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RESEARCH ARTICLE

Soil Erosion Risk Assessment due to Land Use/Land Cover Changes (LULCC) in Bulgaria From 1990 to 2015

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ABSTRACT

Soil erosion by water jeopardizes land use/cover changes (LULCC) for anthropogenic reasons. It results in enormous and irreversible damage if no action is taken. The Balkan Peninsula has experienced considerable LULCC in recent years; however, the influence of such changes on soil erosion has not been adequately explored. This study sought to explore the influence of LULCC in Bulgaria on soil erosion. Annual soil loss quantity was estimated, and the erosion risk classes were defined using the RUSLE (3D) method based on Geographical Information Systems (GIS). The results of this study indicated that annual soil loss in Bulgaria has been decreasing recently due to various support practices (P-factor) rather than LULCC. However, the recent increase in severe erosion risk class indicates that measures against soil erosion are critical for land degradation.

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Introduction

Land use/land cover changes (LULCC) have become more complicated and multidimensional (Latocha et al 2016) in recent years. This situation has given rise to special LULCC contrary to nature, resulting in a large number of changes in the global climate system and the biosphere (Riebsame et al., 1994). These changes primarily include soil erosion by water, which is considered the most important geoenvironmental hazard (Kavian et al., 2017). This phenomenon responds very rapidly to LULCC and has caused serious damage throughout the World (Conforti and Buttafuoco, 2017).

Soil erosion is a widespread problem, particularly in various parts of the Balkan Peninsula (Rousseva, 2012; Milevski and Ivanova, 2013; Blinkov, 2015; Özşahin et al., 2018). However, the effect of LULCC on soil erosion in this region is not well known (Hengl et al., 2007). Bulgaria is one of the critical countries in the Balkan Peninsula suffering major LULCC (Rousseva, 2002a; 2002b; Rousseva and Stefanova, 2006; Rousseva et al., 2003; 2006a; 2006b; 2010; 2016). Indeed, the Bulgarian land has been threatened by uncontrolled LULCC over the last few decades (Rousseva and Stefanova, 2006; Rousseva et al., 2006a; Kercheva and Krasteva, 2007). Since the early 1990s, many agricultural land in the country has been abandoned due to soil erosion (Shishkov and Kolev, 2014).

This study aims to determine the effect of LULCC in Bulgaria on soil erosion. The study used the Revised Universal Soil Loss Equation-3D (RUSLE-3D) model based on Geographic Information Systems (GIS). This model has been widely used in similar studies (Ganasri and Ramesh, 2016; Conforti and Buttafuoco, 2017) and provides quantitative data addressing the effect of LULCC on soil erosion in more concrete terms.

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Thus, it can be used to help determine the way and extent to which LULCC affect soil erosion.

Materials and Methods

Study Area

The study area covers Bulgaria, which is one of the strategic countries in the Balkan Peninsula (Figure 1). It is located at latitude 40°01'29" – 42°07'04" north of the Equator and longitude 26°02'02" – 29°08'23" east of Greenwich.

The geology of the study area is composed of rocks of different ages and species dating from the Precambrian era. The main stages of the development of this land took place over approximately 3.5 billion years and include the Pre-Neogene, Neogene, and Quaternary eras (Shishkov and Kolev, 2014).

The average altitude is 470 m, and much of the land consists of mountains and hills. Approximately 66% of the land has a slope of more than 3 degrees. The land dominated by a high and sloping topography is composed of several large physiological units that run in parallel lines and have deep geological features (Anonymous, 1982).

The climate of the study area is temperate continental with a transition towards a subtropical climate in its Mediterranean version (in the southern parts of the country). According to the meteorological data, the mean annual temperature is 12.13°C and the mean annual precipitation is 648 mm (Anonymous, 2016).

Various soil types occur in the Bulgarian land due to the effects of relief, parent rocks, bio-climatic conditions, and other factors. The most widely spread soil groups include Luvisol, Chernozems, Cambisol, Pseudopodsolic soils, Fluvisols, and Vertisols. The rough terrain and high slope values of the study area generally cause erosion hazards depending on other suitable natural conditions (Shishkov and Kolev, 2014). Indeed, soil erosion is the greatest threat to soil resources in Bulgaria (Rousseva and Stefanova, 2006) due to natural environmental conditions as well as land use and management that accelerate soil erosion processes (Rousseva, 2012). In addition, land use in Bulgaria has been affected by water erosion at a rate of 65% and wind erosion at a rate of 24% (Rousseva et al., 2006a; Rousseva et al., 2010).

Accelerated soil erosion by anthropogenic activity in Bulgaria dates back to the 1950s and has caused severe damage to the national economy over time, becoming a crucial issue on the national agenda in the early 1970s (Blinkov et al., 2013). Since the early 1990s, considerable activities have been carried out to control soil erosion that threatened agricultural areas (Rousseva et al., 2006b; Shishkov and Kolev, 2014). Hence, studies on soil erosion, which have been conducted regularly since 1956, have been conducted more systematically in the last few decades (Rousseva et al., 2006a). To this end, important steps have been taken to decrease soil erosion. For example, studies to estimate soil erosion have been conducted based on erosion models supported by GIS techniques (Rousseva et al., 2010).

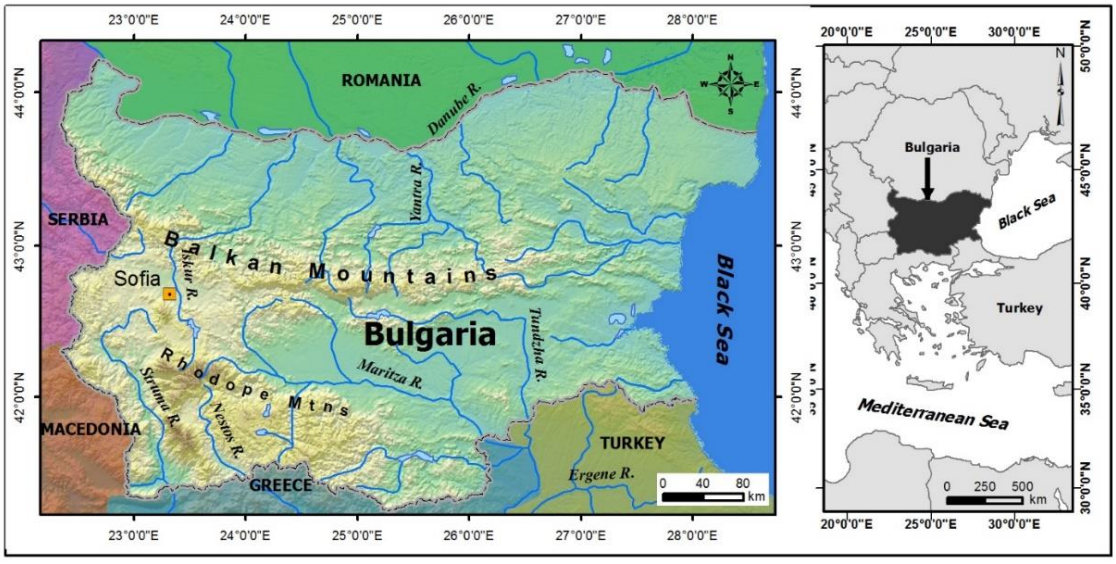

Figure 1. Location map of the study area

Method

This study uses the RUSLE model based on GIS technologies. It applies the RUSLE-3D equation (1) proposed by Renard et al. (1997).

$$A = R \times K \times LS \times C \times P \quad (1)$$

where (Equation 1) A = annual mean soil loss (t ha^{-1} per year), R = rainfall erosivity factor (MJ ha^{-1} per year), K = soil erodibility factor (t ha h MJ^{-1} mm^{-1}), C = cover-management factor (dimensionless), LS = slope length and slope steepness factor (dimensionless), and P = support practices factor (dimensionless).

The input factors of the research method were obtained from various sources. The R-factor (Rousseva and Stefanova, 2006; Panagos et al., 2015a; Ballabio et al., 2017), K-factor (Rousseva and Stefanova, 2006; Panagos et al., 2014), and P-factor (Panagos et al., 2015b) were retrieved from the studies involving high resolution (100 m). The LS-factor (Panagos et al., 2015c) was calculated through a comparison of the recent

Digital Elevation Model (DEM) obtained by the Shuttle Radar Topography Mission (SRTM) and the data from the present research. The C-factor was based on the data sets retrieved from the CORINE Land Cover (CLC) system for the 1990 and 2012 LULCC. Meanwhile, land use land cover change (LULCC) data for 2012 were updated in accordance with the data reported by Panagos et al. (2015d) to obtain the C-factor data for 2015. All these factors were mapped on a 1:100.000 scale in line with all the data used in the study.

The RUSLE-3D model that forms the basis of the study involves fixed and controllable variables to predict soil erosion. The fixed variables include soil erodibility (K-factor) and slope length and slope steepness (LS-factor), and the controllable variables include rainfall erosivity (R-factor), cover-management (C-factor), and support practices (P-factor) (Renard et al., 1997).

This study applied the RUSLE-3D equation by combining the cover-management factor (C-factor) maps generated in different years (1990-2015) based on the LULCC provided that all other factors (R-, K-, LS-, and P-factors) remain constant (Figure 2). Thus, it sought to analyze the effect of LULCC on soil erosion in different years.

Following the application of the model, two different erosion maps with a resolution of 100 x 100 m were generated for 1990 and 2015. These maps were categorized using erosion risk classes (low, slight, medium, severe, and very severe), which have commonly been used in similar studies (Özşahin and Uygur, 2014; Panagos et al., 2015e). Afterwards, the areas falling under these classes as well as their distribution were interpreted from a geographical perspective. In addition, total annual soil loss quantities for the relevant years were obtained, and the data were compared. The reasons underlying the changes over time were analyzed and reviewed to consider their possible future influences.

Results and Discussion

LULCC

The phenomenon of erosion is considered to be the main soil degradation process in Bulgaria. It was even accepted as a national issue with primary importance due to its serious harms to national economy in the early 1970s. Since 1990, attempts have been made to reduce it by taking various measures [e.g., studies on rational land management, development of soil protection policies, and formation of permanent crop pattern]. Accordingly, understanding the current status of the phenomenon of erosion in Bulgaria requires the investigation of the change in the impact of this phenomenon in the period from 1990 to 2015 (Rousseva et al., 2006b).

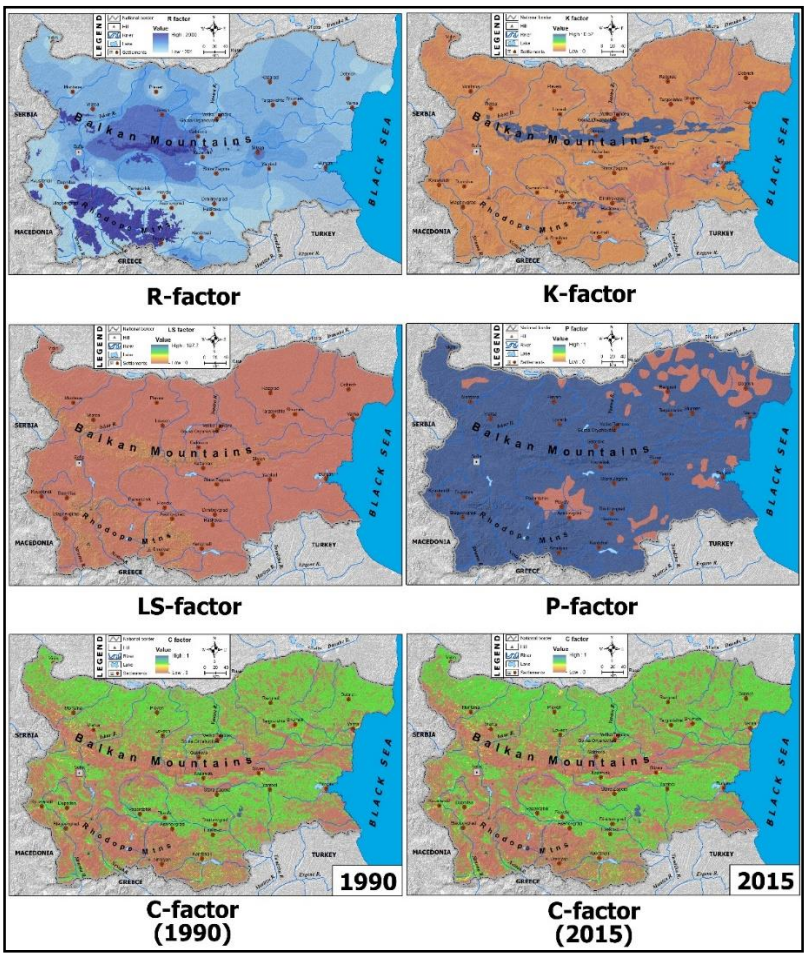

Figure 1. Factor maps of the RUSLE-3D method.

The C-factor reflects the effects of plant cover, crop breeding, and management practices on erosion and is basically determined by today's rapid LULCC stemming from anthropogenic causes (Riebsame et al., 1994). Such uncontrolled changes that intensify soil erosion are lessened by various efforts, including the conservation and rehabilitation of natural vegetation and afforestation. However, such efforts are still quite inadequate in many countries of the world (Walling, 2009). Thus, it is more important today to make efforts that focus on meaningful changes in the C-factor depending on LULCC in order to determine the ultimate temporal and areal effects of erosion. Such efforts primarily involve observing the effect of LULCC on erosion. The C-factor—one of the main parameters predicting soil erosion—has shown a difference as a result of the small but statistically significant LULCC in the study area over the last 25 years (1990-2015) (see Figure 2; Table 1). Table 1 shows the major changes leading to these differences.

Table 1. Rate (%) of areal distribution of LULC class in Bulgaria

LULC classes (1st level)	Area (%)		
	1990	2015	Change
Artificial surfaces	4.863	4.765	-0.098
Agricultural areas	51.505	51.571	0.066
Forests and semi natural areas	42.691	42.663	-0.028
Weetlands	0.101	0.100	-0.001
Water bodies	0.841	0.901	0.060

The main change in the LULCC classes occurred in the artificial surfaces. In the study area, although the artificial surfaces occupied 4.86% in 1990, the rate declined to 4.76% in 2015 (Table 1). This spatial shrinkage acceleration appearing on artificial surfaces may have derived from the developments on mineral extraction sites rather than the changes taking place in settlement or infrastructure areas. As a matter of fact, mineral extraction sites are the main driver of artificial development in Bulgaria, which is one of the countries where urban sprawl is the slowest in Europe (Anonymous, 2018). Accordingly, extension of mineral extraction sites is the main factor causing changes on artificial surfaces. The result is an expansion in the agricultural areas and water bodies, compared to an areal contraction in the forests, semi-natural areas, and wetlands (Table 1). The expansion of the agricultural areas stems from the transformation of forests, semi-natural areas, and wetlands into agricultural land. The areal expansion of the water bodies results from the dams built on rivers. Similar changes have been reported in various parts of the Balkan Peninsula (Jelecek et al., 2007; Panagos et al., 2015b).

LULCC in the study area suggest that the C-factor is the most important controllable variable affecting soil erosion. Thus, uncontrolled LULCC in the study area are most likely to pose a threat of degradation, especially to the agricultural land, in the near future. Rousseva (2006) argued that, since the 1990s, the area covering the abandoned lands has been increasing to a considerable extent due to the decrease in the agriculturally convenient lands, which contributes to the severity of erosion. Shishkov and Kolev (2014) reported a considerable decrease in annual soil loss due to agriculturally convenient lands being replaced by abandoned lands. Özşahin (2016) also reported a threat of degradation to the agricultural land due to the uncontrolled LULCC in the Ergene River basin in the southern part of the study area in the Thracian Peninsula. In this sense, if the actual LULCC continues, it will be possible to foresee a negative change in soil erosion in the near future.

Soil Erosion by Water

The C-factor composing the RUSLE-3D model showed a difference between 1990 and 2015. The areal and proportional distribution of erosion risk for these years was calculated based on the analysis of other factors that affect soil erosion by water (Table 1; Figure 3).

Table 2. Areal and proportional distribution of erosion risk classes

Erosion Risk Class	Soil Loss Class (t ha^{-1} per year)	1990		2015	
		Area (km^2)	Rate (%)	Area (km^2)	Rate (%)
Low	< - 0.5	87802	78.67	87805	78.68
Slight	0.5 - 1	5840	5.23	5870	5.26
Moderate	1.01 – 2	5447	4.88	5462	4.89
High	2.01 - 5	5678	5.09	5687	5.10
Severe	5.01 - >	6834	6.12	6777	6.07
	TOTAL	**111602**	**100**	**111602**	**100**

Accordingly, the erosion risk in Bulgaria differed during the time period studied and has recently tended to decline (-0.051%). However, this downward trend in severe erosion risk has been compensated by the upward trends of almost equal rates (+0.050%) seen in other erosion risk classes (Table 2). The statistical analysis of the variation of the erosion risk classes proved the significance of the results (Table 3). In the study area, all these changes observed in the erosion risk classes seem to have resulted from anthropogenic LULCC. In fact, Rousseva et al. (2006a) explained that current land management in Bulgaria increases erosion risk rather than natural conditions.

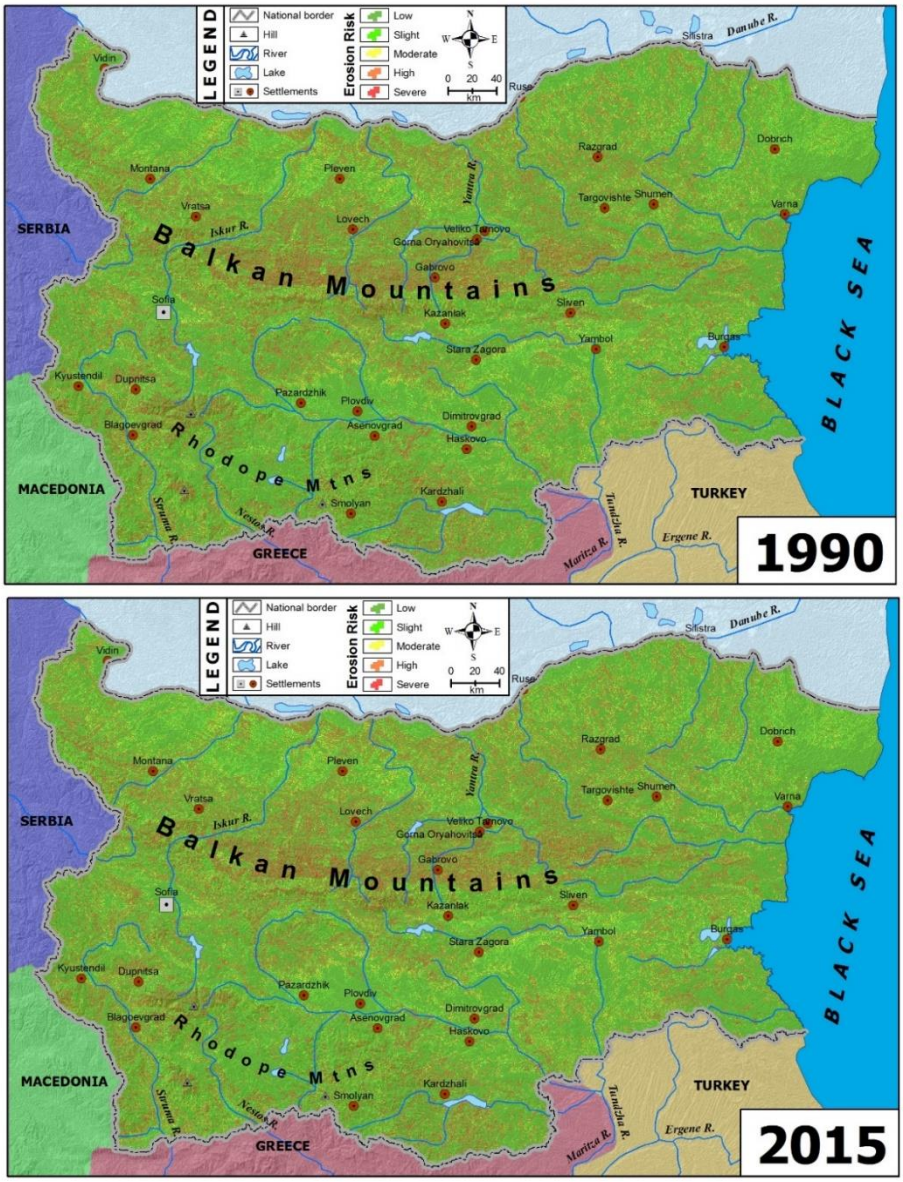

Figure 3. The classified erosion risk distriution map for 1990 and 2015

Table 3. Comparative zonal statistical analysis results of erosion risk classes in the study area

Erosion Risk Class	t	df	Sig. (2-tailed)	Mean Difference	Range	Sum	Mean	Std. Deviation
Low	15735.000	1	0.000	78.67500	0.01	157.35	78.6750	0.00707
Slight	349.667	1	0.002	5.24500	0.03	10.49	5.2450	0.02121
Moderate	977.000	1	0.001	4.88500	0.01	9.77	4.8850	0.00707
High	1019.000	1	0.001	5.09500	0.01	10.19	5.0950	0.00707
Severe	243.800	1	0.003	6.09500	0.05	12.19	6.0950	0.03536

The areal distribution of the erosion risk classes in Bulgaria also varied between years, and the soil loss mostly occurred on the slopes of mountainous terrain with high slope values. Very severe erosion has been observed particularly along the slopes of Balkan Mountains and Rhodope Mountains (Figure 3). The LS-factor, which reflects the effect of both the LULCC including the C-factor and the topography, was prominent as the determining factor in the increase of soil loss due to its high sensitivity to erosion.

The mean soil loss due to spatiotemporal variations of erosion risk in Bulgaria is also an important indicator of the dimension of soil erosion. Accordingly, the highest soil loss was observed in 1990 with 2.20 t ha^{-1} per year. Afterwards, this rate showed a considerable decrease and, in 2015, was just 2.13 t ha^{-1} per year. In particular, the status of the mean soil loss in the area corresponds to the results from similar studies conducted within Europe (Panagos et al., 2015e) and the Balkan Peninsula (Blinkov, 2015).

The relationship between LULCC classes and the mean annual rate of soil loss (t ha^{-1} y^{-1}) was also explored as it

would reveal the effect of LULCC in Bulgarian territory on erosion. The LULCC with the biggest decrease in the mean annual soil loss was found to be cultivated areas (Table 4; Figure 4). As a matter of fact, the mean annual soil loss, which was 3.42 in 1990, fell to 3.40 in 2015 in these areas. This fall in soil loss in cultivated areas may be a product of the policies developed for the protection of cultivated areas after 1990. Indeed, Rousseva et al. (2006b) argue that since 1990, the regulations made in Bulgaria as a result of the radical changes in the political system have been an important factor influential on decreased soil loss in cultivated areas. Over the same period, similar rates of change took place in artificial surfaces and forests and semi natural areas in positive and negative directions, respectively. Moreover, the mean average soil loss declined in water bodies, but did not change in wetlands (Table 4; Figure 4).

Table 4. Change in mean annual soil loss according to LULCC classes

LUC classes (1st level)	Soil Loss Class (t ha^{-1} per year)		
	1990	2015	Change
Artificial surfaces	0.83	0.84	+0.01
Agricultural areas	3.42	3.30	-0.12
Forests and semi natural areas	1.12	1.11	-0.01
Weetlands	0.0001	0.0001	+0.0000
Water bodies	0.003	0.001	-0.002

Conclusion

The present study has found that the erosion risk and mean soil loss in Bulgaria differed between years. The severity of soil erosion and mean soil loss have recently tended to decline as a result of these changes. However, the downward trend seen only in the severe erosion risk was neutralized by the upward trend of almost equal rates (+0.050%) in other erosion risk classes. All these variations and areal differentiations in soil erosion in Bulgaria have been affected primarily by the LULCC shaped under the control of anthropogenic activities, thereby determining the C-factor in the RUSLE-3D model. Garcia-Ruiz et al. (2013) suggest that similar conditions reflecting soil erosion trends have basically stemmed from human activities. The results of the present study concur with those of the research reanalyzing the soil erosion and soil loss in Europe using a similar method. Panagos et al. (2015b; 2015d) highlight that the main cause of the recent decrease in the mean annual soil loss in the European continent is the support practices (P-factor) that consequently improve the C-factor. In addition, the changes taking place in Bulgaria due to socio-economic reasons (e.g., not being used in land capability classification based on ecological features, impacts of incorrect stubble tillage practices, failed crop rotation, deforestation, conversion from cultivated land into forestlands, heavy grazing, insufficient soil and water conservation measures) are also in line with other regions of the Balkan Peninsula (Milevski and Ivanova, 2013; Blinkov, 2015; Özşahin, 2016).

This study revealed that anthropogenic activities are the most important direct or indirect indicators of erosion phenomena. Furthermore, the main contributor to soil erosion is LULCC under human control. Nevertheless, anthropogenic measures that enhance the effect of support practices (P-factor), thereby improving the C-factor, can reduce the influence of the erosion phenomenon. Finally, this paper demonstrated that the GIS-based RUSLE-3D method is very suitable for showing erosion risk and soil loss in terms of spatiotemporal variations.

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RESEARCH ARTICLE

Determination of Nutrition Status of Apple Orchards in Doğanşehir, Malatya

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ABSTRACT

In order to determine nutrition status of the apple orchards in Doğanşehir region of Malatya Province, chemical and physical properties of soil samples, and macro and micro nutrient contents of soil and leaf samples taken from the selected orchards from different parts of the region were determined in 2017. Soil samples were collected from two depths of 0-30 cm and 30-60 cm, 1 kg from each depth, in September. Leaf samples, 100 leaves taken from head level of trees representing the related orchard, were collected 11 weeks after full blossom. Results indicated that soil texture, pH and salinity level was appropriate for apple growing, but loam content was generally high and organic matter was poor. Except Mn and Zn, macro and micro nutrients were found adequate in soil samples of most of the orchards. Sampling depth did not affected soil properties in most of the orchards. Almost all of the leaf samples were found adequate in N, P, Fe, and Cu contents, whereas they were found inadequate in terms of K, Ca, and Zn contents. N content varied between 0.068% and 0.106% in soil samples, and between 1.78% and 2.68% in leaf samples.

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Introduction

Malus genus belongs to Rosaceae family and comprises more than 40 species, that apple (*Malus domestica* Borkh.) is included with its thousands of cultivars (Qian et al., 2010). Apple is one of the most important fruit species with its production quantity, wide range of uses and nutritional benefits. As the fruit is subjected to fresh consumption, it is processed especially for juice and vinegar, but also patisserie, cosmetics, pharmaceuticals etc. Nutritional value of apple is a result of its ingredients that 100 grams of apple includes 84% water, 59 kcal energy, 15.2 g carbohydrate, 2.68 g total fiber, 7.2 mg Calcium (Ca), 0.15 mg Iron (Fe), 115.2 mg Potassium (K), 52.9 IU vitamin A, 0.015 mg thiamine, 0.015 mg riboflavin, 0.07 mg of niacin and 5.8 mg of ascorbic acid (Gebhardt et al., 2002).

Apple is produced throughout the world thanks to its high adaptation skills, hence apple was the most produced fruit species in 2016 with its 89.329.179 tons of world total production quantity. Producing 2.925.828 tons of this production, Turkey was the fourth biggest apple producer in the same year (FAO, 2018). Malatya Province produced 35.823 tons of apple production of Turkey and was the 12th apple producer province in 2016, and apple is the second most produced fruit after apricot in Malatya. Having more than 20 thousand tons of annual apple production, Doğanşehir is the leading apple growing region of Malatya Province (TÜİK, 2018).

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Availability of soil nutrients are related to soil texture, organic matter content, salinity, lime and pH level (Özbek, 1981). When an apple orchard is established, properly ventilated with high water holding capacity and drainage should be selected. An apple tree prefers loamy or silty, moderately calcareous and deep soils with 2% and higher organic matter content (Çolakoğlu, 1979). On the other hand, the tree is sensitive to salinity that does not affect significantly until 1 mmhos cm^{-1} but from this level cause significant yield losses (Havlin et al., 2005). The level of pH plays key role on nutrient availability in soil, and almost all nutrients are sufficiently available at the pH level of 6-7 (Anonymous, 2006; Stiles, 2004).

In terms of fertilization, together with the above soil factors, tree age, cultivar, growth and yield situation are important factors when deciding the amount and the type of fertilizers to be applied (Özkan et al., 2009). Soil analysis is the most common method to determine the fertilizer need of the crops because a positive correlation is expected between soil nutrition contents and plant nutrition contents. However, in many cases this may not be true as a result of various factors such as soil biological, chemical and physical characteristics, balance between available nutrient amounts, developmental situation of plant roots and vegetative parts, cultivars, tree age and climatic conditions, since nutrient uptake is related to those factors. For those reasons, determination of nutritional status of especially perennial plants should be supported by leaf analysis (Uçgun, 2012).

Soil fertility situation, convenience of soil type for fruit growing and nutritional status of fruit orchards in a certain area is possible to be detected by survey studies. According to this method, orchards in adequate amount and distribution to represent a certain area are selected and soil and leaf analyses are performed. Obtained results are used to examine plant nutrition problems and fertilizer applications in the surveyed area (Özkan et al., 2009).

According to their study conducted to determine the fertility of apple orchards located in Erzincan Plain, Güleryüz et al. (1999) reported that soil texture was fine but organic matter, P and Mn contents were poor in the sampled orchards. Topcuoğlu (2003) found soils of apple orchards in Korkuteli area as clay loam and loam textured, slightly alkaline, highly calcareous, salt-free, poor in organic matter content, adequate in terms of macro and micro contents except Zinc (Zn) content. Şeker et al. (2009) examined nutritional status of dwarf apple orchards at different locations of Çanakkale Province by analyzing soil and leaf samples, and significant differences were found between locations, cultivars and orchard management.

Plant growth, yield and fruit quality are significantly affected by growing conditions. Soil fertility and fertilization are some of those conditions which can highly vary between different orchards even in a certain growing area. Doğanşehir is such an area that apple orchards are planted on varying soil properties and under different cultivation practices applied by more than thousand of growers in the region. For those reasons, yield and quality in apple production stimulates significant fluctuations. In order to contribute in improving this situation, this study was conducted to determine nutrition status of the apple orchards selected from different parts of the region.

Materials and Methods

The study was conducted on 20 selected apple orchards in 2017. The orchards were selected from different parts of Doğanşehir region in Malatya Province, Turkey. Orchards were mixed in terms of planted cultivars which were all grafted on MM106 (Malling-Merton 106) rootstock.

Soil and leaf samples (1 sample from each) were collected in required amounts for analyses from different parts of the orchards in order to represent the average. Soil samples were collected from two depths of 0-30 cm and 30-60 cm in September. Soil samples were collected according to Soil Survey Staff (Anonymous, 1993). Leaf samples were collected 11 weeks after full blossom from the third and fourth leaves of current-year shoots when counted from shoot tips to main stem or trunk (Jones et al., 1991; Rosen, 2005; Walker et al., 1993).

In soil samples; texture was detected by hydrometrical method described by Bouyoucos (1952), pH and EC were measured in 1:2.5 soil-water mixture (Jackson, 1962), lime content (%) were detected with Scheibler calcimeter (Çağlar, 1949), and organic matter content was determined according to Walkley Black method (Jackson, 1962). Total N (%) was determined by Kjeldahl method (Chapman and Pratt, 1961). Available P content (kg P_2O_5 da^{-1}) was determined by Olsen method (Olsen, 1982). Exchangeable K (kg K_2O da^{-1}), Ca (kg CaO da^{-1}) and Magnesium (kg MgO da^{-1}) were determined by ammonium acetate-ICP method (Kacar, 1995). Available Fe, Mn, Zn and Cu contents were detected by DTPA-ICP method (Lindsay and Norwell, 1978).

In leaf samples N (%) content was measured according to Kjeldahl method (Chapman and Pratt, 1961). P (%), K (%), Ca (%), Mg (%), Fe (ppm), Mn (ppm), Zn (ppm), and Cu (ppm) were detected by dry combustion-ICP method (Plank, 1992; Kacar and İnal, 2008).

Results and Discussion

Maximum, minimum and average values obtained from physical and chemical analyses performed as part of the study on soil samples collected from apple orchards located in different parts of Doğanşehir were given in Table 1. According to the results, soil types and characteristics significantly varied between the orchards examined.

In terms of pH, maximum, minimum and average values of soil samples were 7.9, 7.3, and 7.58 for 0-30 cm depth and 7.8, 6.1, and 7.4 for 30-60 cm depth (Table 1). While all of the soil samples taken from 0-30 cm depth were in slightly alkaline group, there were one orchard in neutral and two orchards in slightly acid group of which soil samples taken from 30-60 cm depth (Table 1) (Kellog, 1952).

Soil samples of 0-30 cm depth varied between 1.60 and 16.00 % in $CaCO_3$ content and average value was 4.21 %, whereas these values varied between 1.30 and 15.30 %, and 4.73 % was the average value in the soil samples of 30-60 cm

depth (Table 1). In the samples of 0-30 depth, 12 orchards lowly, 3 orchards moderately, 3 orchards highly and 2 orchards were very highly calcareous, whereas soils of 10, 4, 3 and 3 orchards were lowly, moderately, highly and very highly calcareous in the 30-60 cm sampling depth (Evliya, 1964).

Regarding salinity level, all soil samples were classified as non-saline (Dellavalle, 1992). Maximum, minimum and average values were 0.064, 0.011 and 0.025 µmhos cm^{-1} in 0-30 cm samples, and 0.062, 0.011 and 0.02 µmhos cm^{-1} for 30-60 cm samples (Table 1).

Soil organic matter content varied between 0.14 and 2.72 % in 0-30 cm soil samples and the average was 1.61 %. In 30-60 cm soil samples these values varied between 0.17 and 1.79 %, and 0.97 % was the average (Table 1). While 14 samples were poor and 6 samples were slightly humus in 0-30 cm depth, all soil samples taken from 30-60 cm depth were poor (Thun et al., 1955).

Total N contents varied between 0.106 % and 0.068 % in 0-30 cm depth, 0.102 and 0.072 % in 30-60 cm depth (Table 1). Except three orchards, total N content was same in two depths, and while total N level was adequate in 15 samples of 0-30 cm depth, it was 12 in 30-60 cm depth (Anonymous, 1990).

Available P level of soil samples taken from 0-30 cm and 30-60 cm depths varied between 0.70-39.47 kg P_2O_5 da^{-1}, and 0.70-30.03 kg P_2O_5 da^{-1}, respectively (Table 1). Half of the 0-30 cm soil samples contained very high available P level, while this level was 35% in 30-60 cm depth (Lindsay and Norvell, 1978).

Minimum and maximum exchangeable K contents were 11.70 and 100.80 kg K_2O da^{-1}, 5.40 and 94.20 kg K_2O da^{-1} in 0-30 cm and 30-60 cm soil depths, respectively (Table 1). In 0-30 cm soil samples, 65% contained moderate and high, and 35% were inadequate in exchangeable K contents, while these rates were 55% and 45% in 30-60 cm depth (Lindsay and Norvell, 1978).

Soil exchangeable Ca contents varied between 978.60 and 2365.30 kg CaO da^{-1} in 0-30 cm, 858.20 and 2328.90 kg CaO da^{-1} in 30-60 cm soil depth (Table 1). While eight orchards were poor and 12 orchards were moderate in exchangeable Ca contents of 0-30 cm depth, the numbers were nine for poor and 11 for moderate in 30-60 cm depth (Loue, 1968).

Exchangeable Mg contents changed between 54.40 and 176.40 kg MgO da^{-1} in 0-30 cm, and 49.35 and 171.80 kg MgO da^{-1} in 30-60 cm depth (Table 1). All of the orchards were found adequate in terms of exchangeable Mg contents in 0-30 cm depth, whereas 2 of them contained poor exchangeable Mg in 30-60 cm (Loue, 1968).

All soil samples were found with adequate available Fe level (Lindsay and Norvell, 1978). According to Table 1, minimum available Fe contents were 2.75 ppm for 0-30 cm and 4.48 ppm for 30-60 cm samples, whereas maximum available Fe contents were 13.09 ppm for 0-30 cm and 107.30 ppm for 30-60 cm, and the average values were 7.49 and 12.79, respectively (Table 1).

Available Mn contents changed between 2.51 and 25.86 ppm in 0-30 cm samples, and 2.28 and 69.09 ppm in 30-60 cm samples (Table 1). In both of the sampling depth, most of the orchards contained inadequate level of Mn content, and based on the average values available Mn was higher in 30-60 cm (Table 1) (Lindsay and Norvell, 1978).

While 30% of 0-30 cm samples contained adequate level of available Zn contents, the rate was 15% for 30-60 cm depth (Lindsay and Norvell, 1978). Minimum and maximum levels were 0.09 and 2.64 ppm for 0-30 cm depth, and 0.06 and 1.68 ppm for 30-60 cm depth (Table 1).

Available Cu contents were adequate in all samples (Lindsay and Norvell, 1978). Based on the average values soil Cu contents were decreased with depth. Minimum and maximum Cu contents were (Table 1) 0.89 and 19.08 ppm for 0-30 cm and 0.73 and 24.74 ppm for 30-60 cm depth.

Table 1. Maximum, minimum and average values of soil samples

Soil Characteristics	Minimum		Maximum		Average	
	0-30 cm	*30-60 cm*	*0-30 cm*	*30-60 cm*	*0-30 cm*	*30-60 cm*
pH	7.30	6.10	7.90	7.80	7.58	7.40
$CaCO_3$ (%)	1.60	1.30	16.00	15.30	4.21	4.73
EC (µmhos cm^{-1})	0.011	0.011	0.064	0.06	0.025	0.02
Organic Matter (%)	0.14	0.17	2.72	1.79	1.61	0.97
N (%)	0.068	0.072	0.106	0.102	0.095	0.090
P (kg P_2O_5 da^{-1})	0.70	0.70	39.47	30.03	14.80	9.63
K (kg K_2O da^{-1})	11.70	5.40	100.80	94.20	44.74	36.05
Ca (kg CaO da^{-1})	978.60	858.20	2365.30	2328.90	1560.41	1626.62
Mg (kg MgO da^{-1})	54.40	49.35	176.40	171.80	100.54	94.50
Fe (ppm)	2.75	4.48	13.09	107.30	7.49	12.79
Mn (ppm)	2.51	2.28	25.86	69.09	12.93	15.13
Zn (ppm)	0.09	0.06	2.64	1.68	0.61	0.41
Cu (ppm)	0.89	0.73	19.08	24.74	4.06	2.97

Soil texture classes were similar between two sampling depths. Except four orchards, both soil samples were classed in the same texture class (Table 2). The texture class of soil samples taken from 0-30 cm and 30-60 cm depths in orchards number 1, 7, 10 and 20 were clay-clay loam, clay loam-clay, clay loam-loam, and loam-clay loam, respectively.

Table 2. Classification of soil samples according to texture

Classification	Number of Orchards	
	0-30 cm	*30-60 cm*
Sandy Loam	-	-
Loamy	5	5
Sandy Clay Loam	-	-
Silty Loam	-	-
Silty Clay Loam	-	-
Clay Loam	12	12
Silty Clay	-	-
Clay	3	3

Maximum, minimum and average values of macro and micro nutrient contents of leaf samples are given in Table 3. In terms of macro nutrients; N, P, K, Ca and Mg contents varied between 1.78 and 2.68 %, 0.14 and 0.32 %, 0.56 and 1.28 %, 0.58 and 1.38 %, and 0.18 and 0.29 %, and the average values were 2.33, 0.19, 0.87, 0.80, 0.22 ppm, respectively. The micro nutrients which were examined as part of the study changed between 66.20 and 194.60 ppm for Fe, 10.00 and 63.50 ppm for Mn, 6.75 and 45.40 ppm for Zn, 4.70 and 61.20 ppm for Cu. Average values for Fe, Mn, Zn, and Cu contents of leaf samples were 98.46, 32.09, 17.92, and 10.72 ppm, respectively.

Table 3. Maximum, minimum and average values of leaf samples

Nutrients	Minimum	Maximum	Average
N (%)	1.78	2.68	2.33
P (%)	0.14	0.32	0.19
K (%)	0.56	1.28	0.87
Ca (%)	0.58	1.38	0.80
Mg (%)	0.18	0.29	0.22
Fe (ppm)	66.20	194.60	98.46
Mn (ppm)	10.00	63.50	32.09
Zn (ppm)	6.75	45.40	17.92
Cu (ppm)	4.70	61.20	10.72

The relations between soil and leaf mineral contents were examined by correlation analyses performed on the results obtained from soil and leaf samples. Accordingly, significant positive correlations were found between soil K content and leaf Mn content, soil Ca content and leaf Ca, Mn and Zn contents, and soil Mg content and leaf N, P and K contents (Table 4).

