., 2003; De Freitas et al., 2010).

Salinity is one of several environmental stresses that cause major changes in the growth, physiology and metabolism of plants and threaten the cultivation of plants worldwide (Jaleel et al., 2007). Soil salinity has increased due to inadequate irrigation practices, improper fertilizer application and industrial pollution (Ouhibi et al., 2014). Salt exposure reduces tomato fruit size, overall yield and photosynthesis. Too much salinity from NaCl causes the osmotic pressure of the outer solution to be greater than the osmotic pressure of the plant cells, which is necessary to regulate the osmotic pressure to prevent dehydration of the plant cells. Uptake and conversion of nutrient ions such as potassium (K+) and calcium (Ca^{2+}) or excess sodium (Na^{+}) can cause problems. High Na^{+} and chlorates can cause direct toxic effects on enzymatic and membrane systems (Nazarbeygi et al., 2011). The use of high amounts of Ca in saline soils causes an increase in plant tolerance to salinity. Applying calcium to the nutrient solution to alleviate salt stress effects is one of the simple applications. This soilless culture system, which increases usable growth, increases the yield and quality of fruits (Binti Ahmad, 2018).

In tomato cultivation, sufficient K, Mg and Ca in the nutrient solution increase yield and improve fruit quality. However, some physiological disorders can occur despite good manure management and can be associated to a certain degree with these phytonutrients, such as in the case of blotchy ripening (BR), cat face (CF), fruit cracking (FC), and BER (Taylor and Locascio, 2004). Plants can take calcium and magnesium inactively. Therefore, for arid areas where the Ca/Mg ratio is high, the concentration of BER and gold stains of fruits and the uptake of Ca and K by plants in the nutrient solution may cause a decrease of Mg in plants, since the concentration of Ca and Mg in the solution and the absorption mechanism change (Yan and Ying, 2018).

3. Blossom-end Rot and Calcium Relationship in Tomato

The BER of tomato was first mentioned as a physiological disorder at the end of the 19th century (Selby, 1896). Particularly in sensitive cultivars, it may lead to high economic losses in some seasons' environmental conditions. Since Lyon et al. (1942) found a significant correlation between the BER and Ca^{2+} deficiency. Thus, BER is called a calcium-related disorder (Shear, 1975). Indeed, most modern textbooks and technical papers hold that Ca^{2+} deficiency is the primary cause of BER. The BER shows symptoms such as water soaking, turning dark brown on the flower tissue (Fig. 1). In the following stages, the surface of the fruit begins to deteriorate and rot because the tissues are not fully formed. Following this situation, a darkened outer surface is formed. In severe cases, the BER expands from the flower tip tissue to the calyx tip, forming tissue affecting the entire fruit. Symptoms of Ca^{2+} deficiency in tomato usually appear early during fruit growth and fruit development is limited. When limited Ca^{2+} starts to expand rapidly, deficiency symptoms in fruit are exacerbated (Ho and White, 2005).

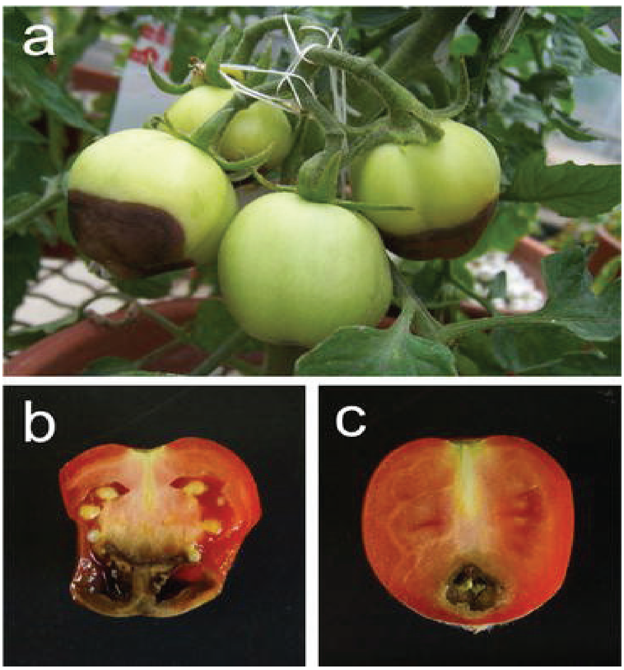

Figure 1. Symptoms of blossom end rot in tomato (Ikeda and Kanayama, 2015)

Among the vegetables of the Solenacea family, BER causes financial losses due to quality and yield losses, which occur mostly during the fruit development stage of tomato and pepper species. BER can occur in all tomato producing regions of the world and cause 23-37% product loss (Aişe et al., 2014).

With increasing K/Ca ratios in the nutrient solution, the incidence of blossom end rot (BER) increases, while the incidence of gold spots decreases (Nukaya et al., 1995). Therefore, it is quite a complex task to better understand the interaction between K, Mg and Ca and to examine the effect of Ca and K:Ca ratio on BER formation.

Blossom end rot is a physiological disorder that causes significant losses in horticultural crops such as tomatoes, peppers and watermelons (Hagassou et al., 2019). Blossom end rot seen at the ends of fruits in fruit-bearing vegetables such as tomatoes is caused by a calcium deficiency in the plant (Ikeda and Kanayama, 2015). The typical manifestation of BER disease in tomato is discoloration and death of the tissues at the tip of the fruit (Figure 1). Calcium has many different roles in the plant body. One of the most important of these is the role of cell wall formation in fruit cells (Hocking et al., 2016). Physiological events such as water uptake, movement of water in the plant and transpiration affect the uptake of calcium by plants. This affects the transport mechanisms of calcium in the tissues in the xylem, affecting the amount of calcium in the cell wall (Hocking et al., 2016).

The fact that calcium is an immobile element in plant tissues ensures that the calcium in the leaves is not transported to the fruit tissues. This explains why even foliar application of calcium does not accumulate enough calcium in fruits. It has been reported that abiotic stresses such as drought stress and salt stress are also effective in blossom end rot (Hagassou et al., 2019). In addition, high ambient temperature is another abiotic stress factor that causes BER (Taylor and Locascio, 2004). While some researchers reported that increasing levels of calcium applications had a reducing effect on BER symptoms in their studies in the soil and hydroponic system, some researchers stated that when they grew plants in the hydroponic system (solutions), the increase in calcium concentrations did not have a significant effect on BER (Hossain and Nonami, 2012). Hossain and Nonami (2012) reported that increasing calcium under salt stress causes decreases in water potential, osmotic potential and fruit development in fruit (EC 8 mS/cm compared to EC 1 mS/cm). Genetically different responses to blossom end rot have been observed among tomato cultivars. Cultural practices, growing environments and characteristics, climatic conditions, the genetic structure of varieties are changing in the open field, greenhouse or soilless farming systems, and the cause of blossom end rot, the physiological events in the plant and its solutions are not fully understood.

4. Studies on Impact of Calcium-induced Salts on Plant Growth and Blossom-end rot Symptoms in Tomato

Lolaei (2012) conducted a study investigating the effect of relieving salt stress by applying different doses of CaCl2 to tomato plants grown under salt stress. In the study, doses of 0, 50, 100 and 150 mM NaCl or CaCl2 (0, 100, 200 and 300 mg L-1) were applied to the nutrient solution. The addition of NaCl to the nutrient solution resulted in a fruit yield of 8.13 kg/plant in terms of the number of fruits per plant, while it was 3.83 kg/plant in the control. The negative effect of NaCl on tomato plants with calcium application gave positive results in fruit yields by 40% as calcium doses increased.

Parvin et al. (2015) investigated the effects of calcium supplementation on flowering, flower drop and fruit yield of tomato plants under salt stress. While the highest number of inflorescences per plant occurred in the control (5.39 plants/unit), the highest salt application (8 dS m-1) was determined as 4.67 plants/unit. The highest fruit yield was measured when 10 mM calcium was applied to the nutrient solution under salt stress.

Parvin et al. (2016) reported that the stomatal conductivity of tomato plants under salt stress decreased in their study on tomato plants. While the Na concentration of the plant was 0.61% in the highest salt application (8 dS m-1), the Na concentration in the control was determined as 0.24%. In the study, the increase in salinity caused a decrease in the amount of potassium and calcium in plant tissues.

Kataoka et al. (2017) investigated the effect of stress on the tomato plant under salinity stress by using chemical fertilization and organo-mineral fertilizer containing calcium sulfate. Researchers have determined that salt stress reduces many biochemical properties of the plant, including yield. Researchers reported that the calcium concentration in the juice of young tomato fruit decreased with salt applications. The rate of blossom end rot increased with increasing salt concentration.

Reitz et al. (2021) reported that 10 ppm calcium chloride application in blossom end rot of tomato decreased the occurrence of blossom end rot compared to control, whereas excessive calcium application (100 and 500 ppm) did not increase the effect of the calcium content of tomato fruit in terms of fruit tissue calcium concentration.

CONCLUSION

Blossom end rot disease causes significant financial losses due to high temperature of the environment, solution salinity and high pH, mineral substance imbalance in the nutrient solution and genetic susceptibility of the variety, especially in the greenhouse environment under the conditions of feeding with Hoagland solution. Although the water content in the fruit tissue increases and the ambient temperature of the plant is high, blossom end rot increases under insufficient transpiration conditions. The main reason for the formation of fruit end rot is that calcium is not transported to the young leaves by remaining immobile in the old plant leaves and is not transported to the young leaves and is insufficiently transmitted from the young leaves to the newly formed fruits. Therefore, in addition to the use of resistant varieties, optimum environmental conditions and ensuring calcium balance can prevent financial losses.

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Chapter 3

INDUSTRIAL FRUIT HARVESTING MACHINERY

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INTRODUCTION

Fruit growing is necessary for human nutrition and has a great value in the food industry. Fruit harvest, which is one of the essential stages of fruit growing, generally means the collection of fruits that come to harvest maturity; transportation, cleaning, classification and storage of harvested fruits until consumption.

Fruit harvesting is carried out by three different methods; manually, semi-mechanized and fully mechanized. In addition to these three general methods, by deciding the fruit maturity with cameras and sensors, then they have made room in the application in automatic systems that collect the ripe fruit with robotic arms and place them in boxes or special plates.

The effect of manually fruit harvesting needs high labor requirements and total expenses. Researchers have done many studies on the labor need for manual harvest tasks. Gezer (2001) defined that is seen in Table 1, the ratio of the labor force required for harvesting in some fruit species to the entire labor force.

Table 1. The share of required labor for harvesting some fruit species in total labor requirement (%)

Fruit Species	Workforce Requirement (%)
Citrus	31
Peach	38
Apple	41
Apricot	43
Olive	50-70
Sour cherry and Cherry	70
Hazelnut	74

That is understood at the values in the Table 1, the workforce required for the harvest of olives, hazelnuts, sour cherries and cherries constitutes more than half of the total workforce. Also, the workforce requirement for peach, apple and apricot harvest is more than one-third of the entire workforce.

Ünal (2005) emphasized that the labor cost of manual harvesting of walnuts constitutes 30-60% of the total production cost.

Burks et al., (2005) stated that according to economic research, approximately 40% of the production cost of citrus fruits in the USA is composed of harvest labor. This situation reduces the foreign competitiveness by half, in their study.

This high share of manual harvesting in production cost items has prompted producers and researchers to seek solutions to reduce the cost of harvesting labor. In this section, that is going to be mentioned about fruit harvest machines used for industrial fruit production.

Mechanized Fruit Harvesting

Fruit harvesters are used for harvesting fruits mainly produced for fabrication. With this method, the trunk or branches of the trees could be shaken, the fruit trees might be sprayed with air or water in waves, and with rake-shaped catch arms, etc., could be penetrated in canopies of trees. These machines can get the power transmission required for their work from the tractor or they have their own engine on them. A single operator generally uses these machineries. Their work efficiencies are higher than working with manual harvesting and semi-mechanized harvesting aids.

Shakers

The machinery working with the principle of transmitting force to the fruit is emphasized to harvest the fruits produced for fabrication purposes. The force created by the mechanical shakers or liquid sprayers attached to the trunk or branch is used for this purpose. It is transferred to the fruit with the trunk, branch and stem gap or directly to the fruit. The inertia force formed in the fruit by shaking creates torsional and tensile stresses in the stem. The fruits detach when the oscillation forces are created to reach a level that the branch cannot carry. In order to reach the optimum harvest level without damaging the tree, the appropriate shaking frequency and amplitude must be selected. Those which transmit force to the fruit through the trunk or branch are more successful in practice (Kirişçi and Tuncer, 1988).

- Trunk shakers have transmitted the shaking force to the fruit through the stem. The most commonly used body shaker is the rotary inertial mass one. In this machinery, the shaker is firmly fixed to the tree trunk. The desired vibration is provided due to two unbalanced rotating masses' different rotation directions and speeds. In this type of shakers, the amplitude is between 5 and 15 mm. The frequency is between 15 and 20 Hz, the power requirement is can change from 30 to 70 kW. The weight of the rotating masses is between 20 and 60 kg, the weight of the shaker is about between 600 and 1000 kg. The body diameter is between 15 and 40 cm. In these shakers, the frequency is adjusted with the help of a hydraulic variator (Gezer, 1997).

The work efficiency of these shakers, suitable for single-trunk trees, is 40-60 trees/h. The body must be well grasped for sufficient vibration to be transmitted during shaking. The surface surrounding the tree varies between 60-100 cm^2. After clamps lose their flexibility, they must be replaced. The clamping force of the clamp should not exceed 10 or 15 kN. Because the clamps placed can strip the tree's bark and damage the cambium layer (Kirişçi and Tuncer, 1988).

Umbrella-type body shakers are machines used especially in olive harvesting (Fig. 1). It can be connected to the front or the back of the tractor and the mini loaders. The gripper in the middle grips the tree trunk and vibration is transmitted to the tree with the shaking movement that occurs with the hydraulic system driven by the tractor. Olives poured into an area with a diameter of approximately 6 meters are collected in the machine's covering. The hydraulic arm can extend 3.5 m. The system needs tractors that have 90 horsepower engine. At the end of the harvest, the covering, where the product is collected, is lifted up to 3 m and trailers, etc. can be unloaded into vehicles.

Figure 1. Umbrella-type trunk shaker (Anonymous a, 2021)

Harvesting hard shells, a trunk shaker that shakes the tree, self-propelled or connected to the tractor and a separate machine that collects the spilled product are used (Figure 2.). The trunk shaker can shake approximately 12 trees per minute one of these machines. The walnuts which are poured with the brushes in front of each wheel, are swept to the sides. Then, the product, which is collected by vacuum effect with another machine, is conveyed to the warehouse by conveyor after foreign materials are removed.

Figure 2. Walnut harvester (Anonymous b, 2021)

There is a different version of trunk shaker machine is used in the harvesting of pome fruits such as apples. These machinery work in a similar principle to the machines used to harvest stone fruits. The vibration system and the units that collect the fruits that are cut or dropped by vibration can be on the same or different machines (Figure 3.).

