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ARAŞTIRMA MAKALESİ RESEARCH ARTICLE

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The Effect of Bio Fertilizer Application on Bulb Yield and Floristic Properties of Different Commercial Tulip Varieties[A]

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Abstract: The research was carried out in the experimental fields of Bayindir Vocational Training School at Ege University between the 2017-2018 vegetation periods. Five different commercial tulip varieties (Canadian Liberator, Van Eijk, Pink Impression, Carousel, Holland Beauty) were used as plant material. The research was carried out with three replications of randomized block design with two factors (cultivars, bio fertilizer application). In this study, first sprouting time, the beginning of flowering time, end of flowering time, flowering longevity, plant height, stem length and bulb yield values were examined.

According to the data obtained from the research; the first sprouting occurred 49-72 days after planting date, the beginning of the flowering was in the range of the first week to the last week of March, and the end of flowering took place in the last week of March and mid-April. The flowering longevity was between 13 and 20 days, plant length was measured between 33.8 - 44.6 cm. Following to this stem length was measured and the value recorded between 27.3 - 36.2 cm. It was determined that the application of bio fertilizer increased bulb yield and did not reveal any impact on the other characteristics which was emphasized in this study.

Keywords: Tulip, floristic trait, bulb yield, Mediterranean climate.

A Yapılan bu çalışma etik kurul izni gerektirmemektedir. This study does not require ethics committee permission.

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Farklı Ticari Lale Çeşitlerinde Biyo Gübre Uygulamasının Soğan Verimi ve Floristik Özellikleri Üzerine Etkisi

Öz: Araştırma Ege Üniversitesi Bayındır Meslek Yüksekokulu deneme tarlalarında 2017-2018 yılları arasında bir vejetasyon döneminde yürütülmüştür. Araştırmada bitkisel materyal olarak beş farklı ticari lale çeşidi (Canadian Liberator, Van Eijk, Pink Impression, Carousel, Holland Beauty) kullanılmıştır. Araştırma iki faktörlü (çeşit, biyo gübre uygulaması) tesadüf blokları deneme desenine göre 3 tekerrürlü olarak yürütülmüştür. Yürütülen çalışmada ilk sürgün çıkışı, çiçeklenme başlangıç tarihi, çiçeklenme bitiş tarihi, çiçekte kalma süresi, bitki boyu, sap uzunluğu ve soğan verimi değerleri incelenmiştir.

Araştırmadan elde edilen verilere göre; ilk sürgün çıkışlarının soğan dikiminden 49-72 sonra, ilk çiçeklenme başlangıcı mart ayının ilk haftası ile son haftası aralığında, çiçeklenme bitişi ise Mart ayının son haftası ile Nisan ayının ortasında gerçekleşmiştir. Çiçekte kalma süreleri 13-20 gün aralığında, bitki boyu değerleri 33,8-44,6 cm aralığında ve sap uzunluğu değerleri 27,3-36,2 cm aralığında farklılık göstermiştir. Biyo gübreuygulamasının soğan verimi arttırdığı, incelenen diğer karakterler üzerine etkili olmadığı belirlenmiştir.

Anahtar Kelimeler: Akdeniz iklimi, Floristik özellik, Lale, Soğan verimi.

Introduction

The origin of the tulip is based on Central Asia. The tulip, which has almost produced no floral scent, however, attracts people with its beauty and charm of its colors. It extends to the Pamir Highlands and Tien-Shan mountains in the north, 4000 m high mountains in the Kashmir region of India in the south, China in the east and extending in a wide geography Eastern Anatolia in the west (Hoog, 1973). In the history of Turkey, it cared enough to give the name of a period in the Ottoman Empire period, not only grown as flowers, but also in the field of literature, architectural works, tile and fabric patterns, such as living in many different areas (Salman et al., 2016).