Table 4. The correlations between some nutrients composition of leaf and soil samples

Soil Nutrient Elements	Leaf Nutrient Elements								
	N	P	K	Ca	Mg	Fe	Mn	Zn	Cu
N	-.141	.264	.187	.175	-.061	-.022	.258	.061	-.258
P	-.262	.404	.374	-.154	-.322	.193	.160	-.088	-.178
K	.040	.076	.118	.273	-.241	-.142	.572**	.233	-.189
Ca	.267	-.053	-.077	.595**	-.159	-.046	.790**	.538*	-.291
Mg	.455*	-.618**	-.402	-.029	.492*	-.242	-.284	-.111	.398
Fe	-.080	-.189	.062	.073	.265	.031	-.366	-.161	.003
Mn	-.186	-.041	.179	.030	.031	.166	-.298	-.120	-.148
Zn	-.102	-.162	.153	.232	.226	.050	.057	-.068	-.069
Cu	-.224	.064	.260	.090	.084	.034	.159	-.094	-.015

*Correlation is significant at the 0.05 level. **Correlation is significant at the 0.01 level.

Colak et al. (2010) examined physical and chemical properties of 1297 soil samples taken from apricot orchards in Malatya and its counties. Most of the soil samples were found clay loam or loamy, and 17 % of the orchards were slightly alkaline, 23.9 % were medium alkaline and 51.4 % were strongly alkaline. Lime contents were found high in 23.9 % and very high in 51.4 % of the orchards. Bozkurt et al. (2000) reported that N and Zn contents of apple leaves were inadequate while P, K, Fe, Mn and Cu contents were adequate according to their study conducted in Van Province. However, Güleryüz et al. (1999) reported that N contents of the leaves in 70 % of the apple orchards were inadequate in Erzincan Province. In another study conducted in apple orchards of Karaman province, researches detected that N levels were medium in 65 % orchards while the P levels were adequate in 88 % orchards (Oktay and Zengin, 2005).

Soil and leaf nutrient contents have important effects on productivity of fruit trees (Dejampour and Zeinalabedini, 2006), and it is emphasized that these contents are not only complementary in terms of productivity but also important for the developmental strength of the apple trees. For that reason, before an orchard is established, soil analyses need to be done in order to determine soil properties. As a matter of

fact, it is known that in the years when sufficient fruits were obtained, nutrient element deficiencies cause yield loses in the apple trees the following year (Gerçekçioğlu et al, 2012).

Conclusion

Results of the soil analyses indicated that the soils of apple orchards in Doğanşehir are generally slightly alkaline, non-calcareous, non-saline and clay loam in texture, and poor in organic matter content, and those characteristics do not significantly depend on soil depth. In terms of macro and micro nutrient contents, most of the orchards were found adequate except Mn and Zn. According to the results, nutrient sufficiency classes were slightly changed with soil depth. When the results of two soil depth compared, Ca, Fe and Mn were found to higher in samples taken from 30-60 cm depth. Leaf sample results showed that even though K and Ca levels were adequate in most of the soil samples, these nutrients were not adequate in leaf samples, indicating a problem in uptake of these nutrients. As a result of the study, it was concluded that the measures would be taken to improve soil organic matter content and macro nutrient fertilization should be done more efficiently of apple orchards in Doğanşehir.

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RESEARCH ARTICLE

Effects of Some Stabilizers on the Textural Properties of Set-Type Yogurt

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ABSTRACT

This study was conducted to investigate the effect of various stabilizers on textural properties of set yogurt. Yogurt samples were prepared by using seven various stabilizers such as sodium caseinate, gelatin, carrageenan, xanthan gum, guar gum, locust bean gum and native corn starch. Control group samples were produced without using stabilizer. Textural analyzes were made with a TA-XT2i texture analyzer. As a result of the statistical analysis, it was determined that stabilizer and storage time had a significant effect ($p<0.01$) on all texture parameters of yogurt samples, the relaxation force values were not affected by only storage period ($p>0.05$). In conclusion, Na-caseinate was the most suitable stabilizer for yogurt texture compared to all stabilizers. These findings may contribute to the selection of stabilizer material or preparation of stabilizer mixtures that can be used in the production of set type yogurt for developing different textural parameters.

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Introduction

Yogurt, a functional food, is one of the most consumed fermented dairy products in the world (Buttriss, 1997; Mckinley, 2005; Weerathilake et al., 2014). Texture of yogurt is as important as its taste and flavor in terms of consumer preferences. (Sodini et al., 2004; Gonçalvez et al., 2005). However, the properties of the milk used in yogurt production, production and storage conditions or transportation to far sales points can lead to textural defects (Trachoo, 2002; Hematyar et al., 2012). Various stabilizers are used to prevent these problems and to create desirable textural characteristics (Keogh and O'Kennedy, 1998; Athar et al., 2000; Mohammadifar et al., 2007).

Stabilizers, called thickeners, gelling agents or hydrocolloids, can be obtained from different sources including animal connective tissues, sea and land plants and microorganisms (Imeson, 2010).

Sodium caseinate is the product obtained by drying after the neutralization of acid casein curd with sodium hydroxide (Supavititpatana et al., 2008). Gelatin, one of the most preferred stabilizers in yogurt production, is a natural protein derived from animal skins and bones. Supavititpatana et al. (2008) investigated the effect of using sodium caseinate and

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gelatin in corn milk yogurt at different proportions and they reported that the higher levels of concentrations of gelatin increased the acidity, hardness, adhesiveness and springiness. Ares et al. (2007) suggested that gelatin can be used in the production of low fat yogurt at 6 mg/g level.

Starch is obtained from various plants such as wheat, corn and potato. Schmidt et al., (2001) reported that characteristics of yogurt that natural wheat starch (NWS) is added into is similar to those of yogurt with gelatin; for this reason, NWS may be preferred as stabilizer in set-type yogurts.

Carrageenan is a polysaccharide derived from seaweed (Glicksman, 1987; Burey et al., 2008). Xanthan gum is obtained as a result of fermentation of the carbohydrate with the bacterium Xanthomonas campestris (García-Ochoa et al., 2000). Thaiudom and Goff (2003) stated that the xanthan gum was the most incompatible with milk proteins and it was followed by guar gum and LBG (locust bean gum). LBG, the endosperm of the locust tree seeds, and xanthan gum are commonly used in food industry (Ünal et al., 2003). Locust bean gum has synergic effects with other stabilizers to reduce serum separation and to increase viscosity (Köksoy and Kilic, 2004). Ünal et al. (2003) reported that LBG concentrations above 0.02% decreased WHC (water holding capacity) and viscosity while it increased syneresis.

Guar Gum is obtained from the seeds of guar plant (Cyamopsis tetragonalobus) (Tripathy and Das, 2013). It is soluble in water and swells to form high viscosity (Köksoy and Kilic, 2004). Mehmood et al. (2008) reported that 0.1% of guar gum in yogurt achieved the best result for low acidity and low pH.

The aim of this study was to determine the effect of different stabilizers such as sodium caseinate, gelatin, carrageenan, xanthan gum, guar gum, locust bean gum and native corn starch on instrumental texture parameters of plain set yogurt.

Materials and Methods

This research was conducted to identify the effect of stabilizers on textural properties of yogurt at Dairy Technology Research Laboratory of Atatürk University. Raw cow milk, starter culture and skimmed milk powder were obtained from Pilot Dairy Plant in Agricultural Faculty of Atatürk University. Stabilizers were supplied from ORKİM-Chemical Substance Trade. Ltd. Company in Turkey.

Textural Analysis on Yogurt Samples

Texture profile analysis (TPA), Stress-Relaxation Tests, Back-Extrusion Tests and Firmness were performed with a TA-XT2i texture analyzer (Stable Microsystems, Goaldming, England). It was equipped with a 5 kg load cell and all analyzes were made on yogurt samples at 4 ºC.

Texture Profile Analysis (TPA)

TPA was performed by using 25 mm cylindrical probe on yogurt samples in cylindric plastic cups in such conditions as at pre-test speed 1 mm/s, test speed 0.5 mm/s, post-test speed 1 mm/s, distance of 5 mm, trigger type auto-5 g, time 5 second, the depth of immersion 5 mm. Adhesiveness, cohesiveness, springiness and gumminess were calculated via force-time curve (Kumar and Mishra, 2004).

Stress-Relaxation Tests

Stress-relaxation tests were identified with compression test mode by using P25 probe. This test was performed at 0.5 test speed, strain 10%, trigger force 5g, hold time 60 sec. Initial maximum force (Fmax), minimum residual force (Fmin), relaxation force, % lost structure were obtained from force-relaxation curve that was monitored as a function of time (Vercet et al., 2002).

Back-Extrusion Tests

Back-Extrusion test was conducted by a modified method of Buriti et al. (2014). The sample container (52 mm diameter x 55 mm height) was filled with yogurt sample up to 50 mm high. Compression disk (35 mm diameter) was 50 mm above the sample surface. It was plunged into the yogurt sample 30 mm deep, and then it was returned to the start position. Test was made in six replications at a pre-test 1.0 mm/s, test of 1.0 m/s and post-test 10.0 mm/s. Consistency and index of viscosity were calculated via mean values obtained a force-time curve.

Firmness

Firmness was determined with a penetration test by using P15 probe at a constant speed. The Probe was driven in the samples with 15 mm depth at a speed of 0.5 mm/s. Maximum force in the force-time curves was calculated as firmness.

Statistical Analyses

All analyses were carried out in duplicate with six parallels. The SPSS statistical software program version 13 (SPSS Inc., Chicago, IL, USA) was employed to analyze experimental data and Duncan's multiple range tests were employed to determine differences between results (SPSS, 2004).

Results and Discussion

Texture Profile Analysis (TPA)

Fig 1 shows the changes in TPA values for the storage period. In samples SC, GG and LBG, three out of four TPA parameters were higher than those of control. The adhesiveness value of SC was similar to that of control, but other TPA values were higher than that of control. LBG increased all TPA values and decreased adhesiveness. Guar gum decreased gumminess while other parameters increased. Sample G had the highest and lowest values in terms of the adhesiveness and cohesiveness properties, and differed from other samples in this respect. It was thought that compounds formed by breaking gelatin of yogurt bacteria increased the adhesiveness and decreased cohesiveness during the storage period. Macit and Bakirci (2017) reported that the protein

values of the gelatin-added yogurt sample decreased rapidly while the acidity values increased during the storage period. These results were partly different from the results reported by Kumar and Mishra (2004). They stated that gelatin additive increased adhesiveness, cohesiveness, springiness and gumminess compared to the control group without stabilizer. Kumar and Mishra (2004) could explain this effect by the fact that interactions between gelatin and casein provided a stronger three dimensional network (Gonçalvez et al., 2005; Ares et al., 2007).

According to Figure 1, all the TPA values of sample CR were lower than those of control. The TPA results of this yogurt sample containing carrageenan were probably related to the composition of commercial carrageenan. Because when calcium is present, κ-carrageenan forms a stiff and brittle gel, while ι-carrageenan forms a soft gel. However, λ-carrageenan is not capable of forming a gel but has a function of thickener (Glicksman, 1987).

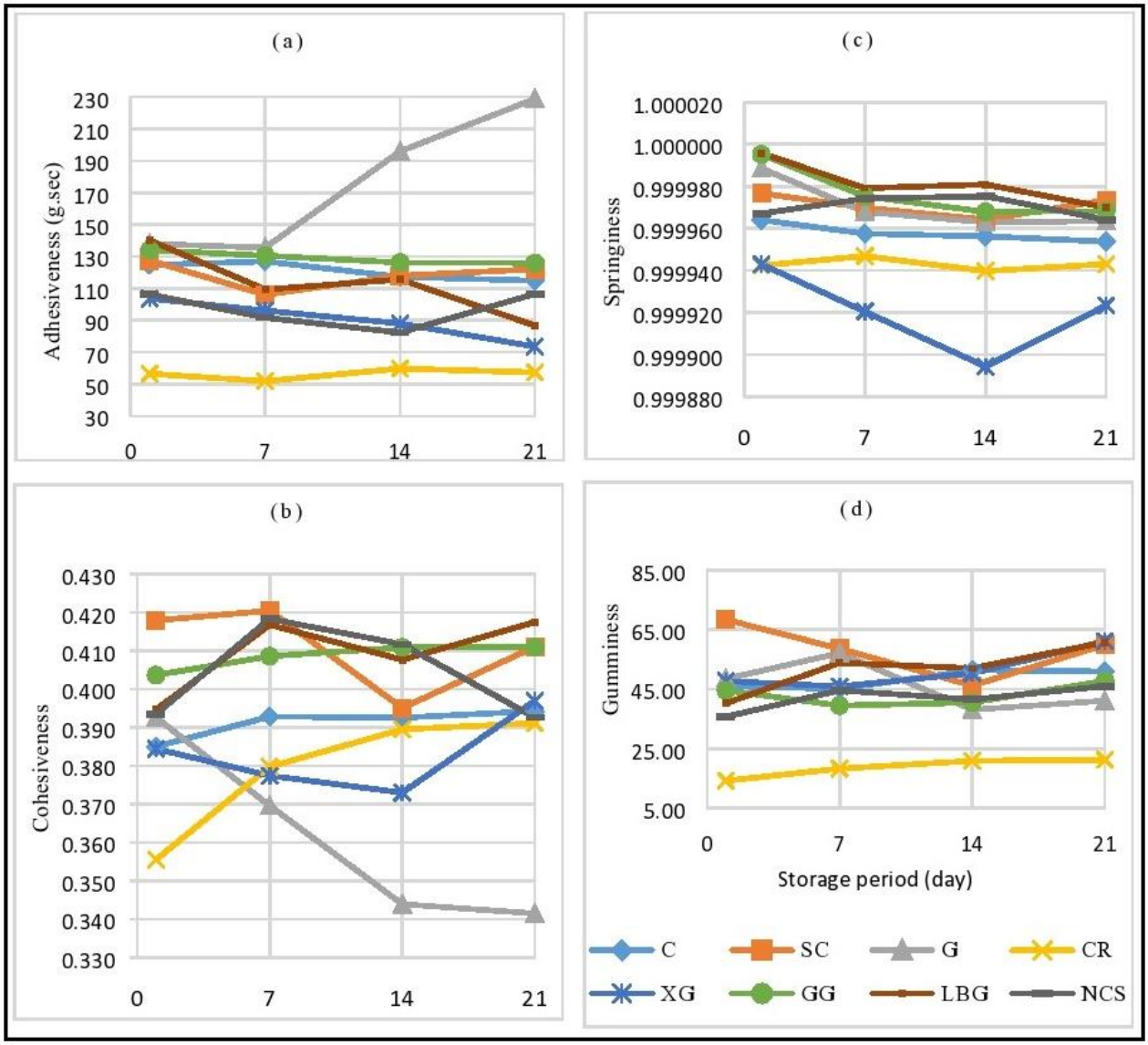

Figure 1. Change of TPA values of yogurt samples during storage period

Stress Relaxation Tests

The stress-relaxation values of yogurt samples were given in Table 1. Stabilizers significantly ($p<0.01$) affected stress-relaxation values of yogurt samples. SC was outstanding sample of this test. Because all stress relaxation values of the SC were higher than those of control. It was thought that the % lost structure value of this sample was higher than that of the control was a proportional increase. The maximum force value of the sample G was the same as the control. While its minimum force value and the % lost structure value were higher than those of control, relaxation force value was lower. All other stabilizers adversely affected stress relaxation values. The highest stress-relaxation values was recorded on day 21.

Table 1. The mean stress relaxation values and standard deviations of yougrt samples

	Sample code	Maximum force (N)	Minimum residual force (N)	Relaxation force (N)	% lost structure
Yogurt Samples (Treatment)	C	1.275 ± 0.032^{b}	0.164 ± 0.015^{c}	1.111 ± 0.038^{b}	13.242 ± 1.041^{d}
	SC	1.364 ± 0.059^{a}	0.203 ± 0.039^{b}	1.141 ± 0.047^{a}	15.137 ± 2.290^{b}
	G	1.282 ± 0.015^{b}	0.215 ± 0.017^{a}	1.062 ± 0.027^{c}	16.783 ± 1.227^{a}
	CR	0.553 ± 0.023^{f}	0.067 ± 0.002^{h}	0.486 ± 0.022^{g}	12.199 ± 0.423^{ef}
	XG	1.112 ± 0.108^{c}	0.135 ± 0.017^{e}	0.974 ± 0.093^{d}	12.416 ± 0.894^{e}
	GG	1.087 ± 0.056^{c}	0.128 ± 0.008^{f}	0.956 ± 0.049^{d}	11.701 ± 0.414^{g}
	LBG	1.104 ± 0.099^{c}	0.132 ± 0.016^{ef}	0.971 ± 0.088^{d}	11.999 ± 0.940^{fg}
	NCS	1.025 ± 0.109^{d}	0.156 ± 0.004^{d}	0.867 ± 0.095^{e}	15.559 ± 0.974^{b}
	P	742.586**	952.970**	875.213**	187.409**
Storage time (Day)	1	1.055 ± 0.275^{b}	0.141 ± 0.042^{c}	0.915 ± 0.241^{ab}	13.415 ± 2.047^{c}
	7	1.056 ± 0.244^{b}	0.146 ± 0.048^{b}	0.905 ± 0.200^{b}	13.917 ± 2.226^{b}
	14	1.063 ± 0.240^{b}	0.141 ± 0.034^{c}	0.923 ± 0.209^{a}	13.361 ± 1.664^{c}
	21	1.091 ± 0.250^{a}	0.159 ± 0.056^{a}	0.920 ± 0.208^{a}	14.480 ± 2.231^{a}
	P	7.643**	82.734**	2.747	32.863**

Mean values ± standart devitions of yogurt samples produced in two parallel. The letters a, b, c, d, d, e, f, g and h indicates means that significantly different at $P < 0.01$ level. $^{**}P < 0.01$

The Back Extrusion and Firmness

The back-extrusion and firmness results were shown in Figure 2. Consistency values of yogurt samples increased during storage period and the highest value was recorded on day 21. Other samples except CR and GG had higher consistency values than that of the control group. The highest consistency value was recorded in the XG example. Xanthan gum is an anionic hydrocolloid and anionic hydrocolloids can interact with positive particles such as proteins or calcium ions in milk. These interactions strengthen the protein network (Soukoulis et al., 2007; Sun et al., 2007). Results regarding consistency values obtained from the current study were partly similar to the findings reported by some researchers. Keogh and O'Kennedy (1998) reported that while xanthan, gelatin and LBG increased the consistency values of stirred yogurt, wheat starch did not show the same effect.

Yogurt samples had the highest index of viscosity value on day 1. This value decreased on day 7 and progressively increased in the later storage period. The highest index of viscosity was detected in the sample SC and NCS. The sodium caseinate is a casein-based product and creates this effect by increasing the density of the protein matrix in the yogurt structure (Remeuf et al., 2003; Amatayakul et al., 2006; Supavititpatana et al., 2009). The starch swells by taking water when it is heated and it increases solution viscosity by forming a gel after a certain temperature.

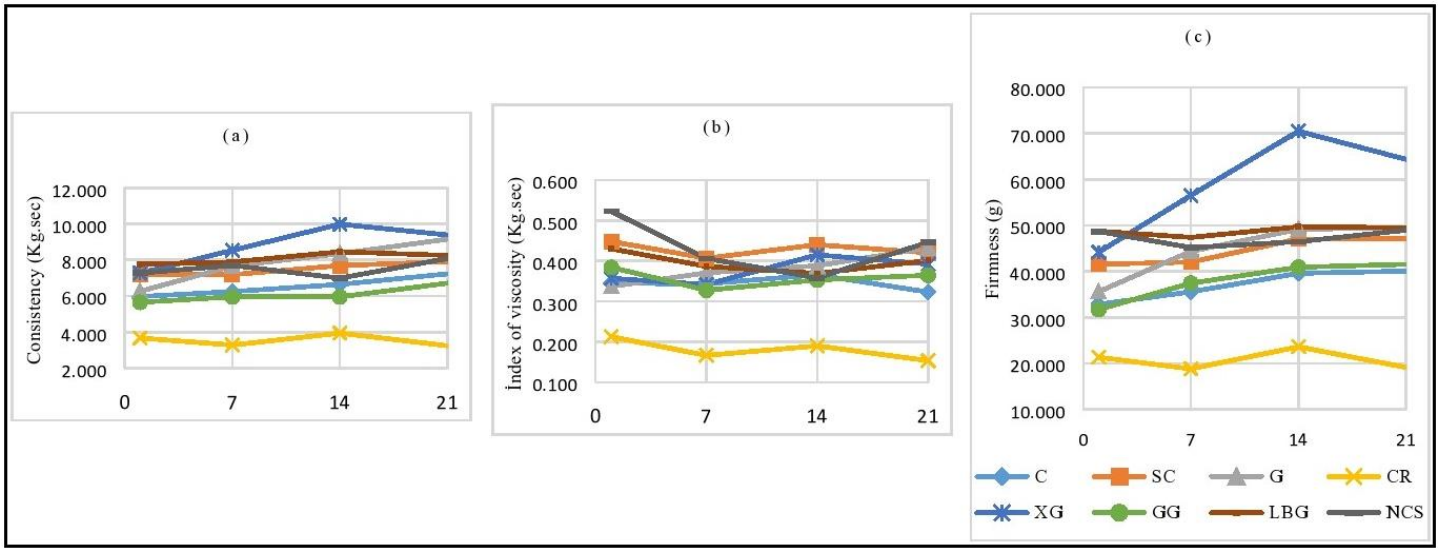

Figure 2. Change of back-extrusion tests and firmness values of yogurt samples during storage period

Therefore, the addition of the starch into yogurt enhances the viscosity (Ares et al., 2007; Schmidt et al., 2001; Mishra and Rai 2006; Williams et al., 2003). Schmidt (2001) reported that there is an electrostatic interaction between starch and protein. At pH<4.6, casein molecules are positively charged and can interact with negatively charged starch molecules. As the pH value decreases, calcium ions of casein dissociate by dissolving from casein and is bound to the starch molecule. These changes make the yogurt gel stronger. The indexes of viscosity values of the other samples were higher than the control group. Hematyar et al. (2012) informed that yogurt samples containing 0.1% xanthan gum had the highest viscosity during ten days of storage. Wei and Xin-huai (2006) reported that gelatin increased the viscosity of yogurt but locust bean gum and guar gum decreased the viscosity. When the addition level of thickeners was 0.1% (w/w), the thickener had a significant effect on texture of yogurt.

The firmness is a commercially important characteristic for yogurt (Damin et al., 2009). The highest average firmness value was detected in the XG sample. The sample CR received the lowest values during the storage period. Köksoy and Kilic (2004) and El-Sayed et al. (2002) reported that xanthan gum can dissolve in the hot and cold water and even the small addition of this stabilizer forms high viscosity.

Conclusion

This study reveals the effect of various stabilizers on the instrumental texture parameters of set type yogurts. SC, GG and LBG in the TPA analyzes, the SC in the stress-relaxation tests were outstanding samples. Except for CR and GG, back-extrusion and firmness values of all other samples were higher than the control. Na-caseinate was the most suitable stabilizer for yogurt texture compared to all stabilizers, since all textural parameters of the yogurt samples added Na-caseinate were higher than that of control. These findings may contribute to the selection of stabilizer material or preparation of stabilizer mixtures that can be used for developing different textural parameters in the production of set type yogurt.

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RESEARCH ARTICLE

The Evaluation of the Antibacterial Activity of *Vetiveria zizanioides* (L.) Nash Grown in Giresun, Turkey

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ABSTRACT

Medicinal and aromatic plants have been known since ancient times due to their aromatic and therapeutic properties. These plants can be used as crude, or in some cases their essential oils or extracts with different solvents. Essential oils with different biological activities are widely used in food, medicinal and cosmetic industries. The essential oil of Vetiveria zizanioides (L.) Nash is one of the most prevalent essential oils. The plant is a perennial, dense, bunch-type grass with stiff stem and has a significantly deep and strong root system. It has many biological activities as antimicrobial, antifungal, antiviral, anticarconogenic, etc. activities. In this study, the antibacterial potential of essential oil obtained from vetiver grass grown in Giresun was investigated for the first time against for pathogen microorganisms (Enterobacter cloacae (ATCC 13047), Enterococcus faecalis (ATCC 29212), Escherichia coli (ATCC 25922) and Proteus vulgaris (ATCC 13315). Considering antibacterial activity, the minimal inhibitory concentration (MIC) value for E. cloacae, E. faecalis, E. coli and P. vulgaris was 15.63, 31.25, 15.63 and 15.63 µg/ml, respectively. According to the results of this study, it is revealed that the essential oil of vetiver has significant antibacterial activity.

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Introduction

Pathogenic microorganisms cause many diseases with different mechanism after entering the body. The substances used for the treatment of the pathogens are either natural or synthetic antibiotics. However, as well as the therapeutic properties, the synthetic antibiotics have adverse side effects on human health (Wang et al. 2006; Ayhan and Taş 2013; Tekiner 2016). Due to the side effects of synthetic antibiotics, scientists have begun to search alternative natural components without side effects. In this regard, medical and aromatic plants used by local people in the treatment of many bacterial diseases attracted the attention of the scientific world. Medical and aromatic plants can be used as crude. Besides, they can be used as essential oils or modified medication formulations and extracts prepared with various solvents (Adorjan and Buchbauer 2010).

Vetiveria zizanioides (L.) Nash study is a plant growing in Southern Asia, Burmese, Ceylon Island, Bangladesh and tropical Africa and used in these countries as an alternative medicine. V. zizanioides called as 'vetiver' belongs to the Poaceae family (Pareek and Kumar 2013; Soni and Dahiya 2015). This plant is perennial plant and has a highly durable reed-like body that is clustered in dense bundles and a strong root system that can descend quite deep (Cındık 2012). Particularly, the roots of the plants have been used since ancient times due to its fragrant nature. The roots of this plants can reach a length of about three meters and contains a high amount of essential oil which has important medical and aromatic properties (Chomchalow 2001; Soni and Dahiya 2015). The essential oil obtained from the roots of the vetiver is used for the treatment of depression, nervous tension, anxiety disorders, sleep disorders, sexual dysfunction (Chomchalow 2001). It also has a commercial importance since it is used as

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a stabilizing oil in perfume production due to its slow evaporation feature (Sellar 2005; Pareek and Kumar 2013). The main active ingredients of vetiver oil are vetiverol, vetivone, khusiyone, various terpenes, sesquiterpenoids and khusimol which are fingerprints of the vetiver. Due to its different active ingredients, this oil has biological characteristics such as being antimicrobial, antiviral and antioxidant (Soni and Dahiya 2015). However, as in all medical and aromatic plants, the vetiver may have different active ingredients with different proportions depending upon the geographical region and climate characteristics in which it grows. Therefore, the antibacterial effect of the essential oil obtained from Vetiveria zizanioides (L.) Nash, which was grown for the first time in the Black Sea Region (Tirebolu/Giresun) of Turkey. The antibacterial activity of the essential oil was evaluated against the pathogen bacteria members (Enterobacter cloacae, Enterococcus faecalis, Escherichia coli and Proteus vulgaris) of the Enterobacteriaceae family.

Materials and Methods

Supply of the Plant Material and Extraction of the Essential Oil

Vetiveria zizanioides (L.) Nash was supplied from the field of İl-Ca Herbal Products Research-Development Production Company in April 2017. The field of this company was located in Tirebolu/Giresun in the Black Sea Region (40.979955, 38.783850). Two- years old vetiver roots were used to obtain essential oil. The roots were thoroughly washed with tap water and then pure water. Afterwards, they were dried in the shade. After grinding the dried roots, 50 gr were taken and subjected to hydrodistillation for 24 hours in clevenger apparatus (Thermal Laboratory Equipment, Turkey). The acquired essential oil was dried in a lyophilizer. The dried essential oil was then dissolved in 10% dimethyl sulfoxide (DMSO) to a final concentration of 500 µg/ml and stored in +4°C for further use.

Bacterial Isolates

The studied bacteria [Enterobacter cloacae (ATCC 13047), Enterococcus faecalis (ATCC 29212), Escherichia coli (ATCC 25922) and Proteus vulgaris (ATCC 13315)] were obtained from the University of Recep Tayyip Erdoğan, Rize, Department of Biology, Bacteria Culture Collection of the Molecular Biology Laboratory.

Antibacterial Tests

Testing the Effectiveness by Disk Diffusion Method

Serial dilutions of essential oil were obtained with 10% DMSO. The prepared concentrations of the essential oils were 7.81, 15.62, 31.25, 62.5, 125, 250 and 500 µg/ml. The antibacterial test was performed via the disk diffusion method. The bacterial strains were grown in tryptic soy broth (TSB, Merck) and then each bacterial solutions containing a cell suspension of 108 cells/ml was spread on Tryptic soy agar (TSA, Merck) with a sterile swab (Janssen et al. 1987; Murray et al. 2003; Gormez et al. 2013). Each 6-mm standard disc was filled with 10 µl of each concentration and placed on agar inoculated with the pathogenic microorganism. As a negative control, 10% DMSO was used. Meropenem (10 µg), vancomycine (30 µg), ampicilline (10 µg) and amoxacillin (30 µg) were used as positive controls. All the experimental groups were incubated at 37 °C for 24 hours. At the end of the specified period, transparent inhibition zone diameters around the standard discs were measured and recorded (Gormez et al. 2015).

Determination of Minimal Inhibitory Concentrations (MIC) of Essential Oil

Minimal inhibition concentration (MIC) was determined by microwell dilution method. Bacterial cultures grown in liquid cultures for 12 hours were adjusted to concentrations of 108 cells/ml by using 0.5 McFarland standard turbidimetry. The essential oil was prepared with 10% DMSO as seven concentrations (7.81 15.62 31.25, 62.5, 125, 250 and 500 µg/ml). The liquid medium (95 µl) and 5 µl of the bacterial solutions were added to each well of the ELISA plates. The final volume was then adjusted to 200 µl by adding essential oil of different concentrations. DMSO was added to the last well as the negative control. The prepared plates were incubated at 37 °C for 24 hours in a shaking incubator. All experiments were repeated three times. The minimum inhibitory concentration value was determined by measuring the turbidity of bacteria with a microplate reader at a wavelength of 600 nm (Zgoda and Porter 2001; Gormez et al. 2013).

Results and Discussion

Members of the Enterobacteriaceae family are Gram-negative bacteria which are important components of human and animal intestinal microflora (Doğan et al. 1996; Torlak 2011). The opportunist and pathogenic members of these bacteria cause many serious infections such as septicemia, urinary system infections, pneumonia, cholecystitis, cholangitis, peritonitis, wound infections, meningitis and gastroenteritis (Foxman 2002). Enterobacter cloacae (ATCC13047), Enterococcus faecalis (ATCC29212), Escherichia coli (ATCC25922) and Proteus vulgaris (ATCC13315) used in this study are these causing serious diseases as mentioned above. For the treatment of these diseases antibiotics worth millions of dollars are consumed every year. Hence, it is vital to identify natural substances having the potential to be used against these bacteria. Vetiver essential oil is rich in various chemicals such as benzoic acid, furfural, vetivene, vetineil vetinate, terpinene-4-ol, 5-epiprezizane, khusimene, a-muurolene, khusimon, kalakoren, ß-humulene, a-longipinen, d-selinene, d-cadinene, valencene, kalaren-gurjunen, a-amorf en, epizizanal, 3-epizizanol, khusimol, iso-khusimol, valerenol, ß-vetivone and vetivazulene (Kokate 1991; Pareek and Kumar 2013).

The odor and chemical composition of an essential oil may vary according to the geography, climate and conditions in which it grows (soil type, altitude, water amount it can find) and to the season (e.g. before the flowering period, after the

flowering period) and even to the period of the day in which it is harvested (Margaris et al. 1982; Pengelly 2004; Putiyanan et al. 2005; Andrade et al. 2011). Due to the reasons mentioned above, a species of plant can produce different essential oils or the essential contents can differ, thus, the therapeutic traits of the essential oil can vary. For this reason, this study was intended to investigate the antibacterial characteristics of Vetiveria zizanioides (L.) Nash growing in a different region (province of Giresun/Turkey). When the results of the study were analyzed, the MIC value for E. cloacae, E. faecalis, E. coli and P. vulgaris was 15.63, 31.25, 15.63 and 15.63 µg/ml, respectively (Table 1). Similar results were obtained from similar studies about antimicrobial activity of vetiver in the literature (Putiyanan et al., 2005; Barad et al. 2013; Soni and Dahiya 2015; Dahiya and Sing, 2015). According to the literature, different extracts and essential oil of the vetiver cultivars and their constituents showed antibacterial effect against Staphylococcus aureus, Escherichia coli and Pseudomonas aeruginosa, Enterococcus faecalis, Klebsiella pneumoniae, Salmonella typhi, Salmonella aureus, Acinetobacter sp., etc. at different rates.

Table 1. Antibacterial activity of the essential oil of *Vetiveria zizanioides* (L.) Nash

BACTERIA	CONCENTRATION (µg/ml)							MIC	NC	PC
	DD*									DD*
	500	250	125	62.5	31.25	15.63	7.81		DMSO	Standard antibiotic discs**
***Enterebacter cloacae* ATCC 13047**	19	16	14	13	10	-	-	15.63	-	22 (MEM)
***Enterococcus faecalis* ATCC 29212**	19	14	12	11	-	-	-	31.25	-	21 (VA)
***Escherichia coli* ATCC 25922**	18	16	13	11	9	-	-	15.63	-	18 (AMC)
***Proteus vulgaris* ATCC 13315**	12	10	10	8	-	-	-	15.63	-	18 (AMP)

MIC, minimal inhibitory concentration, NC: Negative control, PC: Positive control, DMSO; Dimethyl sulfoxide (10%)
*DD, Inhibition zone in diameter (mm/sensitive strains) around the disks (6 mm)
**MEM: Meropenem (10µg), VA: Vancomycin (30µg), AMP: Ampiciline (10 µg), AMC: Amoksacilin (30µg)

The results are in accordance with the previous studies about antimicrobial activity of vetiver. It was observed that the highest inhibitory effect against the used bacteria was obtained in highest concentration (500 µg/ml) and that inhibition effect was lower than these obtained with antibiotics. In the literature, it has been shown that the antimicrobial activity of plant compounds can be folded double than antibiotics (Gormez et al. 2015). However, the results obtained in this study shows lower antibacterial effect than these antibiotics tested. Thus, the compounds with lower antibacterial activity may still have important role in the development of antibacterial drugs that can be used particularly for children and for the treatment of non-severe infections. Currently, only 13.6% of the used antibiotics are approved for the use by children (Andrijasevic and Walters 2010). According to the official sources, antibiotics are the most commonly used drugs for diseases of outpatient treatment in Turkey. It is estimated that at least 50% of the antibiotics used for the outpatient children are unnecessary. It is known that unnecessary use of antibiotics causes the formation of antibiotic-resistant microorganisms which can lead to more severe diseases. In addition, the country's economy may seriously affected because of unnecessary and high priced drugs (Pınar 2012; Lodha et al. 2013). The rational antibiotic use is defined as the use of the appropriate and cheap antibiotic under reasonable time and dosage according to the clinical findings and individual characteristics of patients (Yıldız et al. 2014). At this point, the use of economically produced natural products without side effects would be an appropriate approach as an alternative drug.

Conclusion

The study investigated the antibacterial properties of Vetiveria zizanioides (L.) Nash plant which was first grown in Giresun province. According to the literature, some of the studied bacterial strains can be resistant to antibiotics. Their treatments with many antibiotics are difficult, thus, the use of plant based compounds can be used which may not increase the pathogen resistance.

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RESEARCH ARTICLE

Determination of Some Biological Control Agents Against Alternaria Fruit Rot in Quince

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ABSTRACT

The use of bioagents has become important as an alternative to fungicides to prevent postharvest losses in recent years. In this context, it is aimed to investigate effective of some bacterial and fungal biocontrol agents for control against *Alternari alternata*, which has a wide range of hosts, leading to losses pre and postharvest. In this aim, dual culture of nine bacterial bio-agents isolate [*Bacillus megaterium* (TV 3D), *Bacillus subtilis* (TV 6F, TV 17C, CP 1), *Bacillus cereus* (TV 85D), *Paenibacillus polymxa* (TV 12E), *Pantoea agglomerans* (RK 79, RK 92), *Pseudomonas fluorescens* (MF 3)] and 3 fungal bioagents [*Trichoderma harzianum* (ET 4, ET 14, NT 1)] were tested for antagonistic properties against *Alternari alternata* under *in vitro* conditions. It has been determined that all bio-agents have an inhibitory effect on the growth of pathogen fungus under *in vitro* conditions. RK 79 (79.76%) was the most effective isolate in bio-agent bacteria isolates. All of the bio-agent fungal isolates showed a high hyperparasitic effect and the most effective isolate was ET 4 (67.74%). Consequently, promising results were obtained from these bio-agent bacteria and fungi. It is important to carry out studies *in vivo* bioassays in order to control postharvest decay with bacterial and fungal bio-agents which are determined to be effective.

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Introduction

Quince (*Cydonia oblonga* Mill), among soft-seeded fruits, is a fruit grown in walled gardens in almost every region of Türkey (Büyükyılmaz, 1999). Total quince production in the world is 630,325 tons and Türkey is the first with 139,311 tons in the world (Şirikçi and Gül, 2017). Although fruit production areas show a steady increase, losses during pre and post harvest storage have a significant impact on yield and quality (Acarsoy and Mısırlı, 2010). In developed countries, approximately 20-25% of post-harvest fruits are estimated to be spoiled by pathogens (El-Ghaouth et al., 2004; Droby, 2006; Singh and Sharma, 2007). *Botrytis cinerea*, *Alternaria alternata*, *Monilinia linhartiana*, *Monilinia fructigena*, *Diplocarpon mespili*, *Penicillium* spp., *Mucor* spp., *Aspergillus* spp. fungal pathogens cause diseases pre and post harvest (Wan and Tian, 2005). *Alternaria* diseases are among the most common diseases of many plants in the world among these diseases (Agrios, 1997). *Alternaria alternata* (Kessler) in *Alternaria* genus is an important pathogen that develops during cold storage of fruits in quince, becomes visible during marketing period and thus causes major post harvest losses (Troncoso-Rojas and Tiznado-Hernández, 2014). Synthetic fungicides are used today to prevent post harvest losses, but development of resistance to fungicides, people's awareness of the harmful effects of synthetic pesticides, view of leaving a cleaner world for future generations becoming more widespread have led to the search for environmentally friendly alternative control strategies (Mari et al., 2003; Jayapradha and Yesu, 2016). These new strategies include natural compounds (chitosan, essential oils, elicitors of natural defense mechanism) and biological control (Troncoso-Rojas and Tiznado-Hernández, 2014). Biological control method is a

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suitable for post harvest applications (Mari and Guizzardi, 1998) due to storage conditions where are controlled many parameters and biological control agents can confront with the pathogens, directly (Wilson and Pusey, 1985). In order to prevent post harvest losses, different researchers were determined fungi, bacteria and yeasts used successfully in *in vitro* and *in vivo* assay in biological control of dry and wet rot in fruits (Schisler et al., 1997; Kotan et al., 1999, 2002; Roco and Perez, 2001; Sadfi et al., 2002; Sempere and Santamarina, 2007; Panwar et al., 2013; Pane and Zaccardelli, 2015, Ghosh et al., 2016; Ahmed, 2017).

The aim of this study is to test 9 bacterial bio-agents and 3 fungal bio-agents under *in vitro* conditions against *A. alternata* causing disease in quince in storage conditions.

Materials and Methods

Bio-agent Bacteria

In this study, bacterial bio-agents which different researchers determined to be effective in biological control studies were used. Bacterial isolates, MIS results and their hosts were given Table 1.

Table 1. Bio-agent bacteria used in the study

Isolate	MIS diagnosis	Isolated host	References
TV 3D	*Bacillus megaterium*	Rye	Ekinci et al., 2014
TV 6F	*Bacillus subtilis*	Wheat	Erman et al., 2010
TV 12E	*Paenibacillus polymyxa*	Wheat	Erman et al., 2010
TV 17C	*Bacillus subtilis*	Raspberry	Ekinci et al., 2014
TV 85D	*Bacillus cereus*	Sugarbeet	Erman et al., 2010
RK 79	*Pantoea agglomerans*	Apple	Karakurt et al., 2010
RK 92	*Pantoea agglomerans*	Pear	Ekinci et al., 2015
CP 1	*Bacillus subtilis*	*Ricania simulans*	Tozlu et al., 2018c
MF 3	*Pseudomonas fluorescens*	Soil	Güneş et al., 2015

Bio-agent Fungi

The three isolates of *T. harzianum* isolated from different hosts and stored in Fungal Culture Collection, Plant Protection Laboratory of Atatürk University Faculty of Agriculture were used. The fungal bio-agents, molecular diagnosis and their hosts were given in Table 2.