Figure 3. Trunk shaker for apple harvesting (Anonymous c, 2021)

This machine, seen in Figure 3, consists of sweeping units in the front and side, and cleaning, transmission and storage parts pulled by a tractor. The sweeping units in front and on the sides collect the apples and transmit them to the cleaning unit of the machine. While foreign materials are removed by the airflow created by the 70 cm diameter fan, the product is conveyed to the warehouse with a belt conveyor. During operation, the forward speed can increase to 3 km/h. It can harvest approximately 12 tons of products per hour. Hydraulic units take their movement from the PTO. The total power consumption of the system is up to 15 HP. All units can be controlled from the tractor cabin.

The machine is of tractor-towed type in a different body shaker design made for harvesting stone fruits (Figure 4.). The machine basically consists of hydraulic components for the shaker arm and mechanical components for the belt conveyor and coverings. A wireless controller can control hand-positioned body shaker at the beginning and end of vibration. Coverings are opened both sides of the tree trunk with the help of two workers. The fallen fruits are collected on the coverings by the vibrations transmitted by the trunk shaker . While the coverings are being collected, the spilled fruits fall on the belt conveyor. It is also delivered to the cash registers with a belt conveyor.

Figure 4. Tree shaker for stone fruits (Anonymous d, 2021)

- Branch shakers transmit the shaking force to the fruit through the main branches. Shaking is always done at 1/3 of the branch length and from the place close to the trunk. Their working frequency is 2.5–5 Hz and their work efficiency is low as 17-45 trees/h, but their plucking efficiency is 90% high (Kirişçi and Tuncer, 1988).

- Rope shakers have a simple structure and can often be mounted on the tractor. In this type of shaker, the cable force is provided by an eccentric pulley. The PTO and transmitted to the tree by another articulated steering pulley. When the branch is deflected from its stationary position, it regains its elasticity and thus vibration is provided. The backward stretching of the tree completes the vibrational movement. Harvesting efficiency depends on the time loss of guiding the tractor towards the tree and attaching and removing the clamp from the tree branches and is thus low. In this type of shakers, the stroke distance is 20-60 mm and the vibration frequency is between 5 and 8.5 Hz. The one drawback of these shakers is that branches or trees frequently break due to the need for pre-tensioning, depending on the user's license. In addition, a heavy vehicle is required to meet the reaction forces that occur during the pulling of the cable. Therefore, the mass of the tractor carrying this shaker is important (Gezer, 1998).

Figure 5. Rope shaker (Anaymous e, 2021)

The rope shaker seen in Figure 5, takes power from tractor PTO. The rope shaker needs a minimum 15 HP from a tractor. The rope length is 10 meters.

Mass Harvesters

Increasing the efficiency and productivity of commercially available Mechanical Harvesters can reduce harvesting costs and hasten their adoption. Several design features are being examined as to how they can improve the efficiency of mass harvesters. To help them become more productive and require less hand labor. Better forward speed synchronization of two harvesting machines will improve to the catch frame efficiency and increase the fruit recovery rate. In addition, the development of a yield monitoring system will enable grove managers to monitor yields within a block and allow them to manage production inputs more effectively.

The machines used in harvesting citrus are similar to construction machines due to their large dimensions. These machines generally work as one on each side of the tree line. There is a shaker unit on both sides of the machine. There are long bars arranged circularly on the shaking unit that enters between the tree crown. The plucked fruits fall on the trays standing at an angle to each other on both sides. Elevator unit products on the table are conveyed to the trailer coming from the back of the machine (Figure 6).

Figure 6. Citrus harvester (Anonymous f, 2021.)

The rate of plucking the fruits from the tree by the machine seen in Figure 6 is 95%. This machine can harvest one tree in 12 seconds. It can do work equivalent to 120 workers in a day.

Self-propelled grape and olive harvesters are included in the finishing system and are useful for large-scale enterprises. The machine is seen in Figure 6. is driven by a hydrostatic pump with its 175 horsepower 6-cylinder engine. It moves with the help of hydrostatic motors on each wheel. Its roof is designed to take the trees between the harvesting unit. It can adapt to sloping terrain.

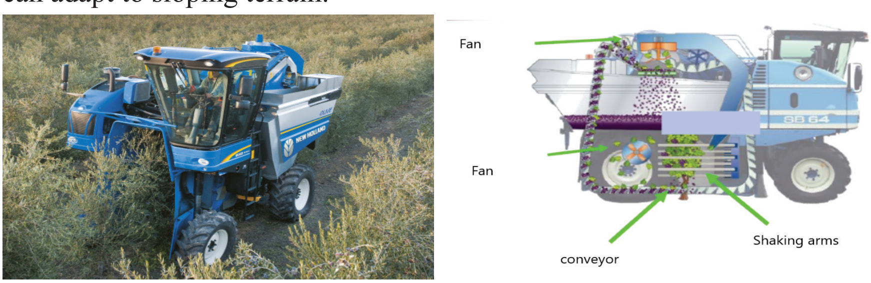

Figure 7. Olive harvester (Anonymous g, 2021)

Shaker arms made of rubber, seen in Figure 7, are the first parts to come into contact with the product. The vibration of the shaker arms harvests the product. Leaves and olives separated from the tree by shaking arms fall into carrier baskets. leaf etc. While foreign materials are thrown out of the product by fans, the products are transported to the warehouse by conveyor. It can be easily emptied to the desired location when the tank is full. It can also be used in grape harvesting in lands where the distance between rows is greater than 3 meters. Optionally, the equipment can be connected for many spraying, pruning, and fertilizing processes.

Automation In Mechanized Fruit Harvesting

This section will give examples of automatic harvesting machines and harvesting robots, which are commercially produced and used in the field, containing today's technology.

Using components that have developed and become widespread with the advancement of technology, an operator only directs the main machine in the orchard; There are also machines in which the remaining fruit harvesting processes are carried out automatically. An example of these machines is the Robotic Fruit Harvester (the FFRobot), shown in Figure 8, designed for apple harvesting.

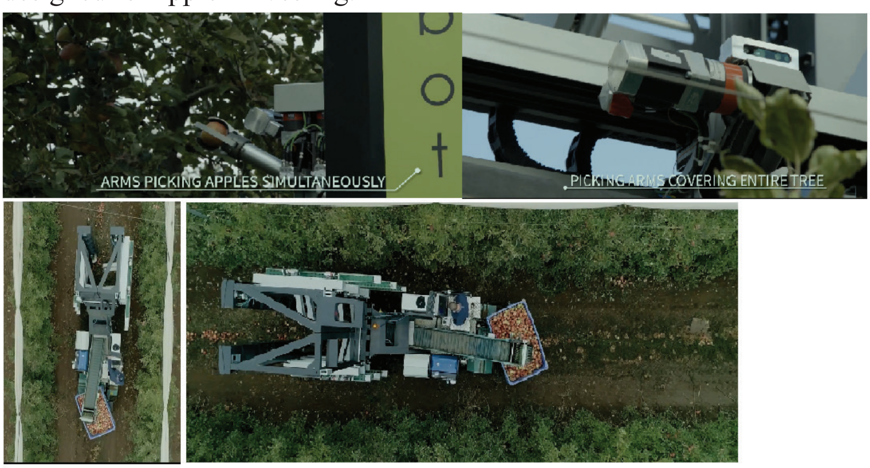

Figure 8. Robotic fruit harvester (Anonymous h, 2021.)

After this machine is positioned by the operator in the row of fruit trees, the cameras on the machine determine the location of the fruits in the three-dimensional spaceplane. Then, the position information of the fruits is evaluated in the processor. Robot arms reach the fruit, break it by rotating the fruit stem on its axis and leaving it on the conveyor belt. The belt conveyor conveys the fruits to the box located at the back of the machine and rotates on its own axis on a table. This machine is what a harvester has to do; It can decide whether the fruit is ripe or not, reach the fruit, pluck it, and place it in the crate. The machine manufacturer emphasizes that this machine is ten times more productive than the average harvester.

There are also fruit harvesting machines that work without the need for an operator. An example of this type of machine is the Agrobot in Figure 9, which can harvest strawberries in the greenhouse and in the field.

Figure 9. Strawberry harvest robot (Anonymous i, 2021.)

This robot can be used in the field and greenhouses. This machine has a working width of 6 meters and a length of 4 meters and has the possibility of adjustment between rows. The robot scans the plants next to it with color and infrared sensors. It performs operations such as coming to harvest maturity and determining the fruit's location in the three-dimensional spaceplane. Then the robot arms pluck the fruit from the stem and place it in the crates located at the bottom.

Scarfe et al. presented the design concept and development status of an autonomous kiwi picking robot in their study published in 2011. The robot is controlled by radio waves. It works autonomously while navigating the orchard, picking fruit, emptying full fruit boxes, picking up empty buckets and protecting the picked fruit from rain. The robot has four arms, each of which can pick fruit once per second (Figure 10).

The movement of the developed robot is provided by a hydraulic pump connected to a 7 kW motor. It can carry up to 1.5 tons of harvested product. It determines the location of the ripe fruit on the tree crown by using GPS and advanced algorithms to determine the location of the fruit. He places the product he collects in the crates, and when the bins are full, he goes to the end of the line and leaves the bins.

Figure 10. Kiwi picking robot (Scarfe et al., 2011)

One company developed a new approach for autonomous fruit harvesting. Tevel Aerobotics Technologies has invented a flying autonomous robot (FAR) that uses artificial intelligence (AI) to identify and pick fruit. The robot can work 24 hours a day and picks only ripe fruit (Figure 11).

Figure 11. Flying autonomous robot (Anonymous j, 2021)

The flying autonomous robot software can detect fruit, foliage, and other objects. Also, it can make fruit classification. It can plan trajectory with fleet management optimization software.

For the food industry, it is necessary to harvest large quantities of fruit on time. For this purpose, fruit harvesting should be mechanized or even gradually automated. When automation replaces mechanized harvesting, a small number of skilled operators will take place the intensive workforce. In the past, mechanization in fruit harvesting meant shaker arms, elevators that carry the collected fruit to the bins, and units that organize the full and empty bins. Fruit harvesting machines developed with the advancement of technology are supported by software and gain abilities such as deciding on fruit maturity and planning the harvest route. Thus, the required time for fruit harvesting can be reduced. The selection of fruit harvesting machines described in this section generally can be evaluated according to the size of the enterprise, the capital structure of the enterprise, and the land and climate characteristics.

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Chapter 4

OCCUPATIONAL HEALTH AND SAFETY IN FORESTRY IN THE EASTERN BLACK SEA REGION

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Introduction

Forestry includes works performed with the principles of multidimensional and continuous use to meet people's needs for goods and services (Enez et al. 2003). Forestry works can be divided into the classifications of silviculture and afforestation, production (cutting, felling, branch clearing, tip removal, bark removal, logging, grading, splitting, loading, transport and stacking), construction, protection and maintenance. According to the ILO classification, forestry falls under the classification of hard labor (ILO 1998).

Forestry operations are very hard, dangerous, and necessitate physical and mental effort because of nature conditions. Therefore, forest labor takes place in heavy labor class. Forest labor which has been made in the open air, on rough and steep slope areas, and by untrained workers has entertained an important risk as a matter of health and safety every time.

Since forestry activities are exposed to natural conditions, they are very difficult and dangerous tasks that require a lot of physical and mental strength. The most important difference that distinguishes forestry work from other jobs is that it requires the worker to be present in the field. This situation causes workers to be directly affected by climatic conditions such as wind, humidity, precipitation, temperature, and topographic conditions such as slope, roughness, and raggedness. The uneven ground makes it difficult for the laborer to move and work, and if it is sloped and rocky, workers put in more energy and risk slipping and hitting rocks. Such external conditions cause a high risk of occupational accidents in forestry operations.

Both natural conditions, such as climatic conditions, topography, and forest ecosystem characteristics, and the need to work in daylight render working times indefinite. Since forests are mostly located in mountainous areas away from settlements, forestry laborers often have to reside in the forest. This situation causes the workers to stay away from their families and social life, and if it last a long time, it can harm their mental well-being.

Today, the number of people permanently living in forest settlements has significantly decreased due to the high migration from the countryside to the city for social reasons. Currently, about 7 million people live in forest villages, and there are 2,123 forest village development cooperatives (287,254 foresters) in our country (OR-KOOP 2003).

In our country, forestry works must be carried out by villagers coming from the nearest forest villages, or forest village development cooperatives as per Article 40 of Forest Law No. 6831. However, if the labor force of villagers or cooperatives in the surrounding area is insufficient, they do not want to work, or they demand inflated prices, villagers and forest cooperatives in other villages can get the job. This reduces the possibility of recruiting pre-trained and qualified laborers (Acar et al. 2005). Forest laborers usually learn their jobs and gain experience with trial and error. This increases the risks against laborers' health and of accidents. Acar et al. (2001) emphasized that the low level of education of forest laborers leads to lowered efficiency, loss of wealth, injuries, and fatalities due to industrial accidents.

Turkey's forests span an area of 22.9 million hectares, of which 46% are located in mountainous areas where the slope is more than 40% (GDF 2021). Most of the forests in the Eastern Black Sea Region are located in sloppy and rough areas. For this reason, forestry work in these regions carries the risk of too many accidents.

A study conducted in the Eastern Black Sea region examined the use of protective clothing and equipment by forest workers engaged in production activities (Gandaseca et al. 2001). The study found that 83% of workers do not utilize protective clothing and equipment, whereas the remaining 17% use boots, eye protection, and earplugs.

Material and Method

Questionnaires containing 20 multiple-choice questions were used to identify the health status of workers employed in production, road construction, and repair, as well as forestry and nursery workers in the Trabzon Regional Forestry Office. In preparing the questionnaires, special care was taken to ensure that the questions were simple enough to be understood by people of all ages and education levels.

In the survey used as part of the study, laborers are divided into three groups based on working hours (temporary/seasonal and permanent workers), age groups (15-30 years old, 30-45 years old, and over 45 years old), and the workgroup in which they work (nursery workers, production, loading and unloading, road construction, afforestation workers).

The prepared questionnaires were administered to 60 production laborers and nursery and afforestation workers (40 people) working in the forestry departments of the Trabzon Regional Forestry Office.

Questionnaire questions and answer options were prepared before going out to the field. To avoid differences in the perception of the answers to the questions, the questionnaires were administered by one interviewer. The application was in the form of a mutual conversation with each of the workers. During these conversations, verbal responses were received and their equivalent options were marked on the questionnaire.

Data collected in the form of questionnaire responses and notes taken during the interview were then scored as a percentage (%) in the office. The results of questionnaires conducted to identify the health status of afforestation and nursery workers, as well as workers involved in the production, road construction, and maintenance, are presented in Table 1 in %.