Tulip is a perennial bulbous and herbaceous plant (Hall, 1940) and was historically cultivated by the Turks in the early 1000s. It is accepted that the tulip came to the Anatolian peninsula with the peoples who migrated from Central Asia toward the west. Although not as much as the Ottomans, the Seljuks used tulips as well. However, it is understood from the documents that the development and use of the tulip began with the rise of the Ottoman Empire. It is also understood from the records that the ruler of the Ottoman Empire, famous for his bans, 4th Murat as well-known also as a good plant breeder. The king was ordered to cultivate 56 kinds of tulips which were highly valuable. In history, it was the Turks who first cultivated tulips and started hybridizations among the tulips initiatives.

Tulip is a bulbous and perennial plant belonging to *Liliaceae* family and has 109 species. Most cultivated tulips belong to *Tulipagesneriana* and are classified into 15 horticultural groups based on morphological traits and flowering characteristics (Van Scheepen, 1996). More hybrid varieties and some species are used in cut flowers, potted plants and landscape design (Menguc and Zencirkiran, 1991). Although tulip can be produced from seed, the main production is made from the bulb. Seed production of the tulip is used for the method of breeding study in order to obtain more new varieties and it may take up to 5 years to see the result of the study. It takes 15-20 years for approaching a new variety to be transformed into commercial production through breeding. Tulips that are produced from bulbs bloom in spring. Early, middle and late blooms varieties are available. In most tulip varieties, a single flower may form on the flower stem, while in some varieties more than one flower (*Tulipaturkestanica*) can be seen. They are between 10 cm and 71 cm in height depending on their variety and growing environments. A total of 19 taxa are grown naturally in Turkey as 17 species, 1 subspecies and 1 botanical variety in Tulipa genus. *Tulipagesneriana*, *T. sprengeri*, (Amasya tulip), *T. armena*, *T. cypria* (Cyprus tulip), *T. slyvestris*, *T. julia*, *T. sintenesii* (Mus tulip), *T. armena* var. armena, *T. armenalycila*, *T sactatixatilis*, *T. pyracox*, *T. aganensis*, *T. orphaanidae* (Manisa tulip) are examples of natural tulip species in Turkey.

Using ecosystem services including natural microorganisms actually knowing as bio fertilizer has been widely utilizing in various agricultural sectors. Through long-time screening and selectivity of specific microbe's species, certain strains cultivate including bacterial soil which producing in lab and marketing with a suitable carrier. Recently these microorganisms are getting interests among many farmers as become well-known as bio fertilizer because of its low cost and effective impact of plant health and productivity. It also enhances soil biological health and reduces using chemical compounds which have been occurred in environmental pollution for decades (Muraleedharan et al., 2010). Besides, these bio fertilizers enable plant to uptake unavailable water and better nutrients cycles in terms of developing rhizosphere and strengthen of photosynthesis mechanisms through environmental stress such as drought and heat (Khalvati et al., 2005). Crop production is strongly depending on essential macro and micro elements available in soil and fertilizers that farmer input to the soil. However, using tremendous chemical fertilizer occur immobilizing the most of macro and micro-elements and in the surface of soil particles. In this situation plants, the nutrient uptake can be limited therefore, the nutrient exchange could not meet plants need (Chen, 2006). In the actual climate, depressing agriculture should take an outstanding role in order of using bio fertilizers. Soil should be better control in terms of improving biological health and physio-chemical properties by replacing chemical fertilizers by bio fertilizers to bring up this fact that despite chemical fertilizer has higher effectiveness to provide higher yield but in opposite, it damages soil health and productivity (Anonymous, 2008). For instance, bio fertilizers can be introduced as bacterial such as Pseudomonas, Bacillus, Azotobacter, Rhizobium and fungus like: ecto and endomycorrhizal fungi, Trichoderma etc.

In this research, the effects of bio fertilizer application on floristic properties and bulb yields were investigated in five different commercial tulip cultivars in the Bayindir district, where a Mediterranean climate is dominant and ornamental plant production is intense.