Table 2. Bio-agent fungi used in the study

Isolate	Isolated host	Molecular diagnosis	Accesion number
ET 4	*Aesculus hippocastanum*	*Trichoderma harzianum*	KT897696*
ET 14	*Pinus sylvestris*	*Trichoderma harzianum*	LN864822*
NT 1	Soil	*Trichoderma harzianum*	MF038806**

*Tozlu et al., 2018a
**Tekiner et al., 2018

Isolation of Fungi

Pathogen fungi was isolated from the infected quince fruits taken from greengrocery (Figure 1). Small pieces of diseased fruit tissue were then surface sterilised with 70% ethanol for 3 minutes and rinsed with sterile distilled water. They were then dried on a sterile Whatman filter paper and placed in 90 mm petri dish containing 20 ml Potato Dextroz Agar (PDA) (Merck, Darmstadt, Germany). Petri dishes were incubated at 25-27°C for 4 days in the incubator and small fungal hyphae were transferred to new PDA to obtain pure culture. The fungal isolate "ET 86" was kept in agar plates in Fungal Culture Collection, Plant Protection Laboratory of Atatürk University Faculty of Agriculture.

Figure 1. Infected quince fruit

Pathogenicity of Fungus

The pathogenicity of the ET 86 isolate was tested on quince fruit. Quince fruits were washed under tap water and then surface sterilised with 70% ethanol and inoculated at the center with a 6 mm PDA plug from 5 day old mycelial cultures growth at 26^0C. Inoculated fuits were maintained at 26^0C, 95% relative humidity in 12 hours light / 12 hours dark in growth chamber. Fruits inoculated only with PDA plug were used as control. The fungal pathogen was re-isolated from the diseases fruits. The re-isolated pathogen exhibited the same morphological characteristics as those original isolates. Koch postulates were completed. Each application was performed with 3 replications.

Molecular Diagnosis of Pathogen Fungus

In order to identify fungal pathogen at species level, molecular sequence was performed. Genomic DNA was isolated from the micelles of the fungus using the protocol prepared by Moller et al. (1992). Using the rDNA of the fungal pathogen, Internal Transcribed Spacer (ITS), region was amplified using ITS1-ITS4 primers. The amplified PCR product was sent to Refgen Co. Ltd. for sequencing, and the result of the sequence was stored in Genbank.

In vitro Tests

In dual culture tests, 20 ml PDA containing petri dishes (90 mm) were used, and bacterial bio-agent isolates were developed in Nutrient Agar (NA) for 24 hours, whereas fungal pathogen isolate was developed in PDA for 5 days. Then, the bacterial bio-agent culture was spread with a sterile swap around petri dishes containing PDA, while a 6 mm fungal disc was placed in the middle part of the petri dishes. Petri dishes were wrapped with parafilm and then incubated in a 27^0C incubator until the entire surface of the control petri dish was covered with the fungal pathogen. As a control, only the pathogenic fungal micelle disc was placed in the middle of the petri dish. Radial development of the fungal pathogen was recorded in mm. Each application was performed with 3 replications, and the bio-agent's inhibition rate on the development of pathogenic fungal colony was calculated using the inhibition rate of radial growth formula stated by Mari et al. (1993).

$$\text{Inhibition}(\%) = (C-T)\times 100/(C-6) \quad (1)$$

C: the diameter of the pathogen colony of control group
T: the diameter of pathogen colony after treatments
6: the diameter of pathogen disk.

In testing of fungal bio-agent isolates, pathogens and fungal bio-agents were developed in PDA at ^{270}C for 3 days. 6 mm discs obtained from the fungal pathogen and bio-agent isolates were placed in petri dish as in Figure 2, and the *T. harzinum* isolate was incubated in the incubator until the entire surface of control petri dish was covered. Each application was performed with 3 replications.

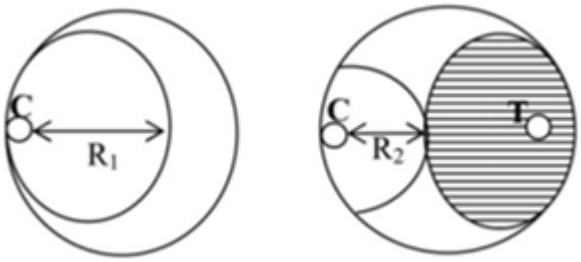

Figure 2. Measurement of radial development of the pathogen mycelia

Inhibition rate (%) of *T. harzianum* isolates on *A. alternata* was calculated according to Skidmore and Dickinson (1976) Formula:

$$\text{PIRG}(\%) = R_1\text{-}R_2/R1\text{x}100 \quad (2)$$

PIRG= Percentage interference rate (%)
R_1= The semi-diameter of the pathogen mycelium in the control petri
R_2= The semi-diameter of the pathogen mycelium in the double culture petri
PIRG>75%: Very high effective (++++),
60%<PIRG≤75%: High effective (+++),
50%<PIRG≤60%: Medium effective (++),
PIRG≤50%: Low effective (+)
Ineffective (-)

Statistical Analyses

The obtained values were analyzed by using JUMP 5.0.1 statistical software, and the difference between the means was compared according to LSMeans Student's test at the significance level of $p<0.01$.

Results

The fungal isolates obtained from the quince were tested for pathogenicity and the result was positive (Figure 3).

Figure 3. Pathogenicity test result and reisolation petri

Table 3 shows the results of the sequencing of pathogenic fungi obtained from the molecular identification, and the sequence was found to be similar to *A. alternata* by 99% as a result of screening using the BLAST program. The result of the molecular sequence was uploaded to Genbank and given an access number of MH992152.

Table 3. ET 86 isolate molecular sequence

1	CCTTCCCCTGTGGTATCCCTAACCTAGATCCGAGGTCAAAGTTGAAAAAAGGCTCTAATGGATGCTAGACCTT
81	TGCTGATAGAGAGTGCGACTTGTGCTGCGCTCCGAAACCAGTAGGCCGGCTGCCAATTACTTTAAGGCGAGTC
161	TCCAGCAAAGCTAGAGACAAGACGCCCAACACCAAGCAAAGCTTGAGGGTACAAATGACGCTCGAACAGGC
241	ATGCCCTTTGGAATACCAAAGGGCGCAATGTGCGTTCAAAGATTCGATGATTCACTGAATTCTGCAATTCACA
321	CTACTTATCGCATTTCGCTGCGTTCTTCATCGATGCCAGAACCAAGAGATCCGTTGTTGAAAGTTGTAATTATT
401	AATTTGTTACTGACGCTGATTGCAATTACAAAAGGTTTATGTTTGTCCTAGTGGTGGGCGAACCCACCAAGGA
481	AACAAGAAGTACGCAAAAGACAAGGGTGAATAATTCAGCAAGGCTGTAACCCCGAGAGGTTCCAGCCCGCCT
521	TCATATTTGTGTAATGATCCCTCCGCAGGTTCACCTACGGAGACCTTGTTACGACTTTTACTTCCTTAAAATGA
594	CCAAGA

The results of the antifungal activity of bacterial bio-agent tested against ET 86 isolates in dual culture tests were given in Table 4 and petri dish views were given in Figure 4. All bio-agent bacteria prevented the development of ET 86 at different levels. The inhibition rates of bacterial bio-agent isolates ranged from 14.28% to 79.76%. The highest inhibition rate was observed in RK 79 (79.76%) isolates, followed by RK 92 (73.21%) and MF 3 (62,50) isolates. The lowest inhibition rate was obtained from TV 3D (14.28%) (Table 4). The inhibition rate of the control application was found to be statistically different from all other tested bacteria ($p \leq 0.01$).

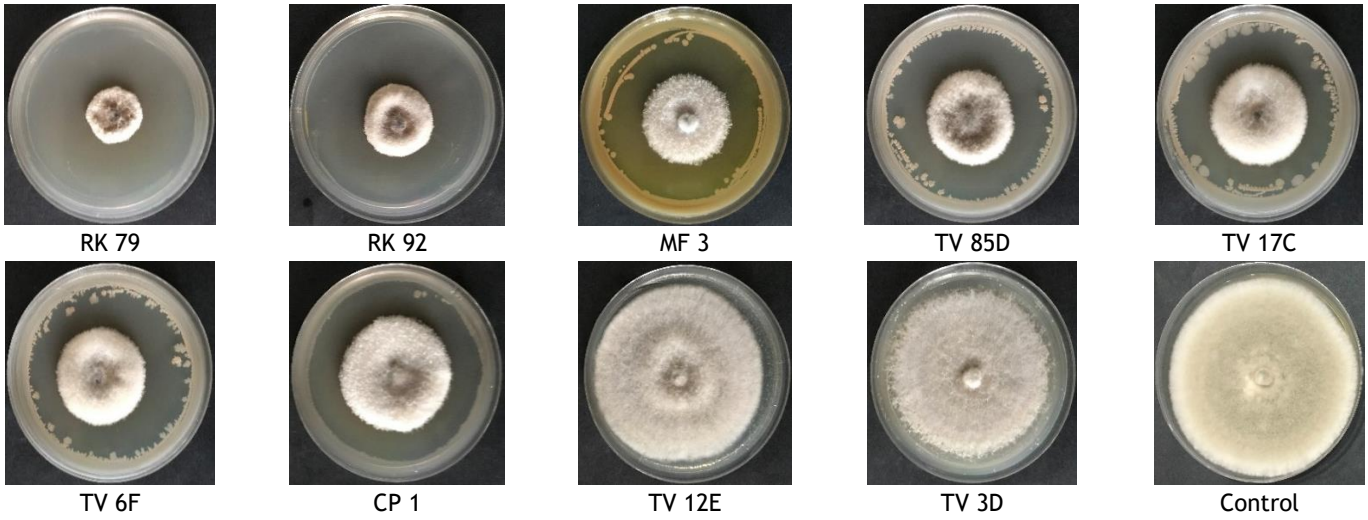

Figure 4. The results of the antifungal activity of bacterial bio-agents tested against ET 86 isolate

Table 4. Percentage inhibition rate of ET 86 with bio-agent bacteria in dual culture test

Bio-agent bacteria	PIRG (%)	
RK 79	79,76	A
RK 92	73,21	B
MF 3	62,50	C
TV 85D	61,31	CD
TV 17C	60,71	CD
TV 6F	59,52	D
CP 1	51,19	E
TV 12E	20,83	F
TV 3D	14,28	G
Control	0.00	H
LSD	3,95	
CV	0,02	

Efficacy of *Trichoderma* isolates tested against ET 86 isolate was tested *in vitro* and the hyperparasitic effects of *T. harzianum* isolates were shown in Table 5. All isolates were highly effective. Among *Trichoderma* isolates, ET 4 (67.74%) had the highest inhibition rate, which was followed by ET 14 and NT 1 (61.29%). ET 14 and NT 1 had an equal effect (Table 5). Petri dish views of the hyperparasitic effects of *T. harzianum* isolates under *in vitro* conditions are given in Figure 5.

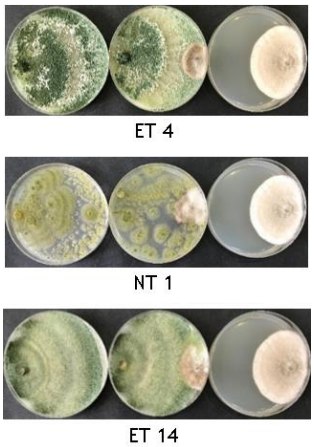

Figure 5. Petri dishes of bio-agent fungi tested against ET 86 (top to bottom: *T. harzianum*, *T. harzianum*+*A. alternata*, *A. alternata*).

Table 5. The hyperparasitic effects of *T. harzianum* isolates against ET 86 *in vitro* condition

Pathogen Fungi	Bio-agent fungi					
	ET 4		ET 14		NT 1	
ET 86	PIRG (%)	HL	PIRG (%)	HL	PIRG (%)	HL
	67.74	+++	61,29	+++	61.29	+++

*PIRG, Percentage inhibition rate (%); HL, Hyperparasitic level

Discussion

Bacterial and fungal bio-agents are used to prevent post harvest diseases successfully. Because storage conditions such as temperature and humidity are controlled conditions. Bacterial and fungal bio-agents used in this study were prevented pathogenic fungi development at different levels under *in vitro* conditions in previous studies.

The effectiveness of bio-agents may be due to various factors. These factors are the genus of the bio-agent, the competitiveness of the bio-agent, the aggressiveness of the pathogen, the host susceptibility and environmental conditions (Frances et al., 2006). 9 bacterial bioagents tested against *A. alternata*, *P. agglomerans* (RK 79) was the most effective bacterial bio-agent isolate, *T. harzianum* (ET 4) was the most effective fungal bio-agent isolate, too. It was determined by different researchers that this bacterial and fungal bio-agent isolate was used effectively against some pathogenic fungi and bacterial plant pathogens (Beer et al., 1984; Kearns and Hale, 1995; Montesinos et al., 1996; Voland et al., 1999; Usall et al., 2001; Kotan et al., 2009; Begum et al., 2010; Tozlu et al., 2018a; Tozlu et al., 2018b).

In addition, there are many studies showing that species belonging to *Pseudomonas* sp., *Pantoea* sp., *Bacillus* sp., *Trichoderma* sp. genera can be used as potential bio-agent against *Alternaria* fruit rot (Roco and Perez, 2001; Pandey, 2010; Pastor et al., 2012; Abbo et al., 2014; Arzanlou et al., 2014; Zhang et al., 2014) These fungal and bacterial bio-agents inhibit the development of pathogens by producing enzymes or antibiotics, rapidly colonizing and competing strongly. Some researchers have determined that *P. agglomerans* prevents the development of pathogens by the antibacterial substances it produces (Chernin et al., 1995; Wright et al., 2001; Kotan et al., 2009). *T. harzianum* effects against post harvest pathogens both direct parasitizing of the pathogen (Goldman and Goldman, 1998; Monte, 2001) and the production of some enzymes (Ulhoa and Peberdy, 1991; Harman, 1993).

Chitinolytic enzymes have an important role in the biological control of post harvest pathogens because they can destroy the structure of chitin in the cell wall of pathogenic fungi. *P. agglomerans* (Kotan et al., 2009) and *T. harzianum* isolates (Tozlu et al., 2018b) used in this study produce chitin degrading enzymes and prevent the development of the pathogens in this way.

In conclusion, RK 92 and ET 4 had the potential as bio-agents for the control of *A. alternata* under *in vitro* conditions, as well as against other fungal pathogens (Kotan et al., 2009, Tozlu et al., 2016, 2018a). Furthermore, it is great importance to test this fungal and bacterial bio-agent in different storage conditions with different temperature and humidity.

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RESEARCH ARTICLE

Influence Factors Analysis of Farmers' Participation in Agricultural Machinery Support Using Random Utility Model in the Agri Province of Turkey

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ABSTRACT

Increase in the level of mechanization in agriculture is a factor that promotes increase in productivity and also helps improve life standards in rural regions. In this study, factors that affect participation in benefiting from machinery and equipment supports were studied through the Ağrı province example. The main material of the study consisted of primary data that was obtained from face to face meetings carried out with agricultural enterprises, which were registered in the Farmer Registration System of Ağrı province. The Probit Regression Analysis method was used to determine participation in benefiting/not benefiting from the support, the relationships between the socioeconomic factors that affect this act, as well as the relationship degrees. According to the results obtained by the model, while the variables of household population, production of arable crops, and the existence of nonagricultural income had a significantly negative effect on participation in benefiting from machinery and equipment supports; the variables of irrigated land size, total amount of agricultural fields in the enterprise, and the existence of tractor(s) in the enterprise had a significantly positive effect.

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Introduction

Turkey is a country with a wide rural geography and population, and has an important economic and human resource potential that can accelerate national development. The awakening of this potential in rural regions requires implementing integrated planning. As part of this, the purpose is to improve the working and living conditions of the rural population in accordance with conditions available in urban areas and to ensure that these conditions are sustained (Anonymous, 2011).

The agricultural sector has a great importance in the economic system of all countries, no matter what their level of development. This sector, which produces the food items required for human nutrition and the raw materials required by the industry sector, creates employment both for itself as well as for other sectors. All countries have implemented comprehensive agriculture policies in order to ensure the development of the agricultural sector. Within these, support policies have an important place (Abay et al., 2005; Erdal et al., 2013; Karakayacı and Oğuz, 2006). A country, which desires to keep the agricultural sector alive, guarantee the food demand, and compete with the global markets, has to maintain the applications of supporting, protecting, and supporting in the agricultural sector (Yorgun, 2006).

The purpose of agricultural support policies in Turkey is to ensure an optimum production structure that is suitable to the country's needs, protect producers and provide them a

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suitable income opportunity, and thus increase the agricultural sector's contribution in the country's economy (Yalçınkaya et al., 2006). In rural areas, economic activity investments, which aim at processing, utilizing, and marketing the agricultural products of real persons and legal entities, and rural development programs, which aim at promoting organizations' investments made for the rehabilitation of their current infrastructure facilities, are being carried out as part of the National Agriculture Strategy in order to provide economic and social development (Anonymous, 2012).

The Machinery and Equipment Support Program under the Rural Development Investment Support Program (RDISP) finances expenditures, which are made for specific agricultural machinery and equipment in the rural area, in the form of donations. In Turkey, machinery and equipment purchases are being supported since 2007 under the Rural Development Investment Support Program. The program aims at strengthening the agricultural sector with respect to agricultural equipment and machinery infrastructure and developing the income and social standards (Anonymous, 2012, 2014).

Improving the socioeconomic development level of a country or a rural area in a specific region depends on implementing new and modern technologies in agricultural production. Mechanization is an important production tool, which provides higher productivity in agriculture by allowing the application of advanced technologies as well as the effective use of soil, water, manure, biocides, etc. Mechanization has played a key role in increasing the productivity, which took place in the agricultural sector of developed countries. In the current global competition environment, this role will certainly have an increasing importance (Evcim et al., 2010).

Mechanization in agriculture, i.e. agricultural mechanization, means that agricultural processes are being realized using machinery and energy. In this way, a faster production with a greater capacity can be possible. Contrary to other agricultural technology applications, utilization of machinery in agriculture both directly affects productivity increase and also allows the application of new production methods in rural areas (İleri, 2016).

In this study, enterprises in Ağrı province, which benefit and do not benefit from machinery and equipment supports under the Rural Development Investment Support Program (RDISP), were studied and the factors that were influential on benefiting from supports were analyzed. Ağrı is one of the provinces that need the highest amount of rural development investment.

Turkey ranked 79th in the Socioeconomic Development Index, which was prepared in 2011, based on criteria such as demography, education, health, employment, competitive and innovative capacity, financial capacity, accessibility, and life quality (Anonymous, 2013). It is expected that in the support application, the political instruments, which can be determined through research, will be such that they will address the major population in Turkey.

Materials and Methods

Materials

The main material of the study consists of primary data that was obtained from face to face meetings carried out with agricultural enterprises, which were registered in the Farmer Registration System of the Ağrı province. The questionnaire was applied in September and October in 2015. In addition, results from previous research carried out on the subject as well as secondary data obtained from the statistics and publications of national and international organizations such as the Ministry of Development, Ministry of Food, Agriculture and Livestock, and the Turkish Statistical Institute (TSI) were also used in the study.

Methods

Sampling

In the study, first, 50 enterprises, which benefit intensively from machinery and equipment supports, were purposively selected in the villages of the central district (10 villages). In the determination process of the producers who did not benefit from the supports, 50 enterprises were purposively selected from the same villages in order to ensure that their enterprise specific characteristics were similar to those of enterprises that benefited from the support. Although probability sampling methods are mainly used in agricultural economy research, there are also studies that make use of purposive sampling, depending on the purpose of the study and the characteristics of the sampled population (Çiçek and Erkan, 1996). In this way, it will be possible to define the factors, which lead to the act of benefiting/not benefiting from the support, more precisely.

The Model

In the last part of the study, the factors that affected the act of benefiting from the support were examined with an economic approach. In the study, Probit Regression Analysis method was used to determine the act of benefiting/not benefiting from the support, the relationships between the socioeconomic factors that affect this behavior, as well as the relationship degrees.

The Probit analysis is a model that is used as an alternative to logistic regression in order to find the effect of one or more explanatory variables on a categorical response variable. The logistic and the Probit regression analyses are very similar to each other and the probability predictions obtained in these have values that are close to each other. While in the logistic regression analysis log-odds (likelihood ratios) are used, in the Probit analysis, cumulative normal distribution is used. Basically, Probit is the inverse of cumulative distribution function of the standard normal distribution (Arı and Önder, 2013).

The cumulative distribution function that is used to predict the Probit Model is assumed to have a normal distribution (Greene, 2003). The Probit model is generally set with the aid of a utility index that cannot be observed (Karlı et al., 2006). Participation of farmers in benefiting from the machinery and equipment supports was modelled using the random utility model. Entrepreneurs had two options: benefiting or not benefiting from machinery and equipment supports. This can be expressed mathematically as follows:

$$U\,(1, m_1 + P; x) \geq U\,(0, m_0; x) \quad (1)$$

In the formula, 1 refers to benefiting from machinery and equipment supports; 0 refers to not benefiting from machinery and equipment supports; m_1 and m_0 refer to the net income obtained by benefiting or not benefiting from machinery and equipment supports, respectively; x refers to factors that influence the act of benefiting or not benefiting from machinery and equipment supports; P refers to the donation support received when benefiting from machinery and equipment supports and the additional income. The utility function is expressed as $U(i, m_i; x) = V(i, m_i; x) + \varepsilon$ and $V(i, m_i; x)$ reflects the (systematic) deterministic component, while ε reflects the random component (Hubbell et al., 2000; Qaim and De Janvry, 2003). Participation in benefiting from the support can be expressed in a partially observable form as follows:

$$U\,(1, m_1 + P; x) + \varepsilon_1 \geq U\,(0, m_0; x) + \varepsilon_0 \quad (2)$$

The systematic component of the utility can be written as shown below, where i = 0.1 and α is the marginal income:

$$V = x\beta^i + \alpha m_i \quad (3)$$

$$(x^1\beta^1 - x^1\beta^0) + \alpha(m_1 + m_0 + P) \geq \varepsilon_0 - \varepsilon_1 \quad (4)$$

The parameter estimates above can be obtained using the maximum likelihood procedure and with the assumption $\varepsilon = \varepsilon_0 - \varepsilon_1$.

If the $x^1\beta = (x^1\beta^1 - x^1\beta^0)$, $m = m_1 + m_0 + P$, *and* $\varepsilon = \varepsilon_0 - \varepsilon_1$ *equality relations are put in place:*

$$x^1\beta + \alpha m_1 \geq \varepsilon \quad (5)$$

Income can be modified as $n(m_i) = log\,((m_1 + P) / m_0)$.

P refers to incentives that are not received by farmers who do not participate in the support, such as the amount of donations received by participating in the machinery and equipment supports and the extra sold products. Since we cannot observe the payments received by farmers upon participating in the support - denoted with P, we can express the received income implicitly with the x variable. We assume that farmers occasionally know the amount of income that is expressed with P. Compared to the contingent valuation model, the random utility model describes the utility obtained by farmers who participate in machinery and equipment supports better compared to those who do not participate in these. In addition, regardless of the presence of a machinery and equipment scenario, the random utility model calculates the average value of willingness to pay with respect to farmer participation.

Assuming that ε denotes an independent and identical distribution, participation in machinery and equipment supports can be shown with the Probit model as follows (Greene, 2003):

$$Prob\,(Y = 1\,I\,x) = \int_{-\infty}^{x'\beta} \phi(t)dt = \phi(x'\beta) \quad (6)$$

$\phi(t)$ is the notation commonly used for the standard normal distribution. The log likelihood function for probability:

$$ln\,L = \sum_{j=1}^{N} ln[\,\phi(x'\beta)] + (1 - I_j) ln\,[1 - \phi(x'\beta)] \quad (7)$$

In the formula, I_j is the dummy variable, which is 1 for the case of benefiting from machinery and equipment supports and 0 for not benefiting from machinery and equipment supports. Parameter estimates are obtained by maximizing the log likelihood function given above.

In the Probit model that was used in the study, the state of benefiting from the RDISP machinery and equipment support was selected as the dependent variable. For enterprises that benefited from the support, this was given a value of 1, and for those that did not benefit from the support it was given a value of 0. Independent variables, on the other hand, were created using socioeconomic factors.

Table 1. Defining model variables

Variables	Definition
RDISP	1 if benefiting from the RDISP machinery and equipment support; 0 otherwise
nhousehold	Number of individuals in household
irrland	Size of irrigated land in enterprises
covarea	Total area of agricultural buildings (barn, hovel etc.) in enterprises
tractor	1 if tractor in enterprises; 0 otherwise
fieldarea	1if only production of arable crops by the enterprise; 0 otherwise
non-agrinc	1 if presence of a nonagricultural income; 0 otherwise
education	Education level of the entrepreneur (years)

Results and Discussion

Some Socioeconomic Properties of the Enterprises

The act of benefiting from the Machinery and Equipment Support Program, which was used as the dependent variable in the study, is a binary variable and 50% of the participants were selected as benefiting enterprises and the other 50% as non-benefiting enterprises.

In the studied enterprises, the age average of the entrepreneurs was 51.5, the youngest entrepreneur was 31 years old and the oldest was 80 years old. The standard deviation of the age variable was 11.56. The average experience of the entrepreneurs in the farms was 35.06 years. While the entrepreneur with the least experience had been practicing agriculture for 5 years, the most experienced one had been practicing agriculture for 61 years. The average household population in the studied enterprises was 6.45. This average household population is represents the definition of a crowded family. While the average household size in the Ağrı province was 6.7 in 1955, it had increased to 7.6 in 2000. While

the share of Ağrı in the country's population was 0.75 % in 1927, it increased to 0.8 % in 2000 (Arıöz, 2007).

The average education degree of the household head was 3.6 years. In the studied enterprises, there were both uneducated entrepreneurs and entrepreneurs with a university degree. The average residence period for households, which were studied as part of the study, in their villages is 49.3 years. While the oldest family in the village had been residing there for 80 years, the newest family had been residing there for 5 years. In addition, 91% of the studied households resided in the village year round.

While 83% of the entrepreneurs that were included in the study had social insurance, 31% had a nonagricultural income.

The most important production element for agricultural enterprises is the land. The land of the enterprises that were included in the study can be qualified as irrigated or dry and was analyzed under 5 groups. The average irrigated land area per enterprise was 91.18 decare and the average dry land area was 90.99 decare. The average enterprise size in Turkey reached 67.5 decare by 2013 (İleri, 2016). The fact that the average enterprise size in the Ağrı province is higher than the average of Tukey suggests that a higher agricultural mechanization level is needed. With respect to irrigated land, 40% of the enterprises had 50 decare and less land, 22% had 51-100 decare land , 15% had 101-150 decare land, 13% had 151-200 decare land, and 10% had 201 decare and more land. In the studied enterprises, 30% of the enterprises with 0-50 decare irrigated land, 54.5% of the enterprises with 51-100 decare irrigated land, 60% of the enterprises with 101-150 decare irrigated land, 69.2% of the enterprises with 151-200 decare irrigated and, and 80% of the enterprises with 201 decare or more irrigated land benefited from the machinery and equipment support. With respect to dry land, 50% of the enterprises had 50 decare and less land, 18% had 51-100 decare land , 9% had 101-150 decare land, 7% had 151-200 decare land, and 16% had 201 decare and more land. In the studied enterprises, 46% of the enterprises with 0-50 decare dry land, 55.6% of the enterprises with 51-100 decare dry land, 55.6% of the enterprises with 101-150 decare dry land, 28.6% of the enterprises with 151-200 decare dry and, and 62.5% of the enterprises with 201 decare or more dry land benefited from the machinery and equipment support. The high standard deviation of the presence of irrigated or dry land shows that the presence of lands among enterprises has a heterogeneous distribution. The average land plot number per enterprise is 6.26.

Table 2. Sample statistics

Variables	**Mean**	**Std. Dev.**	**Min.**	**Max.**
Benefiting from the RDISP machinery and equipment support (Binary)	0.5	0.50	0	1
Age (years)	51.50	11.56	31	80
Farming Experience (years)	35.06	12.89	5	61
Number of individuals in household	6.45	1.79	3	11
Education level of the entrepreneur (years)	3.60	4.04	0	15
Residence period in villages (years)	49.30	14.74	5	80
Resided in the village year round (Binary)	0.91	0.29	0	1
Social Insurance (Binary)	0.83	0.38	0	1
Nonagricultural Income (Binary)	0.31	0.47	0	1
Irrigated Land (m^2)	91.18	105.41	0	753
Dry Land (m^2)	90.99	120.34	0	500
Number of Land Parts	6.26	4.89	0	33
Livestock units (LSU)	22.30	18.96	0	90
House Area (m^2)	136.94	30.63	64	220
Barn Area (m^2)	116.56	83.31	0	360
Hovel Area (m^2)	30.20	75.86	0	540
Number of Tractor	0.85	0.44	0	2
Number of agricultural machines	4.96	2.94	0	11
Amount of Debt (Turkish Lira)	13 468.10	25 497.31	0	147 000
Amount of agricultural support (Turkish Lira)	3478.18	4785.36	0	32 555
Amount of machinery support (Turkish Lira)	3495.30	4365.81	0	17 500

The presence of animals was estimated in livestock units (LSU). While the number of animals per enterprise was 22.30 livestock units, there were both enterprises without any animals and enterprises with 90 livestock units.

In the studied enterprises, the houses where the household resided had an average area of 136.94 m^2, while the smallest house was 64 m^2, and the largest house was 220 m^2.

The enterprises had an average barn area of 116.56 m^2 and average hovel area of 30.2 m^2. While some enterprises did not have barrens or hovels, the largest barren and hovel had areas of 360 and 540 m^2, respectively.

The presence of tractor(s) is an important factor for agricultural enterprises to demand agricultural equipment and machinery. While 85% of the enterprises had tractors, some had 2 tractors. In previous studies, the ratio of enterprises that used tractors to the total number of enterprises in the Ağrı province was identified as 93%. The ratio of enterprises that use tractors to the total number of enterprises in Turkey is 73% (Arıöz, 2007).

In addition to the presence of tractors, the presence of machinery that work as connected to tractors as well as self-propelled machinery are also very important for agricultural enterprises. In the study, the number of agricultural machines owned by the enterprises was analyzed and enterprises were grouped into 3 groups as enterprises without agricultural machinery, enterprises that had 1-5 agricultural machines, and enterprises that had 6-11 agricultural machines. While in the 15% of the studied enterprises there weren't any agricultural machines, 40% had 1-5 agricultural machines and 45% had 6-11 agricultural machines. Those without agricultural machinery did not benefit from the machinery support, while 47.5% of those with 1-5 agricultural machines and 68.9% of those with 6-11 agricultural machines benefited from the support. In the studied enterprises, there were an average of 4.96 agricultural machines per enterprise. The amount of equipment per tractor in the Agri province in 2004 was 5.6 (Arıöz, 2007).

While the entrepreneurs in the sampled enterprises had an average debt of 13 468.1 TL, the average agricultural support received was 3478.18 TL and the average machinery support received was 3495.3 TL. While there were enterprises that had no debts, there were also enterprises that did not benefit from any supports.

Probit Model Results

The Probit model results and the marginal effects are given in Table 3. As the factors that are influential on farmer's decision in benefiting from machinery and equipment supports in the Ağrı province, the following variables were included in the Probit model: household population, size of irrigated land, the total area of agricultural structures in the enterprise, presence of tractor(s) in the enterprise, production of arable crops by the enterprise, the presence of a nonagricultural income, and the education level of the entrepreneur. According to the model results, all of the variables except the education level of the entrepreneur were found to be statistically significant. While the variables of household population, production of arable crops, and the existence of non-agricultural income had a significantly negative effect on participation in benefiting from machinery and equipment supports; the variables of the amount of irrigated land, total amount of agricultural fields in the enterprise, and the existence of tractors in the enterprise had a significantly positive effect.

The negative relationship between the population variable and the act of benefiting from equipment and machinery is a well-expected result. As the population in the enterprise increased, the income per capita decreased and thus the share from the annual production, which was allocated for investments, also decreased. The equipment and machinery support was applied as part of rural development investments such that it supported 50% of the planned investment. As a result, participation in the supports required that a certain investment is made. As the amount of irrigated lands in the enterprises and the total area of the agricultural structures increased, participation in equipment and machinery supports increased as well. Increase in the size of irrigated lands and agricultural structures in an enterprise means that, compared to enterprises with less lands, both the income per unit area in the enterprise increases and the required machinery labor force increases.

Tractors are the most important agricultural machineries required for agricultural mechanization. The presence of a tractor in an enterprise promotes purchasing of equipment and machinery that work in connection to tractors. The results of the study, which show that the presence of tractor(s) in the enterprise has a very significant and positive effect on the state of benefiting from machinery and equipment supports, is in alignment with this observation. In another study that was carried out in the region, the scantiness of agricultural equipment and machinery used in the enterprises had been shown (Arıöz, 2007). Therefore, agricultural mechanization has not been developed in the region. Among the studied enterprises, the participation degree in benefiting from machinery and equipment supports decreases only for enterprises that have only arable crops production. In enterprises that give place to other agricultural production means (husbandry, growing fruit and vegetables, etc.), the tend to benefit from the support increases.

The presence of nonagricultural income in the enterprise has a negative effect on benefiting from the machinery and equipment support. In the region, entrepreneurs who had nonagricultural income generally met their basic needs from nonagricultural resources and practiced farming as a side income source. In enterprises with nonagricultural incomes, agricultural activities are generally carried out according to family needs, the added-value obtained aside from consumption by the household is transferred outside the agricultural sector. As a result, entrepreneurs whose basic income is provided from agricultural practices tend to benefit from the supports to a greater extent. In a study carried out in China, the factors, which were effective on the participation of farmers in agricultural machinery cooperatives, were determined as cooperative management, the farmer's state of being informed about the machinery, the level of household income received from agriculture, and the support rates (Yin et al., 2015).

Table 3. Original parameter and marginal effect estimates of probit model

Variables	Coefficients	Standard error	Z-value	Marginal Effects
nhousehold	-0.12704**	0.05378	-2.36	-0.04027***
irrland	0.00368*	0.00188	1.96	0.00117**
covarea	0.00241**	0.00117	2.06	0.00076**
tractor	1.05358***	0.36087	2.92	0.33396***
fieldarea	0.87754**	0.42669	-2.06	-0.25150**
non-agrinc	-0.61955*	0.42668	-1.66	-0.19272*
education	0.03044	0.03714	0.82	0.00965
Log likelihood function	-55.88225			
Restricted log likelihood	-69.31472			
Chi squared	26.86495			
McFadden Pseudo R-squared	0.19378			

*** Significant at 1%, ** Significant at 5%, * Significant at 10%.

In the Probit model, "marginal effects" were analyzed by increasing the independent variables by 1 unit in order to show how this change affects the dependent variable. Marginal effects show us how the dependent variable is affected by increasing the independent variable by 1 unit (Demir and Yavuz, 2010). The marginal effects of the variables of household population and the presence of tractor(s) have a statistical significance level of 1%; the marginal effects of the variables of the amount of irrigated land, the total agricultural structure area, and the field have a statistical significance level of 5%, and the marginal effect of the variable of nonagricultural income has a statistical significance level of 10%. The marginal effect of the variable of education level is statistically insignificant.

According to the model results, with 1% increase in enterprise population, the probability of participating in machinery and equipment supports decreases by 4%. The 1% increase in the amount of irrigated lands in the enterprises increases the probability of participating in machinery and equipment supports by 0.1%. 1% increase in the area of agricultural structures in the enterprise increases the probability of participating in machinery and equipment supports by 0.076%. The presence of tractor(s) in the enterprise increases the probability of participating in machinery and equipment supports by 33.4% compared to enterprises without tractors. Enterprises that produce only arable crops have 25.2% lower probability of participating in machinery and equipment supports compared to those that produce other products as well. Enterprises that have nonagricultural incomes have 19.3% lower probability of participating in machinery and equipment supports compared to those that do not have nonagricultural incomes.

Conclusion

In Turkey, because of infrastructure problems, the income level in the agriculture sector is lower compared to other sectors. Because of the low income and the challenging life conditions, the agricultural sector has to be supported in order to ensure its sustainability. The agricultural structure of the Agri province, which was selected as the research field, is a typical example of traditional Turkish agriculture. In the studied region, the small and scattered nature of the agricultural enterprises, the low population intensity per enterprise, and the low productivity level result in low agricultural income and the income obtained can solely meet the basic needs of the families. Investments that aim at promoting the development of enterprises can be only realized through supports. Therefore, machinery and equipment supports that target increasing the agricultural mechanization level are an adequate policy.

Machinery and equipment supports result in significant budgetary costs. In the study area, a total of 3.26 million Turkish liras were paid as a support to 527 investors in 2014 - the year during which the research data were obtained (Anonymous, 2015). In order for the supports to reach their goal, the socioeconomic characteristics of agricultural enterprises have to be taken into account and according to these, the target groups; the amount, form, and time of support have to be identified.

According to the Probit model results, while the household population, production of only arable crops, and the presence of a nonagricultural income had negative effect on participation in supports; the presence of irrigated lands, the total agricultural area, and the presence of tractor(s) encouraged benefiting from the machinery and equipment support. The Probit model results showed that generally enterprises that were above a certain economic level, benefited from the support, while enterprises without adequate infrastructure and economic power, enterprises with a major income from nonagricultural activities did not benefit from the support.

According to these results, it can be concluded that the target group of the machinery and equipment supports has to be reevaluated. First of all, those with nonagricultural incomes have to be removed from the group of enterprises that will benefit from the support. The current policy does not include a specific incentive that will allow enterprises, which do not have a certain infrastructure and economic size and have large household population, to benefit from the support. Supports have to be graded according to the infrastructure and economic size of the enterprises.

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RESEARCH ARTICLE

Salt Stress Triggered Changes in Osmoregulation and Antioxidants in Herbaceous Perennial Inula Plants (Asteraceae)

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ABSTRACT

Global demand to cure ailments is a growing need. Inula genus extensively holds hundreds of species in warmer regions of Europe and Asia. It is being well-known for its phytochemical and pharmacological applications in industry thanks to its anti-inflammatory and antimicrobial interests. However, growth and production of Inula in the cutting-edge industry is commonly influenced by salt stress except for the halophyte species such as the *Inula crithmoides*. Salt tolerance level by means of changes in osmoregulation and antioxidant systems in an herbaceous perennial Inula plant has been biochemically evaluated here. Both salt stress treatments caused photosynthetic pigments' degradation, increase in the leaf levels of osmolytes, and induction of oxidative stress indicated by the malondialdehyde (MDA). Higher hydrogen peroxide (H_2O_2) amount was recorded in high salt concentration than low salt. High salinity caused an increase in ascorbate (ASC) and glutathione (GSH) contents besides target enzymes of Inula leaves. NaCl tolerance of Inula also was found comprehensible through the higher concentrations of proline and to a lesser extent, total soluble sugar. Salt tolerance mechanisms of this rich bioresourse needs to be further studied in detail for herbal medicines in pharma sector.

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Introduction

Many geographic regions in the world has undergone changes due to increasing temperatures and fluttering precipitation regimes subsequently affects all aspects of life on earth. Excessive temperature and drought cause increase in soil salinity and significantly reduces product yield and quality. The effects of drought and temperature can be reduced by irrigation however; it leads to a further reduction in the already diminishing water resources. In any event, agricultural activities are the biggest factor in reducing the fresh water reserves in the world. Furthermore, irrigation increases soil salinity. Considering the fact that the world population continues to grow (UN's estimation is 8.6 billion people by 2030) and arable lands are shrinking, it is evident that, yield should be increased at a high rate for nutritional and feeding purposes, for the reason that abiotic stress conditions pose a serious threat to agriculture. Plants cannot escape the conditions in which they exist and are victims of constantly changing conditions, yet they have evolved by developing biochemical and developmental signal cascades for the sustainability of growth, development and agricultural phytomass re-productivity.