Findings

The results of the questionnaires determined that the anatomies of the forest workers working in the region were generally normal. While in nursery workers physical weakness increases and body size decreases with age, the opposite is true for production workers. This is due to the adaptation of the human body to work over some time.

The vast majority of forestry laborers are temporary/seasonal workers. For these laborers, who only be hired in the forestry industry for a limited period of time, an additional source of income is needed. The number of production workers with additional income is much higher than that of nursery workers. While the rate of additional income in both age groups for nursery workers is 8.2% and 7%, respectively, for production workers, it is 44.3% and 30.2%. The reason is that 58% of nursery workers are women and 42% are men. Temporary/seasonal nursery female laborers do not work in another type of business if they do not work in a nursery.

It was found that while all the nursery and afforestation workers have social security, very few of the laborers working in production, road construction, and maintenance works have social security. This was because production works were mostly outsourced to forest villagers through a tender.

It was found that there is a significant difference in the blood pressures of the forest workers working in nursery and afforestation works and production, road construction and maintenance works. The highest rate of normal blood pressure (68.5%) was observed in forest workers working in nurseries and afforestation, while low blood pressure (62.5%) was observed at the highest rate in production workers. This may be because the production, road construction and maintenance works are carried out in rough, steep, sloppy and high-altitude areas. The continuous pressure change is a cause of blood pressure drop. Varicose veins and vascular disease, as well as dental deterioration, increased in both study groups in relation to age.

Table 1. Survey results of forest workers' health status as %.

		Nursery Workers		Production workers	
		Age Groups		Age Groups	
		15–30	30–45	15–30	30–45
PERSONAL CHARACTERISTICS					
The Marriage Rate		76,6	95,8	60	90
Additional income	with	8,2	7	44,3	30,2
	without	72	73,4	55,7	69,8
Bodybuild	Big	17	12	19	24
	Normal	73	72	56	60
	Weak	10	16	25	16
HEALTH PROBLEMS					
Blood Pressure	High	9	25	15	27
	Normal	82	55	14	19
	Low	20	9	71	54
Dental Health	Bad	55	78	61	66
	Normal	45	22	39	34
VARICOSE-VASCULAR DISEASE		6	16	2	13
Pain Giving Diseases	Rheumatism	11	31	38	73
	Back	36	78	54	79
	Nape-shoulder	5	21	49	71
	Arm-leg	13	16	55	57
Common Diseases	Hand-foot chill	35	40	32	50
	Finger whiteness	2,2	14,5	1,1	24
	Hard of hearing	1,6	3,2	-	30
	Fatigue-weakness	72	81	76	84
	Visual defect	1,6	5,5	2	16
Psychological Diseases	Irritability	84	90	90	95
	Thoughtfulness	23	48	72	82
	Insomnia	13	12	20	26
	Headache	67	54	51	74
HEART-STOMACH DISEASES					
Heart attack		-	-	-	12,7
Heart rhythm and palpitation		-	-	12,6	22,5
Breathing difficulty		3,4	12,5	16	17
Breathing occlusion when lifting loads		9,5	13	22	30
Chronic bronchitis and flu		25	28	16,6	24
Peptic ulcer		-	1	5,2	8,6
Stomach-intestinal pains		16	94	25	37,4
BODY INJURIES					
Foot, arm, or other fractures		-	-	28	55
Back injuries		-	-	11	12
Head injuries		-	-	40	65
Sprain		-	-	34	52
Crush		-	-	32	65
Big cuts		-	-	8	10
Eczema and itching		4	13	14	25,4
Fungus and cracking in the feet		12	26	15	24

Table 1 continues.

HABITS					
Smoke	Not	16,4	4,5	14	2
	Little	25,7	18,8	19	11
	A lot	57,9	75,8	67	87
Alcohol users		7	28	19	12
Those who drink a lot of tea and coffee		92	82	95	97
Doing sports		25	8	30	12
Breakfast eaters		71	53	80	68

As a result of the study, pain-inducing diseases (rheumatism, back pain, nape and shoulder pain, arm and leg pain) were detected on average 26.75% in nursery workers, while 59.5% in production workers. In both study groups, it was observed that the incidence of disease increased with age. The most common and painful type of disease in forestry laborers is back pain, averaging at 57% in nursery workers and 65.5% in production workers. The least common types of diseases are nape and shoulder pain in nursery workers and rheumatism in production workers.

Common diseases in forestry laborers include cold hands or feet, white fingers, hearing loss, fatigue and weakness, and visual impairment. The most common disease type in both study groups is fatigue and weakness, and the average rates of this disease are 76.5% in nursery workers and 80% in production workers. The least common type of disease is hearing impairment in nursery workers (2.4%) and visual impairment in production workers (9%). While the hearing impairment is not observed at all in the 15-30 age group of production workers, it is observed in 30% of the 30-45 age group. This can be caused by noise and vibrations from the equipment used in production operations (cutting tools such as chainsaws and brush cutters, hauling vehicles such as sky lines and monorails, transport vehicles such as trucks and trailers, road construction machinery such as dozers and excavators).

Psychological disorders in the forest workers who participated in the study; irritability, absent-mindedness, insomnia, and headaches. The most common type of psychological disorder in forest workers is nervousness: 87% for nursery workers and 92.5% for production workers. The least common psychological disorder is insomnia with 12.5% and 23%, respectively.

Disorders such as heart attack, stenocardia, and palpitations have not been detected in nursery workers. While the heart attack is not observed at all in the 15-30 age group of production workers, it is observed in 12.5% of the 30-45 age group. On the other hand, heart rhythm and palpitation disorders increased by 9.9% by age.

While the stomach and intestinal pain observed in forest workers increased by 78% in nursery workers compared to age groups, the increase was found to be only 12.7% in production workers.

In the category of body injuries; foot, arm, or other fractures, back injuries, head injuries, sprains, crushes, large cuts, eczema and itching, and fungal and cracking diseases of the feet were examined. In the arboriculture group; only eczema and itching, and fungal and cracking diseases of the feet were detected. Head injuries and bruises were the most common among production workers.

Conclusions

In this study conducted in the Trabzon region, in parallel with previous studies, it was determined that irritability, fatigue-weakness, and tooth decay were the most common diseases.

In the study, questionnaire was done with total 100 forest workers who work nursery and afforestation employments, and production, road construction and maintenance employments in Trabzon Forest Enterprise Management. Questionnaires were realize in nursery and land by mutual talk method, and data were evaluated and discussed by percent (%). The health problems identified in forestry workers are similar to the studies conducted by Erdaş et al. (1995) and Acar et al. (1997).

Workers in both lines of business smoke a lot, while these rates on average are 66.8% for nursery workers and 77% for production workers. While alcohol use among forest workers is low, the rates have increased among nursery workers and decreased among production workers as they got older. Tea and coffee drinking habits are very high among both nursery workers and production workers: these average values are 87% and 96%, respectively. Workers in both areas of the business were found to have decreased breakfast and exercise habits as they got older.

In the Trabzon region, there are very few people over 45 years old who work in both nurseries and plantations, as well as in production, road construction, and maintenance. In both working groups, the percentage of marriages among workers increase with age. While the level of an additional source of income is higher for production workers, the frequency of social security registration is higher for nursery workers.

Nervousness, fatigue and weakness, absent-mindedness, back pain, gastrointestinal pain, and tooth decay were the most common complaints of workers in production, road construction, and maintenance, as well as nursery and afforestation workers. It has been observed that the incidence of these diseases increases with age.

It was revealed that production workers experience more health issues and more serious health problems compared to nursery workers. Reasons for this can be listed as production workers working in difficult terrain conditions, difficulties accessing and residing in the field, lack of nutrients, uneducated workers, and not using protective equipment.

The survey found that the habits of workers in both working groups were very similar. Laborers working in production have a higher risk of occupational health and accidents than those working in nurseries. To prevent this, workers should be equipped with protective clothing and equipment.

Figure 1. Protective equipment that production workers must have.

Hiring workers who are trained for their work in complex and hazardous production jobs, and the risks associated with that work, will reduce the risk of occupational accidents and diseases and increase work efficiency (Tunay et al. 2003). The Occupational Safety and Health Law No. 6331 should be reformed in order to be able to train forest workers according to all areas of work and working conditions in the forestry sector and to emphasize their qualifications.

Figure 2. Protective equipment status of production workers working in the region.

Forest workers who perform heavy and dangerous work must undergo a medical examination to determine their physical fitness and endurance for the job before they are hired. Disorders such as migraine, syncope, and epilepsy that will cause a person to lose control of themselves in a seizure should be identified in advance, and the division of labor should be determined accordingly. In addition, detecting the blood groups of forest workers before work will speed up the treatment that can be given to a worker after a serious accident that might occur. Conditions of transportation, accommodation, food and work of forest workers must be ergonomic.

A good communication network (radio or telephone) should be installed to ensure communication for the operational field so that laborers can report possible accidents on the job and their needs. In addition, a fully equipped first aid kit should be available in the operational field in case of an accident. It is necessary to form a mobile medical team and conduct a medical examination in the forest at least once a year.

Forest workers, most of whom are temporary/seasonal workers, should be insured, at least for the duration of their work, because forestry work is very hard work.

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Chapter 5

THE PROBLEM THAT NEGATİVELY AFFECTS AGRİCULTURAL PRODUCTİON: SALT STRESS

Hasan DURUKAN

1. Definition of salt stress and its effect on plants

The increase in the world population brings with it problems related to the nutrition of the increasing population, and in this respect, the importance of agricultural production emerges once again. Factors such as chemical fertilization and unconscious use of water applied in agricultural production cause deterioration in the structure of the soil (Sarıoğlu and Kaya, 2021). In addition to these negative developments in agricultural areas, climate changes and global warming negatively affect agricultural production.

Plants are one of the most important living groups affected by changing environmental conditions. The situations in which the growth, development and yield of plants are negatively affected depending on the changing environmental conditions in the environments in which they live are called stress in plant production (Kuşvuran et al., 2008). Stress factors seen in plants; It is classified as abiotic (salinity, drought, temperature and wind etc.) and biotic stress (disease, competition, allelopathy and insects etc.) factors (Larcher, 1995; Çulha and Çakırlar, 2011; Uyanık et al., 2014; Arıkan et al., 2017).

Salinity is an agricultural problem that reduces and restricts crop production worldwide (Zeng et al., 2001). The salinity problem negatively affects more than 20% of the irrigable areas in the world (Talhouni et al., 2017). Due to the increasing human population, concerns about the protection of limited water resources are increasing, so there is a greater need for the use of low quality water in crop production (Zeng et al., 2001). Salinity, especially in arid and semi-arid regions, is the accumulation of salt on the soil surface with high groundwater and evaporation of salts, which are washed out and mixed with groundwater (Ergene, 1982; Ekmekçi et al., 2005; Demirkol et al., 2019). At the same time, alkalinity, insufficient drainage and quality of irrigation water increase the salinity problem in agricultural areas (Özcan et al., 2000).

Salinity stress, which is one of the abiotic stress factors, limits the growth and development of plants (Çulha and Çakırlar, 2011), but also negatively affects soil fertility (Alpaslan et al., 1998).

High salt concentrations in the plant;

a) in the intake of water,

b) In the intake of nutrients due to the increase in the concentrations of sodium (Na^+) and chloride (Cl^-) ions,

c) Depending on the problems occurring in ion transport, it causes problems in the mineral structure and calcium (Ca^{+2}) balance of the fluid in the cell (Ertekin, 2010; Tuna and Eroğlu, 2017).

Stress factors first cause deterioration in the metabolic and physiological mechanisms of plants (Demirkol et al., 2019). Salt stress is also accepted as one of the stress factors that affect cell metabolism and reduce productivity in plants (Taïbi et al., 2016). Although chlorides, borates, carbonates, bicarbonates and sulfates cause salinity, sodium chloride (NaCl) is mostly seen in nature (Aşçı and Üney, 2016). High amounts of Na^+ and Cl^- ions taken into the plant cause cell death (Çelik and Eraslan, 2015). Salinity affects plant growth and development in two ways. First, it leads to osmotic stress by reducing soil water potential which leads to limiting water intake, secondly, it causes excessive uptake of Na^+ and Cl^- ions in particular, which interferes with various metabolic processes (Abogadallah, 2010). When the salt concentration exceeds its normal level, the water potential in the soil decreases, which causes a decrease in the absorption of water by the plant roots (İbrahimova et al., 2021). The first response of plants to salt stress is usually with a decrease in leaf surface expansion and partial/complete closure of stomata to conserve the water supply (Tardieu et al., 2014; Ali et al., 2017). Very high concentrations of Na^+ ions accumulated on the root surface prevent the uptake of potassium (K), which has a similar chemical structure, by the plant root (Zhu, 2007). The lack of K ion, which plays a critical role in maintaining cell turgor, enzyme activities and membrane potential, leads to growth inhibition in plants (Zhu, 2007). High salinity in the root zone of the plant prevents the normal growth and development of the plant and reduces the crop yield (Jamil et al., 2011). Effects of salt stress on plants; It varies depending on the type of plant, the type and amount of salt applied, and the exposure time (Sadou et al., 2016).

Under saltinity stress, a plant undergoes molecular (expression of stress responsive gene, activation of osmotic function gene, genes related to cell and tissue growth), biochemical (induction of plant hormones such as ethylene, abscisic acid (ABA), jasmonic acid (JA), antioxidant enzyme such as glutathione peroxidase (GPx), glutathione reductase (GR), catalase (CAT), superoxide dismutase (SOD) and ascorbate peroxidase (APX) increase, ion homeostasis, accumulation of osmolytes such as betaine, proline and glycine) and physiological (loss of turgor, reduced water potential, decrease in stomatal conductance, decrease in plant growth, decrease in photosynthesis, decrease in carbon dioxide (CO_2) concentration) changes that inhibit its growth and development (Kumar et al., 2020). Öncel and Keleş (2002) reported an increase in the amount of proline in wheat plants under salt stress.

Salt stress; the effects on the yield amount, macro and micro element concentration, chlorophyll content and antioxidant enzyme amounts in the plant and the studies conducted to reduce the negative effects of stress are indicated under the headings.

1.1. The effect of salt stress on the yield of the plant

Stress factors negatively affect vital functions such as photosynthesis, respiration and growth in plants. In plants exposed to stress factors, growth regresses due to the slowdown in mitosis (Sadou et al., 2016). At the same time, the negative effect of salt stress on plant growth may be caused by osmotic stress resulting in ion toxicity, nutritional deficiencies and metabolic imbalance (Zhu 2002; Tiwari et al., 2010). There are many studies investigating the effect of salt stress on the yield of plants.

Ghosh et al. (2001) investigated the effects of salt stress treatments on some chemical components and yield of potato (Solanum tuberosum L.) and applied increased salt stress (0, 10, 20 and 30 g pot^{-1}). They reported that salt applications decreased the growth and dry matter production, the number of tubers per plant and the average tuber weight in the potato plant, and thus the tuber yield decreased in the potato plant.