Material and Method

The research was carried out over a vegetation period at Ege University, Bayindir Vocational Training School's (38°20.12'N - 27°67.14'E, at an altitude of 105 meters) trial fields between 2017 and 2018 to determine the bio fertilizer application of different commercial tulip cultivars under regional conditions. Five commercial tulip cultivars (Canadian Liberator, Van Eijk, Pink Impression, Carousel, Holland Beauty) were used as plant material. The research was carried out with three replications of randomized block design. The site was examined in terms of the physical and chemical components of soil structure through a soil analysis laboratory (Table 1). The site was typical of a Mediterranean climate. The relative humidity, average temperature and total precipitation were obtained from the planting site for 2017 and 2018 when the research was conducted, and for between 1956 and 2016 for longer-term averages (Table 2).

At the beginning of October, the soil was made by disrupting a vegetable fellow with a moldboard ploughed at 25 cm deep. Before planting, the research plots were cleared of debris and weeds manually and parcelling was performed. Accordingly, bulbs from all 5 cultivars were planted in prepared plots on 23 November 2017 in a randomized block design with three replications. Each of the 30 plots contained 50 bulbs of a single cultivar. Bulbs were planted at a spacing of 10 x 10 cm and 10 cm deep.Planting was completed by hand on one day and the bulbs were irrigated. There was no further irrigation until April.

Secofe-NPK and Secofe-M were used as bio fertilizer.Secofe-NPK contains 5% N, 5% P, 5% K%, 20% organic matter, Rhizobium sp., Azotobacter sp., Pseudomonas sp., Bacillus sp., Aspargillus spp. and the bacterial colony number is 2^6. Secofe-M contains Rhizobium sp., Azotobacter sp., Pseudomonas sp., Bacillus sp., and Aspargillus spp. and the bacterial colony number is 2^8.

After planting bulbs, bio fertilizerwas applied to one of the blocks in the experimental area and the other was evaluated as a control block. On 08.12.2017, 13.03.2018 and 30.03.2018 Secofe-NPK (50 cc/m^2) and Secofe-M (50 cc/m^2) were applied to the area. The application was made by hand sprayer.

After sprouting 50 kg/da Entec-26 (26% N + 31% S) slow release granular fertilizers (19.02.2018), 20 kg/da $CaNO_3$ fertilizer before flowering (05.03.2018) and after flower picking (17.03.2018) process 20 kg/da KNO_3 fertilizer was applied to all plots. After fertilizer application, irrigation was carried out.All bulbs were harvested on 08.05.2018.

The following measurements were conducted during the trial:

a- First sprouting time (when 20 % of the bulbs had sprouted, in days)
b- Beginning of flowering time (when 20 % of the flowers were present, in days)
c- End of flowering time (when 20 % of the flowers wilting)
d- Flowering longevity: (from tepal coloring to wilting, in days)
e- Plant height: (from ground level to the apex of flower, in the middle of the flowering period, in cm)
f- Stem length: (from the ground level to the base of the pedicel, in the middle of the flowering period, in cm)

g- Bulb yield: Planted and harvested 20 tulip bulbs were evaluated according to the bulb size (0-6, 6-8, 8-10, 10-12, 12+ cm), bulb number and weight.

Statistical analysis was applied by using TOTEMSTAT Statistical program (Acikgoz et al., 2004). Probabilities equal to or less than 0.05 were considered significant. If, TOTEMSTAT indicated differences between treatments means an LSD test was performed to separate them.

Table 1. Some physical and chemical properties of soil

Sand (%)	79.1	Soluble Total Salt (%)	0.03
Clay (%)	1.8	Organicmaterial (%)	2.27
Silt (%)	19.1	Total N (%)	0.090
Texture	loamysand	Available P (ppm)	2.54
pH	6.07	Available K (ppm)	40
$CaCO_3$ (%)	0.80	AvailableCa (ppm)	1305