Stress adaptation is ensured by the activation of the salt stress susceptible genes and the synthesis of various functional proteins result in restructuring of the relevant signaling pathways (Shinozaki and Yamaguchi-Shinozaki 2007). Reactive oxygen species (ROS) are generated in plants exposed to salt stress and are produced continuously. ROS is highly reactive and its overproduction has been shown to adversely affect

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membrane potential and the protection of biological macromolecules such as proteins, carbohydrates, lipids and DNA which ultimately leads to oxidative damage (Demiral and Turkan 2005).

Plants develop enzymatic and non-enzymatic defense systems to keep ROS at an optimal level that will not cause damage to the cell or remove redundant ROS from the cell and protect cells from further oxidative injury.

Ascorbic acid and glutathione are classified as non-enzymatic antioxidants, while primary enzymatic ones are superoxide dismutase (SOD), glutathione/ascorbate peroxidase (APX, GPX) and glutathione reductase (GR) (Foyer and Noctor 2009). Glutathione (L-gamma-Glutamyl-L-cysteinyl-glycine, GSH) stands as the most abundant free thiol in biological systems (Hayes and McLellan, 1999). GSH has vital roles in the cell, such as response and detoxification of oxidants or other chemicals and protection of the thiol-redox balance (Xiang C et al., 2001). ASC on the other hand is a well-known antioxidant as well that is involved in defense mechanisms against oxidative stress. Salt stress cause increased oxidation of the apoplastic ASC pool. Higher foliar ASC levels found in plants are able to tolerate oxidative stress with a better capacity (Potters et al., 2004). Analyzing the accumulation of uncharged and relatively stable reactive oxygen species (ROS), such as intracellular H_2O_2, is an important factor to measure membrane damage (Maruta et al., 2012).

To alleviate the damage caused by salt stress, plants generally increase the synthesis of soluble sugars and proline to be able to enhance the efficiency of osmotic regulation. Proline regulates osmotic pressure in cytoplasm and preserve the structure of the cellular components, thereby increases the ability of the plant to resist salt stress (Bates et al., 1973). Soluble sugars can increase the concentration of cell sap and increase the stress tolerance of plants (Ashraf and Foolad 2007). Changes in photosynthetic pigments are also markers of salt stress tolerance.

The chlorophyll content normally shows a downward trend after salt stress in various plants (Karimi and Yusef-Zadeh 2013). The genus Inula which is a member of Asteraceae has ethnopharmacological importance. Especially its flower extracts containing rich flavonoids, phenolic acids and sesquiterpene lactones are a potential agent to relief many ailments (stomach ache, bruises, joint pain) in many countries all over the world used in the pharma industry (Wu et al., 2015). Studies by now are mainly focused on its phytochemical and pharmacological activities of root/flower extracts however, its salt stress tolerance has not been received significant attention even though its growth are greatly affected by abiotic stresses.

Here, we have analyzed how Inula plants (falls in Magnoliopsida class) response to changes at photosynthetic pigments, various osmolytes generally in plants (proline and soluble sugars), oxidative stress (MDA and H_2O_2), several enzymatic and non-enzymatic antioxidants under low and high salt treatments by using above mentioned knowledge. Inula plants under higher NaCl showed a better osmotic regulation and membrane protection, which led to a stronger tolerance.

Materials and Methods

Plant Growth Conditions and Stress Treatment

Inula seeds collected from nature (Hannover, Germany) and seedlings obtained by germination were selected based on the robust morphological traits and placed in the pots containing Miracle-Gro garden mix. Right after young plants were robust enough (after 3 weeks of germination) plants were watered twice a week with Hoagland containing NaCl at 100 (low salt) and 500 mM (high salt) final concentrations, or without salt for the control (non-stressed). All experiments were conducted in an environmental chamber, with following parameters: 16 h/8 h light/dark cycle at 23 °C ± 2, 300 µmol m^{-2} s^{-1} of photon density of the leaf surfaces, and 50-80% relative humidity. Within the following 7 days, the plants were grown under salinity, and then they were harvested to conduct experiments. Leaf material was used to perform all kind of measurements and biochemical assays.

Enzyme Activity Assays

Inula leaves were powdered in liquid N_2. Soluble proteins were extracted in 50mM phosphate buffer (pH 7.4), 1mM EDTA, 1% (w/v) PVP-40 besides 1% (v/v) Protease Inhibitor Mixture. The APX extraction buffer contained ascorbate (5mM). The homogenates were centrifuged at 12000g for 20min at 4 °C and the supernatant was collected for further enzymatic assays. APX activity was determined by rate of ascorbate oxidation at 290nm. The solution contained 50mM phosphate buffer (pH 7.4), 0.2mM H_2O_2 besides 0.5mM ascorbate in final reaction volume. Superoxide dismutase activity was detected with the help of the method of Dhindsa and Matowe (1981). The reaction product was spectrophotometrically measured at 560 nm. Guaicol peroxidase was monitored by the changes in absorbance at 470 nm as Urbanek et al., (1991) suggested (extinction coefficient 26.6 mM^{-1} cm^{-1} fot tetraguaiacol). Glutathione reductase activity was determined with the oxidised glutathione (GSSG) and oxidation of NADPH (Foyer and Halliwell, 1976). Total proteins were calculated by Bradford protein assay.

Non Enzymatic Antioxidants Determination

Inula leaves were harvested (500mg), powdered in liquid N_2 and GSH and was measured spectrophotometrically at 412 nm as described by Griffith (1980). Ascorbate contents were determined at 265 nm with perchloric acid, NaH_2PO_4 (pH 5.6) and sufficient K_2CO_3 with 1 U ascorbate oxidase (Foyer et al., 1983).

H_2O_2, Proline, Sugars and Pigment Contents

Inula leaves (0.25 g) were homogenized in 5% trichloroacetic acid and 0.1 g of charcoal (activated) at 4 °C for H_2O_2 assay. The homogenate was centrifuged at 12,000 × g for 15 min. 0.5 mL of 10 mM potassium phosphate buffer (pH 7.0) and 0.75 mL of 1 M KI were used to add in 0.5-mL of the supernatant which then was measured at 390 nm (Velikova et al., 2000). Proline concentration was determined by the

ninhydrin method of Bates et al. (1973) in dry leaf samples (0.1 g). Proline content was given as mg g^{-1} DW using a standard curve. Dried inula leaf samples were powdered in 80% ethanol. The mix was filtered and the filtrate was centrifuged at 4°. Reducing sugar content was estimated by a color change at 600 nm (Ross, 1959). Total chlorophyll (chl) and Carotenoid (car) content of inula plants have been recorded by using Arnon's equations in 80% acetone (Arnon, 1949).

Statistical Analysis

The means of indicated replicates used for data analyses for all experiments conducted in this study. Significant differences between treatments were evaluated by SigmaPlot, version 11.0 software at 5% ($P \leq 0.05$) level.

Results

MDA and H_2O_2 Level

The concentration of MDA, a reliable biomarker of oxidative stress, was gradually increasing in parallel with the increment in salt concentration in the leaves (Figure 1). 100 and 500 mM NaCl treated leaves induced 1.6 and 2.6-fold higher than the control respectively. As with lipid peroxidation, H_2O_2 amount increased in both 100 and 500 mM NaCl treated gropus. H_2O_2 was found 2.0 and 3.2 fold higher than control plants in 100 and 500 mM NaCl treatments respectively (Figure 1)

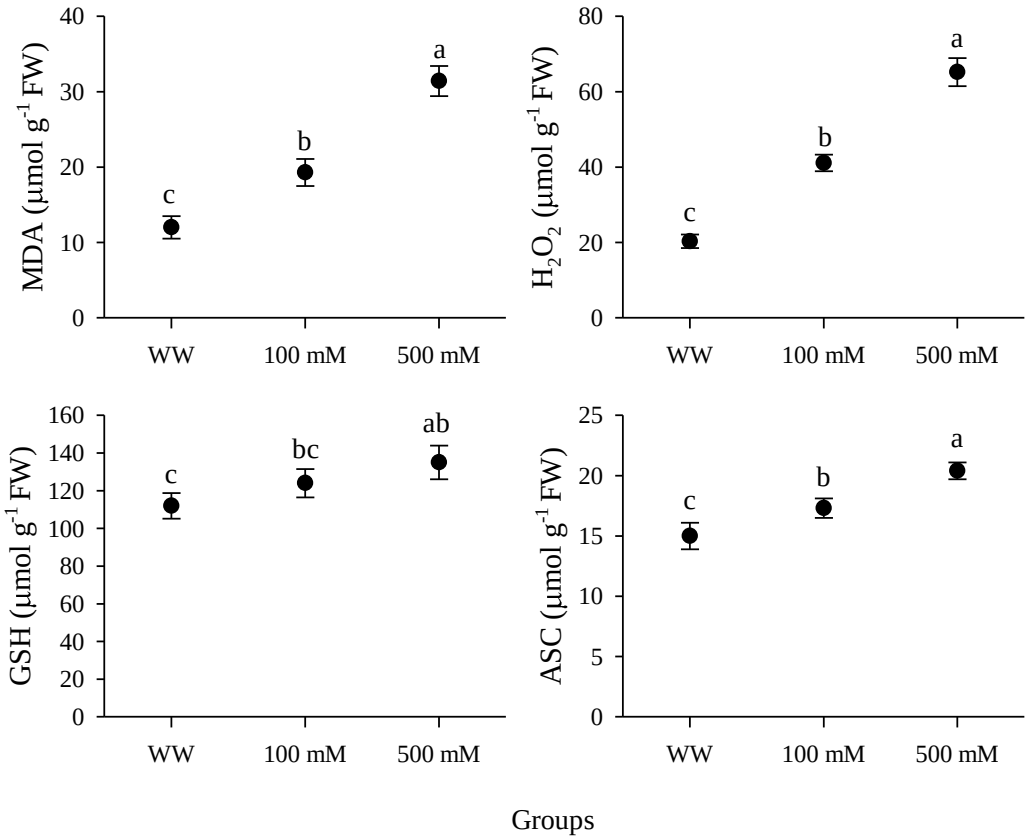

Figure 1 Changes of MDA, H_2O_2, GSH and ASC contents in Inula under different concentrations of NaCl 100 mM (low salt) and 500 mM (high salt) exposure for 7 days. WW: well-watered control, 100 mM: 100 mM NaCl and 500 mM: 500 mM NaCl. Data were shown as the means of ± SD (N = 5). Different letters indicate significant differences between experimental groups ($p < 0.05$). Statistical analysis was carried out using one-way ANOVA followed by Tukey post-hoc test

Antioxidant Substances

The effects of low and high salt exposure on the contents of antioxidant substances (ASC and GSH) in inula plants are shown in Figure 1. Salinity treatments caused an increase in endogenous ASC concentration. As compared to control, ASC increased by 15% and 36% in 100 and 500 mM NaCl treatments, respectively. Low salt (100 µM) treatment did not affect GSH concentration as much as high salt (500 µM) concentration. About 21% increment in GSH content was recorded in 500 mM NaCl treatment with regard to control. However, there was also no statistical difference between the two NaCl treatments (Figure 1).

Osmolytes Accumulation

Levels of two types of osmolytes commonly used by plants: proline (Pro), and total soluble sugar (TSS), was measured in the leaves of inula plants subjected to NaCl stress. The proline content was increased in 100 mM and 500 mM NaCl and recorded 2.5 and 6.1 fold as to control (Figure 2). As compared

to control, the TSS content in leaves of inula plants was increased in 100 and 500 mM NaCl treatments. TSS was recorded 2.8 and 3.0 fold higher in 100 and 500 mM NaCl treatments. However, no significant difference found between sugar contents of 100 and 500 mM NaCl treated plants.

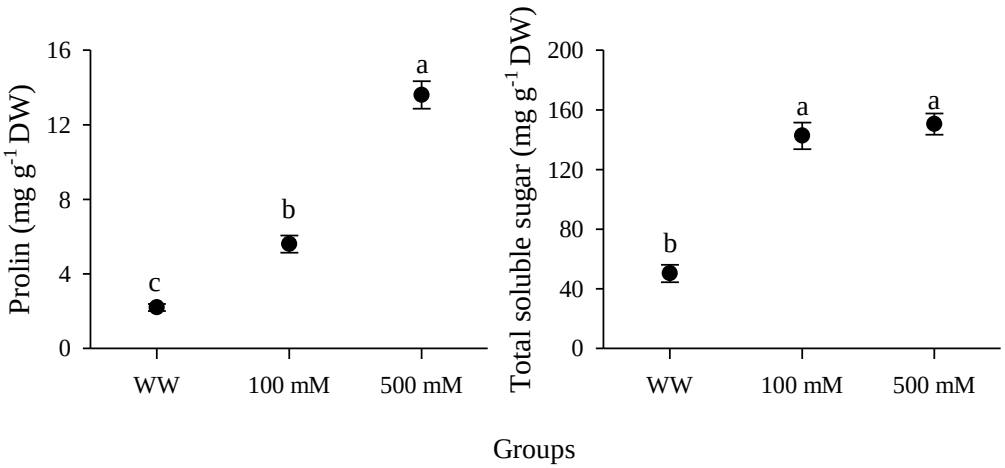

Figure 2 Changes of prolin and total sugar amounts in Inula under different concentrations of NaCl 100 mM (low salt) and 500 mM (high salt) exposure for 7 days. WW: well-watered control, 100 mM: 100 mM NaCl and 500 mM: 500 mM NaCl. Data were shown as the means of ± SD (N = 5). Different letters indicate significant differences between experimental groups (P < 0.05). Statistical analysis was carried out using one-way ANOVA followed by Tukey post-hoc test.

Degradation of Photosynthetic Pigments

Total chlorophyll level show significant decrease in leaves of inula plants subjected to 100 mM NaCl treatment but was disrupted by more than 50% in 500 mM NaCl treated plants (Figure 3). Both stress treatments caused significant reductions in carotenoid concentrations. Concerning carotenoid levels in the leaves of Inula plants undergoing salt stress treatments, 1.3-fold decrease was detected at 100 mM NaCl, and a 47% decrease after 500 mM NaCl treatment as compared to controls (Figure 3).

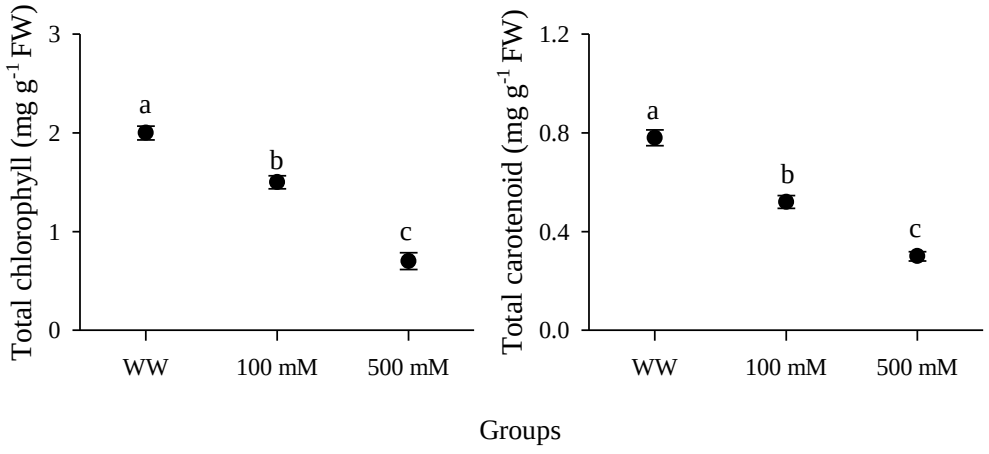

Figure 3 Changes in photosynthetic pigment contents of Inula under different concentrations of NaCl 100 mM (low salt) and 500 mM (high salt) exposure for 7 days. WW: well-watered control, 100 mM: 100 mM NaCl and 500 mM: 500 mM NaCl. Data were shown as the means of ± SD (N = 6). Different letters indicate significant differences between experimental groups (P < 0.05). Statistical analysis was carried out using one-way ANOVA followed by Tukey post-hoc test.

Antioxidant Enzyme Activity

As an expected picture generally, a major increase of all enzyme activities was obtained in response to salt stresses. SOD activity of inula plants under these different NaCl concentrations were given in Figure 4. About 51% and 67% increment in SOD activity was recorded in 100 and 500 mM NaCl treatments comparing to their control. However, there was no remarkable difference between the two NaCl dosages. GPOX activity significantly increased with increasing NaCl levels. GPOX activity was higher in 500 mM NaCl treated plants than that of 100 mM NaCl in terms of increasing ratio. For example, the activity was increased by 100% and 246% in 100 mM and 500 mM NaCl treatments as compared to control, respectively. Regarding APX activity, it increased by 240% under high salt (500 µM) and in low salt (100 µM) concentrations by 104% as compared to its control. At last, GR activity in Inula leaf extract, gave a concentration-dependent boost in response to salinity (about 118% higher than in its respective control) measured in the presence of 500 mM NaCl.

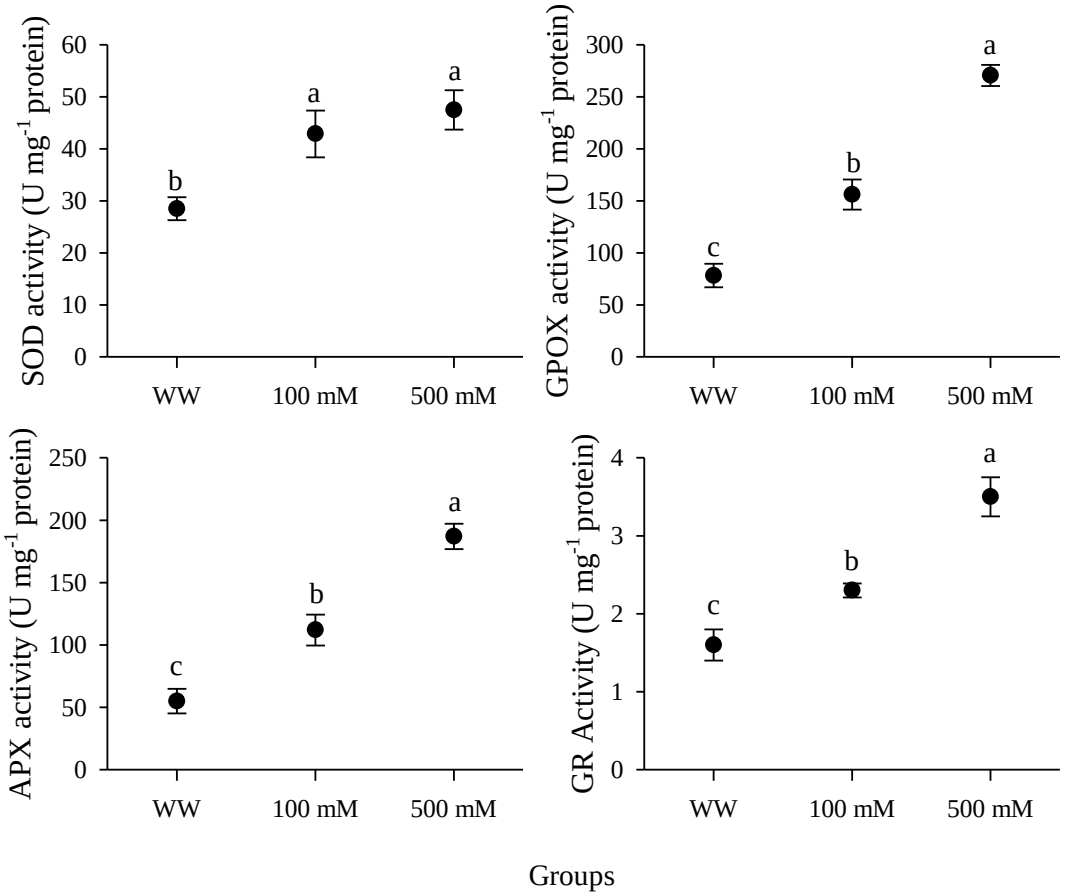

Figure 4 Changes of antioxidant enzymes SOD, GPOX, APX and GR activities of Inula under different concentrations of NaCl 100 mM (low salt) and 500 mM (high salt) exposure for 7 days. WW: well-watered control, 100 mM: 100 mM NaCl and 500 mM: 500 mM NaCl. Data were shown as the means of ± SD (N = 6). Different letters indicate significant differences between experimental groups ($P < 0.05$). Statistical analysis was carried out using one-way ANOVA followed by Tukey post-hoc test.

Discussion

It is a cornerstone in plant physiology that chlorophyll intactness in plants is directly related to plant health. Its concentration under salt stress is a sensitive indicator of the cellular metabolic state of the target plant. A decrease of chlorophyll concentration in many herbaceous and woody species under same saline environments has been reported by numerous researchers (Schiop et al., 2015; Taibi et al., 2016). A marginal reduction in chlorophyll content was detected in Inula plants subjected to two different concentrations of NaCl here in this study, was more obvious in the presence of high salt concentration. This situation appears to be a synergistic effect on the specific enzymes inhibition (i.e. Rubisco or PEP carboxylase) related to chlorophyll synthesis and the acceleration of degradation by the chlorophyllase (Kumar et al., 2017). Carotenoids, besides their role as accessory pigments which called "light-harvesting", have functions on protecting chlorophylls from photo-oxidative injury (Katarina et al., 2014). Carotenoid level was also affected in Inula by salinity meaning direct correlation between carotenoids and chlorophylls lead chlorophyll loss might be due to the carotenoids degradation. Kumar et al., (2017) detected remarkable decrements in chlorophyll and carotenoid contents in oleander plants exposed to salts, monitored more clearly in the presence of higher saline conditions.

MDA is known as a reliable biochemical marker indicating oxidative stress damage. Different salt concentrations generated oxidative stress in Inula here, as supported by the increased amounts of MDA and endogenous H_2O_2. The increments found in the amount of H_2O_2 and lipid oxidation have shown that oxidative stress occurs as a secondary stress in Inula plants. Salinity leads high levels of ROS in plant cells due to malfunction of electron transport chain and accumulated photo reducing power (Hossain and Dietz 2016). This excessive electro-chemical energy can be destroyedvia the Mehler reaction, which generates ROS, such as H_2O_2, besides membranes damages, mirrored in elevated EL and MDA levels (AbdElgawad et al., 2016).

Cellular antioxidant system and its activation is crucial for sustaining redox balance which is a need for salt adaptation or tolerance response in plants (Nikalje et al., 2018). The activities of the target antioxidant enzymes (SOD, GPOX, APX and GR) induced in parallel with increasing salinity. SOD is known as one of the most powerful antioxidants in the system (Sales et al., 2013). We determined that the total SOD activity in the leaves of Inula was greatly increased in both NaCl concentrations. As indispensable antioxidative enzymes, GPOX and APX catalyze H_2O_2 to water and oxygen reactions under stress (Gong et al., 2014). Here, high dose salt treatment induced a greater increase in both GPOX and APX activities. APX and GR also support cellular redox state, by catalyzing H_2O_2 to water and oxygen coupled to ascorbate oxidation, and the reduction of glutathione (GSSG) to GSH by a cofactor (NADPH). In our experiments, most likely that the activation of these enzymes the plants was counteracting higher ROS levels. The results also supported a well-known notion that this enzyme system is a defense arsenal under high salinity. Our results are in conformity with findings that different concentrations of table salt induced SOD, CAT and APX activities in *Nitraria tangutorum* (Yang et al., 2010).

Besides appreciable contribution of the APX, GPOX and GR enzymes in counterbalancing the damages caused by ROS, supporting capabilities of metabolites (ascorbate and glutathione) is creditable as well. Considering, cellular GSH and ASC reductants involved in the defense against ROS it was not a surprise to monitor GSH and ASC increases in leaves of stressed Inula plants. Present findings form a well correlation between GSH and GR activity in Inula exposed to different salinity. Changes in GR are likely to modulate total glutathione pool. Indeed, GR activity boosted with increasing NaCl levels. The fact that NaCl stress further induces activity of GR in Inula plants, might show involvement of different metabolic routes as well as maintaining high GSH levels in the plant tissues. It is also possible that other antioxidant molecules modulate/compensate for fluctiations in the glutathione amount (Kaur and Bhatla, 2016). Our data indicated that different salt stress treatments elevated the level of ASC gradually. Higher endogenous ASC is critical for sustainable antioxidant capacity due to its role in preserving APX activity (Zhou et al., 2009). The results suggested that the increases in GSH and ASC were essential for tolerance to salt stress-induced oxidative stress.

Proline and soluble sugars are for osmotic adjustment in a cell, thus can improve growth under stresses (Singh et al., 2015). In our study, the accumulation of proline showed a linear increase under two NaCl concentrations but this increase was higher in high salt (500 µM) in leaves of inula. Similar to our data, two Mediterranean halophytes (*Plantago crassifolia* and *Inula crithmoides*) showed that high proline accumulation contributes to osmotic balance under 450-600 mM NaCl (Pardo-Domènech et al., 2016). Increased proline level under salinity in the present work, can be because of the up-regulation of proline synthesis and degredation enzymes simultaneously. Indeed, proline accumulation under stress is either because of the upregulation of proline biosynthesis gene expressions (*P5CS, P5CR*) or because of down-regulation of the target genes in its degradation pathway (PDH silencing) (Marco et al., 2015). Sugar accumulation is an osmotic balance pathway as well permitting plants to maintain their storage reserves (Smeekens, 2000). By detecting total soluble sugar increase in parallel with the salt stress, showed that both solutes helped buffering the redox potential of the cell and protected the cellular structures against NaCl. Inula plants may adopted some mechanisms such as synthesizing more osmolytes to rapidly adapt to that NaCl levels. The increase in osmolytes might also be related to the the ion content status of the tissue. Nikalje et al, (2018) have also proved that both proline and TSS were positively correlated with Na increase and thus possible that pathways such as protection of integrity of membranes and/or improved stability of ion transporter proteins or channels might contribute to salt tolerance as well.

Conclusion

Inula leaves exhibited well organized responses to higher NaCl related to the induction of high osmolytes (proline and TSS) and antioxidant systems to ease NaCl damage. Especially, activation of GPOX, APX and GR and non-enzymatic antioxidants (GSH and ASC) accumulation contribute to fight the injurious effects of oxidative stress as expected. Although Inula is not mainly categorized as a halophyte genus, non-halophyte species as used in this study are nevertheless quite robust against high salt and species grown in this niche are suitable for use in pharmaceutical industries thanks to their NaCl tolerance capacity.

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RESEARCH ARTICLE

Spatial and Temporal Change Monitoring in Water Surface Area of Atikhisar Reservoir (Çanakkale, Turkey) by using Remote Sensing and Geographic Information System Techniques

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ABSTRACT

Spatial and temporal changes in surface area of Atikhisar Reservoir were monitored by using remote sensing and geographic information system techniques from 1975 to 2017. Satellite images were processed, analysed and manually digitized to reveal the changes in surface area of the reservoir. The results showed that total surface area of the reservoir was ranged between 1.72km^2 and 3.84km^2 during the monitoring period. Maximum increase in the surface area has been observed with 74.6% while maximum decrease has been observed with 31.8%. These fluctuations could be related with the climatic changes, natural and man-made processes such as sediment transportation, water leakages, excessive water exploitation for drinking, domestic or agricultural purposes, and human interventions along the reservoir. Therefore, surface area should be monitored continuously and all factors influencing the variation in surface area should be considered in decision making processes to support water sharing policy toward the management of water resources.

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Introduction

Reservoirs and lakes have significant role for hydrological cycle and they are used to water storage, irrigation, flood preventing, energy production, and moderating the impacts of the climate change. Reservoirs and lakes are affected by natural processes and human interventions. Significant changes have been observed in reservoirs and lakes worldwide such as variations in shape, size and ecology of reservoirs and lakes (Jiang et al., 2012; Feyisa et al., 2014; Pekel et al., 2016). The expansion of the surface areas was occurred in some part of the world caused by the snow melting and glacial melting due to rising temperature while decreasing of the surface areas was observed because of the global warming, increasing evaporation, and excessive water consumption.

Calculating lake surface area is more appropriate to understand the response of lake to variation in the hydrologic balance than depth and volume (Benson and Paillet, 1989). Monitoring spatial and temporal changes of water surface in lakes and reservoirs is one of the most important issue for both local and global scale within the last century. Reservoirs and lakes serve as a water supplier for the purposes of drinking, domestic usage, agricultural and anthropogenic activities. Therefore, water resources should be continuously monitored to ensure the sustainable exploitation of water from lakes and reservoirs. The management of water resources needs

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inclusive information on the water environment to make more appropriate action plans for supporting the improvement of water resources in a sustainable way (Voutilainen et al., 2007). In this context, remote sensing technologies provide comprehensive data for scientists and researchers on water resources.

Remote sensing of water resources became more important in recent decades due to the climate change and deteriorating ecology issues (Ekercin, 2007). Remote sensing systems can be used to provide historical spatial data with the advantages of acquisition frequency and synoptic capabilities (White and El-Asmar, 1999). Satellite imageries are used to determine the temporal changes in water resources and monitoring changes with satellite imageries makes it possible to achieve more successful results in a short time than traditional methods. Similarly, geographic information system (GIS) is an important technology that commonly applied in numerous fields including change monitoring in water resources and it is a crucial tool for extracting and analysing reliable information from satellite imageries. Therefore, integrating remote sensing data with GIS provides new base data for further analyses.

Monitoring of spatial and temporal changes using satellite images has globally become crucial for better understanding and explaining of environmental changes in the reservoirs. Spatial and temporal changes of water surface in lakes and reservoirs were monitored by several scientists (Sidle et al., 2007; El-Asmar et al., 2013; Abu-Faraj et al., 2014; Hossen et al., 2018; Ji et al., 2018; Tan et al., 2018; Yapiyev et al., 2019). There are few researches on change monitoring of water surface in lakes and reservoirs in Turkey (Akar et al., 2002; Reis and Yılmaz, 2008; Durduran, 2010; Avdan et al., 2013; Bahadır, 2013; Battal et al., 2016; Erener et al., 2016; Yücel and Turan, 2016; Sarp and Ozcelik, 2017; Topuz and Karabulut, 2018). However, there is no published paper on the monitoring of spatial and temporal changes in water surface area of Atikhisar Reservoir. This paper, therefore, aimed to monitor spatiotemporal changes in water surface area of Atikhisar Reservoir by using remote sensing and GIS technologies.

Materials and Methods

Study Area

Çanakkale is located in the north-western part of Turkey along the coasts of Aegean Sea. The city was divided by the Çanakkale Strait and located on both Asia and Europe continents. The climate in Çanakkale is typical transition climate which winter is rainy and cold, and summer is dry and hot (Kale 2017a). Atikhisar Reservoir (Figure 1) was built on Sarıçay Stream which it has its source from Ida Mountains and runs into Çanakkale Strait (Ejder et al., 2016a). The water storage was started in June 1975 in the reservoir. Atikhisar Reservoir is the only drinking water source for more than 130 thousand inhabitants. The reservoir supplies water for the purposes of drinking and irrigation to the people in the basin and it also serves for preventing floods. Normal water level was described as 61 m for the reservoir by The General Directorate of State Hydraulic Works (SHW). SHW also indicated that the surface area is 3 km^2 and volume is 40 hm^3 when the reservoir has normal water level. The reservoir is under pressure of agricultural activities and discharged wastes from rural areas (Akbulut et al., 2010; Selvi and Kaya, 2013). The climate of the basin is largely defined as transition climate by Koç (2001) and the basin shows mountainside characteristic that predominantly formed with Eosen-Oligosen andesite, tuffs, and dacite (Koç, 2007).

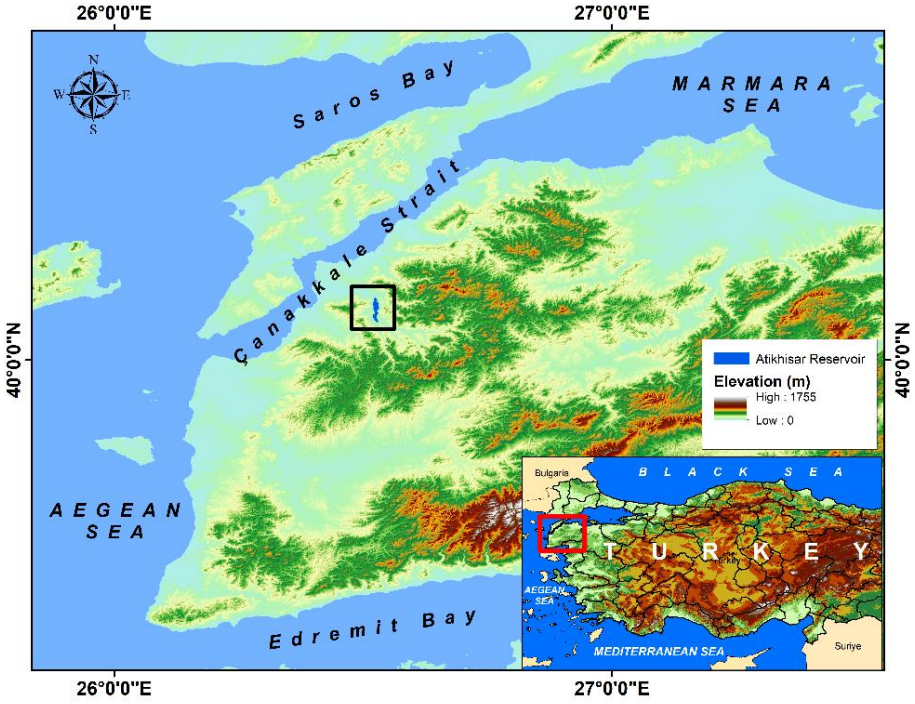

Figure 1 The location of Atikhisar Reservoir

Satellite Imageries

Satellite images are appropriate for monitoring and mapping of wetlands where information about wetland is unavailable and funds are limited (Ozesmi and Bauer, 2002). The most common satellites used to explore the Earth are Landsat satellites. Landsat makes available the longest continuously obtained assembly of space-based remote sensing data for earth surface. Satellite images used in the study were obtained from the United States Geological Survey (USGS) data archive at the same month (i.e., June) in each year between 1975 and 2017 to avoid inter-annual and seasonal variations (https://earthexplorer.usgs.gov). June was selected because of the reservoir gets started to storage water in June 1975. Remotely sensed satellite imageries were collected by satellites of Landsat Multispectral Scanner (MSS), Thematic Mapper (TM), Enhanced Thematic Mapper Plus (ETM+), and Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS). Spatial resolution is 60 m for MSS, 30 m for TM, ETM+, and OLI/TIRS while panchromatic band (band 8) has 15 m spatial resolution for both ETM+ and OLI/TIRS.

To perform image processing techniques, a digital database was created in GIS environment. Then, remotely sensed satellite images were imported and processed by using Erdas Imagine 2014 and ENVI 5.2 software. Radiometric and geometric corrections were executed and images were rectified using geographical projection with World Geodetic System 1984 (WGS84) datum. To extract the water surface area, shapefiles were generated for each images in ArcMap 10.3 software. The water surface area was detected for each images by using appropriate band combination and selection for each satellite sensors. Afterwards, water surface areas were digitized manually by delineating each water body for each time frame.

Results and Discussion

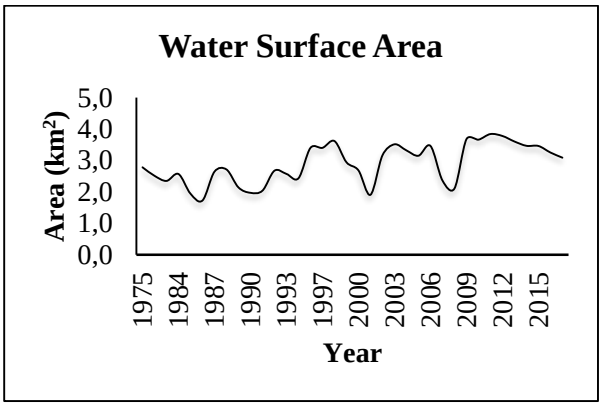

Figure 2 Temporal change in water surface area

Water surface areas were extracted from satellite images between 1975 and 2017. The changes in water surface area were presented in Figure 2. Total area of water surface was calculated 2.78 km^2 in the first year of water storage while 3.09 km^2 in 2017. Total area of the lake water surface ranged between 1.72 km^2 to 3.84 km^2 and minimum surface area was calculated in 1986 while maximum was calculated in 2011 (Figure 2).

Decrease and increase in the surface area were observed during the monitoring period. Maximum increase in the surface area has been observed in 2009 with 74.6% increase while maximum decrease has been observed in 2007 with 31.8% (Figure 3).

The results indicate a significant decreasing trend in surface area during the period between 1975 and 1986. Reservoir significantly lost its water surface area in 1986 with a 38% decrease when compared to the year 1975. Water surface area increased for a short term and decreased again in 1990. Surface area could not reach the initial amount until 1996 and it increased for 3 years between 1996 and 1998 as compared to 1975. Then, water surface area exhibited a sharp decrease in 2001. This decrease was calculated 47.3% when compared with 1998 and 31.5% when compared with the initial amount of area (Table 1).

Spatial and temporal changes in water surface area of Atikhisar Reservoir were presented in Figure 4 by thematic maps created in GIS environment. Figure 4 clearly demonstrates the changes in the water body for the monitoring period from 1975 to 2017.

Surface waters are essential part of the water cycle even though freshwater in lakes covers 0.007% of total water reserves on the earth while the total freshwater reserves account for 2.53% of the total global water reserves (Shiklomanov, 1993). Lakes and reservoirs are the most reachable and available water resources for human consumption and ecosystem (Abdallah et al., 2011). Henceforth, observation stations were built on lakes and reservoirs to observe and collect data for the management of water resources in many parts of the world. However, measurements in the field still require in situ effort, time, and relatively high cost. Nevertheless, several water resources located in the back of beyond have never been observed or measured. Even though observation stations existed in lakes and reservoirs, they commonly measured only water level of the resources while area and volume of the water resources could not measure. However, the measurement of both water surface area and volume of the resources is crucial to the best understanding the responses of water resources to the climate change on regional and global scale. In this respect, the progresses in the remote sensing and GIS technologies have provided novel approaches for monitoring water surface areas and levels of water resources to the scientists.

Numerous methods were used for detection and extraction of water bodies from satellite imageries (Dolan et al., 1991; Gao, 1996; McFeeters, 1996; Braud and Feng, 1998; Frazier and Page, 2000; Xu, 2006; Shen and Li, 2010; Feyisa et al., 2014). Water reflectance is closely equal to zero and has lower value than land in reflective infrared bands. Extracting water bodies can be easier because of darker appearance of water bodies (Raju et al., 2015). Shih (1985) recommended that using band 5 and band 7 could successfully classify the water surface of a lake. Furthermore, USGS stated that band 7 for MSS, band 5 for OLI/TIRS, and band 4 for TM, ETM+ were advantageous for mapping shorelines. In this paper, satellite images obtained

from Landsat have been successfully used to extract water surface area by combining and selecting appropriate bands.