Çelik and Eraslan (2015) reported that the application of nitric oxide (NO) applied to the maize plant under salt stress decreased the fresh and dry weight of the plant compared to the control group.

Taïbi et al. (2016) reported that salt stress showed a significant increase in malondialdehyde (MDA) content in bean (Phaseolus vulgaris L.) plant and caused a significant decrease in dry matter gain in roots and shoots together with oxidative stress.

Sadou et al. (2016) investigated the effect of salt stress (0 (control), 50, 150 and 250 mM) on seedling growth in sunflower (Helianthus annuus L.) and reported that increasing salt concentrations increased CAT enzyme activity.

Ertekin et al. (2017) investigated the effects of salt stress applications (0, 50, 100, 150 and 200 mM) on four Vicia sativa L. cultivars (Selçuk 99, Jade, Yücel and Özveren) in their study, in which increasing salt concentrations increased the root and the root of the plant. They determined that they generally reduced the stem lengths compared to the control groups.

Baydar and Çoban (2017) in their study on the growth, essential oil amounts and components of peppermint (Mentha piperita L.) of different salt stress applications (0, 100 and 150 mM NaCl), the shoot length of the plant, the fresh plant weight of the increased salt stress applications. They found that it reduced the dry matter weight.

Durukan and Demirbas (2018) determined the effects of salt stress applications on tomato plants grown at different doses (0, 3, 6, 9 and 12 dS m^{-1} NaCl) reported that the shoot dry weight of the plant decreased compared to the control group.

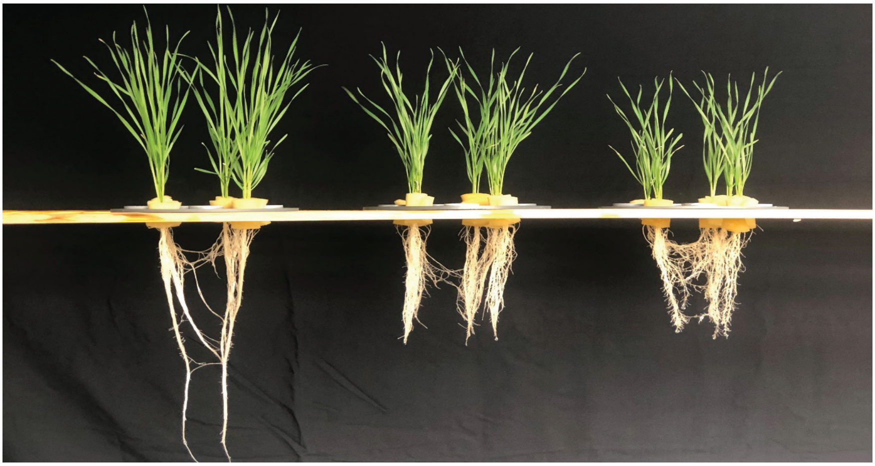

Figure 1. The view from water culture experiment of wheat plant from different salt doses (left to right: control-100-200 mM NaCl) (Demirbaş et al., 2020)

1.2. The effect of salt stress on macro and micro element concentration in the plant

Although basic nutrients are very important in terms of plant growth, development and productivity, their low levels negatively affect the life of the plant. Due to salinity, high osmotic pressure and ion toxicity, it reduces the uptake and accumulation of essential plant nutrients such as nitrogen (N), phosphorus (P), K^+ and water (Kumar et al., 2020). In particular, the increase in Na and Cl concentrations in plant tissues, which cause salt stress, prevents plants from taking other mineral nutrients (Marschner, 1995). In fact, the specific effect of salt stress on plant metabolism is related to the inability to take K and Ca elements due to the uptake of toxic ions (Munns et al., 2002). Soils polluted with Na and Cl ions that cause salt stress prevent plant ion uptake and the absorption of basic ions such as K, Ca, nitrate (NO_3) by their roots (Ashraf and Foolad, 2007). There are many studies investigating the effect of salt stress on macro and micro elements.

Alpaslan et al. (1998) in the study they conducted on six wheat (Gerek, Bolal, Kıraç, Çakmak, Bezostaya and Kızıltan) and six rice varieties (Ribe, Tri-445, Serhat 92, Kros 424, Baldo and Rocca), salt stress was generally determined by copper (Cu), zinc (Zn) and manganese (Mn) reported to increase their content.

Yakıt and Tuna (2006) reported that salt stress adversely affects the macro element contents of the leaves in the salt-stressed maize (Zea mays L.) plant.

Kuşvuran et al. (2008) reported an increase in the amount of Na^+ and Cl^- and a decrease in the amount of K^+ in the salt-treated Cucumis sp. cultivars compared to the control groups.

Tuna and Eroğlu (2017) reported that salt stress reduces the amount of macro elements in the leaf in pepper (Capsicum annuum L.).

1.3. The effect of salt stress on the amount of chlorophyll in plants

Under salinity stress, which is one of the abiotic stress factors, irregularities occur in the opening and closing of stomata in the plant, and photosynthesis decreases due to the decrease in the amount of chlorophyll (Kuşvuran, 2011). Photoinhibition or oxidative stress occurs due to the closure of stomata and the decrease in photosynthesis (Zhu, 2007). There are many studies investigating the changes in the amount of chlorophyll pigment, which is involved in the realization of photosynthesis, under salt stress.

Öncel and Keleş (2002) in six genotypes of two wheat species under salt stress (Triticum aestivum L. cv. Bezostaya-1, cv. Seri-82, cv. Kıraç-66 and Triticum durum Desf. cv. Kızıltan-91, cv. Kunduru 414-44, cv. Ç.1252) reported that wheat plant growth, proportional water content, chlorophyll a, chlorophyll b and total chlorophyll amounts decreased under salt stress in their study.

Santos (2004) determined that increasing salt concentrations (0, 25, 50 and 100 mM NaCl) decreased the chlorophyll content of sunflower (Helianthus annuus L. cv. SH222).

Yakıt and Tuna (2006) reported that salt stress adversely affected the chlorophyll and carotenoid amounts of the plant in their study on maize (Zea mays L.).

Tiwari et al. (2010) investigated the effects of four salt stresses (0, 2, 4 and 6 dS m^{-1}) on the Na^+-K^+ ratio, osmotic concentration, phenols and chlorophyll content in 17 varieties of cucumber genotypes. They determined that stability index and fruit yield decreased in all genotypes compared to control groups.

1.4. The effect of salt stress on antioxidant enzymes in plants

Salt stress damages the physiology, enzymatic activities, protein inhibition, respiration and photosynthesis process of plants due to high

Na^+ ion concentrations (Altaf et al., 2021). Plants close their stomata to minimize water loss under salt stress. Electrons that are not used in carbon dioxide fixation are used to activate oxygen due to the limitation of carbon dioxide gas inlet. Reactive oxygen species (ROS) formed in stress situations also damage cells such as protein, nucleic acid, chlorophyll and membrane lipids (Bayat et al., 2014). The most common ROS are singlet oxygen ($^1O_2$), hydrogen peroxide (H_2O_2), superoxide anions ($O_2^{.-}$) and hydroxyl radicals ($OH^.$) (Abogadallah, 2010). Antioxidant defense systems involved in the clearance of ROS are enzymatic (SOD, CAT, GPx, APX, GR, monodehydroascorbate reductase (MDHAR), dehydroascorbate reductase (DHAR)) (Noctor and Foyer, 1998) and non-enzymatic defense systems (ascorbate (AsA), glutathione (GSH), carotenoids, tocopherols and phenolics) (Sharma et al., 2012; Singh et al., 2021). Plants are protected from the negative effects of salts by using their antioxidant defense systems (İbrahimova et al., 2021). There are many studies investigating the changes in antioxidant defense systems, which are involved in the cleaning of ROS formed under salt stress.

Yaşar et al. (2008) investigated the effect of salt stress on antioxidative enzymes in watermelon (Citrullus lanatus (Thunb.) Mansf.) and reported that GR, CAT, APX and SOD enzyme activities increased, especially in salt-tolerant watermelon varieties.

Taïbi et al. (2016) found that salt-induced oxidative stress was neutralized by enzymatic defense systems and the metabolism of phenolic compounds was induced under extreme conditions in their study on bean (Phaseolus vulgaris L.) plants.

Sadou et al. (2016) reported that increasing salt concentrations increased the SOD, GR, APX and CAT enzyme activities compared to the control groups in their study on the seedling growth of salt stress (0 (control), 50, 150 and 250 mM) in sunflower (Helianthus annuus L.).

Tuna and Eroğlu (2017) reported that antioxidative enzyme activities increased under salt stress in their study on pepper (Capsicum annuum L.) plant under salt stress.

Farooq et al. (2021) in three pea cultivars under different drought (100%, 75% and 50% of field capacity) and salt stress treatments (5.4 mM (control), 50 mM, 75 mM and 100 mM NaCl). In their study, they reported that salt stress applications increased the GPX enzyme activity in the plant and decreased the CAR and SOD enzyme activities compared to the control groups.

1.5. Studies on reducing the negative effects of salt stress on plants

Salinization causes a decrease in the amount of yield in agricultural areas. It has gained importance to eliminate the negativities caused by salt stress, which creates serious problems in plant production, in the plant and soil, and to develop salt-tolerant plant varieties. Among the metabolic products responsible for tolerance development in plants are amino acids, polyols and plant hormones (Yadav et al., 2019). There are many studies in which researches are carried out to eliminate or reduce the possible damage of salt stress to the plant.

Erdal et al. (2010) investigated the development of seedlings and the change in the content of some nutrients in cucumber (Cucumis sativus L.) grown under the salt stress of potassium fertilizer. As a result of the research, the Na, Ca, Mn, Cu and Fe contents of the plant increased with salt stress, while the K and P contents were decreased. They found that their content decreased.

Çavuşoğlu et al. (2007) reported that plant growth regulators (gibberellic acid, ethylene and kinetin) applied to barley (Hordeum vulgare L. var. Nightingale 89) germinated under saline conditions had a positive effect on seed germination and seedling growth.

Ekbiç and Keskin (2018) investigated the effect of tea waste compost applications (0, 40, 80 and 120 g) on onion plants grown under salt stress, and found that the applied salt stress (0 and 75 mM) decreased the K content and increased the Na content. They found that it increased the K content and decreased the Na content.

Torğut and Akbulut (2020) copolymers applied to corn plant under salt stress; reported that it had a positive effect on chlorophyll, MDA and total carbohydrate content and showed a positive effect on the response to salt stress.

Ulukapı et al. (2020) in their study to determine the salt tolerance levels of some radish (Raphanus sativus L.) cultivars (white, black, red, little red radish) and to determine the effect of salicylic acid on germination under salty conditions, depending on the dose of salty conditions and the type of radish plant. Depending on the plant's germination and vegetative growth parameters, salt stress has a negative effect on the plant's germination and vegetative growth parameters, and salicylic acid, depending on the plant variety and the amount of salicylic acid, provides salt tolerance in some varieties, while it is inhibitory in some cultivars.

Köseoğlu and Doğru (2021) in their study investigating the effect of exogenous ascorbic acid applied to the cucumber (Cucumis sativus L.) cv.

Beith Alpha plant under salt stress (100 Mm NaCl), reported that ascorbic acid eliminates the negativity on photosystem II caused by salt stress in the cucumber plant and that it can be used in agricultural production because it increases the salt tolerance of the cucumber plant.

Uslu and Gedik (2020) in their study on salt tolerance of some vetch (Vicia sp.) varieties, reported that increasing salt doses had a negative effect on germination and seedling growth.

2. Importance of salt stress studies

It has been demonstrated by different studies that salt stress is one of the most important stress factors that negatively affect the growth and development of the plant in agricultural production and also cause deterioration in soil structure. Factors such as unconscious use of fertilizers and water cause salinization and adversely affect plant production. Reducing or eliminating the negative effect of salt stress is very important in terms of plant production. It has been determined in different studies that plant growth regulators applied to the soil have a positive effect on reducing or eliminating the negative effects of salt stress on plants. In future studies, it will be important to develop salt-resistant varieties and to make applications that can reduce the negative effects of salt stress in terms of agricultural production.

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Chapter 6

BOXWOODS IN THE WORLD AND TURKEY

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1. HISTORY OF BOXWOODS

The oldest historical record in boxwoods belongs to the Pliocene period (Pliocene Age, the last period of the third geological age (tertiary) which lasted from about 5 million years ago to 2 million years ago) (Larson, 1996). Boxwood has attracted people throughout the history of civilization due to its slow growth, long life, disease and pest-free nature, dense leaves, evergreen and easy reproduction. It is also known as a tree that symbolizes immortality due to the unique qualities of its wood. For this reason, it was erected around mausoleums and cemeteries. Branches of elegant and durable leaves were used in religious and festive ceremonies. For these reasons, it has been grown both in the regions where it is naturally distributed and outside the distribution area for centuries. Again, the high density of its wood and its ability to be shaped easily made it unique. Fossils identified as members of the genus Buxus L. have been found throughout Europe, and the American Boxwood Society claims that boxwood is the oldest species used to establish ornamental gardens because it was used as a hedge around garden edges in ancient Egypt (Larson, 1996). In addition, in ancient Egypt, boxwood was preferred in the manufacture of many items such as combs and writing tablets, pipes, spinning tops, jewelry boxes, carved ornaments and paintings, inlays and coatings. The plant was widely used in Italian gardens during the Renaissance (Larson, 1996). Boxwoods have also been grown for comb making and ornaments since Roman times. The ease with which plants can be shaped by pruning gave rise to the art of topiary. Green statues made of boxwood adorned the Roman and early English gardens. Over the centuries, the use of boxwood continued and its use expanded. The invention and development of the electric loom began to be used in the construction of wooden shuttles due to the great strength and elasticity of boxwood and its superiority of texture qualities. This increased the demand for boxwoods. It has been reported that the annual average of imports from the Caucasus, Turkey and Iran to England in the 1860-1880 period was around 6000 tons (Record, 1921). Boxwood was very well known in Europe in the Middle Ages. The widespread use of the species as landscape and ornamental plants was the result of the development of the renaissance garden style, which began in Italy in the 15th century and reached the north in the 16th and 17th centuries. These ancient garden specimens of boxwood are still found in some historic gardens and parks in Scandinavia (Moe et al., 2006).