Table 2. Some climatic data of the research period and long years

	2017 - 2018			1956 - 2016		
Months	Relative Humidity (%)	Average Temperature (°C)	Total Precipitation (mm)	Relative Humidity (%)	Average Temperature (°C)	Total Precipitation (mm)
Nov.	78.7	11.8	64.5	78.5	12.1	55.4
Dec.	85.0	10.3	107.2	70.6	17.4	48.8
January	83.7	7.3	106.5	78.5	12.1	55.4
February	86.7	10.9	103.8	82.3	9.1	93.3
March	75.6	11.4	90.1	83.1	6.9	108.7
April	62.6	20.0	12.6	79.8	8.3	66.2
May	61.8	23.2	61.9	73.6	11.1	40.5

Results

First sprouting time: The data obtained from the first sprouting times of the study are shown in Table 3. As it demonstrated, there was indicated no difference between the first sprouting dates between the plots where bio fertilizer applied and the control plots (without fertilizer). However, it was determined that there was a difference between the varieties according to the data obtained.

Furthermore, data reveal that Van Eijk cultivar first sprouting was appeared 49 days after the bulb planting and alongside it, Holland Beauty variety reached this stage 72 days after the bulb planting.

Table 3. The values offirst sprouting time, first sprout output range, beginning of flowering time, end of flowering time and flowering longevity

	cultivars	Planting date	First sprouting time	First sproutoutpu trange (days)	beginning of flowering time	end of flowering time	Flowering longevity (days)
BioFartilizer	Canadian Liberator	23.11.2017	23.1.2018	61	14.3.2018	27.3.2018	13
	Van Eijk	23.11.2017	11.1.2018	49	7.3.2018	27.3.2018	20
	Pink Impression	23.11.2017	14.1.2018	52	8.3.2018	25.3.2018	17
	Carousel	23.11.2017	15.1.2018	53	27.3.2018	12.4.2018	16
	Holland Beauty	28.11.2017	8.2.2018	72	13.3.2018	2.4.2018	20
Control	Canadian Liberator	23.11.2017	23.1.2018	61	14.3.2018	27.3.2018	13
	Van Eijk	23.11.2017	11.1.2018	49	7.3.2018	26.3.2018	19
	Pink Impression	23.11.2017	14.1.2018	52	8.3.2018	25.3.2018	17
	Carousel	23.11.2017	15.1.2018	53	27.3.2018	12.4.2018	16
	Holland Beauty	28.11.2017	8.2.2018	72	13.3.2018	2.4.2018	20

Beginning of flowering time: The data obtained from the beginning of flowering stage are given in Table 3. It is seen that bio fertilizer application is not positively effective at the beginning of flowering stage but the difference between varieties was determined. Varieties reached this stage between the first and last week of March. Among the varieties, Van Eijk and Pink Impression varieties came to the earliest stage at the beginning of flowering in 7.3.2018 and 8.3.2018, while Carousel variety came last on 27.03.2018.

End of flowering time: The data obtained from the end of the flowering of five different commercial tulip varieties examined in the study are given in Table 3. Data shows that bio fertilizer does not effect on the end date of flowering time compared to control plots. However, at the end of flowering the varieties showed differences in the last weeks of March and the first weeks of April. The flowering end date was determined at the earliest on 25.03.2018 on Pink Impression and on 12.04.2018 on Carousel.

Flowering longevity: The data on flowering longevity of the tulip varieties are shown in Table 3. Similarly, it was observed that the application of bio fertilizer did not create a difference according to the control plots in the investigated character. However, it was noted that there was a difference between the varieties in terms of flowering longevity. Among the tulip varieties evaluated in the research, the shortest flowering time was found in Canadian Liberator (13 days) and the longest flowering time was found in Holland Beauty (20 days).

Plant height: The data obtained from the research on plant height are demonstrated in Table 4. According to the statistical results, findings show that the application of bio fertilizer was insignificant in terms of plant height however; the interaction between the variety and bio fertilizer variety was statistically significant (table 4). Final data showed that the average values plant height was 44.0 cm in Pink Impression cultivar and the lowest plant height value were 34.7 cm in Holland Beauty cultivar. It is seen that the average values of varieties was found in control plots and bio-fertilizer applied in plots which were in the same statistical group.