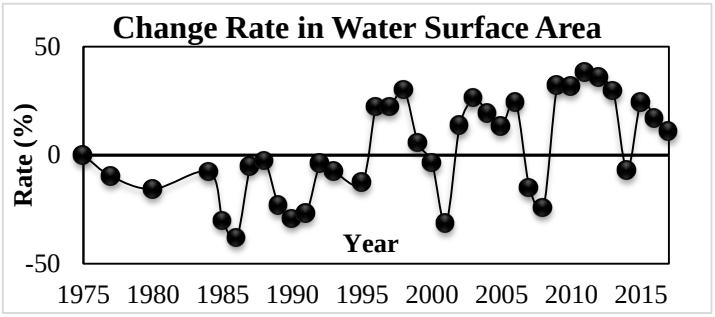

Figure 3 Change rate in water surface area compared to the initial area in 1975

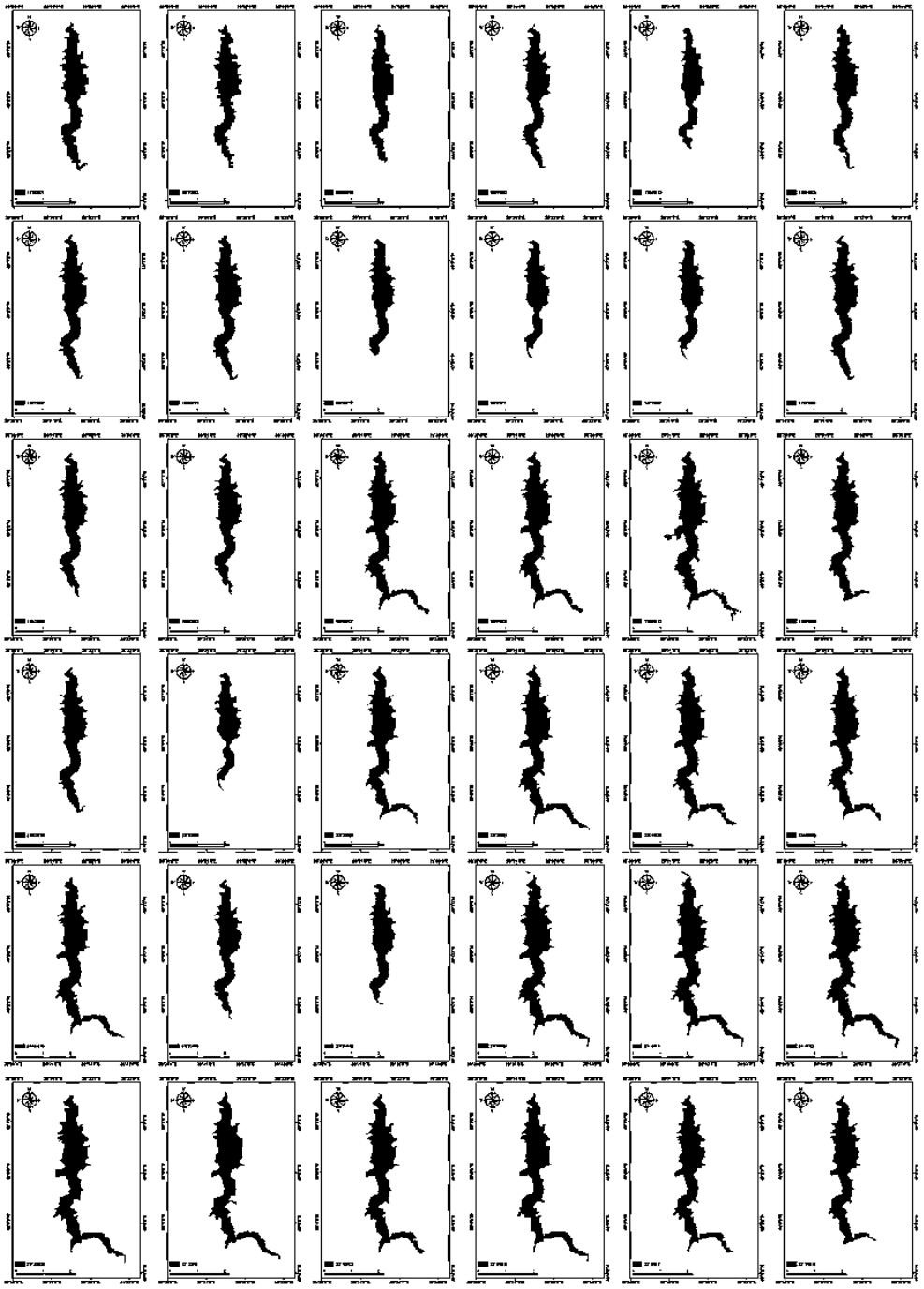

Figure 4 Spatial and temporal changes of water surface in Atikhisar Reservoir

Table 1. Lake surface area and areal change rates in Atikhisar Reservoir

Satellite	Image Date	Spatial Resolution	Surface Area (km^2)	Change Rate of Surface Area Compared with Initial Area (%)	Change Rate of Surface Area Compared with Previous Year (%)
Landsat 2 MSS	01.06.1975	60 m × 60 m	2.783	-	-
Landsat 2 MSS	21.05.1977	60 m × 60 m	2.511	-9.76	-9.76
Landsat 3 MSS	19.06.1980	60 m × 60 m	2.348	-15.63	-6.50
Landsat 5 TM	03.06.1984	30 m × 30 m	2.568	-7.70	9.39
Landsat 5 MSS	13.06.1985	60 m × 60 m	1.941	-30.24	-24.42
Landsat 5 TM	09.06.1986	30 m × 30 m	1.723	-38.07	-11.23
Landsat 5 TM	03.06.1987	30 m × 30 m	2.644	-4.99	53.42
Landsat 5 TM	05.06.1988	30 m × 30 m	2.713	-2.51	2.62
Landsat 5 TM	17.06.1989	30 m × 30 m	2.140	-23.10	-21.13
Landsat 5 TM	11.06.1990	30 m × 30 m	1.969	-29.24	-7.98
Landsat 5 TM	07.06.1991	30 m × 30 m	2.038	-26.76	3.50
Landsat 5 TM	25.06.1992	30 m × 30 m	2.674	-3.92	31.19
Landsat 5 TM	28.06.1993	30 m × 30 m	2.571	-7.61	-3.84
Landsat 5 TM	25.06.1995	30 m × 30 m	2.433	-12.58	-5.38
Landsat 5 TM	27.06.1996	30 m × 30 m	3.403	22.27	39.87
Landsat 5 TM	30.06.1997	30 m × 30 m	3.403	22.29	0.01
Landsat 5 TM	17.06.1998	30 m × 30 m	3.619	30.07	6.36
Landsat 5 TM	29.06.1999	30 m × 30 m	2.943	5.75	-18.69
Landsat 5 TM	15.06.2000	30 m × 30 m	2.683	-3.57	-8.82
Landsat 7 ETM+	10.06.2001	30 m × 30 m	1.906	-31.51	-28.97
Landsat 5 TM	21.06.2002	30 m × 30 m	3.165	13.75	66.08
Landsat 5 TM	24.06.2003	30 m × 30 m	3.516	26.34	11.08
Landsat 5 TM	26.06.2004	30 m × 30 m	3.320	19.32	-5.56
Landsat 5 TM	29.06.2005	30 m × 30 m	3.152	13.25	-5.08
Landsat 5 TM	16.06.2006	30 m × 30 m	3.464	24.49	9.92
Landsat 5 TM	10.06.2007	30 m × 30 m	2.361	-15.15	-31.84
Landsat 5 TM	12.06.2008	30 m × 30 m	2.107	-24.30	-10.79

Landsat 5 TM	24.06.2009	30 m × 30 m	3.679	32.19	74.64
Landsat 5 TM	11.06.2010	30 m × 30 m	3.664	31.66	-0.40
Landsat 5 TM	21.06.2011	30 m × 30 m	3.843	38.11	4.90
Landsat 7 ETM+	08.06.2012	30 m × 30 m	3.781	35.87	-1.62
Landsat 7 ETM+	11.06.2013	30 m × 30 m	3.605	29.56	-4.65
Landsat 8 OLI/TIRS	22.06.2014	30 m × 30 m	3.468	24.61	12.25
Landsat 8 OLI/TIRS	16.06.2015	30 m × 30 m	3.462	24.42	-3.96
Landsat 8 OLI/TIRS	11.06.2016	30 m × 30 m	3.254	16.93	-6.02
Landsat 8 OLI/TIRS	14.06.2017	30 m × 30 m	3.089	11.01	-5.06

Several researches have conducted to monitor the water surface area of the lakes and reservoirs by using remote sensing and GIS techniques. Zhu et al. (2014) monitored the fluctuation of Lake Qinghai using multi-source remote sensing data and they reported that surface area has increased 77 km^2 from 2003 to 2009. Sidle et al. (2007) assessed contemporary changes in water surface area of Lake Inle in Myanmar during the period from 1935 to 2000. Authors pointed out that a loss of 32.4% was occurred in monitoring period attributed to anthropogenic and agricultural activities ongoing in-lake and near-lake. El-Asmar et al. (2013) quantified the changes in surface area of Burullus Lagoon in Egypt between 1973 and 2001 by applying Normalized Difference Water Index (NDWI) and Modified Normalized Difference Water Index (MNDWI). Authors documented that 42.8% of the total surface area of the lake was declined for this period due to the anthropogenic activities. Abu-Faraj et al. (2014) calculated water surface area of the Dead Sea in Jordan for the period from 1984 to 2012. Authors indicated that water surface area declined from 679 km^2 to 620 km^2 during the monitoring period. Liu and Yue (2017) evaluated the changes in Lake Hulun in China between 1975 and 2015. Authors indicated that lake area fluctuated during this period and presented both decreasing and increasing trends. Hossen et al. (2018) evaluated the changes in surface area of Manzala Lake in Egypt. Authors noted that water surface area of the lake declined by 46% for the period between 1984 and 2015. Ji et al. (2018) investigated the changes in the surface area of Tonle Sap Lake in Cambodia from 2000 to 2014. Authors stated that water surface area showed an overall decreasing trend during this period. This reduction in the surface area of the lake was found to be related with runoff from river. Mohsen et al. (2018) detected changes in Lake Burullus using GIS and remote sensing. Authors reported that there was a significant decrease in the water area about 49% from 1972 to 2015. In addition, a rapid reduction was noticed in the surface area of the lake between 1972 and 1984. Tan et al. (2018) analysed areal changes of 24 lakes along the Silk Road from China to Europe. Authors indicated that surface areas of 15 lakes had decreased while areas of 9 lakes had increased from 2001 to 2016. Yapiyev et al. (2019) estimated water storage changes in small endorheic lakes in Northern Kazakhstan and they documented that total water surface area of the lakes reduced 7% from 1986 to 2016 although surface area of some smaller lakes had increased.

In Turkey, Akar et al. (2002) determined changes in surface area of Acıgöl and Urmia (in Iran) lakes by using different digital image processing techniques such as manual digitalization, semi-automatic vectorization, supervised classification, unsupervised classification, and object based classification methods. The results of all methods pointed out that water surface area of both lakes were reduced from 1975 to 2010. Ekercin and Örmeci (2008) explored the changes in water reserve of Tuz Lake and they indicated that water reserve has decreased markedly in the lake with a decrease of 43 ha. Reis and Yılmaz (2008) monitored changes in water of Seyfe Lake using remote sensing from 1975 to 2001 and stated that a decrease of 33% was observed in the water surface area of the lake for this period. Durduran (2010) investigated changes in the lakes of Beyşehir, Tersakan, Kulu, Suğla, Bolluk, Samsam, Tuz in Konya. Author reported that increases were detected in Bolluk and Samsam lakes while decreases were observed in Tersakan, Kulu, Beyşehir, and Tuz lakes. Furthermore, author pointed out that Suğla Lake was completely dried. Avdan et al. (2013) analysed temporal changes of water surface area in Akşehir Lake and documented that a decline of 43% was occurred in the water surface area of the lake for the period from 1984 to 2005. Bahadır (2013) determined spatial changes of Akşehir Lake and indicated that lake area was reduced from 354 km^2 to 119 km^2 between 1975 and 2010. This reduction was found to be affected by decrease in precipitation and streamflow on the contrary of increase in water consumption and evaporation. Şanlıyüksel Yücel et al. (2014) investigated change detection of acid mine lakes in Çan county (Çanakkale, Turkey) using satellite images and they reported that the numbers and total areas of acid mine lakes were increased from 1987 to 2011. Total area of all acid mine lakes reached maximum level of 12.42 ha in 2011. Authors have highlighted that the increase in total area and number of acid mine lakes lead to significant environmental risks such as fish death in the other surface waters. Erener et al. (2016) determined the changes in reservoir area of Yuvacık Dam Lake

in Kocaeli by applying of remote sensing and GIS technologies. Authors reported that water surface area had declined 10% from 2001 to 2005. Yücel and Turan (2016) analysed areal changes in two mine lakes in Çanakkale, Turkey. Authors reported a reduction in the total areas of the mine lakes from 25 ha to 21 ha between November 2014 and October 2015. They indicated that these changes in total areas of the lakes were attributed to mean precipitation. Sarp and Ozcelik (2017) assessed the spatiotemporal changes in water surface area of Lake Burdur and also compared different water body extraction methods such as Support Vector Machine (SVM) classification, NDWI, MNDWI, Automated Water Extraction Index (AWEI). Authors declared that a reduction of approximately 20% in water surface area was determined between 1987 and 2000 while a decrease by nearly 10% was observed from 2000 to 2011 in lake area. Consequently, a total of 32% decline was detected in water surface area of the lake. Şanlıyüksel Yücel and Yücel (2017) determined surface areas of mine lakes in abandoned coal mines of Çan coal basin in Çanakkale by using remotely sensed satellite imageries and unmanned aerial vehicle (UAV). Authors reported that total surface area of all lakes were decreased even two lakes were completely dried from 2013 to 2014. On the other hand, if these dried lakes are excluded from the calculation, total area of lakes found to be increased. The reasons for decrease and increase in the total area of lakes have been attributed to natural and anthropogenic processes such as erosion, precipitation, wind, mining activities, draining water to the stream.

In this paper, fluctuations were observed during the monitoring period in the water surface area of the reservoir. The minimum area has been calculated in 1986 while the maximum has been calculated in 2011. On the other hand, maximum decrease in the surface area has been observed in 2007 with 31.8% while maximum increase has been observed in 2009 with 74.6% increase. These changes could be related to the climatic changes such as rising temperature, declining precipitation, increasing evaporation, decreasing surface runoff and snow melting. Similarly, Kale (2017a) reported that the temperature had an increasing trend in addition to the document reported by Kale (2017b) claiming that evaporation had increasing trend in Çanakkale for future periods. Moreover, Ejder et al. (2016a) noted that annual streamflow of Sarıçay Stream was decreasing and streamflow presented a decreasing trend. Likewise, decreasing trends caused by the climate change have been reported for other rivers. For instance, Ejder et al. (2016b) reported that the streamflow of Kocabaş Stream showed a decreasing trend, Kale et al. (2016a) documented that Bakırçay River streamflow had a tendency to decrease, Kale et al. (2016b) stated that streamflow of Karamenderes River had a decreasing trend. Kale et al. (2018) reported that streamflow for Tuzla, Büyük Menderes, and Gediz Rivers presented decreasing trends. Kale and Sönmez (2018a) documented that streamflow of Akkaya Stream had decreasing trend. Kale and Sönmez (2018b) pointed out that the streamflow of Daday Stream tended to decrease. Sönnmez and Kale (2018) noted a significantly decrease in the streamflow of Filyos River. As seen in the literature, the climate change is commonly the driving force for the variations in the amounts of water resources. However, there are some other factors affecting the water resources beside the climate change such as anthropogenic activities (Gao et al., 2011; Jackson et al., 2011; Zhou et al., 2015), agricultural activities (Dügel and Kazanci, 2004; Yercan et al., 2004; Kaçan et al., 2007; Durdu, 2010), excessive consumption of water, and unsustainable usage of the water. Turkey is not a water rich country on the contrary to popular belief (Hisar et al., 2015). Therefore, water resources should be used in a sustainable way.

Reservoirs can also be used for fish production and recreational fisheries. It supplies extra economic income and employment opportunities by fish restocking activities in the reservoirs. Reservoirs present different horizontal and vertical characteristics in terms of primary productivity, physical habitat, and fish distribution (Kale and Acarli, 2018). Şaşı and Berber (2012) noted that coastal vegetation is predominantly key for keeping species alive to allow feeding, breeding, and growing activities in the reservoirs. Coastal vegetation presents variation according to the changes in water surface area and water level. Changes in water surface area of the reservoir may also affect the fish distribution, population structure, reproduction, feeding, survival rate, and habitat sharing by causing variations in bathymetric zone and shoreline.

The limitation of this study could be the only usage of single band selection to detect water bodies from satellite imageries. Some classification methods could be used for differentiating the water and land surfaces. However, actually, single band selection is not a weakness due to water has lower values (equivalent to zero) than land features. Both features were distinguished successfully from satellite images by single band selection. Lower valued pixels have demonstrated the water bodies in the available images and then shapefiles were digitized and extracted manually. Therefore, the limitation has been overcome. Furthermore, to extract water bodies from satellite imageries, different unsupervised (Isodata) and supervised (Maximum Likelihood, Mahalanobis Distance, Minimum Distance) classification methods, automated water extracting indices such as NDWI, MNDWI, AWEI, and Water Ratio Index (WRI) should be used and the results of these methods should be compared for further studies.

Conclusion

Atikhisar Reservoir provides water for the purposes of drinking, domestic usage, agricultural and other anthropogenic activities. It is of great importance since it is the only water resource in the basin. In this paper, spatial and temporal changes were monitored in water surface of the reservoir from the first construction time of the reservoir to the present time (1975-2017) by using remote sensing and GIS technologies. Satellite imageries provide historical data and the integration of remote sensing and GIS techniques has many advantages and benefits to monitor spatiotemporal changes. This paper presents the richest assessment for monitoring of spatial and temporal changes in surface area of Atikhisar Reservoir from the first construction time to the present. During the monitoring period, spatially decrease and increase were observed in water surface of the reservoir. These variations could be related with the climatic changes including rise in

temperature and evaporation on the contrary of decline in precipitation regimes, excessive water exploitation for drinking, domestic, or agricultural purposes, sediment transportation, and water leakages. Therefore, the relationships between water surface and other driving forces should be investigated in further studies. Moreover, continuously monitoring is compulsory for supporting decision-making processes to take measures or to establish appropriate water sharing policy toward ensure the sustainability of water resources in Atikhisar Reservoir. This paper also noticeably confirms that integrating remote sensing and GIS techniques is valued to extract better results from historical satellite imageries.

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RESEARCH ARTICLE

Financial Literacy in Agricultural Products Industry: The Case of Kastamonu

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ABSTRACT

The aim of this study was to reveal the literacy in banking sector of real or legal bank clients who have the right to take commercial and agricultural loans, have bank accounts and are operating in agricultural products industry in Kastamonu city center and districts, and which groups are more financially literate. In the study, the data was acquired by using face-to-face survey method with 400 real and legal persons who are operating in agricultural products industry, and it was determined that the financial literacy level of bank clients increase as the educational level increases. In the survey created in order to measure their knowledge about banking, among the answers given by those concerned, we have tried to determine problems that were considered to be related to each other. Considering the results obtained from the research, suggestions were developed, regarding what must be done in order to improve the banking sector literacy of bank clients in Kastamonu. The survey data indicate that the farmers are not attending to the banking sector at a professional level.

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Introduction

Banks have an important position in the financial markets. Having a significant place in every fields of our lives and constituting one of the foundation stones of the economy today, the basic function of banks is to establish connection and mediate between persons and organizations fund surplus and persons and organizations having funding need. While the banks carrying out their basic functions, they touch almost every point of social and economic life in order to provide profit and value maximization, and actively operate in the markets with their broad range of products.

Since banking activities have to act in unison with all sectors that direct the country economics, they exist where capital exists; that is why they dynamically continue their existence in every sectors that constitute basis for development of a country. They are in contact with both persons operating in agriculture, especially the agriculture and livestock sectors having a considerable share in our country's economy in regard to the significance of agriculture in Turkey, and legal persons.

In the study, we have tried to reveal whether the farmers, who operate in the production of agricultural products in Kastamonu city and its districts, benefit from banking products and services or not in order to make these activities sustainable. The information regarding the literacy level of individuals, who are engaged in farming and benefit from banking products and services, and for what purpose they use these products and services has been introduced as a result of the surveys conducted.

Materials and Methods

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Conceptual Framework

Financial literacy means that the people have enough knowledge to use and manage their money in the most efficient way. The main factor represented in financial literacy is the financial pillar of the correct use of scarce resources, which is also shaped in the nature and definition of economics. Financial literacy includes four important concepts. These concepts are income, spending, wealth and debt. From the perspective of banking, what is made of monetary aggregates or all liquidable financial assets can ben given as example for income; the expenditure arising from purchases and sales in financial transactions including taxes for spending; the interests of financial aggregates used, credit cards in particular, for debts; and financial aggregates for wealth. Financial literacy means for persons to have knowledge regarding money and capital markets in order to live in social wealth, to use this in the most efficient way, and to be in discipline and determination with required methods and knowledge. The ability to manage the situations of having liabilities and receivables before banks and to be familiar with basic concepts in banking sector constitute the outlines of the conceptual framework. Individuals who want to improve themselves on the financial literacy should pay attention to the concept of literacy under three main topics:

- Managing the money
- Choosing financial products and services
- Making savings

Within the above-mentioned conceptual framework, in terms of financial literacy, what banking sector expects from the ones with fund surplus and the ones with funding need is based on the principles that the communication is clear, the desired outcomes are achievable, the goals are realistic and the stakeholders share their wishes openly.

Agricultural sectors, on the other hand, have great importance on the economy for the reasons that they meet the food needs, provide raw materials for agro-industries, provide employment and reduce foreign dependency. In order to sustain the agricultural economy, it is a necessity for all stakeholders, especially the individuals who operate in the sector, live in villages and provide for themselves by these means, to basically understand or interpret the law, regulations, rights and processes of funding amounts and conditions, organizations and institutions for the production of goods and services. "Daily agricultural life" depending on the sustainability of financial power required has an important place in the information chain of banks, who are the most easily accessible mediators for the continuance of this power. The main purpose for taking loans is to provide inputs in sufficient amount with the loan taken and to ensure the production amount and sustainability (Aksu, 2012).

Agricultural subsidies in our country are mostly provided by the projects supported by the government and state banks who participate in their funding processes. Cooperatives and unions have been seen as a tool by the state in order to support the agriculture, and been effective in the funding of traditional Turkish agriculture and in the development of funding. Along with the fast-growing banking sector, many public or private banks provide subsidies in suitable terms in order to support farmers (Özçelik et al., 2005).

Forming the basis for the study, the sample is Kastamonu, a city located in Karadeniz Region of our country, where loans for agriculture and livestock are used quite intensively. Despite the fact that 59% of the lands of Kastamonu are woodlands and heaths, it is known that the total agricultural area is 367,445 hectares. 123,891 hectares of this area is suitable for dry farming and 243,554 hectares area is suitable for irrigable farming. In Kastamonu that is not completely under the influence of Karadeniz climate, the important agricultural products produced are wheat, barley, potato, sugar beet and garlic(www.kastamonutarim.com).

When it is examined in terms of banking sector, according to Türkiye Bankalar Birliği (The Banks Association of Turkey) data, there are 184 ATMs of banks having 9577 member businesses around the city and 7 banks are operative with 567 employees. Total deposit is 1,484,881 (thousand) TL and 558,202 (thousand) of which is from agricultural sector.

Literature

Kofarmata (2016) attests that poorer farmers are more likely to be excluded from the credit market than better-off households. Consequently, the finding in the credit market model recommends that there is need to build trust, encourage commercial farming, apply modern farming tools, strengthen property rights and increase financial literacy among farmers Lalrinmawia and Gubta (2015) examines the level of financial literacy among farmers of Lunglei district India. A survey of 320 farmers all over the district of Lunglei had been conducted. Das (2016) approaches adopted in measuring the level of financial literacy in different studies and finally an analysis is carried out on determinants of financial literacy level among different groups of people. Gaurav and Singh (2012) assesses the financial literacy and cognitive ability of farmers using data from a unique field experiment in the Indian state of Gujarat. Using ordered response models, the effect of farmers' education on cognitive ability and financial literacy is estimated on the one hand, and the relationship between cognitive ability and financial literacy is analysed on the other. Cole et. Al. (2009) show that Önancial literacy is a powerful predictor of demand for Önancial services. Schuchardt et. Al. (2009) identify critical research questions that could inform outcomes-based financial education, relevant public policy, and effective practice leading to personal and family financial literacy. Lusardi et. Al. (2010) examined financial literacy among the young showed that financial literacy is low. Akdağ (2018) has examined the factors affecting the decisions of individual investors in TR81 level 2 cities (Bartın, Karabük Zonguldak). While Aydın and Ağan (2018) have investigated the effect of irrational decisions on financial investment choices, Bayrak and Pelenk (2018) have established their research sample on the financial literacy levels of the students of Recep Tayyip Erdoğan University, and Bayrakdaroğlu and Bilge (2018) have researched the effect of financial education on financial literacy in women. Berekeci and Arıçay (2018) have conducted a field research on Islamic financial literacy at Kahramanmaraş Sütçü İmam University; and Conturk (2018) has evaluated the factors that affect the

familiarity level of students of Muğla Sıtkı Koçman University with financial matters. While Durmuş and Yardımcıoğlu (2018) have studied on financial literacy through theology students, Güney and Tanyıldızı (2016) have conducted a field research regarding tradesmen and craftsmen of Ağrı city. Kanmaz (2018) and Karyağdı (2018) have respectively tried to measure the literacy of individual equity share investors and the level of financial awareness of students of Bitlis Eren University Vocational School of Health Sciences. While Sakınç (2018) have addressed the importance of financial literacy in evaluating the savings, Sebetçi (2018) have researched the relationship between mobile applications and financial literacy.

Data Set and Method

In the study, the data was obtained by face-to-face survey method, conducted on 400 real and legal persons operating in agricultural products sector in Kastamonu. The data has been analyzed by using T test and ANOVA test with the help of SPSS 22 statistics package software. While conducting ANOVA test in this study, Lenave statistics was used in order to obtain data regarding whether intergroup variants had been distributed ordinarily. According to the Leneve statistics, it was determined that intergroup variants had not been distributed equally. In the study, Tamhane's T2 and Thamhane's T3 test statistics have been utilized. In cases where intergroup variants are not equal, post-hoc statistics to be used change. Statistics to be used in this case: Games-Howell, Tamhane's T2, Tamhane's T3, Dunnet's C and Dunnet's T3; and they are only processed as "multiple test" (Sparks, 1963).

Results and Discussion

Table 1. Demographic characteristics of participants

	Frequency	Percentage
Gender		
Male	346	86.5
Female	54	13.5
Age		
Ages 18-30	23	5.8
Ages 31-45	169	42.3
Ages 46-55	103	25.8
Ages 56-65	49	12.3
65 and older	56	14.0
Educational Status		
Primary School	175	43.8
Secondary school	88	22.0
High School	118	29.5
Associate Degree	5	1.3
License	14	3.5
Experience in the Sector		
10 years and less	105	26.3
11-20 Years	114	28.5
21-30 Years	91	22.8
31-40 Years	56	14.0
More than 40 years	34	8.5

According to the Table 1, 13.50% of participants are males and 86.50% females. The vast majority of participants are males. When the graph regarding the ages of participants is reviewed; it is seen that 5.75% are between ages 18–30, 42.25% between ages 31–45, 25.75% between ages 46–55, 12.25% between ages 56–65, and 14% age 65 and above. When the graph regarding the educational status of participants is reviewed; 45.75% of the participants stated that their educational level is primary education, 22% secondary education, 29.5% high school education, 1.25% associate degree, and 3.50% license education. 26.25% of the participants stated that they have been operating in their sector for 10 or less years, 28.50% between 11-20 years, 22.75% between 21-30 years, 14% between 31-40 years and 8.50% 40 or more years.

According to research data, 55% of the participants prefer public banks and 44.8% prefer private banks. We observe that the most important factor affecting the bank preferences of clients is interest rates. It is seen that, in addition to the interest rates, the advice from clients' acquaintances and the bank products are also effective on clients' preferences. The vast majority of clients perform loan transactions most frequently at banks. It appears that another transaction performed intensively at banks is deposits and withdrawals. The majority of bank clients have stated that they do not experience any problems with their banks.

The vast majority of participants who use credit cards expressed that they have 1 or 2 credit cards. It is noteworthy that 23.5% of the clients using credit cards do not know whether an annual operating fee is cut from their credit cards. 72.8% of credit card users stated that they sometimes or never check their expenditure bills. This situation indicates that the clients are vulnerable to be abused. Consumer's loan and agricultural loans come to the forefront as loan types that bank clients generally prefer. It is seen that the clients mostly receive their monthly receipts via mail. 23.8% of clients have stated that they do not receive their monthly receipts. Failure of clients who do not follow-up their receipts to check their account activities may cause delays for them to intervene to mistakes caused by banks, or may expose them to credit card frauds.

Bank clients in general have stated that the transactions regarding their businesses are performed under their control. It is seen that 56.3% of the clients do not have information about how to claim their rights in cases where they have problems with banks. It is necessary to increase the level of knowledge of clients about claiming their rights. It appears that the vast majority of bank clients (86.5%) are not aware of Credit Bureau nor Findex, which monitor whether they meet the required conditions for them to be able to take loans. 66.3% of bank clients have stated that they have active loan payments, and 33.8% of them have stated that they have no active loan payments. While 70.8% of the clients using credit cards check their receipts, 29.3% of them have stated that they do no check the receipts.

A large proportion of bank clients (90.3%) have stated that they do not benefit from the services provided by banks, equity shares, securities and the like capital market instruments.

Table 2. Descriptive statistics

Basic Variable	Sub Variable	Percentage %
Which bank do you work with the most?	Public Sector	55.3
	Private	44.8
Why do you prefer this bank?	Interest rates	50.5
	Products	14.8
	Accessibility	2.0
	Advice of an acquaintance	22.5
	Interest free banking	1.5
	Attention of employees	8.8
What transaction do you do the most?	Loan transactions	60.5
	Deposit operations	11.3
	Deposits-withdrawals	28.2
What is the most significant problem that you have experienced with your bank?	None	70.8
	Loan transactions	6.5
	Mortgage Transactions	3.5
	Insufficient branches	7.5
	Lack of briefing	6.3
	Intensity	5.5
How many credit cards do you have?	None	11.5
	One	35.3
	Two	30.3
	Three	12.8
	Four	5.3
	Five or more	5.0
Do they apply annual operating fee for your credit card?	Yes	42.8
	I don't know	23.5
	No	33.8
Do you check the slip coming out of the machine when you do purchases with your credit card?	Yes	42.3
	Sometimes	30.5
	No	27.3
What type of loans do you prefer most frequently?	Consumer's	30.5
	Agriculture	48.3
	Other	21.3
How do you receive your receipt?	By mail	51.7
	Electronically	24.5
	I do not receive any receipts	23.8
Do you personally handle the bank transactions regarding your business?	Yes	66.5
	Sometimes	30.5
	No	3.0
Do you know where to apply when you have a problem with banks?	Yes	43.8
	No	56.3
Do you know what Credit Bureau or Findeks are?	Yes	13.5
	No	86.5
Do you have any existing loans?	Yes	66.3
	No	33.8
Do you check the monthly receipt that you receive when you learn about your credit card debts?	Yes	70.8
	No	29.3
Do you benefit from capital market instruments such as stock bonds and securities etc.?	Yes	9.8
	No	90.3
Do you read the documents that you sign at banks?	Yes	36.8
	No	63.2
Does the gender of officer serving you at the bank matter to you?	Yes	23.5
	No	76.5
Does the age of officer serving you at the bank matter to you?	Yes	26.8
	No	73.3
Does it matter to you whether the officer serving you at bank is from Kastamonu?	Yes	41.8
	No	58.3
Do you use online banking?	Yes	28.5
	No	71.5
Do you use mobile banking via your mobile phone?	Yes	30.0
	No	70.0
Do you have a private retirement fund or a health insurance at a bank?	Yes	33.3
	No	66.8
Are you familiar with the North Anatolian Development Agency and its activities?	Yes	27.3
	No	72.8
Are you familiar with the Institution for Supporting Agriculture and Rural Development and its activities?	Yes	61.5
	No	38.5

36.8% of bank clients have stated that they read the documents that they sign; 63.2% of them have stated that they do not. Clients failing to read the documents that they sign indicate that they are not aware of their legal obligations. Such costumers are likely to experience problems with banks. Bank clients in general have stated that the gender, age or hometown of the personnel serving them at bank do not matter to them. It is seen that the bank clients prefer to perform their transactions directly through bank and ATMs more, and they do prefer Internet and mobile banking less.

It is evident that the bank clients in general are not aware of NADA (North Anatolian Development Agency) taking part in regional development and its activities. At the same time, the clients in general have stated that they are aware of the Institution for Supporting Agriculture and Rural Development and its activities.

Table 3. T test table regarding gender variable

	Gender	N	$\bar{x}$	Standard Deviation	t	sd	p
Which bank do you work with the most?	Male	346	1.4422	.49737	-.539	398	.590
	Female	54	1.4815	.50435			
Why do you prefer this bank?	Male	346	2.2746	1.66543	-2.586	398	**.010**
	Female	54	2.9074	1.71858			
What transaction do you do the most?	Male	346	1.9711	1.31624	-3.563	67.151	**.001**
	Female	54	2.7222	1.45909			
What is the most significant problem that you have experienced with your bank?	Male	346	1.8902	1.56763	.166	398	.868
	Female	54	1.8519	1.62999			
How many credit cards do you have?	Male	346	1.8410	1.29241	1.665	398	.097
	Female	54	1.5370	.90518			
Do they apply annual operating fee for your credit card?	Male	346	1.9480	.86989	2.218	398	.027
	Female	54	1.6667	.84675			
Do you check the slip coming out of the machine when you do purchases with your credit card?	Male	346	1.8671	.83386	1.052	398	.294
	Female	54	1.7407	.73164			
What type of loans do you prefer most frequently?	Male	346	1.8815	.69812	-1.848	398	.065
	Female	54	2.0741	.79745			
How do you receive your receipt?	Male	346	1.6734	.81311	-2.890	398	.004
	Female	54	2.0185	.83532			
Do you personally handle the bank transactions regarding your business?	Male	346	1.3179	.52483	-4.513	398	.000
	Female	54	1.6667	.54944			
Do you know where to apply when you have a problem with banks?	Male	346	1.5636	.49666	.110	398	.912
	Female	54	1.5556	.50157			
Do you know what Credit Bureau or Findeks are?	Male	346	1.8902	.31313	2.871	60.862	.006
	Female	54	1.7037	.46091			
Do you have any existing loans?	Male	346	1.3092	.46285	-2.867	67.669	.006
	Female	54	1.5185	.50435			
Do you check the monthly receipt that you receive when you learn about your credit card debts?	Male	346	1.2861	.45260	-.708	398	.479
	Female	54	1.3333	.47583			
Do you benefit from capital market instruments such as stock bonds and securities etc.?	Male	346	1.9104	.28601	1.144	63.951	.257
	Female	54	1.8519	.35858			
Do you read the documents that you sign at banks?	Male	346	1.6358	.48189	.350	398	.727
	Female	54	1.6111	.49208			
Does the gender of officer serving you at the bank matter to you?	Male	346	1.7775	.41656	1.365	66.711	.177
	Female	54	1.6852	.46880			
Does the age of officer serving you at the bank matter to you?	Male	346	1.7457	.43612	1.400	67.238	.166
	Female	54	1.6481	.48203			
Does it matter to you whether the officer serving you at bank is from Kastamonu?	Male	346	1.5780	.49459	-.457	398	.648
	Female	54	1.6111	.49208			
Do you use online banking?	Male	346	1.6879	.46404	-4.032	92.723	**.000**
	Female	54	1.8889	.31722			
Do you use mobile banking via your mobile phone?	Male	346	1.7052	.45661	.574	398	567
	Female	54	1.6667	.47583			
Do you have a private retirement fund or a health insurance at a bank?	Male	346	1.6908	.46285	2.359	67.669	**.021**
	Female	54	1.5185	.50435			
Are you familiar with the North Anatolian Development Agency and its activities?	Male	346	1.7110	.45396	-2.157	79.202	**.034**
	Female	54	1.8333	.37618			
Are you familiar with the Institution for Supporting Agriculture and Rural Development and its activities?	Male	346	1.3584	.48022	-2.789	398	**.006**
	Female	54	1.5556	.50157			

($p<0.05$)

According to the T test table regarding the opinions of participants in terms of banking sector associated with gender variable; while male clients make their bank choices mostly based on the interest rates, female clients make their bank choices based on variables such as the attention of personnel and number of branches. While male clients are more interested in loan transactions, female clients are more interested in money deposit and withdrawal transactions. The level of awareness of male clients regarding whether an annual operating fee is cut is lower compared to female clients. According to the data regarding in what way the bank clients receive their receipts; while male clients mostly prefer receipts sent by mail, female clients mostly prefer electronic receipts. It has been determined that male clients personally attend to bank transactions of their businesses but female clients prefer other people. The level of knowledge of male participants about Credit Bureau and Findeks is higher compared to female participants. According to the averages of situations regarding whether the clients have an active loan payments; it has been determined that male clients have more loan payments than female clients. According to the averages regarding the use of Internet banking by bank clients; it has been determined that male clients use Internet banking more than female clients do. It is observed that more female bank clients are included in private retirement funds or health insurances than male bank clients. It is seen that male participants are aware of NADA's (North Anatolian Development Agency) activities more than female participants are. Male participants are aware of institutions that provide support for development, such as the Institution for Supporting Agriculture and Rural Development, more than female participants are.

Table 4. ANOVA test regarding age variable

		N	$\bar{x}$	Standard Deviation	Sum of Squares	df	Average of Squares	F	p
What transaction do you do the most?	Ages 18 - 30	23	2.6957	1.42812	21.043*	4	5.261	2.903	.022
	Ages 31 - 45	169	2.0118	1.33179	715.854**	395	1.812		
	Ages 46 - 55	103	2.2816	1.45128	736.898***	399			
	Ages 56 - 65	49	1.9184	1.30443					
	Age 65 and above	56	1.7500	1.17937					
	Total	400	2.0725	1.35899					
What is the most significant problem that you have experienced with your bank?	Ages 18 - 30	23	3.0000	1.95402	41.595	4	10.399	4.337	.002
	Ages 31 - 45	169	1.9822	1.69900	947.115	395	2.398		
	Ages 46 - 55	103	1.6602	1.31770	988.710	399			
	Ages 56 - 65	49	1.5306	1.11993					
	Age 65 and above	56	1.8571	1.60032					
	Total	400	1.8850	1.57416					
Do you check the slip coming out of the machine when you do purchases with your credit card?	Ages 18 - 30	23	1.6522	.71406	8.599	4	2.150	3.261	.012
	Ages 31 - 45	169	1.7574	.77557	260.401	395	.659		
	Ages 46 - 55	103	1.8252	.82161	269.000	399			
	Ages 56 - 65	49	2.1837	.88208					
	Age 65 and above	56	1.9643	.87312					
	Total	400	1.8500	.82109					
What type of loans do you prefer most frequently?	Ages 18 - 30	23	1.5652	.84348	5.979	4	1.495	2.988	.019
	Ages 31 - 45	169	1.8284	.74011	197.599	395	.500		
	Ages 46 - 55	103	2.0194	.69987	203.578	399			
	Ages 56 - 65	49	2.0204	.59476					
	Age 65 and above	56	1.9821	.64642					
	Total	400	1.9075	.71430					
Do you know where to apply when you have a problem with banks?	Ages 18 - 30	23	1.1739	.38755	7.269	4	1.817	7.874	.000
	Ages 31 - 45	169	1.4970	.50148	91.168	395	.231		
	Ages 46 - 55	103	1.7282	.44709	98.437	399			
	Ages 56 - 65	49	1.6327	.48708					
	Age 65 and above	56	1.5536	.50162					
	Total	400	1.5625	.49670					
Do you know what Credit Bureau or Findeks are?	Ages 18 - 30	23	1.5217	.51075	3.386	4	.847	7.719	.000
	Ages 31 - 45	169	1.9231	.26726	43.324	395	.110		
	Ages 46 - 55	103	1.8350	.37304	46.710	399			
	Ages 56 - 65	49	1.8776	.33120					
	Age 65 and above	56	1.8750	.33371					
	Total	400	1.8650	.34215					
Do you have any existing loans?	Ages 18 - 30	23	1.4783	.51075	3.160	4	.790	3.617	.007
	Ages 31 - 45	169	1.3195	.46768	86.277	395	.218		
	Ages 46 - 55	103	1.2233	.41849	89.438	399			
	Ages 56 - 65	49	1.4286	.50000					
	Age 65 and above	56	1.4643	.50324					
	Total	400	1.3375	.47345					
Do you benefit from capital market instruments such as stock bonds and securities etc.?	Ages 18 - 30	23	1.8261	.38755	1.591	4	.398	4.675	.001
	Ages 31 - 45	169	1.9349	.24742	33.607	395	.085		
	Ages 46 - 55	103	1.9612	.19415	35.198	399			
	Ages 56 - 65	49	1.7959	.40721					
	Age 65 and above	56	1.8214	.38646					
	Total	400	1.9025	.29701					

Table 4. (continued)

		N	$\bar{x}$	Standard Deviation	Sum of Squares	df	Average of Squares	F	p
Do you read the documents that you sign at banks?	Ages 18 - 30	23	1.2609	.44898	5.763 87.215 92.978	4 395 399	1.441 .221	6.525	.001
	Ages 31 - 45	169	1.5680	.49682					
	Ages 46 - 55	103	1.7379	.44195					
	Ages 56 - 65	49	1.6939	.46566					
	Age 65 and above	56	1.7321	.44685					
	Total	400	1.6325	.48273					
Does the age of officer serving you at the bank matter to you?	Ages 18 - 30	23	1.6522	.48698	3.161 75.217 78.378	4 395 399	.790 .190	4.150	.001
	Ages 31 - 45	169	1.6391	.48170					
	Ages 46 - 55	103	1.8058	.39750					
	Ages 56 - 65	49	1.8163	.39123					
	Age 65 and above	56	1.8393	.37059					
	Total	400	1.7325	.44321					
Do you use online banking?	Ages 18 - 30	23	1.1739	.38755	7.767 73.743 81.510	4 395 399	1.942 .187	10.401	.003
	Ages 31 - 45	169	1.7041	.45778					
	Ages 46 - 55	103	1.7961	.40485					
	Ages 56 - 65	49	1.7755	.42157					
	Age 65 and above	56	1.7679	.42602					
	Total	400	1.7150	.45198					
Do you use mobile banking via your mobile phone?	Ages 18 - 30	23	1.3478	.48698	5.612 78.388 84.000	4 395 399	1.403 .198	.198	.001
	Ages 31 - 45	169	1.6450	.47994					
	Ages 46 - 55	103	1.7282	.44709					
	Ages 56 - 65	49	1.7959	.40721					
	Age 65 and above	56	1.8750	.33371					
	Total	400	1.7000	.45883					

* Intergroup ** Intragroup *** Total ($p<0.05$).