When we look at the historical process in our country, it is seen that boxwood has been used for different purposes by many civilizations in the Anatolian lands. In the Ottoman period, it is understood from the documents of the Ottoman period that the amount of tax to be collected from the boxwood wood produced in Trabzon and Rize was an important product at that time (Atakan, 2013). Again, in the Ottoman period, it was reported that boxwood, which is abundant in Turkey's Black Sea coast, Bartın and Southern Anatolia, was exported from Bartın and Yenice to foreign countries, especially England, and shuttles were made from these exported boxwoods (Kayacık, 1981). Although most of the boxwood is supplied to the London market from different countries, it has been reported that it mainly comes from Turkey or Odessa. However, due to increasing costs, wars and the rapid decline of quality boxwood in boxwood populations, boxwoods from Turkey and Russia were rapidly replaced by West Indian boxwood, Casearia praecox, Tabebuia rosea and Phyllostylon brasiliensis species (Britannica, 2013).

2. PLACE AND PROPERTIES IN BOTANIC

Buxus spp. The phylogenetic position of the genus genus has been investigated in detail (Köhler and Brückner, 1990; von Balthazaar et al., 2000). Buxus spp. It contains approximately 104 species in two main centers of diversity, throughout the Caribbean-Latin America and Asia, and a small part in Africa (The Plant List, 2013). The Mediterranean includes the distribution areas of Buxus sempervirens L. and Buxus balearica Lam. Boxwoods are woody plants with an evergreen appearance in the form of shrubs or trees. Buxus genus can grow in a wide ecological area and even above 3000 m altitude (Kayacik, 1981).

B. sempervirens, often called Turkish boxwood, was long considered a single species, but was determined to be a subspecies by botanists (Record, 1921). B. sempervirens L. is mostly a 1-2 m tall shrub, sometimes a 15 m tall tree. The leaves, which are arranged oppositely and bilaterally on the shoot, are short-stalked, long-ovoid, full-edged, leathery and poisonous. The upper surface is bright green, the lower surface is hairy along the veins, and the leaves are yellowish light green in color and have smooth edges. The length can be 1.5-3.5 cm and the width 0.5-1.5 cm. The leaf tip is rounded or slightly notched. Young shoots are 4-cornered. It usually blooms from March to April, but can vary greatly with altitude and latitude changes. Male and female parts are on the same flower. The flowers are in the form of a compound spike and are attached laterally to the axil of the petiole on the shoot. Each flower has 4 yellow colored stamens and the longer female stamens. The female organ ovary has 3 eyes. There are 6 seeds in a capsule. Its seeds are 5-6 mm long, 3-angled, dark brown in color and shiny (Davis, 1982; Köhler, 2007).

B. balearica is an evergreen shrub that is endemic to the Mediterranean Basin, usually growing on rocks (La´zaro, 2005). B. balearica differs from B. sempervirens L. in that it has adapted to the long summer drought, which is the main characteristic of the Mediterranean climate. It does not exceed

4-5 m in length. Its leaves are long, egg-shaped and usually lanceolate, 2.5-5 cm long, 1-1.5 cm wide. The ends of the leaves, which are light green on both sides, are rounded or slightly notched. It looks beautiful as some leaves turn reddish in autumn. Its shoots are hairless. The petals of the flowers are white in color, and the capsule-shaped fruit is longer than 1 cm when mature. It blooms from late February to May, depending on the population (La´zaro and Traveset, 2005) and grows naturally in basalt, serpentine and calcareous lands up to 900 m high (Davis, 1982; Blanca et al., 1999; Köhler, 2007). A single individual in the B. balearica species, a monoic plant, can produce more than 30,000 inflorescences. Each inflorescence contains a female flower surrounded by a variable number (one to six) of male flowers. It is suitable for use in park and garden arrangements because it can withstand summer drought, showy leaf structure, does not shed its leaves in winter and has the ability to shoot (La´zaro, 2005).

Boxwoods go through a period of juvenile sterility and therefore reach maturity only after a few (3-8) years. Boxwoods are pollinated by wind and insects (Diptera, Hymenoptera). Reproduction can be made with seeds and cuttings. Its seeds mature between June and July, ripening seeds are extracted by rodents and ants at a high rate (about 80%). The seeds germinate under the boxwoods in March, but the germination rate is low. Most germinating plants die during the hot and dry summer months (La´zaro, 2005; Köhler, 2007).

3. PLACE IN THE WORLD

The genus Buxus grows in a wide ecological area. Boxwood species are distributed among five major geographic regions. Boxwood is most common in Europe, the Mediterranean basin and the Middle East, China, Japan, Korea, Malaysia and the Philippines, Africa, the Caribbean Islands, Mexico and South America, India, the northwestern Himalayas and the former Soviet Union. The only regions that are not a native species of boxwood are North America and Australia. B. sempervirens is native to most of Europe (Portugal, Spain, France, United Kingdom, Ireland, Germany, Belgium, Italy, Luxembourg, Switzerland, Austria, Italy, Slovenia, Croatia, Montenegro, Macedonia, Albania, Serbia, Kosovo, Greece, Turkey) is widespread. In addition, some parts of northern Africa (Morocco, Algeria) and western Asia (Georgia, Iran, Azerbaijan, Russia) are within the distribution area of boxwood. In some countries, the name B. colchica Pojark is used instead of B. sempervirens.

Long-leaved boxwood (B. balearica) naturally spreads in the region between the Canary Islands and the Eastern Mediterranean (Larson, 1996; Decocq et al., 2004). It is found in the Baleric Islands and southern Spain and a single population in Sardinia. It also spreads in Morocco, Algeria and

Turkey (Tutin et al., 1968). (Figure 1) (Table 1)

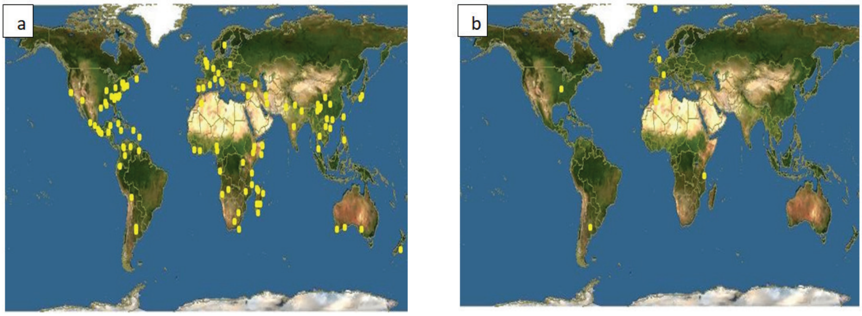

Figure 1. Distribution areas of Buxus L. worldwide (a. Buxus sempervirens, b. Buxus balearica (https://www.discoverlife.org/mp/20q?search=Buxus&guide=Trees&cl=US/GA/Clarke/Vines 23.09.2019).

Table 1. Current boxwood species in the world (The Plant List, **2013).**

Buxus acuminata Müll.Arg.	Buxus macowanii Oliv.
Buxus acunae Borhidi & O.Muñiz	Buxus macrocarpa Capuron
Buxus acutata Friis	Buxus macrophylla (Britton) Fawc. & Rendle
Buxus aneura Urb.	Buxus madagascarica Baill.
Buxus arborea Proctor	Buxus malayana Ridl.
Buxus austroyunnanensis Hatus.	Buxus marginalis (Britton) Urb.
Buxus bahamensis Baker	Buxus megistophylla H.Lév.
Buxus balearica Lam.	Buxus mexicana Brandegee
Buxus baracoensis Borhidi & O.Muñiz	Buxus microphylla Siebold & Zucc.
Buxus bartlettii Standl.	Buxus moana Alain
Buxus benguellensis Gilg	Buxus moctezumae Eg.Köhler, R.Fernald & Zamudio
Buxus bissei Eg.Köhler	Buxus mollicula W.W.Sm.
Buxus bodinieri H.Lév.	Buxus monticola G.E.Schatz & Lowry
Buxus braimbridgeorum Eg.Köhler	Buxus moratii G.E.Schatz & Lowry
Buxus brevipes Urb.	Buxus muelleriana Urb.
Buxus calcarea G.E.Schatz & Lowry	Buxus myrica H.Lév.
Buxus capuronii G.E.Schatz & Lowry	Buxus natalensis (Oliv.) Hutch.
Buxus chaoanensis H.G.Ye	Buxus nyasica Hutch.
Buxus cipolinica Lowry & G.E.Schatz	Buxus obovata Urb.
Buxus citrifolia (Willd.) Spreng.	Buxus obtusifolia (Mildbr.) Hutch.
Buxus cochinchinensis Pierre ex Gagnep.	Buxus olivacea Urb.
Buxus conzattii Standl.	Buxus pachyphylla Merr.
Buxus cordata (Radcl.-Sm.) Friis	Buxus papillosa C.K.Schneid.
Buxus crassifolia (Britton) Urb.	Buxus pilosula Urb.
Buxus cubana Baill.	Buxus portoricensis Alain
Buxus ekmanii Urb.	Buxus pseudaneura Eg.Köhler

Buxus excisa Urb.	Buxus pubescens Greenm.
Buxus flaviramea (Britton) Mathou	Buxus pubifolia Merr.
Buxus glomerata Müll.Arg.	Buxus pubiramea Merr. & Chun
Buxus gonoclada (C.Wright) Müll.Arg.	Buxus pulchella Baill.
Buxus hainanensis Merr.	Buxus purdieana Baill.
Buxus harlandii Hance	Buxus rabenantoandroi G.E.Schatz & Lowry
Buxus hebecarpa Hatus.	Buxus retusa Müll.Arg.
Buxus henryi Mayr	Buxus revoluta (Britton) Mathou
Buxus heterophylla Urb.	Buxus rheedioides Urb.
Buxus hildebrandtii Baill.	Buxus rivularis Merr.
Buxus historica Borhidi & O.Muñiz	Buxus rolfei S.Vidal
Buxus holttumiana Hatus.	Buxus rugulosa Hatus.
Buxus humbertii G.E.Schatz & Lowry	Buxus rupicola Ridl.
Buxus ichagensis Hatus.	Buxus sclerophylla Eg.Köhler
Buxus imbricata Urb.	Buxus sempervirens L.
Buxus itremoensis G.E.Schatz & Lowry	Buxus serpentinicola Eg.Köhler
Buxus jaucoensis Eg.Köhler	Buxus shaferi (Britton) Urb.
Buxus laevigata Spreng.	Buxus sinica (Rehder & E.H.Wilson) M.Cheng
Buxus lancifolia Brandegee	Buxus stenophylla Hance
Buxus latistyla Gagnep.	Buxus subcolumnaris Müll.Arg.
Buxus leivae Eg.Köhler	Buxus triptera Eg.Köhler
Buxus leonii (Britton) Mathou	Buxus vaccinioides (Britton) Urb.
Buxus linearifolia M.Cheng	Buxus vahlii Baill.
Buxus lisowskii Bamps & Malaisse	Buxus wallichiana Baill.
Buxus liukiuensis (Makino) Makino	Buxus wrightii Müll.Arg.
Buxus loheri Merr.	Buxus yunquensis Eg.Köhler

According to the records of The Plant List (2013), 104 accepted species of boxwood are distributed worldwide (Table 1).

4. SITUATION AND DISTRIBUTION AREAS IN TURKEY

Boxwood species are distributed in both open and forest areas (rocky areas, broad-leaved, deciduous and evergreen forests) along river beds, slopes and moist valleys or basins in our country. Two species of boxwoods naturally spread in Turkey. These are Anatolian boxwood (B. sempervirens L.) and Spanish boxwood (B. balearica Lam.). Within the scope of the "Boxwood Selection (B. sempervirens L. and B. balearica Lam.), detected. In the project, the flora of Turkey Buxus spp. In addition to the locations previously determined by researchers (Davis, 1982; Avcı and Özhatay, 2005; Aytuğ, 1984; Korkmaz and Engin, 2001), within the scope of screening for species, new locations were determined. As a result of the study conducted by Sari (2021a) in the provinces of Artvin, Rize, Trabzon, Giresun, Ordu, Sinop, Kastamonu, Zonguldak, Bartın, Karabük, Düzce, Bolu in the Black Sea Region, Sakarya, Kocaeli, Istanbul, Bursa, Bilecik in the Marmara Region and Kahramanmaraş in the Mediterranean Region. , Adana, Osmaniye, Hatay and Antalya provinces have been identified as current boxwood locations.

Among these locations, only B. balearica species is distributed in Adana and Antalya locations, while both species are distributed in Hatay province (Figure 2).

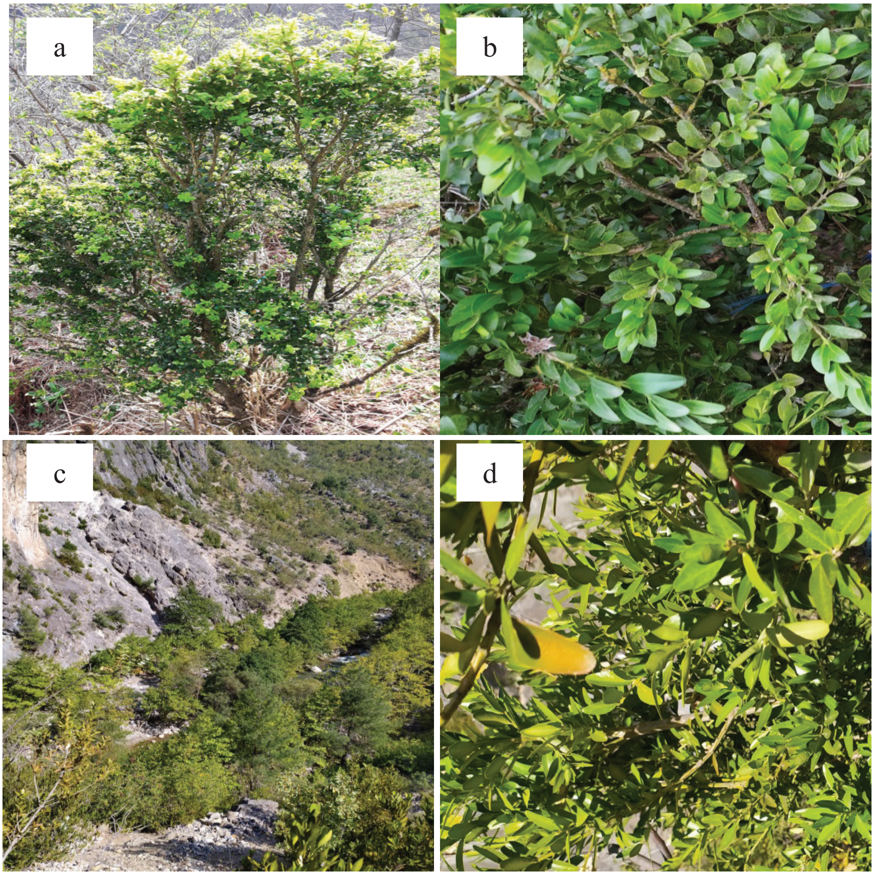

Figure 2. Images from the natural distribution of B. sempervirens and B. balearica (a,b: B. sempervirens; c,d: B. balearica).