Table 4. Data of plant height and stem length of different tulip cultivars of bio fertilizer application

cultivars	plantheight (cm)			stemlength (cm)		
	control	biofertilizer	mean	control	biofertilizer	mean
CanadianLiberator	34,2 c	35,4 d	34,8 c	27,7 d	29,2 c	28,5 d
Van Eijk	39,7 b	38,6 c	39,2 b	31,9 c	30,5 b	31,2 c
Pink Impression	44,8 a	43,1 a	44,0 a	36,2 a	34,5 a	35,4 a
Carousel	39,5 b	39,7 b	39,6 b	33,6 b	34,7 a	34,2 b
HollandBeauty	34,4 c	34,9 d	34,7 c	27,4 d	28,4 c	27,9 d
Mean	38,5 a	38,3 a		31,4 a	31,5 a	
LSD (%)	A: 0,72	B: 0,46	AXB: 1,02	A: 0,70	B: 0,44	AXB: 0,99
CV.	1,55			1,85		

A: cultivars B: bio fertilizer AXB: cultivars X bio fertilizer interaction

Stem length: The values obtained for the stem length of different commercial tulip varieties are given in Table 4. According to the statically analysis results, it was found that the application of bio fertilizer was insignificant despite interaction between the variety and bio fertilizer levels was statistically significant (table 4). When the average stem length data of the cultivars used in the study were evaluated, it was observed that the longest stem length value was measured in Pink Impression variety with 35.4 cm and the lowest stem length value was measured in Holland Beauty (27.9 cm) and Canadian Liberator (28.5 cm) varieties. The average values of the plots with bio fertilizer and control plot varieties were evaluated in the same statistical group.

Bulb yield: In this study, yield values obtained from different commercial tulip varieties are given in Table 5. According to the results of statistical analysis, cultivar, bio fertilizer application and interaction effects between the cultivar x bio fertilizer application were shown a significant difference (table 5). The average bulb yield values of the varieties in the plots treated with bio fertilizer (539.1 g) were higher than the average bulb yields of the varieties in the control plots (492.6 g). Final results were revealed that the highest bulb yield value was found to be 723.4 g with Pink Impression and Van Eijk variety had the lowest bulb yield (338.5 g). In general, the bulb yield values of the cultivars treated with bio fertilizer were higher than the bulb yields of the cultivars in the control plots (Table 5).

Table 5. Bulb yield values of different commercial tulip cultivars in bio fertilizer application

cultivars	bulbyield (g)		
	control	biofertilizer	mean
CanadianLiberator	482.0 c	568.6 b	525.3 b
Van Eijk	319.2 e	357.9 e	338.5 e
Pink Impression	700.0 a	746.9 a	723.4 a
Carousel	496.0 b	532.8 c	514.4 c
HollandBeauty	466.0 d	489.1 d	477.5 d
Mean	492.6 b	539.1 a	
LSD (%)	A: 5.75	B: 3.63	AXB: 8.13
CV.	0.92		

A: cultivars B: bio fertilizer AXB: cultivars X bio fertilizer interaction

The yield increase rate of 20 tulip bulbs planted and harvested in the study is evaluated in Table 6. It was determined that the yield rate was higher in the varieties treated with bio fertilizer. The highest bulb yield increase value was obtained from Pink Impression with 358.2% and the lowest was obtained from Van Eijk with 162.9%.

The calibrated data of twenty tulip bulbs harvested in five different commercial tulip varieties evaluated in the study are presented in Table 7. While 6-8 caliber bulbs are used for bulb production, larger bulbs are used for sale. When the number of bulbs having 8-10, 10-12 and 12+ caliber values is examined, it is seen that the productivity is higher in the varieties treated with bio fertilizer. As stated in the previous yield assessments, the Pink Impression varieties showed a successful performance in terms of bulb caliber data in the varieties treated with bio fertilizer. Salman et al. (2018) and Fayaz et al. (2018) support the data obtained from the tulip bulb yield.