As a result of the variance analysis conducted for investigating the bank attitudes of bank clients from different age groups; It was determined that the average of the group aged 65 and above has the lowest result compared to other groups. When the reasons for preference and group averages are correlated, it has been concluded that the group aged 65 and above are more interested in loan transactions. According to the data regarding the most significant problems that clients experience with banks; it is clearly seen that the bank clients aged between 18 - 30 experience more problems than other groups do. Based on the group averages, it has been concluded that the more the age level is the less the slips given after shopping are checked. According to the group averages regarding the type of loans preferred by clients most frequently; it has been determined that the bank clients aged between 18 - 30 use more consumer's loan compared to other age groups. According to the group averages regarding whether the bank clients know where to apply when they have problems with banks; it has been concluded that the bank clients in age groups of 18 - 30 and 46 - 55 have less knowledge compared to the clients in other age groups. It has been determined that the bank clients in the age group of 15 - 30 are more aware of the credit rating agencies than the bank clients in other age groups are. It has been determined that the bank clients aged between 46-55 have more loan payments compared to bank clients in other age groups. It has been determined that the bank clients aged between 56-65 benefit from capital market instruments provided to them by banks, such as equity shares, securities etc., more than the bank clients in other age groups do. It has been determined that the bank clients aged below 45 read the documents that they sign at banks more than the bank clients aged above 45 are. It has been concluded that the clients aged 31 - 45 are more interested in the age of bank personnel serving them than the clients in other age groups are. According to the group averages of customers; it has been determined that the clients aged 18 - 30 use internet banking more than the clients in other age groups do. It has been determined that the clients aged 18 - 30 use mobile banking more than the clients in other age groups do.

Table 5. ANOVA test regarding educational status

		N	$\bar{x}$	Standard Deviation	Sum of Squares	df	Average of Squares	F	p
Why do you prefer this bank?	Primary School	175	2.0686	1.48784					
	Secondary school	88	2.2159	1.60064					
	High School	118	2.9407	1.86874	66.000	4	16.500	6.113	.000
	Associate Degree	5	1.0000	.00000	1066.160	395	2.699		
	License	14	2.5000	1.95133	1132.160	399			
	Total	400	2.3600	1.68449					
Do you check the slip coming out of the machine when you do purchases with your credit card?	Primary School	175	2.1543	.83334					
	Secondary school	88	1.6136	.73394					
	High School	118	1.5932	.73073	32.828	4	8.207	13.726	.000
	Associate Degree	5	1.0000	.00000	236.172	395	.598		
	License	14	2.0000	.67937	269.000	399			
	Total	400	1.8500	.82109					
Do you know where to apply when you have a problem with banks?	Primary School	175	1.7429	.43831					
	Secondary school	88	1.5455	.50078					
	High School	118	1.3729	.48563	13.240	4	3.310	15.347	.000
	Associate Degree	5	1.0000	.00000	85.197	395	.216		
	License	14	1.2143	.42582	98.438	399			
	Total	400	1.5625	.49670					
Do you read the documents that you sign at banks?	Primary School	175	1.6857	.46556					
	Secondary school	88	1.6364	.48380					
	High School	118	1.5254	.50148	2.562	4	.640	2.798	.026
	Associate Degree	5	1.6000	.54772	90.416	395	.229		
	License	14	1.8571	.36314	92.977	399			
	Total	400	1.6325	.48273					
Do you have a private retirement fund or a health insurance at a bank?	Primary School	175	1.6686	.47208					
	Secondary school	88	1.6932	.46382					
	High School	118	1.6949	.46241	4.553	4	1.138	5.338	.000
	Associate Degree	5	2.0000	.00000	84.224	395	.213		
	License	14	1.1429	.36314	88.777	399			
	Total	400	1.6675	.47170					
Are you familiar with the North Anatolian Development Agency and its activities?	Primary School	175	1.8343	.37289					
	Secondary school	88	1.6818	.46844					
	High School	118	1.6356	.48332	5.468	4	1.367	7.313	.000
	Associate Degree	5	2.0000	.00000	73.830	395	.187		
	License	14	1.3571	.49725	79.298	399			
	Total	400	1.7275	.44580					
Are you familiar with the Institution for Supporting Agriculture and Rural Development and its activities?	Primary School	175	1.3943	.49010					
	Secondary school	88	1.5114	.50274					
	High School	118	1.2966	.45871	2.751	4	.688	2.954	.020
	Associate Degree	5	1.4000	.54772	91.959	395	.233		
	License	14	1.2143	.42582	94.710	399			
	Total	400	1.3850	.48720					

($p<0.05$)

According to the ANOVA test table regarding the investigation and correlation of educational status and bank clients' behavior; It has been determined that the clients with primary and secondary educational status are more interested in interest rates than the clients in other groups are. According to the group averages of the bank clients; when the educational status and the shopping slip checking situation are correlated, it has been concluded that the more the educational level is the more the slip checking rate increases. When the bank clients' educational status and behavior regarding where to apply when they have problems with banks are correlated, it has been determined that the more the educational level is the more the awareness level of clients increases. It has been determined that the more the educational level of bank clients is the more they read the documents that they sign. It has been determined that the participants with license degrees benefit from services at banks more, such as private retirement funds or health insurances. It has been concluded that the participants with license degrees are more aware of NADA (North Anatolian Development Agency). Moreover, it has been concluded that the participants with license degrees are more aware of the Institution for Supporting Agriculture and Rural Development and its activities.

Conclusion

As a result of our study that aims to measure the banking sector literacy of bank clients based in Kastamonu city, who have the right to take individual, commercial and agricultural loans, have accounts at banks and operate in agricultural products industry, it is seen that the farmers operating in agricultural products industry have an active interaction with banking sector. In the light of the answers given to the questions in the survey and the data in the frequency tables, it is seen that the farmers take rational decisions and act in accordance with their own prosperity.

Their preferences that they direct with specific decisions, such as the banks they work with, the criteria that they

consider when choosing a bank, the types of credit cards and the purpose of using credit cards, indicate that the farmers are actively benefiting from the banking sector. They have headed towards bank loans, sometimes to relieve themselves during difficult economic periods, and sometimes to move their businesses to an advanced position.

The fact that all farmers participating in the study are literate indicates that the educational level of those who operate in agricultural products industry has increased. All farmers in our sample, who conduct activities regarding agricultural products, have received education at different levels and applied to banking sector by their own decision.

When the results of the data are compared with similar studies, the results obtained from Kastamonu city show similarities with certain results obtained throughout Turkey. In rural regions where the livestock breeding is very common and the same products of the same bank are demanded, our farmers who do not want to use information technologies, even today's technologies such as ATM and Mobile banking, desire to carry out their banking transactions through their acquaintances and face-to-face, if possible. Suggestions are given as follows:

- It is necessary to conduct a perception analysis regarding agricultural industry by banks on real persons carrying out small-scale businesses as well as the large-scaled companies.
- The necessity of the roles of banks in improving both the quality of raw materials and products and the quality of service by advancing the knowledge that those who work at this sector had inherited from their ancestors.
- The banks are expected to create awareness not only with their products but also by including the subjects, which would help the stakeholders in their decision making processes, in their advertisements while providing funds.
- The government subsidies not spreading on every field increase the need for those operating in the industry to incur liabilities; and the adaptation of villagers who cannot bring enough income, especially in villages, to the changing conditions of banking is highly important.

The survey data indicate that the farmers are not attending to the banking sector at a professional level. The purpose appears to be the success of short-term plans and seasonal activities. In order to ensure the farmers to benefit from banking sector at a higher level, it is necessary to increase the communication between banks and farmer unions. In order to restore the agricultural industry, which had a big share in our country's economy during the Republic Period but has weakened within the time passed until today, it is necessary for banks to regulate their credit policies and provide convenience to agriculture entrepreneurs at all sizes, regardless of their scales. For our farmers with low educational level not to become distanced from the sector, what opinion comes into prominence is that there can be organized some enlightening and encouraging seminar activities by banks and that deposit surplus at banks can act as a driving force in agricultural economy.

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RESEARCH ARTICLE

Comparison of Spray Transfer and Penetration of Different Hydraulic Nozzles at Low Application Volume

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ABSTRACT

Seven hydraulic nozzle types (standard-ST; hollow cone-KH; multirange-LU; standard with narrow angle-STD; antidrift-AD; air-induction-IDK; twinjet air-induction-IDKT) were compared in terms of spray transfer and drop penetration. Spray treatments were carried out at a constant application volume of 90 L ha^{-1} with a linear-motion simulator. WSP's were placed onto metal poles and into artificial plant at both horizontal and vertical planes. Two different operating pressures (250 and 500 kPa) and the nozzle position angles (0º and 45º) were used in the experiments. Spray transfer levels at vertical plane were quite lower than the spray transfer levels at horizontal plane. The greatest spray coverage was achieved with LU and ST nozzles producing fine droplets. The greatest drop penetration at vertical plane was obtained from IDK nozzle. Only 25% of the drops transferred to the open target reached the stem and root collar region of the plant canopy. With increasing operating pressures, spray coverage increased by 1,17 times at horizontal plane and 1,50 times at vertical plane. With increasing nozzle position angles, spray coverage at vertical plane increased by 40%. The greatest coverage was achieved on front surface of the vertical target and drops reaching to side and rear surfaces were quite low.

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Introduction

Success of chemical treatments largely depends on sufficient transfer of the active ingredient to the targeted harmful agent and adsorption of the active ingredient by the targeted surface. Such a case is then closely related to spray technology serving a bridge between the target and the chemical and application performance of these sprays (Azimi et al. 1985). Spray droplets have low transfer energy within a certain trajectory to the target and they may also be transferred to off-target because of drifts. Such cases increase pesticide losses, thus reduce application performance. Just because of losses, excessive pesticide doses are applied for sustainable impact on target. However, excessive applications ultimately end up with residue problems over foodstuffs.

Hydraulic nozzles are commonly employed to generate a spray pattern and spray drops transferred from a certain height toward to ground plane at a position along the direction of propulsion. Drop transfer efficiency of these type of nozzles is low, thus application volumes are frequently increased (Coates and Palumbo, 1997). However, in excessive applications, spray drops are not able to be adsorbed by the target and flow over to soil surface. Such applications then become uneconomic (Bode et al., 1983; Hoffmann and Salyani, 1996; Piche et al., 2000; Zhu et al., 2004). Although high-volume applications seem to increase pesticide adsorption of the target surface in

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theory, experimental researches revealed less adsorption levels, increased variation in pesticide distribution and greater loss of drops at high-volume applications (Salyani and Whitney, 1988; Whitney et al., 1989; Reed and Smith, 2001; Wolf, 2005). Considering the biological efficiency, it was pointed out that low-volume applications even increased application efficiencies. Reed and Smith (2001) carried out a study to investigate the effects of different application volumes (56 L ha^{-1}, 112 L ha^{-1} and 168 L ha^{-1}) on biological efficiency of treatments applied against the tobacco budworm (*Heliothis virescens* F. [Lepidoptera: Noctuidae]) larvae and reported significantly reduced pest population with 56 L ha^{-1} application volume as compared to the greater application volumes. In standard nozzles, although use of large orifice nozzles was seen as a proper strategy to reduce drifts, the variation in pesticide distribution of the nozzles with a pre-chamber orifice providing coarse pulverization confute such a strategy (Wolf, 2005).

With regard to spray characteristics, while fine droplets are transferred to the target parallel to ground plane, mid-size and coarse droplets are delivered more to the plant canopy sections close to the ground (Zhu et al., 2002; Zhu et al., 2004). However, there is not any information about the transfer of spray droplets to stem and branch-like upright sections of the canopy. In vegetables, cutworm (*Agrotis* spp.), russet mite (*Aculus lycopersici* Massee), white mold (*Sclerotinia sclerotiorum* Lib) and grey rot (*Botrytis cinerea* Pers) disease agents are generally encountered over the stems and root collars of the plants and pesticides are recommended to be applied to green parts of the plants. Therefore, spray should be transferred vertically toward to frontal surfaces of the target for an efficient fight with the disease and pests encountered over plant stems and root collars.

The present study was conducted to determine the most appropriate hydraulic nozzle types able to transfer spray droplets to the targeted sections vertically and horizontally and to put forth the effects of nozzle position angle and operating pressure on spray transfer in horizontal and vertical planes.

Materials and Methods

Experimental Site

Experiments were conducted in a closed facility and indoor temperature and relative humidity were regularly measured with a digital thermo-hygrometer (TFA 30.5013 Dostmann GmbH & Co.KG, DE).

Hydraulic Nozzle Types and Operational Parameters

Seven different types of nozzles were used in this study and nozzle characteristics are provided in Table 1. Nozzle discharge rate was measured with a digital sensor-type flow meter (Sprayer Calibrator, Spot On®, Model: SC-1, IL, measurement precision: ±2.5%; measurement range: 0,08-3,79 L min^{-1}). Experiments were conducted within the range of low application volume (LV) (50-200 L ha^{-1}) at constant 90 L ha^{-1} application volume and forward speed was calculated with the aid of Equation (1);

$$V = \frac{1}{3.6} \cdot \frac{600 \cdot q}{B \cdot N} \quad (1)$$

V : Forward speed, m s^{-1}
q : Nozzle discharge, L min^{-1}
B : Nozzle spacing, m (0,5 m)
N : Application volume, L ha^{-1} (90 L ha^{-1})

Table 1. Hydraulic nozzle types and operational parameters

Nozzle type*	Material*	Screen type	Pressure (kPa)	Discharge (L min^{-1})	Spray height (cm)	Spray angle (°)	Application volume (L ha^{-1})	Forward speed (m s^{-1})
ST110015	POM	Cylindrical	250	0,54	40 cm	110°	90	2,00
		(50 mesh)	500	0,76			90	2,83
LU120015	POM	Cylindrical	250	0,54	40 cm	120°	90	2,00
		(50 mesh)	500	0,76			90	2,83
IDK120015	POM	Cylindrical	250	0,54	40 cm	120°	90	2,00
		(50 mesh)	500	0,76			90	2,83
IDKT120015	POM	Cylindrical	250	0,54	40 cm	120°	90	2,00
		(50 mesh)	500	0,76			90	2,83
STD80015	POM	Cylindrical	250	0,54	70 cm	80°	90	2,00
		(50 mesh)	500	0,76			90	2,83
KHØ1.2	POM	Cylindrical	250	0,67	70 cm	68°	90	2,48
		(50 mesh)	500	0,91			90	3,37
AD120015	POM	Cylindrical	250	0,54	40 cm	120°	90	2,00
		(50 mesh)	500	0,76			90	2,83

*ST: standard flat spray nozzles (Lechler, DE); LU: multi-range flat spray nozzles (Lechler, DE); IDK: air injector flat spray nozzles (Lechler, DE); IDKT: symmetrical twin flat spray air injector nozzles (Lechler, DE); STD: standard narrow-beam flat spray nuzzles (Lechler, DE); KH: hollow cone nozzles (Toyman, TR); AD (Lechler, DE): anti-drift flat spray nozzles
**: polyacetal

Six polyacetal (POM) nozzles were sequentially installed over a boom arm with 50 cm spacing. In each nozzle head (Arag SRL 40642W7 Model, IT), 50 mesh cylindrical screen was used to prevent clogging. Spray height of the nozzles was determined based on spray beam angle. Narrow-angle ones were adjusted to spray from 70 cm distance and standard beam angles were adjusted to spray from 40 cm distance. In spray transfer experiments, effects of two different operating pressures (250 kPa and 500 kPa) and two different spray position angles (0˚ and 45˚) were investigated. For position angle, spray line over which the nozzles were installed was positioned along the forward direction.

Spray Simulator

For spray treatments, a 12-meter long, linear-motion speed-controlled spray simulator was used as presented in Figure 1. The simulator moves over two heavy-type industrial profiles (90×180 mm) and uses a power supply of 1000 W servomotor (Delta ASDA-B2, Taiwan, TW). It is equipped with guide pulleys with a transmission rate of 1/2.5 for power transmission. Vehicle motion is controlled by a personal computer connected to servomotor. The communication between the driver and the motor is realized over a Modbus protocol. Forward speed of the vehicle is adjusted through changing rotation of servomotor shaft. Motor shaft speed changes between 1-5000 rpm and there is a linear relationship of [$n=118{,}03 \cdot V$] (R^2=1) between vehicle speed (V, km h^{-1}) and motor speed (n, rpm). Boom arm of spray simulator is 2,2 m long, located at one side of the vehicle and has an adjustable spray height.

Figure 1. Spray simulator

A field type sprayer (TP600 Piton Taral®, TR) with 600 litres polyethylene tank was used to generate hydraulic pressure for the fluid (Figure 2). The sprayer is equipped with TAR30-type piston-membrane pump (double piston, 40 kg cm^{-2} nominal pressure, 30 L min^{-1} nominal discharge, 67% yield, Taral®, TR). Pump shaft of the sprayer is operated at 600 rpm with an electrical gear-motor (MSD 90L2, 2780 rpm, Gamak, TR).

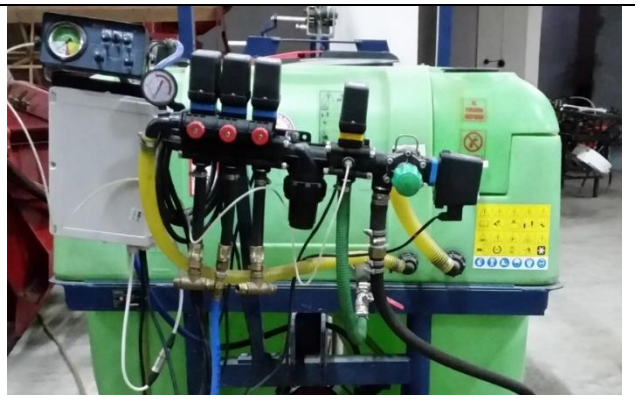


Figure 2. Sprayer and electro-valve installation

Method of Sampling

As sampling material for spray treatments, 26×76 mm water-sensitive papers (WSP, Novartis, Syngenta Crop Protection, Basel, CH) papers were used. About 40 cm long metal poles were used to place WSP samples. Papers were placed vertically at the top and bottom of the poles in a three-sided fashion. The first side constituted frontal surface along the spray forward direction; the second side constituted the side surface of the spray; the third side constituted the rear face behind the spray forward direction. To place WSP samples at three different sides, 30×30×80 mm wooden chocks were used and samples were attached to frontal sections of all three sides with clips. To determine spray transfer along the horizontal plane, extra WSP samples were placed at the top and bottom horizontally parallel to the ground (Figure 3).

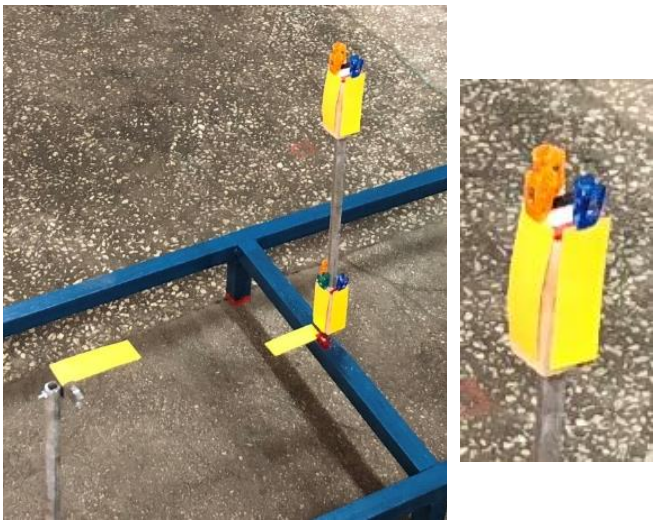


Figure 3. Placement of water sensitive papers onto sampling pole

Wooden chocks used on metal poles were also placed into root collar of the artificial plant canopy in the same fashion and WSP samples were again attached to front, side and rear surface of the chocks. Another WSP was placed horizontally at root collar close to ground to determine spray penetration into the canopy (Figure 4). The artificial plants in pots were positioned under the boom arm at 3×3 matrix arrangement and 50×50 cm row spacing. Total number of leaves and total leaf area were determined and proportioned to canopy projection

area and then leaf area index was calculated as 1,17.

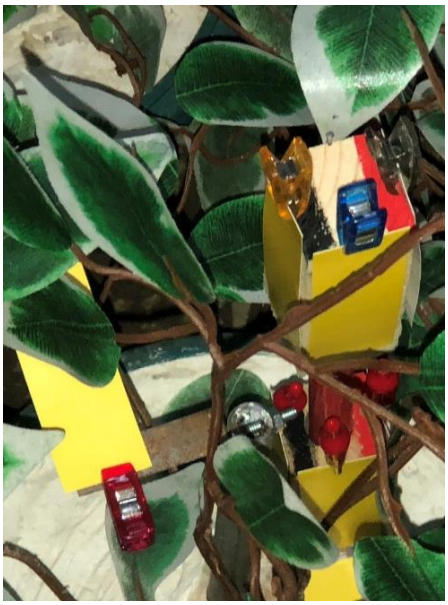


Figure 4. Placement of water sensitive papers into the plant canopy

Spray Coverage

All of the WSP samples at horizontal and vertical orientation were classified based on treatments and recorded at 600 dpi resolution *.jpeg image files into a computer. Card samples were analysed through the following process steps:

- Card samples were scanned through a scanner (HP Scanjet 4850, US) at 600 dpi resolution *.jpeg files and recorded into a computer as classified based on nozzle type, operating pressure, position angle, sampling section and frontal surface.
- With the aid of an image processing software, each image was clipped referenced to image boundaries.
- Coloured WSP images were converted into grayscale images with the aid of ImageJ (Wayne Rasband, National Institutes of Health, USA, Java 1.6.0_02) software. The threshold (t) value to be applied in the range of 0-255 to card images was calculated with the linear equation specified by Sanchez-Hermosilla and Medina (2004) (Equation 2).

$$t = 0.38g + 78.75 \quad (R^2 = 0.91) \qquad (2)$$

- Mean grey level (g) of the images was determined with the aid of a macro module written in image processing software. Before to determine grey level, each image was filtered and stain images over the card surface were decoupled. The "enhancement-sharpen" module of the software was used for filter process and mask matrix size was adjusted as 3×3. A separate threshold was applied to each card image and spray coverage ratios were determined as percentage (%).

Statistical Analysis

The effects of nozzle type, operating pressure and nozzle position angle on spray transfer were assessed through repeated-measures ANOVA. Drop transfer at top and bottom sections were assessed as repeated measure factor and results were assessed for front, side, rear and horizontal surfaces separately. In assessments made for spray penetration, the card samples taken from plant canopy were used. Assessments were made through two-way ANAVO in accordance with randomized blocks design. Significant means were separated with Duncan's multiple range test at 5% level.

Results

Experiments were conducted in a closed facility under controlled conditions. Indoor temperatures varied between 21,2 ˚C -21,7 ˚C and relative humidity values varied between 39%-43%.

Spray Transfer at Horizontal and Vertical Plane

The effects of nozzle position angle on spray transfer were not found to be significant (Table 2). The LU and ST nozzles had the greatest spray coverage ratios; they were followed by KH nozzles and the lowest spray coverage ratios were observed in IDKT nozzles. In all spray treatments, spray coverage ratios increased distinctively with increasing operating pressures (Figure 5). Such an increase was not found to be significant in LU nozzles. It was observed that position angle significantly increased spray coverage ratios.

Table 2. Spray transfer at horizontal plane

Nozzle type	Nozzle position angle		*Mean±SD (F=95,13; p<0,01)
	0˚	45˚	
LU120015	28,0±4,9	34,0±5,0	31,0±5,7 a
ST110015	32,2±5,8	28,7±6,5	30,4±6,3 a
KHØ1.2	28,4±10,5	28,4±8,6	28,4±9,4 b
STD80015	26,8±5,6	23,4±4,7	25,1±5,4 c
AD120015	22,2±2,4	24,7±4,0	23,5±3,5 c
IDK120015	18,1±2,8	18,2±2,7	18,2±2,7 d
IDKT120015	11,8±2,8	12,6±2,3	12,2±2,5 e
Mean±SD (F=0.43; p=0.516)	23,9±8,5^{ns}	24,3±8,3^{ns}	

^{ns}: not significant; p<0.01: highly significant; *: the means indicated with different letters in the same column (a-e) are significantly different at 5% level.

Table 3. Spray transfer at vertical plane

Nozzle type	Nozzle position angle		*Mean±SD (F=48,3; p<0,01)
	0˚	45˚	
LU120015	3,8±5,1	6,4±9,3	5,1±7,5 a
ST110015	3,8±3,8	5,8±8,5	4,8±6,6 ab
IDK120015	2,8±2,5	5,6±5,9	4,2±4,7 bc
AD120015	3,7±2,9	4,5±5,0	4,1±4,1 bc
STD80015	4,0±6,6	3,6±6,5	3,8±6,5 c
IDKT120015	3,3±2,2	2,7±2,6	3,0±2,4 d
KHØ1,2	1,6±2,3	4,3±7,5	3,0±5,6 d
**Mean±SD (F=252,3; p<0,01)	3,3±4,0^{y}	4,7±6,8^{x}	

p<0,01: highly significant; *: the means indicated with different letters in the same column (a-e) are significantly different at 5% level; **: the means indicated with different letters in the same row (x-y) are significantly different at 5% level.

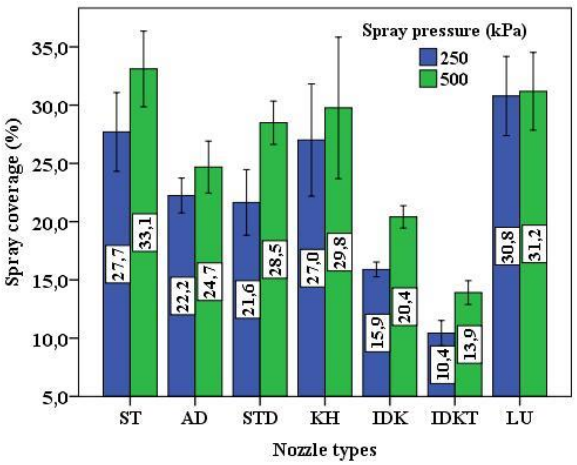


Figure 5. Effects of operational pressures on spray transfer at horizontal plane (means were indicated with ±2SE)

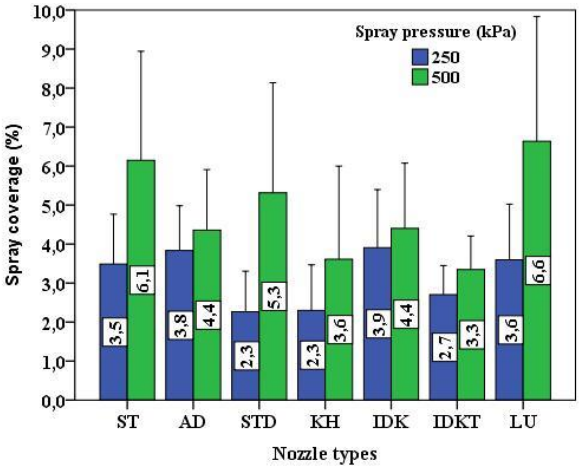


Figure 6. Effects of operational pressure on spray transfer at vertical plane (means were indicated with ±2SE)

In Table 3, spray coverage ratios of the drops transferred to horizontal plane were compared. The greatest spray coverages were obtained from LU and ST nozzles and the lowest ratios were obtained from KH and IDKT nozzles. When the nozzle position angle was set as 45º, significant increases were observed in spray transfer efficiency of LU, ST, IDK and AD nozzles at vertical plane. In Figure 6, increasing spray transfers are presented at vertical plane under high-pressure conditions. Positive effects of pressure on spray transfer at vertical plane varied with the nozzles, but increasing values were observed in all nozzles.

Spray Penetration into Plant Canopy at Horizontal and Vertical Plane

It was observed according to general means provided in Table 4 that spray drop penetration into plant canopy at horizontal plane decreased with increasing nozzle position angle. The greatest penetrations were respectively obtained from ST, LU and AD nozzles and the differences in penetration ratios of the other nozzles were not found to be significant. As presented in Figure 7, drop penetration ratios increased at high operating pressures. It was observed that KH nozzles had greater penetration ratios at low pressure.

Table 4. Spray transfer into plant canopy at horizontal and vertical plane

Nozzle type	Nozzle position angle		*Mean±SD (F=19,5; p<0,01)
	0˚	45˚	
ST110015	12,5±2,6	7,0±1,9	9,8±3,6 a
LU120015	10,0±4,2	7,2±2,0	8,6±3,4 a
AD120015	5,1±0,4	6,8±1,1	6,0±1,2 b
STD80015	4,9±1,4	3,8±1,2	4,3±1,3 c
KHØ1,2	5,8±2,8	2,8±0,9	4,3±2,5 c
IDK120015	5,3±3,2	3,1±0,5	4,2±2,5 c
IDKT120015	2,1±0,4	4,8±0,7	3,4±1,5 c
Mean±SD (F=11,9; p<0,01)	6,5±4,0^{x}	5,1±2,2^{y}	

p<0,01: highly significant; *: the means indicated with different letters in the same column (a-e) are significantly different at 5% level; **: the means indicated with different letters in the same row (x-y) are significantly different at 5% level.

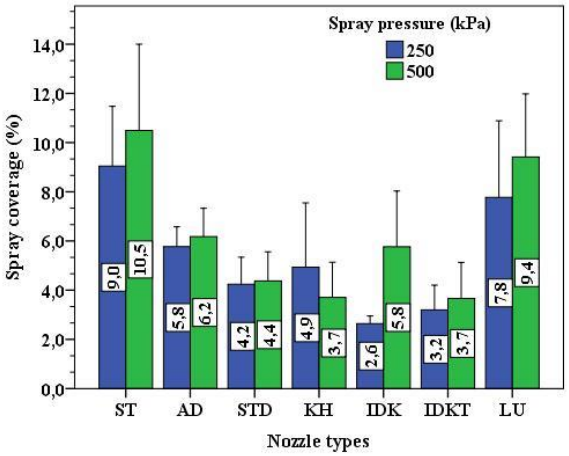


Figure 7. Effects of operational pressure on spray penetration into plant canopy at horizontal plane (means were indicated with ±2SE)

According to statistical assessments for spray penetration into plant canopy at vertical plane (Table 5), the greatest penetration values were obtained from IDK and AD nozzles and the lowest penetration values were obtained from KH and STD nozzles. The spray position angle of 45º along the forward movement direction of the spray increased penetration values. As can be seen in Figure 8, the greatest penetrations into the plant canopy at vertical plane were obtained from IDK and AD nozzles. General means revealed that penetrations increased at high pressures, but distinctively decreased in KH nozzles.

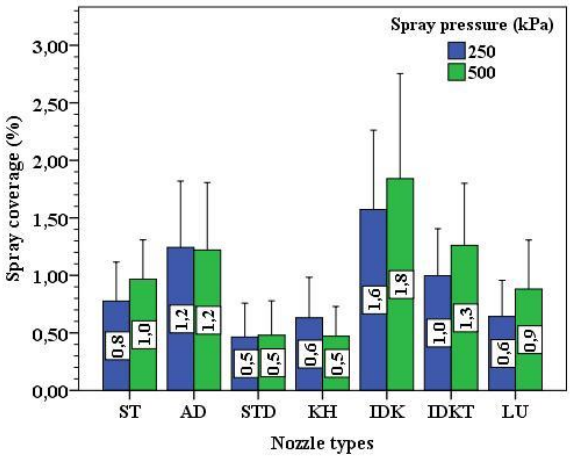


Figure 8. Effects of operating pressure on spray penetration into plant canopy at vertical plane (means were indicated with ±2)

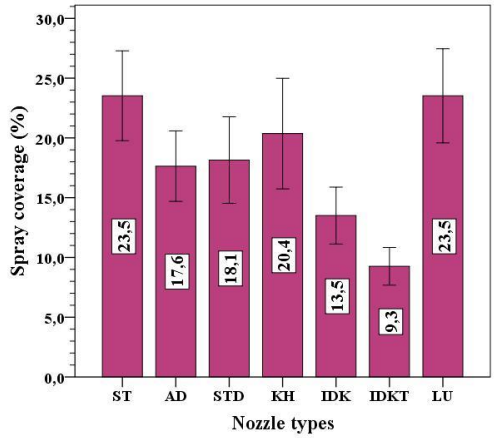
Table 5. Spray penetration into plant canopy at vertical plane

Nozzle type	Nozzle position angle		*Mean±SD
	0˚	45˚	(*F*=18,1; *p*<0,01)
IDK120015	1,51±1,71	1,90±1,71	1,71±1,70 a
AD120015	0,85±0,66	1,62±1,52	1,23±1,22 b
IDKT120015	1,10±0,98	1,16±1,07	1,13±1,01 bc
ST110015	0,67±0,59	1,07±0,79	0,87±0,72 cd
LU120015	0,72±0,76	0,80±0,84	0,76±0,79 de
KHØ1,2	0,32±0,34	0,78±0,81	0,55±0,65 e
STD80015	0,51±0,62	0,44±0,64	0,47±0,62 e
Mean±SD (*F*=15,3; *p*<0,01)	0,81±0,96^{y}	1,11±1,19^{x}	

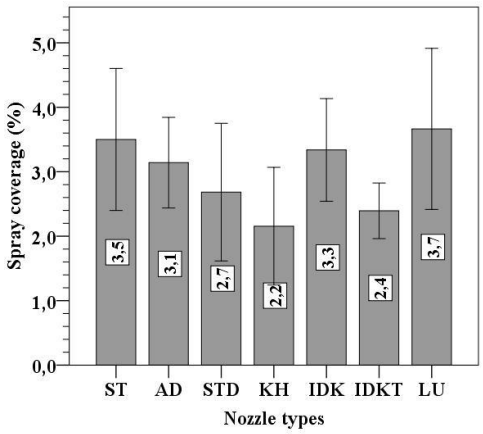
p<0,01: highly significant; *: the means indicated with different letters in the same column (a-e) are significantly different at 5% level; **: the means indicated with different letters in the same row (x-y) are significantly different at 5% level.

With regard to spray transfer and penetration, greater volume of drops reached to horizontal plane than the vertical plane (Figure 9a, 9b). In general, the greatest spray coverages were obtained from LU and ST nozzles, but increasing coverages in IDK nozzles were observed only at vertical plane. Among the nozzle types, KH nozzles yielded the least coverage ratio. Of the drops transferred to open target at horizontal and vertical planes, only 25% reached to stem and root collar of the plant canopy (Figure 9c).

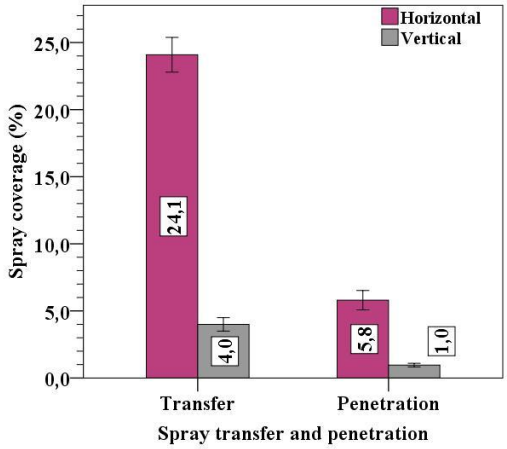
With increasing operating pressures, spray coverage ratios increased by 1.17 times at horizontal plane and 1.50 times at vertical plane (Figure 9d). While nozzle position angle did not have significant effects on spray transfer at horizontal plane, position angle yielded 40% increase in spray transfer at vertical plane. (Figure 9e). Along the forward motion of the device, the greatest coverage was achieved at front surfaces and quite low drop volumes were achieved in side and rear surfaces at vertical plane (Figure 9f).



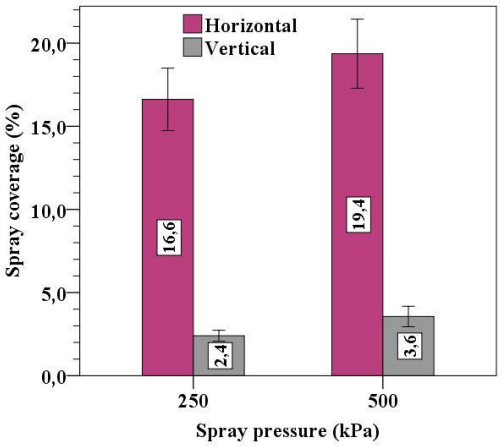
(a) Spray transfer of the nozzles at horizontal plane



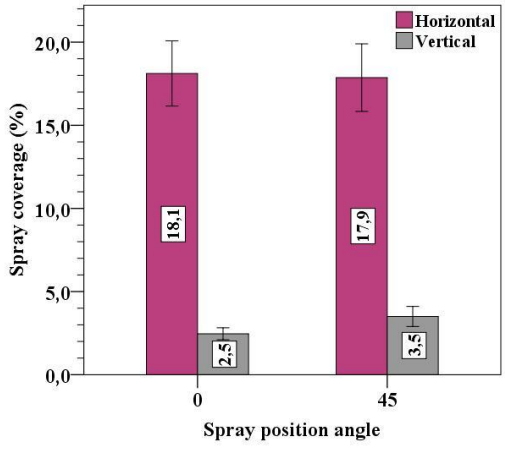
(b) Spray transfer of the nozzles at vertical plane



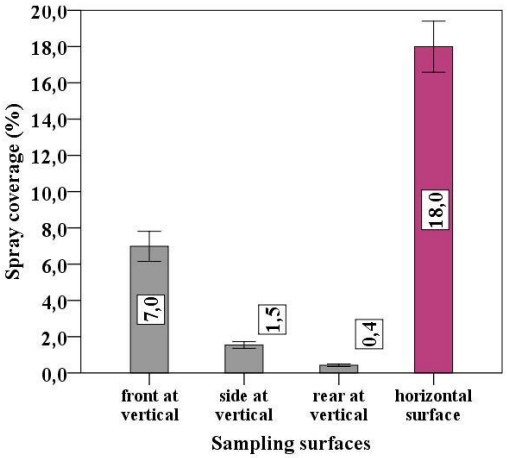
(c) Comparison of spray coverage ratios at target surface and plant canopy



(d) Effects of operating pressure on spray coverage ratios



(e) Effects of nozzle position angle on spray coverage ratios



(f) Spray coverage ratios of different frontal surfaces at horizontal and vertical planes

Figure 9. Spray coverage ratios at horizontal and vertical planes

Discussion

Various qualitative and quantitative methods are used in spray treatments to determine drop adsorption of the target surface, coverage ratios, drop density and spray penetration (Sayıncı and Bastaban, 2009). Among these methods, water sensitive papers (WSPs) are commonly used in assessment of different parameters (Foqué and Nuyttens, 2011; Malneršič et al., 2016; Guler et al., 2006; Salyani et al., 2013). In sampling practices, papers (WSPs) are placed parallel to ground plane or placed over the leaf surfaces of the plant canopy. Following the spray treatments, the coverage ratio of the stains generated by spray drops is determined (Sayıncı and Bastaban,

2011). However, there are not any studies about spray transfer at horizontal and vertical planes. In present study, significant differences were observed in spray transfer at horizontal and vertical planes. Spray coverage ratios of the drops reached to vertical plane were quite lower than the drops reached to horizontal plane. Such a case clearly indicated that spray drops were not able to reach sufficiently to vertical root collars and stems of the plants.