5. USAGE AREAS

Boxwood is a sought-after material especially in turnery due to its hard, durable wood structure. It is used in the weaving industry, in the manufacture of machine beds, in mold making. In addition, marquetry is used in the manufacture of household items such as ship flasks, tool handles, combs, spoons, rolling pins, salt shakers, pestles, backgammon stamps, mouthpieces, ornaments such as bracelets, necklaces, toys, and writing blocks (Türkyılmaz, 2004; Baytop, 1999). In the past, printing blocks have been used to make machine parts (press rollers, bobbins, weaving shuttles where surface smoothness and low wear are required), optics, surgical instruments and containers of all kinds. Figurines, seals, small boxes and combs made of boxwood have survived from the pre-Christian cultures of Egypt and Mesopotamia. The traditional range of uses has also been used to make weapon parts (crossbows, scabbards), musical instruments, parts of agricultural implements, marquetry products, writing tablets and panel paintings, drawing tools, arrow pieces, various religious objects, sacred temple jars, church crosses, and rosaries. Richter, 1988).

Although the boxwood trade has declined today, its most important applications can be found in artistic fields such as sculpture, carving and inlay. Boxwood is also preferred for remaking old woodwind instruments.

Boxwood has fascinated people in all cultures for its slow growth and longevity (boxwoods can be found at 600 years old), disease resistance, and the unique properties of its wood. As a mystical symbol of immortality, boxwood is still often found today around religious buildings and in cemeteries. Its durable and flamboyant green-leaved branches are used in both religious and worldly festivals (Brondegard, 1992; Gottwald, 1958; Record and Garrat, 1925).

With increasing industrialization in Europe, the boxwood trade reached its peak between 1860 and 1910. In this period, it reached a processing amount of over 10,000 tons. However, the rapid depletion of large and quality boxwoods in the most important supply regions (Caucasus, Turkey and Iran) has made boxwood wood rare. Therefore, the trade volume of boxwood experienced a sharp decline (Gottwald, 1958).

There are volatile alkaloids in the roots, stems and leaves of boxwood. Because of this feature, different parts of boxwoods have been used in the treatment of some diseases in alternative medicine from time to time. Among these diseases, it has been applied in a wide range of uses such as leprosy, epilepsy, treatment of toothaches, antipyretic, antipyretic, and diaphoretic (Baytop, 1999). However, the use of boxwood in the treatment of diseases in alternative medicine is risky. Because boxwood contains toxic alkaloids in its structure, it causes vomiting, diarrhea and respiratory disorders if used in high amounts. For example, it has been observed that this amount has a lethal effect in horses fed 750 g of boxwood leaves (Akkemik and Kaya, 1998; Türkyılmaz, 2004).

It is quite common to make spoons and ornaments from wood by the people in Kastamonu province and districts of Turkey. In fact, some families continue their livelihood only in this way. Apart from these uses, mainly boxwoods are widely used as ornamental plants in the world and in our country. Its variable morphological characteristics have made boxwoods popular for ornamental uses. Boxwoods are used as hedges, potted plants and various decorative purposes (Larson, 1996). One of the areas where boxwoods are used most intensively in our country is ornamental plants. Boxwood shoots were used as green filler in floriculture and even exported. Boxwood is used alone or in groups in parks and gardens because of its evergreen leaves in winter, its ability to grow in polluted weather conditions in cities, its ability to shoot and its beautiful appearance. Since the trunk has a high ability to shoot, the desired shape can be given by cutting it with scissors. In addition to its natural species, cultural forms and foreign boxwood species can also be seen in parks and gardens in our country (Avcıoğlu et al., 2013). Boxwood branches are used by florists as filling material throughout the year. Eyyüp, (2021) determined the need for cut greens (green boxwood) in Istanbul as 166000 bales.

6. GROWTH REQUESTS

Boxwood grows up to 3000 m above sea level. It is damaged by extreme frosts and can withstand temperatures down to -23 °C. Boxwood grows well in soils rich in organic matter. It is one of the tolerant plants that can grow between 5.5-7.5 in terms of soil pH (Güngör et al., 2002). However, in some sources, the pH must be in the appropriate range so that the nutrients can be taken up by the plant. The optimum soil pH for boxwood has been reported to be between 6.8 and 7.5. If the pH is below the recommended range, lime should be applied. While research on boxwood nutrition is not extensive, a significant amount of nutritional research has been done on boxwood determining fertilization regimens to achieve optimum growth. However, there is no regular schedule to guide the fertilization of boxwoods. The most reliable guide in fertilizer application is soil analysis. Fertilizing can be done when the boxwood begins to show signs of nitrogen deficiency. The earliest sign of nitrogen deficiency is yellowing of the lower leaves. A fairly homogeneous yellowing occurs, which is more evident on the older leaves inside the plant. Again the leaves shrink and thin in nitrogen deficiency and turn quite tan in winter. Boxwood leaves remain on the plant for three years under normal conditions. If shedding occurs earlier, this could be another sign of nitrogen deficiency. Studies have reported that NPK fertilizer application at 10-6-4 ratios is the most appropriate application. Also, Hefley (1979) determined that nitrate nitrogen produced higher growth levels compared to ammonium nitrogen.

Fertilizer can be applied around the base of the plant by hand or by drip irrigation. Fertilizer should be applied close to the surface as the roots are close to the surface. Care should be taken that the given fertilizer does not come into contact with the roots as it will cause root blight. If fertilizer is applied too much, this can cause leaves to turn brown and even branches to die. For deep fertilization, it is not recommended to fill with fertilizer by making holes. Although this practice prevents evaporation, deep root fertilization cannot be beneficial because the roots of the boxwood grow close to the surface.

7. REPRODUCTION

7.1. Replication with cuttings

The most widely used method for the propagation of boxwoods is vegetative clonal propagation, which has the same characteristics as the parent plants. For this, propagation can be made by taking cuttings from the end and side branches of the main plant. The most suitable branches should be one year old. These branches can be prepared by cutting them to a length of about 10 cm. Although rooting of boxwood differs according to species and varieties, there is no significant problem in rooting. However, planting with 3500-4000 ppm of indole butic acid (IBA), an auxin that promotes root formation, for 5 seconds will increase the rooting rate (Langé, 2014). Prepared cuttings can be planted directly in perlite, peat, vermiculite, etc. media or their mixtures (peat + perlite 3:1) (Sari, 2021b) (Figure 3) in order to cure the cuttings.

Figure 3. Preparation of cuttings for planting and hormone application

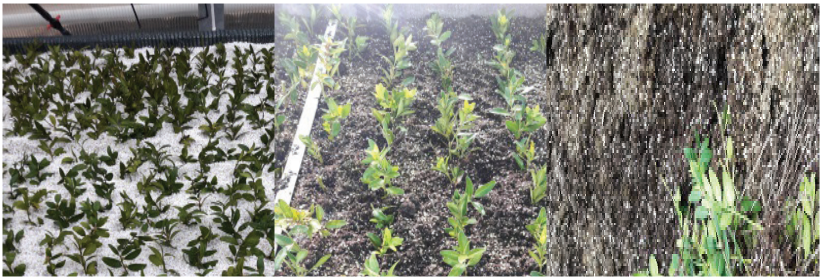

Figure 4. Planting of cuttings in rooting medium and rooted cuttings

Boxwoods have a rooting time and rooting rate of 1 to 3 months, depending on different species and cultivars. At the end of this period, the boxwoods are transferred to pots (Figure 4).

7.2. Propagation by seed

Boxwoods can also be propagated by seed, but since they will be different from the mother plant, they are used for breeding rather than commercial cultivation.

7.3. Propagation by tissue culture

There are two in vitro studies on boxwoods. These are limited reference sources on the in vitro growth of semi-rigid shoot exsplanets of B. hyrcana.

One of these studies is a study on in vitro propagation of B. hyrcana. As a result of the study, they reported that the maximum in vitro shoot formation (4.43) in B. hyrcana was obtained by using 1.00 mgl^{-1}BAP medium. The optimum hormone combination for the highest (7.63) root formation was found to be 0.50 mgl-1 BAP and 1.00 mgl^{-1}NAA (Kaviani and Negahdar, 2017).

B. hyrcana, used as an ornamental plant, is a threatened species due to attacks by some pathogens. The growth of the plant is very slow. It is propagated by rooting cuttings. In the study, semi-rigid shoot explants were used to evaluate the effect of different concentrations of indole-3-butyric acid (IBA 0, 0.5, 1, 1.5, 2 mgl^{-1}) and kinetin (KIN 0, 0.5, 1, 1.5, 2 mgl^{-1}) on rooting. It was used in the in vitro propagation of B. hyrcana. The maximum number of leaves (11.43 per explant) was obtained from the combination of 2 mgl-1 kinetin and 0.50 mgl^{-1} IBA. The highest rooting was obtained with 6.50 roots per explant from 1 mgl^{-1} kinetin + 1 $mgl-^{1}$ IBA medium. The obtained in vitro rooted plants were grown in plastic pots containing peat and perlite (1:1 ratio) and acclimatized to the external environment in the climate greenhouse. As a result, it has been determined that 95% of plants maintain their vitality by adapting to the external environment (Negahdar et al., 2019).

8. COMMERCIAL USES OF BOXWOODS

Boxwoods contain 104 species and 759 cultivars, each exhibiting a wide variety of forms and leaves (Table 2). Different types of boxwood vary widely in size, shape, leaf characteristics, growth rates and durability. Among the many commercially grown and sold boxwood species and cultivars, the most common are B. harlandii, B. microphylla "Compacta", B. microphylla var. japonica, B. sempervirens "Elegantissima", B. sempervirens "Graham Blandy", B. sempervirens "Suffruticosa", B. sempervirens "Vardar Valley", B. sinica var. insularis "Justin Brouwers", B. sinica var. insularis, B. sinica var. insularis "Wintergreen" and Buxus "Green Mountain".

Table 2. Boxwood species and the number of varieties obtained from the species (Batdorf, 2021).

Species	Number of varieties
Buxus balearica	1
Buxus bodinieri	4
Buxus harlandii	5
Buxus microphylla	89
Buxus microphylla var. *japonica*	60
Buxus sempervirens	492
Buxus sinica var. *insularis*	47
Buxus wallichiana	1
Buxus L.	60
Total	759

9. CURRENT THREATS ON BOXWOODS

Boxwood blight fungus (Cylindrolaclodium buxicola) and boxwood moth (Cydalima perspectalis), which have entered our country from abroad in recent years, cause the drying of boxwoods (http://sura.ormansu.gov.tr, 2017).

9.1. Boxwood moth (Cydalima perspectalis)

The boxwood moth has caused significant damage to boxwoods in many countries in Europe, the Caucasus and Turkey in natural and landscape boxwood locations since 2006. The origin of the moth is recorded as northern China, but it is native to East Asia (China, Japan, Korea) (Inoue, 1982). However, the principle was defined in 1859 and spread by a long way. Cydalima perspectalis was seen in Europe in 2006 (Krüger, 2008). Its spread was mostly through commercial activities. This is due to undetected egg transport. For example, the importation of Italian boxwood for mink in the 2012 Sochi Winter Olympics caused the pest to enter the North Caucasus basin and spread throughout the Caucasus, Georgia and spread to Artvin. Later, all Black Sea Region and Marmara

Region boxwood locations were affected. In recent studies, it has been determined that trust has started to be seen in the Mediterranean Region as well (Ak et al., 2021) (Figure 5). Its active period is between May and September. The adult moth can spread 5-10 km per year. Plant (2019) found that the larvae of B. microphylla, B. sinica var. insularis and B. sempervirens, Ilex purpurea, Euonymus japonicus and Euonymus alata were also found to cause damage.

9.1.1. Biology

Eggs: 0.8-1 mm in diameter, in a flat layer on the underside of the leaves and greenish. The temperature threshold must be 10.9 ºC and above for egg development. Widespread diffusion is due to the flight of trust. However, it spreads between regions and countries mostly due to commercial activities.

Moths: They have a wingspan of about 4 cm^2.

Box moth (Melanic variant): Wings almost completely brown

Box moth (Common variant): Wing margins are brown.

The moth begins to lay eggs 2-3 days after it starts to fly.

Pupae: White cocoon around 1.5-2 cm long leaves. When the day length falls below 13.5 hours, the larvae go to sleep. They can survive down to -30 ºC.

Figure 5. Boxwood moth (Cydalima perspectalis) (Ö.SARI, European Boxwood & Topiary Society (EBTS), https://www.ebts.org/box-moth-and-caterpillar/).

9.1.2. Methods of struggle

Use of pheromone traps: It works with a bait obtained by using the synthetic pheromone of the female insect. For this purpose, funnel-type traps are used. Sticky traps can be used for high-intensity infestations. It is also used in a biological insecticide consisting of spores of Bacillus thuringlensis var. aizawai bacteria. The moth infected with this insecticide moves slowly, changes color, shrivels and dies within 2-5 days. As a result of perforation of the moth's intestines, it leads to its death. However, since it deteriorates under UV light, it cannot stay on the leaves for more than ten days.

Göttig (2017) investigated the repellent effect of extraction and different concentrations of oils in his study using six plant extracts, seven essential oils and a seed oil. As the most effective herb, Sambucus nigra (black elderberry) was the most effective, but it significantly reduced the egg number of Thymus vulgaris. The researcher reported that essential oils and plant extracts may have a repellent effect on female individuals, and the caterpillars that ate the treated plant leaves died within 24 hours.

It has been determined that the female moths do not lay eggs while the caterpillars feed on the leaves. A chemical analysis was performed on the excrement produced by the caterpillars. Three chemicals were found as a result of the analysis. Trials were made with these substances on the antennae of moths. These substances caused some reactions in male and female individuals. These substances were guaiacol, (±)-linalool, and veratrol. In the next step, this chemical mixture was produced synthetically and the results were quite effective when the synthetic mixture was placed in a plastic bottle and placed near the flower pots. Egg laying was reduced by 75% compared to the control. It is thought that the protection of boxwood populations can be achieved by using this mixture commercially (Szelény et al., 2020).

Trichogramma: These parasites feed on the eggs laid by the boxwood moth. These parasites are effective as a biological method to combat boxwood moth, but should be applied within 48 hours as it is a living product. The application is done every two weeks and it is possible to achieve 90% efficiency if at least two consecutive applications are made (Göttig, 2017).

9.2. Boxwood Blight

Boxwood plants growing in temperate regions are increasingly threatened by a devastating new disease caused by the fungus Ascomycete Calonectria pseudonaviculata Henricot (synthetic Cylindrocladium pseudonaviculatum, Cylindrocladium buxicola). The disease, which was seen in England in 1994, has spread to continental Europe, parts of western Asia and North America (Malapi-Wight et al., 2014) (Figure 6).

Figure 6. Boxwood locations affected by boxwood moth (Cydalima perspectalis) and boxwood fungus (Cylindrolaclodium buxicola).