Table 6. The yield values of planted and harvested 20 tulip cultivars (%)

	control			bio fertilizer		
cultivars	sowing weight (g)	harvested yield (g)	%	sowing weight (g)	harvested yield (g)	%
Canadian Liberator	181.4	482.0	265.7	183.4	568.6	310.0
Van Eijk	219.1	319.2	145.7	219.7	357.9	162.9
Pink Impression	208.9	700.0	335.1	208.5	746.9	358.2
Carousel	181.2	496.0	273.7	181.7	532.8	293.2
Holland Beauty	206.2	466.0	226.0	207.5	489.1	235.7

Table 7. Bulb size values of 20 tulip bulbs harvested

Cultivars	control						bio fertilizer					
	<6	6-8	8-10	10-12	12+	yield (g)	<6	6-8	8-10	10-12	12+	yield (g)
Canadian Liberator	35.3	25.3	9.3	10.0	0.7	482	36.0	31.3	10.7	14.0	1.3	569
Van Eijk	17.3	9.3	2.0	6.0	2.7	319	18.7	10.0	2.7	7.3	3.3	358
Pink Impression	32.7	27.3	16.0	14.0	1.3	700	35.3	31.3	15.3	14.0	4.0	747
Carousel	24.0	16.0	10.0	11.3	0.7	496	22.0	22.7	8.7	16.0	0.7	533
Holland Beauty	13.3	26.0	18.7	2.7	0.0	466	16.7	30.0	19.3	5.3	0.0	489

Discussion and Conclusion

Numerous strains of microorganisms are key components of soil where the PGPR-B/M (plant growth-promoting rhizo bacteria or mycorrhizal) term has been created for was first explained by Kloepper and Schroth in 1978 (Ghumare et al., 2014). Plant growth-promoting rhizobacteria provide a capability to utilize ecosystem services for plant such as fix atmospheric nitrogen, uptake P and microelements like Fe for plants. Microorganisms used in bio fertilizers integrate with soil in terms of enhancing nutrients availability. Their role is to enrich and

provide a suitable biological life with long-term sustainability. Besides, they occur no harmful to the environment and can be replaced with chemical fertilizers. Using those microorganisms for plant growth can minimize the application of chemical formulation of nutrients strength soil structure and promote crops production. Bio fertilizers are cheaper and remarkable in affecting the yield of cereal crops. They play a key role in maintaining long term soil fertility and sustainability by mobilizing fixed and insoluble P in the soil into available form to plants, plus increasing their value and availability. In bio fertilizers, beneficial bacteria are Azotobacter, Azospirillium, Rhizobium, Mycorrhizae which are very essential in crop production it can also make the plant resistant to unfavourable environmental stresses.

Our results showed the significant positive difference between using bio fertilizer and non-fertilizer in our study. This is supporting by the recent studies where showing a similar finding (Ali et al., 2014; Fayaz et al., 2018). Application of bio fertilizers enhances plant height in rose and tulip species where didn't show significant different in our study (Singh, 2005). In some studies on the impact of biofertilizers on tulips yield the similar effects were indicated as our study found the same result (Ullah Khan et al., 2009). This finding supports our final data in terms of using bio fertilizer enhances tulips yield and quality.

According to the results of the research carried out with different commercial tulip varieties in Bayindir ecological conditions where the Mediterranean climate is dominant;

There was a difference between the varieties in terms of the characters examined. Bio fertilizer application had no effect on the other investigated properties except bulb yield. Bio fertilizer application increased the bulb yield and the amount of commercially available bulbs. In the tulip bulb production to be made in the region under the influence of the Mediterranean climate, bulb production with bio fertilizer application will provide an advantage for cut flower production.

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This study does not require ethics committee permission. The article has been prepared in accordance with research and publication ethics. The authors contributed jointly to the study and there were no conflicts of interest among the authors.

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