In vertical plane, nozzle position angle relatively increased both spray transfer and penetration, but spray coverages were quite low. In all treatments made at constant volumes, drop diameters decrease, thus coverage ratios increase with increasing operating pressures (Sayıncı and Bastaban, 2011). Greater coverage ratios and penetrations were also achieved in this study with increasing operating pressures. However, spray coverage ratios were still at quite low levels as compared to horizontal plane.

Diameter-class of spray drops is a significant parameter influencing spray transfer and penetration into the target. At 300 kPa (3.0 bar) operational pressure, ST and LU nozzles produce fine drops (Serim and Özdemir, 2012; Lechler®, 2018); AD nozzles produce medium-size drops (Lechler®, 2018); IDK nozzles produce coarse drops (Lechler®, 2018) and IDKT nozzles produce extremely large drops (Lechler®, 2018). Since nozzle types produce different-size drops, terminal velocity and kinetic energy of the drops vary with the nozzle types. Fine drops have greater terminal velocities and thus have lower kinetic energy and greater drift potential (Sayıncı, 2016).

Conclusion

In horizontal and vertical planes, the greatest coverage ratios were achieved with LU and ST nozzles. The KH nozzles had the lowest spray coverage ratio and spray penetration at vertical plane and penetrations decreased with increasing operating pressures. Coverage ratio of IDK nozzles increased with increasing pressures and the greatest spray penetration into plant canopy was achieved at vertical plane. Despite the twin-flow, IDKT nozzles did not yield a significant advantage in spray transfer and penetration. Since IDKT nozzles have high spray transfer energy, spray penetration at vertical plane was greater than the nozzles producing fine spray drops. In STD nozzles with narrow beam angle, spray coverage ratios decreased with increasing position angles, thus this type of nozzles had the least spray penetration. AD nozzles have low drift potential, thus spray coverage ratios increased with increasing nozzle position angles. The second greatest spray penetration into the plant canopy was achieved with AD nozzles.

This study was conducted in a closed facility under controlled conditions, thus, there were not any drifts. Under present conditions, volume of drops transferred at vertical plane was quite lower than the volume of drops transferred at horizontal plane. Considering the negative impacts of potential drifts in practice, there is a need for alternative spray equipment able to better manage pests and diseases over the root collars and stems of the plants. In this case, the spray coverage rate at the spray pressure of 500 kPa increased compared to the low pressure levels. IDK and AD nozzles producing middle and coarse drops yielded greater spray penetration at vertical plane. However, at ideal weather conditions, ST and LU nozzles producing fine drops yielded greater spray coverage ratios, thus they were found to be more suitable for chemical treatments to plant leaves.

Acknowledgements

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RESEARCH ARTICLE

Determination of Yield, Yield Components and Oil Ratio of Some Winter Canola (*Brassica napus* L.) Cultivars under Semi-Arid Conditions

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ABSTRACT

This study was carried out to determine the yield, yield components and oil ratio of some canola cultivars under semi-arid conditions. Trials were established in the trial field of Department of Field Crops, Faculty of Agriculture, Harran University in randomized complete blocks trial design as 3 replications. In the experiment, Licord, Es-Astrid, Embleme, Eldo, Elvis, EGC-102, Licrown, Bristol, Es-Nectas and Es-Hydromel winter cultivars were used. In the results of study; the highest seed yield was obtained from Elvis cultivar (2270.3 and 2081.7 kg ha^{-1}) in two years of the experiment. According to the results of two years between the cultivars; the plant height was from 125.13 to 146.57 cm, number of branches 3.83-5.76 (per $plant^{-1}$), number of pods 115.20-194.73 (per $plant^{-1}$), number of seeds 21.00-27.30 (per pod^{-1}), 1000 seed weight 3.07-3.78 g, oil ratio 27.16-44.96%, number of flowering days 157-169, and the number of maturation days was from 198 to 214. Because of seed yield and especially oil ratio were observed very high, Elvis variety can be recommended in conditions of less rainfall areas with limited irrigation facilities.

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Introduction

Due to the its importance in human and animal nutrition, raw material in the industry and usage area, the production and consumption of oilseed plants have increased in recent years. Canola production has shown a large increase in the last 40-50 years in the world, took the second place after soybean in oilseed production, and took the 3rd place after palm and soybean in the vegetable oil production (Anonymous, 2016). Contrary to the developments in the world, the cultivation areas and production of oilseed plants in our country has fluctuated in the last 25-30 years. While the area of oilseed plants decreased by 25% in this period, an increase of 10 % of oilseed production was observed (Uyanık and Kara, 2011). The production of oilseed plants was able to meet 30 % of the vegetable oil needed for our country and the remaining 70 % was tried to be met by oilseed or crude oil imports (Uğur, 2012).

Canola seeds contain approximately 40-45% of oil (Jawad et al., 2017) and 20-25% of protein ratio according to their growing conditions and cultivar (Tan et al., 2017). The remaining cake after removing the oil is an important animal feed since it has a protein content of 33-44% (Doğan and Zincirlioğlu, 1982). Canola is a very valuable plant for beekeepers because of attracting honey bees, opening yellow flowers in early spring, pollen and nectar source (Süzer 2014).

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Crop rotation systems, climate and soil conditions are suitable for canola which is demanded by oil and feed industry. Canola is an important oil plant in terms of oil acids composition (linoleic acid: 19.4%; oleic acid: 59.8%; linolenic acid: 10.2%; eicosenoic acid: 0.2%; palmitic acid: 9.2% and erucic acid: 0.3%) (Tan et al., 2017).

Canola; with regard to its features the presence of winter and summer forms, the wider adaptation than most oil plants (Aminpanah, 2013), not too much soil demand and the suitability for mechanization, is an important plant should be involved in agriculture (Süzer, 2012). In addition to these properties, on account of high oil ratio and oil acids in human nutrition and suitability in biofuel use (Durrett et al., 2008).

Canola can be grown as winter and summer in terrestrial and subtropical climatic zones, as well as growing in sea and temperate climates (İncekara et al., 1983). It is important that winter varieties to put in the fallow fields in the Thrace, Central Anatolia and Passage Regions of Turkey and include in the crop rotation (Kolsarıcı, 1987). In addition, the Aegean coastal region, Mediterranean and Southeastern Anatolia Region which have a moderate winter season, are important for the second crop agriculture, and have an important potential in terms of canola agriculture (Tan et al., 2016).

Rapeseed, as winter or summer cultivars, or depending on the environmental factors, from sowing to harvest on average 100-210 days, in general 40-60 days after flowering, and as for summer sowing reach the harvest maturity in 80-90 days (Tan, 2009; Öz, 2013).

Many studies were conducted on canola both in Turkey and world. Başalma (2004), reported that in 25 winter canola cultivars used study, the highest seed yield was obtained from the Contact cultivar with 2650 kg ha^{-1} in 2000 year and from the Licord cultivar with 3013 kg ha^{-1} in 2001, the highest oil yield was obtained from the Contact cultivar with 1141 kg ha^{-1} in 2000 year and from Licord cultivar with 1367 kg ha^{-1} in 2001.

Öz (2013), in a research where the canola varieties sown in winter, seed yield was 1610-3850 kg ha^{-1}, plant height 160.7-195.6 cm, number of branches 7.5-10 per $plant^{-1}$, number of pods 462-803 per $plant^{-1}$, number seeds 19.9-25.4 per pod^{-1}, 1000 seed weight 3.2-3.8 g, number of flowering days 114.7-126.7, number of physiological maturity days 164.3-171, oil yield 640-1610 kg ha^{-1} and the oil ratio ranged from 43.46 to 47.6%.

Bilal et al. (2015), was showed in his study; seed yield per plant was 9.67-21.12 g, plant height 164.14-194.0 cm, 1000 seed weight 6.97-7.64 g, number of maturation days 186.64-212.90; Ahmed et al. (2016), seed yield was 595.6-889.3 kg ha^{-1}, number of pods 72.3-97.7 per $plant^{-1}$, number of seeds 17.1-36.5 per pod^{-1}, plant height 82.7-99.4 cm; Noreen et al. (2016), number of pods was 108-199 per $plant^{-1}$, number of seeds 19-22 per pod^{-1}, plant height 68.40-93.25 cm; Khan et al. (2018) reported that the number of pods per plant varied from 364 to 388 per $plant^{-1}$ and oil ratio between 45% and 47%.

It is great important to increase the production areas and to produce high yielding cultivars per unit area and to take a canola which is an oil plant in crop rotation systems (wheat etc.). In order to contribute to the closure of the oil deficit and to increase the production of canola, it is very important to determine the varieties with high yield potential and to put these into production systems. In a plant species which is partly new for a region, it is great important to determine the appropriate varieties and production techniques (Coşgun and Öztürk, 2015).

Sanliurfa is the hottest city in Turkey. Average annual rainfall is about 400-450 mm. Growing drought-resistant plants in a place that is so arid is extremely important. Canola plant has the potential to be considered as a plant which can be used in areas where irrigation possibility is not available, especially due to its drought resistance. However, few studies have been performed in the region.

This study was carried out to determine the yield, yield components and oil ratio of some canola cultivars under the Harran Plain conditions and to help the studies to be carried out thereafter.

Materials and Methods

10 winter canola cultivars (Licord, Es-Astrid, Embleme, Eldo, Elvis, EGC-102, Licrown, Bristol, Es-Nectas and Es-Hydromel) were used as plant material. Trials were established in the trial field of Department of Field Crops, Faculty of Agriculture, Harran University according to the randomized block trial design as 3 replications in 2011-2012 and 2012-2013 growing seasons. In the experiment, each plot was 6 m in length with 5 rows, inter-rows and intra-rows spaces were 30 and 5 cm, respectively.

The soil of the trial area is clay and the lime content is very high. In addition, the pH is slightly alkaline. Some physical and chemical properties of trial site are given in Table 1.

Table 1. Some physical and chemical properties of trial site

Depth (cm)		0-20
Organic Matter (%)		1.13
Total Salt (%)		0.089
pH		7.6
Lime (%)		5.4
P_2O_5 (kg ha^{-1})		3.8
K_2O (kg ha^{-1})		9.1
Fe (ppm)		2.07
Zn (ppm)		0.42
Texture (%)	Sand	23.96
	Clay	53.64
	Silt	1.8

Sowings were done by hand in the form of 2 seeds per one bed on November 8, 2011 and November 12, 2012. After the emergence, plants were thinned in stage of 3-4 leaves (Jenkins and Leitch, 1986). Superphosphate (pure phosphorus 80 kg ha^{-1}) was applied as the basal fertilizer for the phosphorus requirement of the plant. Half of Ammonium sulphate (21%) was added as a source of nitrogen by sowing and the remaining nitrogen was appilied as Ammonium Nitrate (33%) fertilizer (60 kg ha^{-1} of pure N) during the branching period of the plants. Fertilizers were applied manually to the sides of the plant

rows. No irrigation was applied during the growing seasons. Weed control was done by hand when it was seem necessary. In both years, no diseases and pests have emerged.

The area in which the experiment was established is Harran Plain and the summers are hot and dry, and the winters are cold and rainy. The average annual rainfall was 365 mm and the average temperature was 17.2 °C. Distribution of the precipitation by seasons; 56 % was in winter, 30 % in spring, 13 % in autumn and 1 % in summer. The average number of rainy days was 70 days. When the average meteorological data for the experimental years (November-June) are examined from table 2, the average monthly temperature was 5.5 °C and the highest temperature was 30.6 °C in 2011-2012 growing season (November-June); the average monthly minimum temperature was 8.3 °C and the highest temperature was 29.0 °C during 2012-2013 growing season (November-June). While total rainfall was 483.1 mm in 2011-12 growing season (November-June), total rainfall was 491.25 mm in 2012-13 growing season (November-June). In both trials, more precipitation occurred when compared to the average of longs terms (Anonymous, 2013).

Since the varieties reached harvest maturity on different dates, the plants were harvested manually in the 1st year of the experiment on 7-13 June 2012 and in the 2nd year on June 10-16 June 2013 with the mowing from the soil level. 3 rows out of 5 rows in the middle part of each plot were harvested, 0.5 m part of the head and ends of the each plot and 2 edge rows put away to eliminate side effects.

Table 2. Average meteorological data for the experimental years (Anonymous, 2013)

	2011-2012			2012-2013			1929-2013
Months	**Monthly Avg. Temp. (°C)**	**Rainfall (kg/m²)**	**Avg. Relative Humidity (%)**	**Monthly Avg. Temp. (°C)**	**Rainfall (kg/m²)**	**Avg. Relative Humidity (%)**	**Average of Long Terms (°C)**
November	9.4	62.1	53.7	14.9	68.4	65.6	12.9
December	7.4	47.1	57.4	8.3	142.8	73.0	7.5
January	5.5	170.9	81.0	6.8	86.8	69.5	5.4
February	5.8	95.8	57.0	9.3	107.2	73.6	6.8
March	9.7	35.8	47.3	12.9	12.1	-	10.7
April	19.3	23.3	42.4	18.4	18.0	44.9	16.0
May	22.4	42.3	40.8	22.9	56.2	43.4	22.1
June	30.6	5.8	21.2	29.0	-	24.0	28.0
Average	13.76	-	43.39	15.31	-	49.25	13.67
Total	-	483.10	-	-	491.25		-

Yields were obtained from the harvested plots and the agronomic characters such as plant height, number of branches per plant, number of pods per plant, number of seeds per pod and 1000 seed weight were calculated from the randomly selected 10 plants (Öğütçü, 1979). The number of flowering days were calculated from the sowing time to the first flowers appear in each plot (Chay and Thurling, 1989), and the maturation days was decided as 80% of the pods were large, spherical and blackish colored on the plants (Schuler et al., 1992).

The oil ratios (%) were determined for all cultivars from the sufficient amount of seed grinded and dried in the oven at 70 ^{0}C for 48 hours, then 5 g of each sample was taken and boiled in hexane for 6 hours in Soxholet device (Bilsborrow et al., 1993).

The variance analysis of the obtained data in randomized complete blocks design were made in JMP 13.2.0 statistics program and the means were grouped with regard to the Tukey HSD test ($p \leq 0.05$).

Results and Discussion

In the analysis of the combined years, variance analysis of each year was done separately since there were differences between the years. There were statistically significant differences among the cultivars in terms of all traits studied.

Seed Yield

Statistically significant differences of yield between cultivars varied from 421.7 to 2270.3 kg ha^{-1}. Becker (1993), stated that there were high differences between the cultivars explain the quantitative characteristics such as yield and yield components are less or more affected by the environmental conditions is consistent with project results. In particular, it is thought that the yield varies depending on the genotype x environment interaction. While the highest seed yield was obtained from the Elvis variety (2270.3 and 2081.7 kg ha^{-1}), the lowest yield was obtained from the Es-Nectas variety (421.7 and 658.7 kg ha^{-1}) in two years of the trials.

The results of the study were found similar with the results of some researchers; Gizlenci et al., 2011 (2193-4439 kg ha^{-1})

and was found lower than the result of Gizlenci et al., 2013 (2861-5746 kg ha^{-1}) and was found higher than the result of Ahmed et al., 2016 (595.6-889.3 kg ha^{-1}) (Table 3). This difference is due to the dissimilarity of experimental sites, the time of planting, the variation of soil and climatic conditions as well as the plant material used.

Table 3. Averages regarding to seed yield (kg ha^{-1}), plant height (cm) and number of branches (per plant^{-1}) and CV (%) values in winter canola cultivars

Cultivars	Seed Yield (kg ha^{-1})		Plant Height (cm)		Number of Branches (per plant^{-1})	
	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
Licord	1466.3^{d}	1328.7^{d}	142.83^{ab}	136.73^{ab}	5.16^{bcd}	4.56^{bcd}
Licrown	1269.7^{e}	1302.7^{d}	146.23^{a}	135.73^{ab}	5.00^{cde}	4.73^{bc}
Es-Astrid	1758.7^{c}	1614.7^{c}	139.57^{abcd}	135.17^{ab}	5.16^{bcd}	4.93^{b}
EGC-102	1403.0^{d}	1338.3^{d}	132.73^{cde}	127.13^{bc}	4.73^{def}	4.36^{cde}
Elvis	2270.3^{a}	2081.7^{a}	130.93^{de}	134.23^{abc}	5.46^{abc}	5.33^{a}
Es-Hydromel	1958.3^{b}	1867.7^{b}	127.53^{e}	125.13^{c}	4.33^{fg}	4.16^{ef}
Eldo	1804.7^{c}	1586.3^{c}	134.63^{bcde}	127.53^{bc}	3.93^{g}	3.83^{f}
Es-Nectas	421.7^{g}	658.7^{f}	134.80^{bcde}	130.17^{bc}	4.53^{ef}	4.30^{de}
Embleme	967.0^{f}	857.7^{e}	146.57^{a}	141.23^{a}	5.76^{a}	5.56^{a}
Bristol	1472.3^{d}	1212.7^{d}	140.57^{abc}	135.93^{ab}	5.56^{ab}	5.50^{a}
% CV	2.86	3.43	2.22	2.57	3.62	2.89
			F value			
Cultivars	459.07**	244.79**	13.52**	6.78**	30.87**	57.28**

*The differences between the averages indicated in the same letter in each column are not significant ($p \leq 0.05$)

Plant Height

The highest plant height was obtained from the Licrown and Embleme (146.23 and 146.57 cm) cultivars in the first year, and from Embleme (141.23 cm) variety in the second year. Plant height values between cultivars ranged from 125.13 to 146.57 cm according to the results of two years (Table 3).

The research results were compatible with the results of Gizlenci et al., 2007 (120.4-141.5 cm), and lower than the results of Öz, 2013 (160.7 195.6 cm); Bilal et al., 2015 (164.14-194.0 cm), and higher than the results of Ahmed et al., 2016 (82.7-99.4 cm); Noreen et al., 2016, (68.40-93.25 cm). Türkeç et al. (1993) stated that the plant height is a genotypic factor, the overgrowth causes plant fall down and is not suitable for combine harvesting. Although plant height is a genetic feature that can be directly affected by planting time, irrigation and fertilization. Therefore, the differences found between the experiments are a natural result.

Number of Branches

In the two years of the experiment, significant differences were found between the cultivars. The Embleme cultivar was in the first group by forming the highest number of branches (5.76-5.56 per plant^{-1}) in both years. The number of branches varied from 3.83 to 5.76 per plant^{-1}.

The study results were consistent with the results of Gizlenci et al., 2007 (2.88-5.12 per plant^{-1}), and lower than the results of Öz, 2013 (7.5-10 per plant^{-1}); Gizlenci et al., 2011 (5-8.5 per plant^{-1}), and higher than the result of Noreen et al., 2016 (2.75-4.00 per plant^{-1}). Since the number of branches have positive effect on the yield of canola, as the number of branches increases, both the seed yield increases and the losses that may occur in the plant rows can be compensated (Başalma, 1997). The fact that the Elvis variety, which gave the highest seed yield per decare, is also placed in the first rank in terms of the number of branches confirms this result.

Number of Pods

The highest number of pods was obtained from the Licord and Elvis cultivars (194.73 and 193.27 per plant^{-1}) in the first year, from the Elvis variety (191.23) in the second year. Among the cultivars, the number of pods varied from 115.20 to 194.73 per plant^{-1} in the results of two years (Table 2).

The results obtained from this study were consistent with the results of Noreen et al., 2016 (108-199 per plant^{-1}), and lower than the results of Öz, 2013 (462-803 per plant^{-1}); Khan et al., 2018 (364-388 per plant^{-1}), and higher than the result of Ahmed et al., 2016 (72.3-97.7 per plant^{-1}). Different results in previous studies were due to the genetic differences of the cultivars, sowing time, climate and soil factors.

Number of Seeds

The number of seeds ranged from 21.00 to 27.30 (per pod^{-1}). In the first year of the experiment the Elvis (27.30 per pod^{-1}) cultivar, in the second year the Embleme (24.37 per pod^{-1}) and EGC-102 (24.50 per pod^{-1}) cultivars gave the most number of seeds.

The research results were consistent with the reults of Gizlenci et al., 2011 (16.5-29.6 per pod^{-1}) and higher than results of Öz, 2013 (19.9-25.4 per pod^{-1}); Noreen et al., 2016 (19-22 per pod^{-1}). Among the cultivars used in the trial, the number of groups formed not too much statistically, and therefore the number of seeds among the cultivars can not be said to be very different. However, it is stated by a couple of researchers that the number of seeds per pod^{-1}, which is one of the important characters affecting the yield, varies according to the cultivars, cultivation conditions and climatic conditions (Hodgsen, 1979).

Table 4. Averages regarding to number of pods (per plant^{-1}), number of seeds (per pod^{-1}), 1000 seed weight (g) and CV (%) values in winter canola cultivars

Cultivars	Number of Pods (per plant^{-1})		Number of Seeds (per pod^{-1})		1000 Seed Weight (g)	
	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
Licord	194.73^{a}	181.40^{ab}	23.76^{ab}	21.77^{ab}	3.39^{cd}	3.19^{cd}
Licrown	145.70^{d}	138.83^{d}	23.86^{ab}	22.17^{ab}	3.15^{de}	3.25^{abcd}
Es-Astrid	168.76^{c}	164.00^{c}	24.66^{ab}	22.47^{ab}	3.31^{cde}	3.26^{abcd}
EGC-102	142.80^{d}	134.10^{d}	25.40^{ab}	24.50^{a}	3.93^{cd}	3.32^{abcd}
Elvis	193.27^{a}	191.23^{a}	27.30^{a}	23.20^{ab}	3.43^{bc}	3.28^{abcd}
Es-Hydromel	172.87^{bc}	165.20^{c}	21.50^{b}	21.00^{ab}	3.07^{e}	3.08^{d}
Eldo	122.83^{e}	118.17^{e}	25.46^{ab}	22.13^{ab}	3.67^{ab}	3.52^{a}
Es-Nectas	115.20^{e}	121.40^{e}	22.70^{ab}	20.90^{ab}	3.51^{bc}	3.43^{abc}
Embleme	185.10^{ab}	173.10^{bc}	25.43^{ab}	24.37^{a}	3.30^{cde}	3.24^{bcd}
Bristol	174.90^{bc}	183.60^{ab}	22.50^{ab}	20.43^{b}	3.78^{a}	3.48^{ab}
% CV	2.74	2.48	6.96	6.71	3.4	2.87
			F Values			
Cultivars	123.49**	141.70**	3.15*	2.60*	17.48**	6.31**

*The differences between the averages indicated in the same letter in each column are not significant ($p \leq 0.05$)

1000 Seed Weight

The highest 1000 seed weight was obtained from the Bristol cultivar (3.78 g) in the first year of the experiment, from the Eldo cultivar (3.52 g) in the second year. According to the results of two years, 1000 seed weight values varied from 3.07 to 3.78 g (Table 4).

The results obtained from the study were consistent with the results of Öz, 2013 (3.2-3.8 g); Gizlenci et al., 2011 (2.9-4.9 g) and lower than the results of Gizlenci et al., 2013 (3.91-4.57 g); Bilal et al., 2015 (6.97-7.64 g). It is known that 1000 seed weight is related to the hereditary structure of the cultivar (Degenhardt and Kondra, 1981). Differences in the results of the research might be caused by experimental areas, planting time, climate and soil conditions.

Oil Ratio

The highest oil ratio (44.96 %-43.90%) was obtained form the Elvis cultivar in both trial years. The oil ratio varied from 27.16 % to 44.96 % among the cultivars used in the experiment.

The results obtained from the study were consistent with the results of Tan, 2009 (12.31 %-46.47%) and lower than the results of Öz, 2013 (43.46 %-47.6%). The differences between the results of the research were caused by the genetic structure of the cultivars and the environmental interaction (Öğütçü and Kolsarıcı, 1978). Zukalova et al. (1985) stated that the oil ratio is affected by the presence of potassium and magnesium, soil structure and pH. Schuster (1970) indicated that the oil ratio values of canola varying in accordance with year, cultivar, location and environmental factors but the genetic structure of the cultivars is more effective than environmental conditions.

Number of Flowering Days

In both trial years, Es-Nectas cultivar (161-157 days) came to the earliest flowering. The latest number of flowering days was obtained from the Es-Nectas cultivar (169 and 164 days).

According to the results of two years between flowering days (157-169 days) a difference of 12 days appeared (Table 5). Between the 1st and 2nd years of the experiment, difference between the number of flowering days was approximately 4 to 5 days. The reason for this that can be attributed to a more

rainy in March-April months of the first year than the second year (Table 1). The results of the study were consistent with the result of Süzer (2016) in terms of the number of flowering days (9-17 April). Although there are no significant differences between the number of flowering days of the cultivars used in our study, it can be said that flowering of the some cultivars are earlier than others due to their genetic structure and reaction to environmental conditions.

Table 5. Averages regarding to oil ratio (%), number of flowering days (days) and number of maturation days (days) and CV (%) values in winter canola cultivars

Cultivars	Oil Ratio (%)		Number of Flowering Days (days)		Number of Maturation Days (days)	
	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
Licord	40.06^{b}	39.90^{b}	167^{ab}	162^{ab}	212^{ab}	207^{a}
Licrown	20.73^{g}	27.56^{f}	164^{bc}	160^{abc}	209^{bc}	204^{abc}
Es-Astrid	30.00^{e}	29.90^{e}	163^{bc}	159^{bc}	208^{bc}	201^{cd}
EGC-102	27.20^{f}	27.83^{f}	167^{ab}	162^{ab}	212^{ab}	208^{a}
Elvis	44.96^{a}	43.90^{a}	161^{c}	159^{bc}	206^{c}	201^{cd}
Es-Hydromel	32.23^{d}	33.03^{d}	161^{c}	157^{c}	206^{c}	198^{d}
Eldo	29.10^{e}	29.86^{e}	163^{bc}	158^{bc}	209^{bc}	200^{cd}
Es-Nectas	27.16^{f}	27.23^{f}	169^{a}	164^{a}	214^{a}	206^{ab}
Embleme	35.26^{c}	35.33^{c}	165^{abc}	160^{abc}	210^{abc}	202^{bcd}
Bristol	35.00^{c}	35.36^{c}	165^{abc}	161^{abc}	210^{abc}	204^{abc}
% CV	1.77	1.69	1.00	0.93	0.81	0.79
			F Values			
Cultivars	445.26**	304.53**	7.62**	5.82**	6.94**	12.32**

*The differences between the averages indicated in the same letter in each column are not significant ($p \leq 0.05$)

Number of Maturation Days

Elvis and Es Hydromel cultivars (206 days) came to the maturity earliest in the first year of the experiment, and Eldo cultivar (198 days) in the second year. The latest number of maturation days was obtained from the Es-Nectas cultivar (214 days) in the first year of the experiment and from the EGC-102 cultivar (208 days) in the second year. The values of the number of maturation days have shown a difference of 8-10 days in both years (Table 5).

The results of the study were consistent with the result of Bilal et al., (2015) in terms of the number of maturation days (186.64-212.90 days), and contradict with the results of Tan (2017) (149-163 days) and Öz (2013) (164.3-171 days). In research, it can be explained the reason of early maturity resulted from the differences between the number of maturation days, genetic structure of the cultivars and especially less rainfall of March and April months in the second year and the averages monthly temperature were higher in the second year than in the first year. Vegetation period is influenced substantially by the genetic structure of the cultivars (Özer and Oral 1997).

The highest seed yield per hectare was obtained from the Elvis cultivar (2270.3 and 2081.7 kg ha^{-1}) in the 10 winter canola cultivars sown under Harran Plain conditions in two years, and the lowest seed yield was obtained from the Es-Nectas cultivar (421.7 and 658.7 kg ha^{-1}). According to the results of the two years; the plant height values were observed between 125.13 and 146.57 cm, number of branches 3.83-5.76 per plant^{-1}, number of pods 115.20-194.73 per plant^{-1}, number of seeds 21.00-27.30 per pod^{-1}, 1000 seed weight 3.07- 3.78 g, oil ratio 27.16 %-44.96, number of flowering days 157-169 and number of maturation days 198 and 214.

Conclusion

As a result of this study; seed yield per hectare, number of branches, number of pods and number of seeds per pod, early maturation and especially because of the high oil ratio, Elvis cultivar got featured. It was concluded that like Sanliurfa where there is less rainfall and especially where irrigation possibilites are scarce, Elvis cultivar can be cultivated. It can contribute to decrease oil deficit partially and can be used as parent in breeding activities.

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RESEARCH ARTICLE

The Effect of Rosehip Seed Supplementation into Laying Hens Diets on Performance, Egg Quality Traits, Yolk Lipid Profile and Serum Parameters

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ABSTRACT

This study was carried out to determine the effect of dietary rosehip seed (RS) supplementation into layer diets at different levels on performance, egg quality traits and some serum parameters. A total of 72 Lohmann layers, 46 weeks old, were divided into three treatment groups. The control group was fed with commercial layer diet (K), and the other two groups were fed with basal diet + 10% ground rosehip seeds (K1) and basal diet + 15% ground rosehip seeds (K2) for 12 weeks. The water and feed were provided as ad-libitum during the trial. The rosehip seed supplementation level at 15% into layer diets increased the feed consumption and egg yield ($p<0.05$), and decreased the damaged egg ratio. Though some egg quality traits such as the yolk colour, shell thickness and shell weight increased ($p<0.05$) in eggs from K2 group, there were no significant differences ($p> 0.05$) among the groups in respect to other egg quality traits such as shape index, shell strength, albumen and yolk indexes and Haugh unit values. Total cholesterol, cholesterol esters, free fatty acids and triglyceride contents in the egg yolks from treatment groups were not affected by dietary treatments ($p> 0.05$). Serum parameters such as albumin, total cholesterol, VLDL, triglyceride and ALT values increased ($p <0.05$) with the RS supplementation at level of 15% into layer diet. Results showed that rosehip seed supplementation into layer diets may be beneficial to improve egg quality traits especially such as shell thickness and to decrease damaged egg ratio. But further investigations are needed to clarify the use of rosehip seed in layer diets and its effects on performance, egg quality and serum parameters.

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Introduction

The poultry sector plays an important role in Turkey. However, inadequate of animal feed resources in both quantitatively and qualitatively is most often the limiting factor of the development of livestock production in Turkey (Celebi et al., 2013). In this context, feed producers and scientist have researched to alternative feed materials. Many agricultural and agro-industrial products have the potential as animal feeds (Garipoglu, 2004). Rosehip seed (RS) is one of this fruit wastes. RS is as a waste after processing into products such as fruit juice, jam, marmalade and tea. It has been reported that the remaining seeds are rich in energy and do not cause metabolic disease by grains-based feds (Nichita et al., 1981; Macit et al., 2002).

RS represents approximately 20% to 44% of R. canina fruit and has 93.48% dry matter, 8.72% crude protein, 6.0% digestible protein, 7.97% crude fat, 1.87% crude ash, 31.56-44.05% crude fiber, 30.87% nitrogen free extract, 64.44% acid detergent fiber, 64.78% neutral detergent fiber, and 1800 kcal. ME/kg ground R. canina seed (Nichita et al., 1981; Macit et al., 2002). In another study on the content of mineral substances (Kadakal and Nergiz, 1999), it was found that RS has an average of 4181.2 mg / kg potassium, 2724 mg / kg calcium, 1045.2 mg / kg magnesium, 46 mg / kg iron, 39.8 mg / kg sodium, 29.6 mg / kg of nickel, 9.8 mg / kg of zinc, 4.9 mg / kg of copper, 0.1 mg / kg of cadmium, 55.08% linoleic acid, 20% arachidic acid and 19.31% oleic acid. In addition, it has been stated that

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RS reduce serum cholesterol and triglyceride value in animal experiments (Kadakal and Nas, 2018). Andersson et al., (2012) reported that the total plasma cholesterol and the LDL-cholesterol levels were reduced by 4.9% and 6%, respectively.

Little or no published information is available on the quality of feed provided by Rosehip fruit or on how it could be evaluated as feed ingredient in poultry diets.

This study was carried out to determine the effect of dietary rosehip seed supplementation into layer diets at different levels on layer performance, egg quality traits, egg yolk lipid profiles and some blood parameters in layers.

Materials and Methods

A total of 72 Lohmann layers, 46 weeks old, were divided into three treatment groups, and placed to six cages for each treatment (four birds per cage). The laying hens were reared in poultry houses of Food and Livestock Application and Research Center of Ataturk University. The control group was fed with commercial layer diet (K), and the other two groups were fed with basal diet + 10% ground rosehip seeds (K1) and basal diet + 15% ground rosehip seeds (K2). The water and feed were provided as ad-libitum during the trial. After one week of the adaptation period, the chickens were weighed and randomly divided into three groups, and experiment lasted for twelve weeks.

Formulation and chemical composition of diets on dry matter basis are shown in Table 1. The RS was obtained from a fruit juice plant in Gumushane. The experimental diets were formulated to meet the NRC nutrient requirements of layers (NRC, 1994). ME (kcal /kg DM) was calculated using following formula given by Görgülü (2014).

$$ME = 3212 - 6.66CP\% + 37.34\ EE\% - 14{,}43\ CA\% - 34.60\ CF\% \quad (1)$$

Table 1. Chemical composition of commercial layer diet and RS

			Chemical composition (%)	
			Commercial layer diet	Rosehip seed
Soybean meal	18.13	Dry matter	89.47	93.4
Maize	52.81	Crude protein	16.50	8.7
Barley	6.00	Ether extract	4.88	8.00
Full fat soy	1.65	Crude fiber	4.49	44.1
Sunflower meal	7.50	Ash	11.70	1.9
Ground corn	2.04	ME (kcal kh^{-1})	2720	1899*
Soya oil	1.60			
Ground limestone	6.82			
Salt	0.30			
DCP 18	2.65			
D-L Methionine 99	0.15			
L-Lysine	0.10			
Vitamin Premix[1]	0.25			

[1]Premixes were formulated to meet recommended levels for minerals and vitamins (NRC, 1994)
*Calculated by Görgülü (2014)

Egg production and feed consumption were measured daily, egg weight was measured biweekly and body weight was measured monthly. 12 eggs was randomly collected from each group at the beginning, midst and end of the experimental period to assess egg quality parameters (Kaya and Macit, 2012). Egg quality parameters were shape index, shell strenght, shell thickness, shell weight, yolk color, yolk index, albumen index and Haugh units . At the end of the experiment, 6 animals from each group were selected and blood samples were taken from the wing vena using heparinized tubes and centrifuged at 3000 x g for 5 minutes. Plasma lipid profile, some mineral and enzyme contents were determined by using commercial kits (DDS Spectrophotometric Kits, Istanbul Turkey) in the Mindray Perfect Plus 400 brand autoanalyzer in the Faculty of Medicine, Department of Biochemistry. In order to determine the lipid profile of egg yolk, a total of 18 eggs taken from each sub group at the end of the experiment were immediately broken and egg whites and yolk were separated. Egg yolks were placed in pre-weighed 50 ml capillary fragments. To determine the egg yolk cholesteryl ester (CE), triglyceride (TG), free fat acid (FFA), cholesterol (COL), phosphotidylserine (PS) and phosphotidylcholine (PC) of egg samples the HPTLC methods were used (Hara and Radin, 1978; Macala et al., 1983).

The data were analyzed using general linear model procedure of SPSS 20.0 (2011) program. Significant differences among means were tested using Duncan's Multiple Range Test (Duncan, 1955).

Results and Discussion

The results of the performance parameters are given in Table 2. It was found that there were significant differences among the groups in terms of performance parameters such as feed consumption, egg production, cracked egg yield and egg weight. Egg production and feed consumption values were increased ($p < 0.01$) and cracked egg yield was decreased (p

<0.05) in the group fed with diet including 15% ground rosehip seed (K2). Eggs from K1 were heavier than eggs from K and K2 (p <0.01). There is a negative correlation between energy content and consumption of diet (Ozkan and Acikgoz, 2007). Due to the high fiber and low energy content of the RS, the chickens in the K1 and K2 groups consumed more feed to meet their nutritional needs, especially their energy needs. Some researchers reported that feed consumption increased in broiler groups fed with the addition of rosehip seed (Nichita et al., 1981). Vlaicu et al., (2017) reported that the diets including high cellulose content because of rosehip powder negatively affected the feed consumption of the layers.

Table 2: Least squares means for performance parameters of laying hens

Trait	FC (g/day)	EP (%)	CEY (%)	EW (g)	FCR (kg feed/kg egg)
K	95.03^{b}	72.49^{b}	4.41^{b}	65.89^{b}	2.21
K1	111.29^{a}	79.87^{b}	4.34^{b}	68.38^{a}	2.09
K2	118.51^{a}	89.29^{a}	1.39^{a}	64.85^{b}	2.08
SEM	2.84	3.35	1.98	0.76	0.20
P	**	**	*	**	ns

$^{a, b:}$ Means in rows with different superscripts are significantly different *(P<0.05), **(P<0.01), ns: non significant, FC: Feed consumption, EP: Egg production, CEY: Cracked egg yield, EW: Egg weight, FCR: Feed conversion ratio

Table 3: The effect of RS on egg quality traits of laying hens

Trait	Shape index (%)	Shape strength (kg/cm^2)	Shell thickness (mm×10^{-2})	Shell weight (g)	Yolk color	Yolk index (%)	Albumen index (%)	Haugh unit
K	73.59	0.569	0.338^{b}	7.03^{b}	7.19^{b}	38.84	7.54	78.03
K1	74.61	0.521	0.338^{b}	7.39^{b}	7.58^{b}	39.10	8.11	80.78
K2	76.01	0.800	0.375^{a}	7.98^{a}	8.20^{a}	38.84	7.22	77.26
SEM	0.84	0.089	0.036	0.22	0.18	0.83	0.57	2.64
P	ns	ns	*	**	**	ns	ns	ns

$^{a, b:}$ Means in rows with different superscripts are significantly different *(P<0.05), **(P<0.01), ns: non significant

It was determined that there were no significant differences among the groups in terms of shape index, shell strength, yolk index, white index and Haugh unit. The birds in K2 group produced better eggs in terms of shell thickness, shell weight and yolk color significantly than the control group. Calcium is an important macro mineral for egg shell formation of laying hens. The improvement in external quality parameters such as cracked egg yield, shell thickness and shell weight obtained from the birds in the K2 group may be due to the fact that the RS is rich in Ca (2724 mg / kg) (Kadakal and Nergiz, 1999). On the other hand, it has been reported that the RS is rich in carotenoids (Gao et al., 2000). The increase in egg yolk color with the addition of 15% RS may be due to the carotenoid content of RS.

Table 4: The effect of Rose canina seed on egg yolk lipid profiles of laying hens

Trait	CE	TG	FFA	COL	PS	PC
K	4.86	56.25	0.389	20.43	0.278^{b}	6.44
K1	4.87	56.04	0.420	20.65	0.503^{a}	6.77
K2	5.94	56.03	0.303	21.24	0.468^{a}	5.95
SEM	0.47	1.21	0.646	0.36	0.062	0.367
P	ns	ns	ns	ns	*	ns

$^{a, b:}$ Means in rows with different superscripts are significantly different *(P<0.05), **(P<0.01), ns: non significant, CE, cholesteryl ester; TG, Triglyceride; FFA, Free fat acid; COL, cholesterol; PS, Phosphatidylserine; PC, Phosphatidylcholine

Table 5: The effect of RCS on serum parameters of laying hens

Blood Parameters	K	K10	K15	SE	P
Uric acit (µmol/L)	4.65	3.66	3.65	0.52	ns
Total protein (g/L)	3.36	4.07	4.29	0.47	ns
Albumin (g/L)	1.02^{b}	1.39^{ab}	1.71^{a}	0.16	*
Globulin (g/L)	2.33	2.69	2.58	0.33	ns
ALT (U/L)	7.5^{b}	8.5^{b}	30.0^{a}	6.15	*
Triglycerides (mg/L)	699.5^{b}	1146.3^{ab}	1644.8^{a}	365.6	*
Cholesterol (mmol/L)	86.08^{b}	137.5^{ab}	164.5^{a}	20.69	*
HDL (g/L)	18.25	25.5	28.0	4.41	ns
VLDL (g/L)	139.92^{b}	229.33^{ab}	329.00^{a}	74.7	*
LDL (g/L)	64.25	55.50	61.00	11.72	ns
Ca	12.11^{b}	19.08^{a}	19.83^{a}	2.21	*

$^{a, b:}$ Means in rows with different superscripts are significantly different *(P<0.05), **(P<0.01), ns: non significant

The yolk lipid profile of the eggs collected at the end of the experiment are given in Table 4. There were no differences among the groups. It has been determined that the addition of RS to the laying hens' diets increased egg yolk phosphatidyl serine content.