All boxwood taxa tested so far have been affected by boxwood fungus, although some taxa of boxwoods are more susceptible to fungus than others. They reported that there is an urgent need to develop blight-tolerant boxwood cultivars due to the impact of this disease on landscape areas and commercial growers (Douglas, 2012; Lamondia, 2014).

As boxwood blight begins to dominate, more and more emphasis is placed on cultivar selection. All types and varieties of boxwood are susceptible to this disease. More than 70 cultivars commonly used in the USA were evaluated.

In the genus Buxus, B. balearica, B. bodinieri, B. glomerata, B. harlandii, B. microphylla, B. macowanii, B. riparia, B. sinica, and B. sempervirens are susceptible to the disease. However, there are differences in cultivar susceptibility. Studies have shown that B. microphylla cultivars are generally more resistant and B. sempervirens cultivars are more susceptible. However, there are some exceptions to this (Ganci et al., 2013; Bush et al., 2016) (Table 3).

Table 3. Susceptibility to boxwood blight of some boxwood cultivars (Ganci et al., 2013; Bush et al., 2016).

Highly sensitive	B. sempervirens 'Suffruticosa' B. sinica var. insularis 'Justin Brouwers'
Sensitive	B. microphylla var. japonica 'Morris Dwarf' B. microphylla var. japonica 'Morris Midget' B. sempervirens 'Jensen' B. sempervirens 'Marginata' Buxus X 'Glencoe' B. sempervirens 'American' B. sempervirens 'Elegantissima'
Moderately sensitive	Buxus X 'Green Mound' Buxus X 'Conroe' (Gordo) B. microphylla 'Green Pillow' B. microphylla 'Grace Hendrick Phillips' B. microphylla 'Jim Stauffer' Buxus X 'Green Mountain'
Moderately resistant	B. microphylla 'Winter Gem' B. sempervirens 'Dee Runk' B. sempervirens 'Fastigiata' Buxus 'Green Gem' B. microphylla 'John Baldwin'
Most d resistant (recommended for new plantings)	B. microphylla 'Golden Dream' B. harlandii B. sinica var. insularis 'Nana' B. microphylla var. japonica 'Green Beauty'

9.2.1. Fighting the disease

1. Fungi-bearing host plants should be identified and checked when they enter the regions. It should be determined whether they are sprayed with fungicide before entry, and if they are, with which drugs they are sprayed.

2. Plants entering from outside should be kept in quarantine for several weeks.

3. It should be checked whether the plants come from the infected area.

4. Disinfection of the tools used in the landscape areas and in the distribution locations of boxwood should be ensured.

This pathogen does not like very hot and dry weather. This is why it can be too hot for boxwood blight fungus in the summer and in hot countries. It is necessary to be careful in the spring and autumn months, usually at temperatures between 23-28 ºC. Like other fungi, boxwood blight fungus spores need water and moisture for germination and infection. Therefore, it is necessary to explore the disease by visiting the nurseries or the locations where the boxwood spreads, especially after rainy weather. Diseased plants should be removed from the environment (Ganci, 2014; Bush et al., 2016).

Some applications that can be done to prevent the spread of the pathogen in infected boxwoods:

1. To remove the plants from the environment and burn them. Burying the ash in the ground after incineration,

2. Removal of all leaves by cutting,

3. Removal of only symptomatic branches and leaves.

After these applications, an intensive fungicide program should be applied to protect the plants. Also, attention should be paid to rainy years.

After spraying, the pathogen can be brought under control to a great extent. However, it is useful to mulch in nurseries or landscaping areas in case the soil is contaminated. Studies have shown that mulching reduces boxwood blight fungus by up to 100%. Pine bark can be recommended for mulching. However, the effect of the mulch type on the spread of this pathogen is not moist. The purpose is to prevent the pathogen from passing from the soil to the plant leaves. It is generally recommended not to use synthetic mulch. However, mulch should not be used alone. It was concluded that using a spraying program and mulching technique would be more beneficial (Palmer, 2014; Ganci, 2014; Bush et al., 2016).

As future goals,

1. Highly resistant boxwood cultivars should be developed.

2. Efficient biological control methods and other low-risk control products should be studied,

3. Reliable pre-disease prediction models should be developed.

10. INTERNATIONAL UNION FOR THE CONSERVATION OF NATURE AND NATURAL RESOURCES (IUCN)

The Red List Classes and Criteria,created under the International Union for Conservation of Nature and Natural Resources (IUCN), are designed as an easily understandable system for classifying species at high risk of global extinction (IUCN, 2001; IUCN, 2012).

10.1. Place of Boxwood Species in IUCN Red List Class

IUCN (International Union for Conservation of Nature & Natural Resources) Risk Categories (Allen et al., 2014); Extinct: EX, Extinct: EW, Critical: CR, Endangered: EN, Susceptible: VU, Near Threatened: NT, Low-risk: LC, Insufficient data: DD, and Not Evaluated: (NE). Many of our genetic resources, including Buxus sempervirens and Buxus balearica, are subject to genetic erosion by environmental and other pressures and are in danger of extinction. Worldwide, 17 species are included in various categories in the IUCN list. These species are; Buxus vahlii (CR), Buxus capuronii (CR), Buxus rabenantoandroi (EN), Buxus nyasica (EN), Buxus humbertii (EN), Buxus itremoensis (EN), Buxus calcarea (EN), Buxus obtusifolia (VU), Buxus arborea (VU), Buxus colchica (NT), Buxus citrifolia (NT), Buxus monticola (NT), Buxus sempervirens (LC), Buxus sinica (LC), Buxus microphylla (LC), Buxus bartlettii (LC), Buxus macowanii (LC).

In our country, population density decreases due to the above-mentioned disease and pest threats (Cydalima perspectalis and Cylindrolaclodium buxicola) and due to reasons such as construction, human activities, tourism activities, grazing and agricultural activities in the areas where the species naturally spread. So much so that the presence of boxwood in the Central and Eastern Black Sea Region in our country has decreased by approximately 90% as a result of the location trips. Despite these threats, Buxus sempervirens is in the low risk (LC) category on the IUCN list. However, in the examinations made, the presence of boxwood populations in the Black Sea Region has reached the critical (CR) level. Buxus balearica, on the other hand, is in the not yet evaluated (NE) category in the IUCN list. In field studies conducted in Buxus balearica, no effect on diseases and pests was found (Sari and Çelikel, 2019). However, due to reasons such as construction, human activities, tourism activities, grazing and agricultural activities, this species, which has already spread in limited areas in our country, has also caused a decrease in its population. Especially the locations in Hatay and Antalya are the locations where there are intense tourism activities and human activities are extremely high. For these reasons, the future of Buxus balearica is also under threat.

11. CONCLUSION AND RECOMMENDATIONS

Boxwood species, which are used in the world as an ornamental plant with their impressive leaves, are very important as ornamental plants and medicinally. Many varieties of boxwood have been developed in the world and are sold commercially as potted ornamental plants, hedge plants and cut greens. Due to this importance of boxwoods, they are preserved in many botanical gardens, in the collections of breeding and breeding companies. These collections are used especially for the development of new varieties from boxwood with very high ornamental plant value. We see that these varieties are used for the development of resistant varieties against increasing boxwood diseases and pests in recent years. In addition, the American Boxwood Society (ABS) in the USA and the European Boxwood & Topiary Society (EBTS) in Europe, together with boxwoods. They are associations established and operating in order to carry out studies involving different purposes and to contribute to the production and trade of boxwood. The mentioned organizational structures reveal the importance of boxwood throughout the world.

Although researches on boxwoods have been carried out in different areas in the world, there are hardly any studies on boxwoods in our country. There are no studies on the evaluation of naturally spreading boxwoods as ornamental plants.

Boxwood, which was an important plant for the people living in the states established in the Anatolian geography in the past, was also very important in the Ottoman period. It can be described as an industrial plant of the period, especially because of the features it had at that time. In addition, with the Industrial Revolution, it is understood from the records that especially England imported boxwood wood, mainly from the Black Sea Region, in order to use it in the construction of shuttles in the textile industry. While these records can be accessed from publications in England, unfortunately there are not enough resources in our country. Boxwoods have gradually lost their importance in our country with the advancement of technology since the republican period. However, the importance of boxwood has not been lost in America and Europe and different areas of use have been developed. Especially as an ornamental plant, it has preserved its importance and value today. Due to the destruction caused by diseases and pests in our country, boxwood has become the agenda again in recent years and its importance has begun to be understood. In the Black Sea region, since 2011, boxwood locations have decreased in the provinces of Artvin, Rize, Trabzon, Giresun, Ordu and Sinop, Kastamonu, and very small areas remain. It has been observed that the large boxwood forests, especially in the provinces of Rize and Giresun, have completely disappeared. In the Western Black Sea, boxwood locations in the provinces of Zonguldak, Bartın, Karabük, Istanbul and Bilecik have completely dried up. In addition, with the recent detection of the boxwood moth in Hatay province in the Mediterranean Region, it is a bitter reality that the boxwood moth has started to seriously threaten this region and that the boxwood existence in our country is facing the threat of extinction (Ak et al., 2021).

As a result, the areas where boxwoods are distributed are difficult geographical areas. It is very difficult to fight against diseases and pests by keeping these areas under control. Although some studies have been carried out for the protection of boxwoods, these studies have been insufficient. More studies are needed in order to protect the last remaining boxwood locations, which are very valuable for our country and have been heavily destroyed in the Black Sea Region. For this purpose, a nationwide study was carried out with the support of TAGEM for the reproduction and protection of materials obtained from nature, and the last remaining boxwoods were sampled before the institution and reproduced in the Black Sea Agricultural Research Institute. In this way, an important step has been taken in order to transfer the boxwood of our country to the future. In addition, there is a need for more comprehensive studies in order to protect the boxwood and transfer it to the ornamental plants sector. For this reason, all kinds of studies will contribute to the transfer of the boxwood existence of the region to the future.

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Chapter 7

CONCENTRATION OF SOME TRACE ELEMENTS IN THE MUSCLE TISSUE OF CAPOETA TRUTTA FROM AĞIN REGION OF KEBAN DAM LAKE (ELAZIĞ)

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Introduction

Water pollution has been a growing issue for the last decades (Zhou et al., 2020). Therefore, water pollution is one of the biggest challenges that humans face in recent years (Al-Akeel, 2018). Water pollution originates from different sources such as domestic, agricultural, municipal, mining, industrial activities, urbanization and landfills drainage waters (Chakraborty and Tare, 2006; Chatterjee et al., 2007; Gupta et al., 2009; Al-Akeel, 2018). These pollutants, which are either organic, nutrient, or trace element pollutants, are very deleterious to the natural ecosystems and eventually harmful to humans (Al-Akeel, 2018). Therefore trace element pollution in surface water is a global environmental problem (Edet and Offiong, 2002; Tiwari et al., 2015; Zhou et al., 2020).

Leather industries has significant economic influence in the national economy of many developing countries (Saxena et al., 2016). However, enormous amount of water and pollutants are discharged during leather processing processes (Kaul et al., 2001). Leather industry consumes approximately 130 different types of chemicals ranging from common salt (sodium chloride) to toxic chromium sulfate (Dandira et al., 2012). For each ton of raw salted hides processed between 680 to 850 kg of solid waste is produced, and the amount of wastewater released is estimated to be 20 m^3 with chromium concentrations between 1500-3000 mg/L (Sabur et al., 2013). Therefore, leather industries are also one of the significantly polluters worldwide because of the complex nature of their wastewaters (Saxena et al., 2016).

The consumption of fish worldwide has increased speedily in recent years particularly with the awareness of its nutritional and therapeutic benefits. In addition to being important source of protein, fish are enriched with essential minerals, vitamins, and unsaturated fatty acids (El-Moselhy, 2000; Bawuro et al., 2018). Fish is considered as one of the most significant indicators of metal pollution in aquatic environment (Rashed, 2001; Adebayo, 2017). Fish may absorb dissolved elements and heavy metals from surrounding water and food (Adebayo, 2017).

Leather industry wastewater contains significant amounts of heavy metals. Heavy metals, on the other hand, can be accumulated by aquatic organisms and transported to upper trophic levels through the food chain (Blasco et al., 1999; Mason et al., 2000). In addition, low concentrations of heavy metals in fish and other aquatic organisms, which constitute an important link of the food chain, cause physiological disorders, while high concentrations can cause death (Coello and Khan, 1996; Del Vals et al,. 1998; Van den Belt et al., 2000).

The main sources of heavy metal pollution in the Euphrates Basin, where Elazig and Keban Dam Lake are located, are mineral processing in the first years and leather processing recently. The beginning of mining operations in the Euphrates Basin dates back many years. Among the first processed metals are lead, silver in Keban, and copper in Maden. In addition, chromium, ferrous manganese, silicon and calcium sprouts are other raw materials produced in significant quantities in the Euphrates Basin. (Yıldırım, 1988). Leather processing started with the establishment of a leather factory in Ağın district. The aim of this study can be listed as follows: (1) determination of the concentrations of some trace elements in the muscle tissue of Capoeta trutta from Ağın Region, where leather factory wastewater is poured in Keban Dam Lake, (2) the variation of these trace element concentrations with some biological characteristics of fish (weight, length and sex) and (3) determination of the potential health risk from the consumption of these fish.

Material and Methods

Keban Dam Lake (KDL) is located within the boundaries of the provinces of Tunceli, Elazığ and Erzincan on the Eastern Anatolia Region of Turkey. It, impounded on the Euphrates River, is one of the largest dam lakes in Turkey. Its main purposes are hydroelectric power generation, irrigation, fishing and recreation (Varol, 2019a; Varol and Sünbül, 2018). In addition, KDL ranks first in rainbow trout production among freshwater resources in the country (Varol, 2019b; Varol and Sünbül, 2017). However, recreational activities, municipal effluents, trout farming activities, agricultural runoff can cause trace elements (TEs) pollution in the dam lake (Varol, 2019a, 2019b, 2020).

This research was carried out in Ağın Region, located at $39^{0}\,0^{\prime}\,11\ 12^{\prime\prime}$ northern latitudes and $38^{0}\,53\ 48^{\prime}\,99^{\prime\prime}$ east longitudes (Figure 1).