There was no significant difference ($p > 0.05$) in uric acid, total protein, globulin, HDL, LDL, but albumin, ALT, cholesterol, triglyceride, VLDL and Ca were increased by addition of RS 15% (Table 5). In the study carried on broiler, it was found that the serum urea, creatinine, uric acid, triglyceride, total protein, glucose, K and Cl were not affected by the addition of rosehip, but cholesterol level decreased because of high cellulose content and flavonoids (Tekeli, 2014). In the different study, it has been reported that phenolic compounds such as flavonoids, anthocyanidins and anthocyanins reduced endogenous cholesterol absorption and synthesis (Nurulhuda et al., 2012). It is also emphasized that the RS may have hypocholesterolemic activity because it is rich in phenolic compounds.

As a result, it was determined that the addition of 15% RCS into the laying hen diets improved the egg yield and egg quality traits especially such as shell thickness, yolk color, and decreased cracked egg yield. But further investigations are needed to clarify the use of rosehip seed in layer diets and its effects on performance, egg quality and serum parameters.

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RESEARCH ARTICLE

Effects of Rhizobacteria on Plant Development, Quality of Flowering and Bulb Mineral Contents in *Hyacinthus orientalis* L.

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ABSTRACT

Size of bulbs is directly proportional to the quality of the flower, the commercial value of the bulb and getting more bulblet. The research was carried out to evaluate the effects of PGPR on plant growth parameters, flowering, bulb quality and bulb mineral contents in hyacinth (*Hyacinthus orientalis* L. cv. Aiolos) under greenhouse condition. In the study, there were 5 applications: (T_1) *Pseudomonas putida strain* RCK-42A, (T_2) *Kluyvera cryocrescens strain* RCK-113C, (T_3) *Paenibacillus polymyxa strain* RCK-12E, (T_4) *Bacillus subtilis strain* RCK-17C, and (T_5) Control (uninoculated bacteria). The surface-sterilized bulbs were incubated separately by shaking at 80 rpm for two hours at 28 ºC to coat the bulbs with the bacteria. The chlorophyll content (50.02), leaf length (26.03 cm), leaf area (268.38cm^2), flower fresh and dry weight (15.54 g and 0.88 g) in T_2 (*Kluyvera cryocrescens* strain RCK-113C) was found as the maximum according to other applications. The highest leaf width (6.37 cm) and the highest floret number were observed in T_4. It was shown that the maximum bulb diameter (42.57 mm), bulb length (40.01 mm) and bulb weight (12.01 g) were determined in T_2. The maximum N (2.90%), P (1.98%) and Ca (1.74%) were found in T_3. Maximum Fe (0.48 mg kg^{-1}), Mn (151.20 mg kg^{-1}) and Zn (35.28 mg kg^{-1}) were found in T_1. Use of especially *Kluyvera cryocrescens* strain RCK-113C and *Pseudomonas putida* strain RCK-42A bacterial isolates may be effective in maintaining the sustainability of the environment and growing medium in the cultivation of hyacinth and also the development of bio fertilizer.

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Introduction

Hyacinth (*Hyacinthus orientalis L.)* belongs to *Hyacinthaceae* Batsch ex Borkh family and *Hyacinthus* genus. Hyacinths are used in the landscape studies (Xie and Wu, 2017) and cultivated mainly for indoor, outdoor and balcony decorations (Ekim et al., 2000). The plant has commercial importance for cut flower and as well as in garden designs, and duplicating bulbs are also sold on the market in order to contribute to the economy (Xie and Wu, 2017). The plant is also used industries related to perfumery for obtaining essential oil extracts (Kizil et al., 2016).

Seeds using for development of new cultivars are not preferred for commercial multiplication in hyacinth. Their natural propagation rates are very slow and take 4–6 years to develop a bulb size capable of flowering and seed set under optimum conditions (Kizil et al., 2016). In general, the amounts of stored reserves present in corm, bulb or rhizome have certain effects on the performance of vegetative propagated plants. Size of bulbs is directly proportional to the quality of the flower, the commercial value of the bulb and getting more bulblet (Rees, 1969; Padhye and Cameron, 2007; Parlakova, 2014). In the direction of this information, plant nutrition is important for the best development of *hyacinth*, bulb growth and number of bulbs.

The production and profit increase in agriculture brought along the intensive use of inputs. In this case, different microorganisms selected from rhizosphere are used for nutrition in order to increase the plant growth. Plant growth

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promoting rhizobacteria (PGPR) that promote plant growth are used as organic fertilizer because of the useful effects on plant growth. PGPR have several important bacterial characteristics that have been generally attributed to their ability to fix atmospheric nitrogen, secretion of certain organic compounds, solubilize soil phosphate, produce antibiotics, phytohormones and siderophores, or suppress deleterious rhizobacteria (Glick, 1995; Pérez-Montaño et al., 2014). There are many reports showing that PGPR have promoted the reproductive and growth parameters of ornamental plants (Parlakova, 2014; Arab et al., 2015; Parlakova Karagöz and Dursun 2019a,b), vegetable crops (Botta et al., 2013; Pahari et al., 2017), fruits (Arikan and Pirlak, 2016; Pii et al., 2017.) field crops (Mirshekari et al., 2012; Di Benedetto et al., 2016; Nosheen et al., 2018). There is no study using PGPR as plant growth promoting agent in hyacinth cultivation around the world.

The aim of this study was to examine the effects of PGPR (*Paenibacillus polymyxa, Pseudomonas putida, Kluyvera cryocrescens* and *Bacillus subtilis*) on growth parameters, flowering, bulb quality and bulb mineral contents of hyacinth. This study also aimed at producing big sized quality bulbs in a maximum number and good quality by using PGPR during the cultivation of hyacinth.

Materials and Methods

Materials and Plant Set-up

Bulbs of *Hyacinthus orientalis* L. (cv. Aiolos) used in the experiments were purchased from Asya Lale Company in Turkey (Konya). Bulbs free of rotten and wounded were at 16-17 cm circumference length of bulbs. The study was carried out under the natural light in greenhouse at the Department of Horticulture of Agricultural Faculty, Atatürk University between on December 8 in 2016 and on June 10 in 2017.

The daytime temperatures were recorded as 26 ± 2 ^{0}C and night temperatures were recorded as 10 ± 2 ^{0}C in the greenhouse. Surfaces of bulbs were disinfected in 3% sodium hypochlorite by dipping the bulb for 3 min and washing three times in distilled water.

All of the bacterial strains (*Pseudomonas putida strain* RCK-42A*, Kluyvera cryocrescens strain* RCK-113C*, Paenibacillus polymyxa strain* RCK-12E and *Bacillus subtilis strain* RCK-17C*)* were acquired from the culture collection unit in the Department of Plant Protection, Faculty of Agriculture at Atatürk University (Table 1).

Table 1. Nitrogen fixation (N), phosphate-solubilising activity (P) of the tested bacterial strains.

Code of application	Bacterial strains	Isolated from	N	P
T_1	*Pseudomonas putida* RCK-42A	*Poaceae* sp.	W+	W+
T_2	*Kluyvera cryocrescens* RCK-113C	*Allium* sp.	+	+
T_3	*Paenibacillus polymyxa* RCK-12E	*Poaceae* sp.	S+	+
T_4	*Bacillus subtilis* RCK-17C	*Rubus sp.*	S+	W+

+: Positive; S+: Strong positive; W+: Weak positive; -: Negative
Kotan et al., 2005; Kotan et al., 1999; Erman et al., 2010

The best nitrogen fixing and best phosphorus solubilizing of the bacterial strains given in Table 1 were selected by considering the results obtained in previous studies and some biochemical test results of each strain (Erman et al., 2010). Absorbance of the bacterial suspensions was measured spectrophotometrically at 600 nm. The bacterial suspensions were properly diluted to 1x10^8 CFU ml^{-1} in distilled water. Approximately, 0.2g of sucrose (10 mg mL^{-1}) was put in each Erlenmeyer flasks. The surface-sterilized bulbs were soaked separately in these suspensions and incubated by shaking at 80 rpm for two hours at 28 ºC in *the Erlenmeyer flasks* to coat the bulbs with the bacteria. The bulbs untreated by bacteria were used as the control. The experimental growing medium includes 1:1 ratio of farm soil in field condition and sand for ensuring drainage. Control and treated bulbs were planted in black polyethylene bag having 3-liter volume, 14.5 cm length and 20.5 cm^2 diameter on December 8 in 2016 and harvested on June 10 in 2017.

Experimental Design and Greenhouse Studies

In the study, there were 5 applications: (**T_1**) *Pseudomonas putida strain* RCK-42A, (**T_2**) *Kluyvera cryocrescens strain* RCK-113C, (**T_3**) *Paenibacillus polymyxa strain* RCK-12E, (**T_4**) *Bacillus subtilis strain* RCK-17C, and (**T_5**) Control (uninoculated bacteria). Research was established in a completely randomized design with 3 replications having 5 plants in each replication. For each application, total 15 hyacinth bulbs were planted, one bulb per pot. Total 75 bulbs (at 16-17 cm circumference length) were used. During the experiment period, irrigation was performed according to the irrigation needs of the hyacinth plant.

Quantitative and Qualitative Parameters and Measurements

Vegetative growth of hyacinth plant [diameter of stems (mm), chlorophyll content (SPAD), leaf area (cm^2), leaf width (cm), leaf length (cm)], some morphological parameters of hyacinth, bulbs [average bulb diameter (mm), bulb length (mm) and bulb weight (g)] and some morphological parameters of hyacinth flower [flower stem diameter (mm), number of floret per flower, flower diameter (mm), flower length (mm), flower fresh and dry weight (g)] were determined. Total leaf width and length were recorded as the sum of all the individual leaf widths and lengths for one particular plant (Addai, 2010). The leaf area was measured using CI 202 Portable digital brand leaf area meter. Bulb tissue samples were oven dried at 68 °C

for 48 h, ground, and passed through a 1-mm sieve. The Vapodest 10 Rapid Kjeldahl Distillation Unit (Gerhardt, Germany) and the Kjeldahl method and were used to determine total N (Bremner, 1996). Macro (K, P, Ca and Mg) and micro (Fe, Na, Mn, Cu, Zn) nutrients bulbs were also determined according to the Mertens (2005) method. The contents of K^{+}, Mg^{+2} and Ca^{+2} were determined after wet digestion of dried and ground sub-samples in a H_2SO_4-Se-Salisylic acid preparation. Phosphorus (P) was determined spectrophotometrically by the vanadomolybdophosphoric method (Lott et al., 1956) after reaction with ascorbic acid. K^{+} and Ca^{+2} were determined by flame photometry, and Mg^{+2}, Fe, Cu, Na, Mn and Zn were determined by atomic absorption spectrometry using the AOAC (1990) method.

Statistical Analysis

Data have been evaluated by analysis of variance, which was performed using the SPSS version 20.0 statistical software package (SPSS Inc., Chicago, IL, USA). Duncan's multiple range was used to compare significant difference. $p<0.05$ has been set to be the maximum acceptable limit and to be considered a significant result.

Results

According to the results, applications exerted a significant effect on diameter of stem (mm), chlorophyll content (SPAD), leaf area (cm^2), leaf width (cm) and leaf length from some morphological values in studied hyacinth cultivar (Table 2).

The highest diameter of stem was obtained from the T_3 (17.76 mm). There were significant ($p>0.05$) differences in terms of chlorophyll content (SPAD) and leaf area (cm^2) in all bacterial applications compared to the control application (T_5). However, chlorophyll content (50.02) and leaf area (268.38cm^2) in T_2 application was found as the maximum according to other applications. The highest leaf width was obtained from T_4 (6.37 cm). The highest leaf length (26.03 cm) was determined in T_2. The T_3 in terms of the leaf length parameter is in the same statistical group with the control (Table 2).

Table 2. The effects of the applications on some morphological values of hyacinth plant.

Applications	Diameter of stems (mm)	Chlorophyll content (SPAD)	Leaf area (cm^2)	Leaf width (cm)	Leaf length (cm)
T_1	16.13±0.81 b	38.29±0.96 c	252.17±0.95 b	4.20±0.10 c	23.10±0.53 b
T_2	15.27±0.44 c	50.02±1.51 a	268.38±0.47 a	5.63±0.21 b	26.03±0.93 a
T_3	17.76±0.85 a	45.81±0.76 d	228.04±9.76 c	5.83±0.06 b	15.83±0.81 c
T_4	14.76±0.63 c	44.37±0.86 e	257.01±5.64 b	6.37±0.38 a	21.83±1.68 b
T_5	12.78±0.54 d	45.08±1.73 b	182.98±2.85 d	3.43±0.25 d	17.23±1.05 c
Mean	15.34±1.79	44.71±4.03	237.72±31.74	5.09±1.15	20.80±4.01
F	22.25*	35.34*	126.85*	85.65*	46.64*

ns: non-significant at $p>0.05$, * Significant at $P<0.05$. Data (means±SD). There is no difference between the means shown with the same letter at $p<0.05$ significance level. T_1: *Pseudomonas putida strain* RCK-42A; T_2: *Kluyvera cryocrescens strain* RCK-113C; T_3: *Paenibacillus polymyxa strain* RCK-12E; T_4: *Bacillus subtilis strain* RCK-17C; T_5: Control (uninoculated bacteria).

The applications had significant ($p<0.05$) effects on the floret number (number $flower^{-1}$), and the average floret number was 13.25 number $flower^{-1}$ (Table 3). The highest floret number was obtained from T_4.

Flower stem diameter and flower diameter was not significantly affected by bacterial applications (Table 3). The T_1 produced the highest flower length (20.15 mm), while the flower length was 15.74 mm in the case of control application (T_5).

Table 3. The effects of applications on some morphological values of hyacinth flowers.

Applications	Flower stem Diameter (mm)	Floret number (number/flower)	Flower diameter (mm)	Flower length (mm)	Flower fresh weight (g)	Flower dry weight (g)
T_1	7.36±0.53	13.00±0.60 b	8.17±0.47	20.15±.73 a	9.48±0.74 c	0.66±0.06 b
T_2	7.50±0.17	13.98±0.73 ab	7.57±0.13	18.73±0.47 b	14.54±0.69 a	0.88±0.05 a
T_3	7.60±0.43	13.97±0.31 ab	7.53±0.31	17.08±0.90 c	12.46±1.31 b	0.72±0.06 b
T_4	7.90±0.60	14.17±0.17 a	7.90±0.60	15.06±0.63 d	12.12±0.81 b	0.88±0.09 a
T_5	7.38±0.37	11.12±0.74 c	7.38±0.36	15.74±0.77 d	8.84±0.24 c	0.67±0.04 b
Mean	7.55±0.43	13.25±1.27	7.71±0.45	17.35±2.04	11.49±2.27	0.76±0.11
F	0.74 ns	15.56*	1.89 ns	26.00*	23.59*	8.74*

The highest flower fresh weight (14.54 g) and flower dry weight (0.88 g) were found in T_2 application. In terms of flower dry weight, T_2 was in the same group with T_4 application.

The effects of the applications on bulb diameter, bulb length and bulb weight of hyacinth plant were presented in Table 4. It was determined that the highest bulb diameter was in T_2 bacteria application. The bulb length was found significant ($p<0.05$) in applications. T_1 and T_2 applications were in the same group with bulb length compared to the control. The effect of bacteria applications on bulb weight (g plant $^{-1}$) was determined significant ($p<0.05$). The highest bulb weight was in T_2 application.

Table 4. The effects of the applications on some morphological values of hyacinth bulbs.

Applications	Bulb diameter (mm)	Bulb length (mm)	Bulb weight (g plant^{-1})
T_1	41.28±1.27 b	39.66±0.62 a	11.18±1.44 a
T_2	42.57±0.43 a	40.01±0.58 a	12.01±0.77 a
T_3	40.87±.0.76 b	37.93±0.11 b	11.27±0.79 a
T_4	38.28±0.19 c	36.55±0.76 c	8.81±0.38 b
T_5	35.98±0.33 d	34.88±0.95 d	7.91±0.29 b
Mean	39.80±2.052	37.81±2.06	10.23±.79
F	41.67*	31.50*	13.43*

Table 5. Findings of macro (%) and micro (mg kg^{-1}) nutrient analysis of hyacinth bulbs.

Applications	N	P	K	Ca	Mg
T_1	2.80±0.20 a	1.76±0.20 a	0.29±0.04 a	1.44±0.19 b	210.40±1.90 a
T_2	2.40±0.01 b	1.88±0.13 a	0.33±0.06 a	1.66±0.02 ab	187.00±12.00 c
T_3	2.90±0.05 a	1.98±0.10 a	0.25±0.03 b	1.74±0.07 a	203.82±1.93 ab
T_4	2.77±0.17 a	1.98±0.39 a	0.29±0.05 a	1.50±0.20 ab	199.12±1.27 b
T_5	1.70±0.32 c	1.33±0.02 b	0.18±0.01 b	1.18±0.13 c	184.26±0.98 c
Mean	2.51±0.48	1.78±0.31	0.27±0.06	1.50±0.23	196.92±11.30
F	20.70*	5.06*	5.55*	7.22*	12.01*
Applications	***Na***	***Fe***	***Mn***	***Zn***	***Cu***
T_1	0.50±0.08	0.48±0.06 a	151.20±0.40 a	35.28±1.01 a	52.00±1.00 a
T_2	0.44±0.03	0.39±0.02 b	142.00±3.00 b	27.00±2.00 c	52.00±1.89 a
T_3	0.49±0.03	0.34±0.02 b	147.73±2.73 b	31.64±.064 b	51.35±.1.40 a
T_4	0.45±0.06	0.39±0.01 b	135.28±2.00 c	33.00±1.00 b	53.33±1.53 a
T_5	0.37±0.20	0.28±0.02 c	90.28±1.14 d	15.80±0.74	30.74±.0.09 b
Mean	0.45±.0.63	0.38±0.07	133.30±23.02	28.54±7.23	47.89±8.97
F	3.26 ^{ns}	16.62*	420.82*	128.78*	156.11*

The applications had significant effects on N, Ca, Mg, P and K (at $p<0.05$) from macro-nutrient elements. The maximum N (2.90%), P (1.98%) and Ca (1.74%) were found in T_3 application while the maximum (0.33%) K was found in T_2 application. It was found that N macro-nutrient element was the same group in T_1, T_3 and T_4 bacteria applications. All of the bacteria applications significantly increased P content of plant compared to the control (T_5). All the applications were in the same group for K macro-nutrient element when compared to the control (T_5) and T_3 applications (Table 5). Applications had significant (at $p<0.05$) effects on Mg. According to control application, maximum Mg (210.40 mg kg^{-1}) was found in T_1 application (Table 5). There were no significant ($p>0.05$) differences between the applications in terms of Na. Applications had significant effects on Fe, Zn, Mn and Cu micro nutrient elements at $p<0.05$. Maximum Fe (0.48 mg kg^{-1}), Mn (151.20 mg kg^{-1}) and Zn (35.28 mg kg^{-1}) were found in T_1 bacteria application, while maximum Cu (53.33 mg kg^{-1}) was found in T_4 (Table 5).

Discussion

The present study showed that the effects of PGPR supply on growth and development of the hyacinth plants and bulbs are important. This is the first report on the growth promoting effect of bacterial application on hyacinth. However, similar reports were obtained for different plant species. Researchers reported that bacterial applications including *Bacillus* and *Pseudomonas* strains can stimulate the growth and increase the yield in (Nelson, 2004; Sahu et al., 2018) [tomato (Mena-Violante and Olalde-Portugal, 2007; Le et al., 2018), sugar beet (Çakmakçı et al., 2006), chickpea (Elkoca et al., 2008),

apricot (Altindag et al., 2006), strawberry (Pii et al., 2017) eg.].

It is clear that the rate of growth of a plant depends on a thick stem. The results indicate that diameter of stem hyacinth was high with T_3 application (17.76 mm). Asghar et al. (2002) stated that inoculation with isolate S84 increased (33.3%) stem diameter in *Brassica juncea* L. Likewise, Esitken et al. (2006) reported that applying *Bacillus* OSU-142 increased the stem diameter and leaf area of sweet cherry trees. The positive effects of *Paenibacillus polymxa* RCK-12 E on the diameter of stem hyacinth was explained by N_2 fixation ability and production of antimicrobial substance (Glick 1995; Pérez-Montaño et al., 2014). The chlorophyll content is intimately related to plant dry matter production (Buttery and Buzzell, 1977). Therefore, any increase in leaf chlorophyll content would rise net photosynthesis and thus rise total plant growth and development. The chlorophyll content of hyacinth leaves ranged between 38.29 and 50.02 in the present study. Alam et al. (2001) illustrated that bacterial inoculation of rice plants led to the increase in chlorophyll content. Bailey (1963) stated that the length of hyacinth leaves is 20-30 cm and leaf width is 1.25-3.75 cm. Smigielska et al. (2014) reported that leaf lengths ranged between 24.30 and 28.40 cm. The average leaf length was the same with the finding. However, the average width of leaf was different from the finding and the applications had enhancing effect in terms of the parameter. In addition, the highest leaf width (6.37 cm) was determined in T_4 bacteria application.

De Silva et al. (2000) stated that the treatment of *Pseudomonas fluorescens* Pf 5 increased in the stem diameter and leaf area of high bush blueberry. These findings, in which the maximum leaf area was obtained by T_2 bacteria application, were supported by the findings of De Silva et al. (2000). Also, Sharaf-Eldin et al. (2008) stated that inoculation of *Bacillus subtilis* FZB24 increased the flowers per corm and leaf length.

In flower bulbs, inflorescence is an important sink organ (Van Die et al., 1970). The reason for this is that the flowering is dependent on the existing photosynthesis or reserves stored in the bulb scales (Wassink, 1965). In this study, the decrease in the parameters of some leaves (Chlorophyll content) may be interpreted because the possibility that more reserves may be transferred into the flowers for the development of inflorescence instead of leaf and bulb growth. It was obtained in the present study that the bacterial applications had promoting effects on floret number, flower length and flower stem diameter. Before flower initiation, the quality of the inflorescence and offsets can thus be influenced by the nutritional status of the bulbs (Roodbol et al., 2002). As a result, inflorescence will be able to develop and grow at the expense of bulb growth with a good plant nutrition.

In active growth period, bulbs with root and leaves need nutrients and water; basic needs of bulbs are phosphate and superphosphate or ammoniumphosphate are reported to be beneficial (Addai, 2011). Deficiencies in nitrogen are cause the development of small plants and bulbs by reason of early maturity (Scott, 2008; D'Haene et al., 2018). The number of florets per inflorescence is influenced in nutrition in the previous season and season when the plant blooms. The nutritional requirements of the bulb change according to cultivar types (Roodbol et al., 2002). They observed that the large bulbs required higher nutrient levels than small bulbs (Roodbol et al., 2002).

The concentrations of macro and micro plant nutrient content in hyacinth bulbs were significantly affected by PGPR applications. The reasons of the increases in plant growth may be due to the increasing nutrient uptake, providing plant growth hormones, improving chlorophyll content and organic acids with bacterial applications. These findings in the present study were found to be consistent with the findings of previous studies (Shen et al., 2004; Zare et al., 2011; Parewa et al., 2014; Parlakova Karagöz et al., 2016). In the PGPR applications, the highest contents of N, P and Ca were observed in the T_3 bacteria application. In the PGPR applications, the highest contents of P, K, Mg Ca were observed in the *Pseudomonas+Azotobacter* application that had differed significantly from other applications (Zare et al., 2011). The highest contents of Mg, Fe, Mn and Zn were determined in T_1, *Pseudomonas putida strain* RCK-42A, application. Gravel et al. (2007) reported that *Pseudomonas putida* B strain 1 increased Mg content of leaves of tomato plants. PGPR inoculation could compensate for nutrient deficiency, improve a plant development by microorganisms in the root zone, stimulate root development of plants and result in better absorption of nutrients and water from the grown medium (Egamberdiyeva, 2007; Soussi et al., 2016).

In conclusion, in hyacinth cultivation, the PGPR applications (especially *Kluyvera cryocrescens strain* RCK-113C and *Pseudomonas putida strain* RCK-42A) may have a potential for the production of biofertilizer required in organic agriculture because of rendering insoluble phosphates into soluble form and, biological N_2 fixation encouraged directly to improve the plant growth by means of the bacteria. The PGPR applications could be ideal in the cultivation of hyacinth as cut flowers, landscaping plants, potted plants. So, sustainability in the landscapes may be achieving. We expect that this demand can be met by this study.

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REVIEW ARTICLE

Organic Agriculture Potential of Eastern Black Sea Region

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ABSTRACT

Mankind caused a lot of harm to their environment unintentionally during agriculture. Thus nowadays production techniques that are compatible with nature, making the right use of the resources, targeting sustainable development, looking after animal welfare are beginning to spread throughout the world. Especially organic agriculture among those techniques gained a seat as it depends on customer preference. Organic agriculture that has the following five fundamental features: compatibility to nature, self sufficiency, sustainability, welfare, traceability began with the production of dried grape, dried figs, dried apricots and nuts in our country during the 1980s with the contractual agriculture system intending to export. During the following years, hardshell and dried fruits, frozen fruits and vegetables, fresh fruits and vegetables, spices and legumes followed the previous ones in export. Also, production and exportation of rose water, rose oil, olive oil, cotton and textile products increased considerably. In our country where there is a wide variety of products for organic agriculture, in eastern black sea region tea and nuts are the most cultivated products. Organic agriculture is carried out in every province of the region, the contribution of provinces in percentage as follows: Rize 42%, Ordu 25%, Artvin 13%, Trabzon 10%, Gumushane and Giresun 5%. Organic stock raising is done only in Gumushane and Ordu. Gümüşhane has the most promising potential for organic stock raising.

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Introduction

In order to obtain maximum yield from agricultural activities from the beginning until today, intensive agricultural practices were focused on in monocultural way, and those practices increased continuously which led to usage of mineral fertilizers and synthetic pesticides. With those practices; problems such as reduction in organic substances in soil, extinction in soil microorganism activities, soil erosion, increase in disease and harmful factors, rise in environmental pollution and destroy in natural balance (Walaga et al., 2005). Likewise, intensive agricultural activities made in order to obtain high yield with conventional agriculture led to over exploitation of soil, environmental pollution, destroying of natural balance and product quality and formation of remaining in the product (Bayram et al., 2007). In order to remove the hitches that took place and make the production and consumption of the products healthier, conscious producers and consumers came together and then suggested and developed the Ecological Agriculture concept (Öztürk, 2004).

The European countries that considered such adverse outcomes suggested the "Organic Agriculture" concept and started the works to make agricultural production to be sensitive to environment and human health as well as be sustainable. In the year 1972, ''International Federation of Organic Agriculture Movements'' (IFOAM) which have its headquarters in Germany was founded. Organic agriculture was thought to be an alternative to traditional agriculture and named as “Ecological”, “Organic” or “Biologic Agriculture”, varying by countries (Çavdar, 2003).

Organic agriculture is a way of production which is done without using chemical inputs, using natural fertilizers and biological controls in plant and animal production in a way not to destroy natural balance as well as provided that in each stage products are under control and certificated for not damaging human health (Okcu et al., 2013). Among the general purposes of organic agriculture are; to protect biological and

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mineral structure of soil, not to damage natural flora and fauna, strengthen the ecological relationship destroyed between soil-human-plant-animal and to use regional sources in agricultural production as much as possible (Yavuzer and Bengisu, 2015). With organic agriculture, the health of farmers making the production and environmental health are also protected along with consumer health, and thanks to that; chemicals in the products arriving to table are blocked and this allows to grow up healthy generations (Ertem and Çiçekli, 2010). By developments in world trade of ecological agriculture started at 1970s, European origin companies demanded ecological product from Turkey and so during the years 1984-1985, organic agriculture practices started in our country. In those years, this took place in Aegean Region with dried fig and dried grape which are among the traditional export products of Turkey. After that, these products were followed by dried apricot and hazelnut and so other regions were involved (Atiker, 2004).

Eastern Black Sea Region is prominent with its topographical diversities and has a potential to grow various products with this characteristic at different microclimate zones. Factors such as inclined structure of the region, being short of land assets of agricultural establishments, reduction in youth population living at agriculture zone create difficulties in agricultural production. However, the will of the local people to work and their liking for agriculture constitute the biggest guarantee to overcome those barriers. Though it is easy to make organic agriculture in the region, it is very important that this issue is conducted not based on individuals but on areas within the region (Özcan and Yazıcıoğlu, 2015). Eastern Black Sea Region is rainy in every season and yearly temperature difference is low. Summer is cool, winters are mild. The mountains block the humid whether of seaside to pass towards inland and thus there is an important climatic difference between seaside and inland of the region. Based on abundant and regular precipitation at the seaside, flow rate of the rivers are high. Therefore, irrigation is not needed so much and fallow agriculture is rarely observed (Anonymous, 2017a).

Organic Plant Production

As we review the areas where organic agriculture is made in Turkey by region, we observe that Eastern Anatolian Region ranks the first. This region is followed by Aegean Region, Southeastern Region, Central Anatolian Region, Mediterranean Region and Marmara Region (Yavaş and Akgül, 2015).

In Eastern Black Sea Region, 88719 tons of organic plant production were performed in 2016 with total of 10365 farmers on 9247 ha area. Besides, there are farmers (2725), areas (3528 ha) and product (9647 tons) at transition stage from conventional agriculture to organic agriculture. Transition process is the period from the beginning of an organic production in a certain area up to certification of products. Products in this process are named and considered as transition product, and they are not allowed for organic marketing. Transition period is three years for perennials and two years for annual plants (Anonymous, 2017b). With these, areas of organic production and the products obtained show an increase. When the numbers of farmers are reviewed, Rize comes first in the highest number of organic product producers with 7902 farmers which is followed by Trabzon with 962 farmers and Artvin with 952 farmers The highest production is performed in the city of Rize (68514 tons) among 6 cities examined for organic production. Rize is followed by the cities of Ordu (8983 tons) and Gümüşhane (5907 tons). (Table 1)

Table 1. Amount of farmers, areas and production for Eastern Black Sea Region (Anonymous, 2017c).

City	Number of Farmers	Number of Farmers At Transition Process	Total Area (Ha)	Total Area At Transition Process (ha)	Amount of Production (tons)	Amount of Production At Transition Process (tons)
Artvin	952	325	1198	469	3138	1365
Rize	7902	1576	4319	1014	68514	3917
Trabzon	962	344	739	585	1882	985
Gümüşhane	25	15	457	169	5907	1093
Giresun	20	191	131	469	295	837
Ordu	504	274	2403	822	8983	1450
Total	**10365**	**2725**	**9247**	**3528**	**88719**	**9647**

There are three products (tea, hazelnut, blueberry) which are organically grown in Artvin city and it is the city in which a minimum of seven organic products are grown. Total number of organic production is 3138 tons. Organic hazelnut growing is made the most with 2189 tons of production amount, and when the amounts of production at transition process is added, it will reach 2900 tons (Table 2).

Table 2. Amounts of organic plant production for Artvin city (Anonymous, 2017c).

City	Product name	Amount of Production (tons)	Amount of Production At Transition Process (tons)	Total (tons)
	Tea	946.96	564.56	**1511.52**
Artvin	Hazelnut	2189.04	800.39	**2989.43**
	Blueberry	2.01	0.00	**2.01**
Total		**3138.01**	**1364.95**	**4502.96**

In Rize, 68514 tons of organic production is performed with 7902 farmers on 4319 ha area (Table 1). The most grown product in Rize city in organic production and in total plant production. Total amount of organically products is 68514 tons, and great majority of that is tea. Organic amount of tea production which the farmers usually obtain income is 67143 tons. The most grown products after tea are hazelnut and kiwi which have 790 tons and 550 tons of outputs respectively. Along with those products, there are slight amounts of organic production of apple, chestnut, mulberry and subtropical fruits, and the products which are also at transition period ensured Rize to be the city where the organic cultivation in Eastern Black Sea Region is made most (Table 3).

Table 3. Amounts of organic plant production for Rize city (Anonymous, 2017c).

City	Product name	Amount of Production (tons)	Amount of Production At Transition Process (tons)	Total (tons)
	Pear	0.00	0.52	**0.52**
	Chestnut	3.99	1.41	**5.40**
	Tea	67142.97	3467.48	**70610.45**
	Timothy Grass	0.85	0.00	**0.85**
	Mulberry	1.40	0.36	**1.76**
	Apple	2.37	0.63	**3.00**
	Hazelnut	789.76	320.33	**1110.10**
	Fig	0.00	0.36	**0.36**
	Euonymus	0.86	0.32	**1.18**
Rize	Cherry	0.20	0.00	**0.20**
	Kiwi	549.35	105.60	**654.95**
	Lemon	0.00	0.35	**0.35**
	Tangerine	3.67	2.05	**5.72**
	Blueberry	3.27	7.60	**10.87**
	Corn	5.99	7.37	**13.37**
	Orange	0.42	1.70	**2.12**
	Peach	0.12	0.00	**0.12**
	Trabzon's Date	3.17	0.32	**3.49**
	Table Grape	5.28	0.88	**6.15**
Total		**68513.68**	**3917.30**	**72430.97**

In Trabzon city, 1882 tons of organic production is performed with 962 farmers on 739 ha area (Table 1). Ten organic products is produced and this number will reach 11 after strawberry production completes its transition process. The most grown product is hazelnut (981.76 tons) which is followed by Timothy grass (148.07 tons) and tea (132.41 tons). In Trabzon, the amount of total organic production reaches 2867.18 tons together with transition process (Table 4).

Table 4. Amounts of organic plant production for Trabzon city (Anonymous, 2017c).

City	Product name	Amount of Production (tons)	Amount of Production At Transition Process (tons)	Total (tons)
	Tea	830.60	132.41	**963.02**
	Timothy Grass	41.98	148.07	**190.05**
	Strawberry	0.00	78.84	**78.84**
	Beans	0.85	0.81	**1.66**
	Hazelnut	981.76	618.57	**1600.33**
Trabzon	Euonymus	0.35	0.00	**0.35**
	Kiwi	17.12	0.00	**17.12**
	Blueberry	6.67	0.38	**7.05**
	Corn	0.86	6.37	**7.24**
	Trabzon's Date	0.60	0.00	**0.60**
	Table Grape	0.92	0.00	**0.92**
Total		**1881.72**	**985.46**	**2867.18**

Gümüşhane is the highest organic production produced city in produced Eastern Black Sea Region in terms of field crops. In Gümüşhane, totally 5907 tons of organic production performed with 25 farmers on 457 ha area (Table 1). The organic products grown in the city are corn, clover and barley with have 3836.42, 1657.65 and 120.31 tons of production amounts respectively (Table 5).

Table 5. Amounts of organic plant production for Gümüşhane city (Anonymous, 2017c).

City	Product name	Amount of Production (tons)	Amount of Production At Transition Process (tons)	Total (tons)
	Barley	120.31	20.34	**140.65**
	Wheat	88.71	62.27	**150.97**
	Timothy Grass	56.76	0.99	**57.75**
	Beans	0.29	0.17	**0.47**
	Common Vetch	8.35	4.41	**12.76**
Gümüşhane	Sainfoin	102.91	66.60	**169.51**
	Corn (Silage)	3836.42	598.75	**4435.17**
	Fallow	35.33	0.00	**35.33**
	Potato	0.00	0.07	**0.07**
	Clover	1657.65	339.61	**1997.26**
Total		**5906.73**	**1093.22**	**6999.94**

In Giresun, 295 tons of organic production is performed with 20 farmers on 131 ha area (Table 6). Giresun has the least farmer numbers and area, however; the amount of organic production will increase when farmers and areas at transition stage complete the process. Organic breeding is made in 3 different products which are hazelnut, nuts and blueberry, but the number of products will reach 5 with kiwi and corn which are at transition process. Hazelnut is the most grown product in organic production (196.84 tons) which is followed by chestnut (93 tons) and blueberry (5 tons).

Table 6. Amounts of organic plant production for Giresun city (Anonymous, 2017c).

City	Product name	Amount of Production (tons)	Amount of Production At Transition Process (tons)	Total (tons)
	Chestnut	93.00	0.00	**93.00**
	Hazelnut	196.84	835.11	**1031.95**
Giresun	Kiwi	0.00	0.54	**0.54**
	Blueberry	5.00	0.00	**5.00**
	Corn	0.00	1.00	**1.00**
Total		**294.84**	**836.65**	**1131.50**

In Ordu city, 8983 tons of organic production is performed with 504 farmers on 2403 ha area (Table 7). Ordu is the city which has the highest number of diversity in product growing. After the products will complete their transition process, 26 different products (such as barley, wheat, rye, kiwi) will be grown organically. Crab apple is one of the primary products which are grown organically (3000 tons). This is followed by hazelnut (2471.02 tons) and wild pear (2000 tons) (Table 7).

Table 7. Amounts of organic plant production for Ordu city (Anonymous, 2017c).

City	Product name	Amount of Production (tons)	Amount of Production At Transition Process (tons)	Total (tons)
	Raspberry	250.00	0.00	**250.00**
	Pear	0.15	0.00	**0.15**
	Barley	0.00	5.27	**5.27**
	Blackberry	200.00	0.00	**200.00**
	Wheat	0.00	68.80	**68.80**
	Chestnut	0.11	12.27	**12.38**
	Rye	0.00	3.16	**3.16**
	Timothy Grass	0.00	0.23	**0.23**
	Mulberry	0.12	0.00	**0.12**
	Apple	1.54	0.00	**1.54**
	Plum	0.21	0.00	**0.21**
	Beans	0.00	47.96	**47.96**
	Hazelnut	2471.02	989.59	**3460.61**
Ordu	Linden	7.00	0.00	**7.00**
	Fig	0.69	0.00	**0.69**
	Euonymus	0.15	0.00	**0.15**
	Kiwi	0.00	3.60	**3.60**
	Rosehip	50.00	0.00	**50.00**
	Corn	1.39	172.21	**173.60**
	Potato	0.00	143.33	**143.33**
	Table Grape	0.28	0.00	**0.28**
	Wild Pear	2000.00	0.00	**2000.00**
	Crab Apple	3000.00	0.00	**3000.00**
	Sloe	1000.00	0.00	**1000.00**
	Clover	0.00	2.40	**2.40**
	Oat	0.00	0.72	**0.72**
Total		**8982.65**	**1449.54**	**10432.19**

Organic Animal Production

Turkey has been introduced to organic agriculture during 1980s, and quite successful results were obtained in plant production. However, there was no adequate development in animal production as in plant production. There are very few company which can be shown as an example for organic animal production (Külekçi and Aksoy, 2015).

Organic animal production is defined as the animal production in which unnaturally produced products are not directly or indirectly used as input in animal production or used at minimum level if they have to be, organic forages are preferred for animal nutrition and healthy animals are raised, each level is under control and certificated (Tekeli, 2017).

When organic stockbreeding data in Eastern Black Sea Region are reviewed, it is observed that organic cattle raising is done only in Gümüşhane city and egg poultry is only done in Ordu city. A total of 3300 tons production was made in Gümüşhane city from 776 heads of bovine and 211500 eggs were obtained in Ordu city from 10750 chickens (Table 8).

Table 8. Organic animal production data for Black Sea Region (Anonymous, 2017c).

Cities	Type of Animal	Total Farmers	Total Animals	Total Milk (tons)	Total Number of Eggs
	Calf	0	81	0	0
Gümüşhane	Cattle	0	140	0	0
	Cow (Milk)	3	555	3300	0
Total		**3**	**776**	**3300**	**0**
Ordu	Laying Hens	36	10750	0	211500

Organic beekeeping is made in Eastern Black Sea Region in the following cities ranked by honey production: Trabzon (58 tons; 3393 hives;17 farmers), Artvin (38 tons; 1536 hives; 51 farmers) and Rize (8 tons; 2210 hives; 30 farmers)

Table 9. Organic beekeeping production data for Black Sea Region (Anonymous, 2017c).

Cities	Product	Total Farmers	Total Hives	Total Honey (tons)
Artvin	Honey	51	1526	38
Rize	Honey	30	2210	8
Trabzon	Honey	17	3393	58
Gümüşhane	Honey	13	1050	7
Ordu	Honey	2	239	2

Conclusion

The most important purpose of organic agriculture is to create high quality and healthy products for future generations and provide its sustainability based on environmental and food safety. In this regard, one of the regions having the highest otential of organic agriculture is the Eastern Black Sea Region. Eastern Black Sea Region is one of the most suitable regions due to its characteristics such as not having much developed industry, receiving too much rain and having natural habitat for many plants. That usage of artificial fertilizers and chemical drugs are scarcely any is an indication that the region will not face difficulties in transition to organic agriculture.

Consequently, strategies regarding organic agriculture should be developed for Eastern Black Sea Region which is suitable for organic agriculture, and organic agriculture should be enabled to become widespread in the region.

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