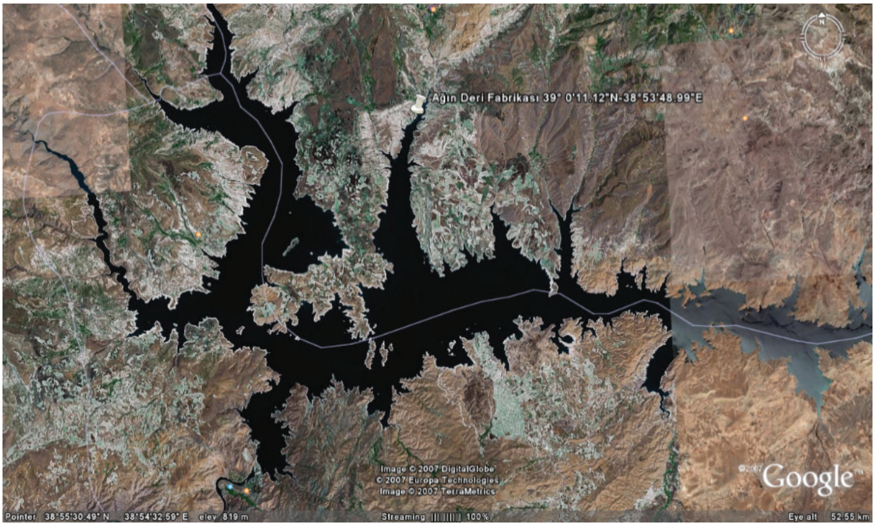

Fig 1. Geographical location of the study area

Sampling and Analyses

Fish samples were collected Ağın Region of KDL by gill net between November 2005 and October 2006. They were immediately transported to the laboratory in a freezer bag with ice and then, approximately 5 g homogenized muscle (cleaned from skin) was taken from them. Muscle samples were stored at -20°C until analyses. The concentrations of iron (Fe), zinc (Zn), copper (Cu), chrome (Cr) and cadmium (Cd) in the muscle tissue of C. trutta were determined by Atomic Absorption Spectrophotometry (AAS), (Perkin Elmer Model 370). A total of 215 C. trutta ranging from 101.5-1163.1 g in weight and 196-471 mm in total lenght were used in the present study. Fish were grouped as 90-199 g (W1), 200-299 g (W2), 300-399 g (W3), 400-499 g (W4) and ≥500 g (W5) in weight and as 90-199 mm (L1), 200-299 mm (L2), 300-399 mm (L3) and 400-499 mm (L4) in length.

Reagents and apparatus

All reagents were of analytical grade unless otherwise stated. Distilled water was used for the preparation of solutions. All the plastic and glassware were cleaned by soaking, with contact, overnight 0.1 N nitric acid solution and then rinsed with distilled water prior to use. HNO_3 used for digestion are supplied by Merck.

Blank preparation

At each step of the digestion processes of the samples acid blanks were done using an identical procedure to ensure that the samples and chemicals used were not contaminated. They contain the same digestion reagents as the real samples with the same acid ratios but without fish sample. After digestion, acid blanks were treated as samples and diluted with the same factor. They were analysed by AAS before real samples and their values were subtracted to check the equipment to read only the exact values of TEs in real samples. Each set of digested samples had its own acid blank and was corrected by using its blank sample.

Statistical Analyses

All statistical analyses were performed by using SPSS ver.22.0 computer program (IBM Corporation). T-test was used to determine the difference between sex relationship accumulations of TEs, and one-way analysis of variance (ANOVA) was used to determine the difference between weight and length groups.

Results and Discussion

In this study, the concentrations of Fe, Zn, Cu, Cr and Cd were determined in muscle tissue of C. trutta. The lowest Cu concentration was determined in November (3.16 mg/kg) and the highest Cu concentration was determined in June (7.58 mg/kg). Although Cu concentrations were close to each other in the spring months (Table 1), they were statistically found significant according to the data of all months (P<0.05). The lowest Fe concentration was recorded in November (22.26 mg/kg), and the highest Fe concentration was recorded in June (50.31 mg/kg), (Table 1). It was determined that the accumulation of Fe in the muscle tissue of C. trutta was statistically significant depending on the months (P<0.05). Zn concentration was the lowest (20.29 mg/kg) in November and the highest (68.99 mg/kg) in June (Table 1). It was determined that the accumulation of Zn element in the muscle tissue of C. trutta was statistically significant depending on the months (P<0.05). Cr value was the lowest in November (0.014 mg/kg), and the highest in July (0.027 mg/kg) (Table 1). It was determined that the monthly change of Cr element in the muscle tissue of C. trutta was statistically insignificant (P>0.05). Cd concentration increased and decreased irregularly over months as in other TEs. The lowest Cd value was found in December (0.013 mg/kg), and the highest Cd value was found in June (0.029 mg/kg). The accumulation of Cd in the muscle tissue of C. trutta was not statistically significant depending on the months (P>0.05).

Among the TEs, the level of Zn was the highest followed by Fe. Cr and Cd showed the lowest mean concentration and they followed by Cu. According to the mean value of all months, concentration of TEs was ordered as Zn>Fe>Cu>Cr>Cd.

Table 1. Monthly variation of some TEs concentrations (mg/kg) in the muscle tissue of C. trutta from Ağın Region of the KDL

Months	**Cu**	**Fe**	**Zn**	**Cr**	**Cd**
November (2015)	3.17	22.27	20.29	0.0140	0.0145
December	3.57	24.26	27.26	0.0158	0.0138
January (2016)	4.83	31.21	32.95	0.0159	0.0153
February	4.05	28.55	33.63	0.0163	0.0152
March	4.79	30.56	37.77	0.0176	0.0172
April	4.71	33.89	59.88	0.0192	0.0179
May	4.71	38.06	52.67	0.0194	0.0192
June	4.58	50.32	68.99	0.0230	0.0230
July	4.05	46.62	59.06	0.0270	0.0239
August	4.74	35.45	56.00	0.0231	0.0210
September	3.65	36.72	54.13	0.0208	0.0210
October	3.59	34.36	51.17	0.0120	0.0200
Mean	4.45	34.35	46.15	0.019	0.018

In the present study, the seasonal changes of TEs levels in muscle tissue of C. trutta was also given (Table 2). In general concentrations of the tested elements were observed to be higher in summer, but lower in autumn (Cu and Cd) and in winter (Fe, Zn and Cr). It was determined that among to seasons the accumulation of Cu and Zn was statistically significant ($P<0.05$), while the accumulation of Fe, Cr and Cd was not statistically significant ($P>0.05$).

This increase of TEs levels in summer could be due to an increase of the pysiological activity of fish during this season caused primarily by the increasing water temperatures. In contrast, Zyadah (1999) found that the higher values of heavy metals in winter and spring and also noted that this increase was due to the decrease in wastewater from agricultural activities during these seasons.

C.trutta examined during the research were weighed between 101.5 and 1163.1 g. They were divided into five different groups as 90-199 g (W1), 200-299 g (W2), 300-399 g (W3), 400-499 g (W4) and ≥ 500 g (W5) depending on their weight. The accumulation levels of TEs were compared amongst weight groups. The changes of TEs levels according to the weight groups are given in Table 3. The lowest level for Cu, Fe and Zn in the muscles of C. trutta was found in group W4, and the lowest level for Cr and Cd in the muscles of C. trutta was found in group W1. The accumulation levels of all TEs were not statistically significant ($P>0.05$) among weight groups.

Table 2. Seasonal variation of TEs levels (mg/kg) in the muscle tissue of C. trutta from Ağın Region of the KDL.

TEs	Autumn	Winter	Spring	Summer
Cu	3.466	4.150	4.735	5.458
Fe	31.115	28.004	34.167	44.128
Zn	41.861	31.280	50.109	61.350
Cr	0.075	0.071	0.073	0.079
Cd	0.072	0.075	0.078	0.078

Table 3. The concentration of some TEs depending on weight groups in the muscle tissue of C.trutta from Ağın Region of the KDL (mg/kg)

TEs	90-199 g (W1)	200-299 g (W2)	300-399 g (W3)	400-499 g (W4)	≥500g (W5)
Cu	4.97	4.77	3.92	3.34	5.16
Fe	37.31	34.40	34.52	24.28	32.18
Zn	30.37	38.22	32.67	24.31	25.50
Cr	0.07	0.08	0.08	0.08	0.09
Cd	0.06	0.08	0.09	0.07	0.07

Total 215 C.trutta examined during the research was lenghted between 196-471 mm. The fish were divided into four groups as 90-199 mm (L1), 200-299 mm (L2), 300-399 mm (L3) ve 400-499 mm (L4) depending on their lenght. The accumulation levels of TEs were compared among length groups. The changes of TEs levels according to the lenght groups are given in Table 4. The lowest level for Cu and Fe in the muscles of C. trutta was found in group L3, and the lowest level for Zn and Cr in the muscle tissue of C. trutta was found in group L1. On the other hand, the lowest level

for Cd in the muscle tissue of C. trutta was found in group L4. It was determined that the accumulation of Cu and Zn was statistically significant (P<0.05), while the accumulation of Fe, Cr and Cd were not statistically significant (P>0.05).

Table 4. The concentration of some TEs depending on lenght groups in the muscle tissue of C.trutta from Ağın Region of the KDL (mg/kg)

TEs	90-199 mm (L1)	200-299 mm (L2)	300-399 mm (L3)	400-499 mm (L4)
Cu	5.25	4.78	3.55	6.12
Fe	38.01	35.81	27.51	37.12
Zn	11.61	39.38	23.52	27.14
Cr	0.07	0.08	0.08	0.08
Cd	0.08	0.08	0.098	0.06

In the present study, 84 were female and 131 were male in the 215 C. trutta individuals examined. The effect of sex on the TEs levels was also examined (Table 5). Although the concentration of all elements (except Cd) analysed in muscle tissue of male fish were found to be higher than those of female fish. It was determined that the accumulation of Zn was statistically significant (P<0.05), while the accumulation of Cu, Fe, Cr and Cd were not statistically significant (P>0.05) between sexes.

Table 5. The concentration of some TEs depending on depending on sexes in the muscle tissue of C.trutta from Ağın Region of the KDL (mg/kg)

Sex	Cu	Fe	Zn	Cr	Cd
Female	4.096	31.889	28.818	0.076	0.080
Male	4.796	34.792	36.953	0.078	0.078

Karadede and Ünlü (2000) were determined accumulation of some heavy metals (Cd, Co, Cu, Fe, Hg, Mn, Mo, Ni, Pb and Zn) in muscle, liver and gill tissue of Acanthobrama marmid, Chalcalburnus ossulensis, Chondrostoma regium, Carasobarbus luteus, Capoetta trutta and Cyprinus carpio from Atatürk Dam Lake. They were found in muscle tissue of Acanthobrama marmid Cu=0.09-3.49; Fe=2.17-16.72; Zn=3.06-16.35 ppm; Chalcalburnus mossulensis Cu=1.12-4.13; Fe=14.29-29.49; Zn=11.49-27.77 ppm; Chondrostoma regium Cu=1.24-3.86; Fe=5.33-18.16; Zn=2.90-10.08 ppm; Carasobarbus luteus Cu=0.05-2.66; Fe=1.29-21.04; Zn=2.92-18.57 ppm; Capoetta trutta'da Cu=0.45-4.29; Fe=0.23-7.03; Zn= 2.06-9.75 ppm and Cyprinus carpio Cu=1.26-3.90; Fe=10.48-12.21; Zn=7.39-11.50 ppm. Mol et al. (2010) determined Zn, Cu, As, Cd, Hg and Pb levels in Capoeta trutta, Silurus triostegus, Acanthobrama marmid, Aspius vorax, Carasobarbus luteus, Chalcalburnus mossulens and Cyprinus carpio living in Atatürk Dam Lake and found as Zn=10.27±0.10; Cu=0.241±0.003 mg/kg; in Capoeta trutta; Zn=12.38±0.21; Cu=0.101±0.003 mg/kg in Silurus triostegus; Zn=16.94±0.30; Cu=2.785±0.030 mg/kg in Acanthobrama marmid; Zn=10.46±0.18; Cu=0.215±0.002 mg/kg in Aspius vorax, Zn=19.74±0.37; Cu=0.258±0.001 mg/kg in Carasobarbus luteus;

Zn=13.72±0.30; Cu=0.465±0.020 mg/kg in Chalcalburnus mossulens, Zn=17.45±0.39; Cu=0.385±0.006 mg/kg in Cyprinus carpio from Atatürk Dam Lake. They have reported that the heavy metal concentrations of different species differ despite living in similar environments. Our results show that Cu, Fe and Zn concentrations were lower than that of the results of studies above give for C. trutta from Atatürk Dam Lake

Eroğlu et al. (2016) were found the concentration rates of all elements determined in muscle tissues differs according to the weight and lenght group of C. trutta caught in Karakaya Dam Lake. The lowest level of concentration of all elements in the muscles of C. trutta was found in 100-399 g in weight group. When length is taken into account the lowest concentration of all elements for C. trutta was found in 200-299 mm in length group. As a result, it is found that all elements accumulation in the muscle of C. trutta changes according to the weight and length groups. In addition, all elements (except for Fe) in muscle tissues C. trutta are found in higher in male than female

Canpolat and Çalta (2021) reported that when the accumulation of heavy metals in muscle tissue was compared according to sex, Cu, Cr and Cd were slightly higher in female individuals, and Fe and Zn in male individuals. The results of all studies showed that the accumulation of Cu, Fe, Zn, Cr and Cd elements in the muscle tissue of C. trutta was not statistically significant.

The concentrations of heavy metals in the organs of fish are determined primarily by the level of pollution of the water and food, and so are indicative of the level of the pollution in the environment. The concentrations, themselves, are the result of uptake and release processes with characteristic kinetics for element and their biological half time. In addition, many factors can influence metal uptake like species of fish, age, sex and size of individuals, feeding behavior, metabolic capability, reproductive cycle, swimming pattern, geographical location and time of capture (Al-Yousuf et al., 2000; Canpolat and Çalta, 2003; Farkas et al., 2003; Watanebe et al., 2003; Zhao et al., 2012; Baharom and Ishak, 2015; Bawuro et al., 2018). In general, our findins showed similarities with the results of others.

Conclusion

In conclusion, there was a clear difference between the concentrations of TEs within muscle tissue of fish. However, there was no rather clear difference for some TEs levels between the comparable parameters such as fish size, sex and seasons. Sometimes, smaller fish showed higher concentrations of a metal or bigger fish of another metal. TEs pollution affects not only aquatic organisms, but also public health due to bioaccumulation in food chain. Our results show that TEs levels in the muscle samples taken from C. trutta from Ağın Region of KDL were under the dangerous limits given by EPA (1989) and FAO (1983) and therefore there is no any risk for public health by eating of C. trutta (Table 6). In addition, the results of the present study showed that wastewater of leather industry had little effect on the heavy metal accumulation in the muscle tissue of Capoeta trutta living in Keban Dam Lake.

Table 6. Heavy metal concentration in the muscle tissue of C. trutta and acceptable values suggested by EPA (1989), WHO (1989) and FAO (1983).

	Cu	Fe	Zn	Cr	Cd
Present study (mg kg^{-1})	**4.45**	**34.35**	**46.15**	**0.018**	**0.018**
EPA (1989), (mg g^{-1})	**54**	**410**	**410**	**4.1**	**1.4**
WHO (1989), (mg kg^{-1})	**3**	**146**	**10-75**	**0.15**	**0.18**
FAO (1983), (mg kg^{-1})	**10**	**-**	**150**	**-**	**0.2**

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