

## EFFECTS OF NITROGEN AND ZINC TREATMENTS AT DIFFERENT DOSES ON MAIZE YIELD AND YIELD COMPONENTS UNDER KAHRAMANMARAŞ CONDITIONS

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### Abstract

*This study was carried out in 2019 in Kahramanmaraş University Field Crops Department to determine nitrogen and zinc fertilizer needs of maize plants in Kahramanmaraş Region. Experiments were conducted in split-plots design with 3 replications. Soil nitrogenous fertilizer (Urea) treatments were arranged as: 0 kg/da (N0), 15 kg/da (N15), 30 kg/da (N30). Foliar zinc treatments were arranged as 0 ppm (Zn0), 2500 ppm (Zn5), 5000 ppm (Zn10). Dekalp DKC6890 hybrid maize variety was used as the plant material of the experiments. Present findings revealed that nitrogen and zinc treatments had significant effects on the first cob height, cob length, cob thickness, number of rows per cob, number of kernels per cob and kernel yield of maize plants, but the effects of nitrogen and zinc treatments on plant height and thousand kernel weight were not found to be significant.*

*Keywords: Maize, Nitrogen level, Zinc level, Yield, Yield components*

### 1. INTRODUCTION

Maize (*Zea mays* L.), belonging to the family of Gramineae, is a foreign-pollinating, warm -season cereal adapted to different climates. It constitutes an important source income for farmers worldwide (Shaw, 1988). With increasing populations, maize have become a popular cereal both in the world and Turkey. Maize is used in both human nutrition and animal feeding. It is also used in various sectors of the industry. Just because of high unit area yields and silage yields, it is a popular crop of the farmers and because of kernel starch, sugar and oil contents, it is a highly popular crop among industry specialists. A fully-ripened maize kernel contains 70% starch, 10% protein, 2% sugar and 2% ash (Kün, 1994). In recent years, potential use of maize in biodiesel production have increased the demands for maize crop. After wheat and paddy, maize has the third largest cultivation area (185.121.342 ha), but has the greatest unit area yield (933 kg\da) among the cereals (Anonymous, 2019a).

In Turkey, maize consumptions have increased with increasing populations and the annual consumption per capita reached to 57 kg (Şehirli et al., 2000). Worldwide, maize is mostly cultivated in American Continent. The USA is the leading maize producer and meets about 40-45% of world production (Babaoğlu, 2005). Following the USA, China, Azerbaijan, Brazil and Mexico are the other large maize producers of the world.

In Turkey, maize was cultivated in 510.000 ha land area and annual production was 3.500.000 tons in 2007. The maize cultivated lands increased to 639.000 ha and annual production increased to 6.000.000 tons in 2019. Maize could be cultivated as the main or second crop. Especially in GAP (Southeastern Anatolia Project) region, maize production has increased with increasing irrigated lands.

Maize is included in C-4 plants and requires significant quantity of nitrogen throughout the growth and development of the plant. Nitrogen is used in protein synthesis, DNA and RNA-like metabolic processes of the plants (Bozcuk, 1986). Maize uptakes quite large quantities of nutrients from the soil and maize nitrogen uptake largely relies on soil texture, moisture, temperature and irrigation (Sencar, 1988). Fertilization is essential in agricultural fields for high yields. Insufficient nitrogen levels of the soils constitute significant limitations in maize cultivation (Demari et al., 2016). Nitrogen is needed from the initial growth stages of the plants. Since maize plants are not sufficiently benefit from the nitrogen over the soil surface, nitrogen deficiency should be met through fertilization. Zinc deficiency is encountered in world soils and Turkish soils. Zinc deficiency is seen either because of insufficient zinc levels of the soils or unavailable forms of zinc for plant uptake (Dumral, 2015).

Besides high yields, quality is also a significant criterion in maize cultivation based on purpose of growth. Seed quality is largely influenced by genotypes, growing conditions, storage, disease and pests and the other environmental factors (Maiti and Wesche-Ebeling, 1998). Zinc deficiency is seen in people of countries fed largely on cereals. Therefore, enriching cereal grains in zinc through fertilization will also positively influence human health (Brohi et al., 2000). Zinc deficiency in maize plants manifests itself from the initial growth stage. Under zinc deficiency, internodes are shortened and shape deformations or malformation is encountered in cobs (Çolakoğlu, 2010). Since maize more benefit from sunlight than the other cereals, it could produce greater quantities of dry matter. Therefore, supply of fertilizers and nutrients at proper quantities may improve maize yields (Çolakoğlu, 2010). This study was conducted to determine nitrogenous and zinc fertilizer needs of maize plants.

## **2. MATERIALS AND METHODS**

This study was conducted over the experimental fields of Kahramanmaraş Sütçü İmam University Agricultural Faculty in 2019 as the main crop. Kahramanmaraş province is located in Mediterranean region between 37° 38' north latitudes and 36° 37' east longitudes and average altitude of the province is 568 m. Mediterranean climate is dominant in the region. Winters are warm and rainy, summers are hot and dry, day/night temperature difference is low. Dekalp DKC6890 hybrid maize cultivar was used as the plant material of the study.

Experiments were conducted in split-plots experimental design with 3 replications. Plots were 5 m long, row spacing was 0.70 m and on-row plant spacing was 0.20 m. Each plot had 4 rows planted. Plot size was 4 x 0.70 m x 5 m = 14 m<sup>2</sup>. Soil nitrogenous fertilizer treatments (urea) were arranged as N0 (0 kg/da), N15 (15 kg/da) and N30 (30 kg/da). The first half of the nitrogenous fertilizer was applied at sowing and the other half was applied when the plants reached to 3-leaf stage. Foliar zinc treatments were arranged as Zn0(0ppm), Zn5(2500ppm) and Zn10(5000ppm) in the form of ZnSO<sub>4</sub>.7H<sub>2</sub>O and applications were made at 3-4 leaf stage of the plants.

At harvests, one row from each side and 50 cm from the top and bottom of the plots were omitted as to consider side effects. Measurement, counting and blending of harvested plants were conducted and average of measurement values were taken.

Plant height, the first cob height, stalk diameter, number of nodes, cob thickness, cob length, number of rows per cob, number of kernels per cob, single cob yield, thousand kernel weight and yield per decare were determined in accordance with the methods specified in West et al. (1920), Evans (1972), Gençkan (1976), Sencar (1988), Engin et al. (1989), Ülger (1986), Cihangir (2013) and Yürürdurmaz (2007). Experimental data were subjected to analysis of variance with the use of SAS software and significant means were compared with the use of Duncan's multiple range test (SAS, 1999).

### 3. RESULTS AND DISCUSSIONS

In terms of nitrogen and zinc doses, significant differences were observed in investigated parameters (except for plant height)

The greatest plant height (151.6 cm) was observed in N30 treatment, it was followed by N15 treatment (149.2 cm) and the lowest plant height (141.4 cm) was observed in N0 treatment. Nitrogenous fertilizers promote vegetative development of the plant (Gökmen et al., 2001, Kü, 1994), thus increase plant height. Similar with the present findings, Ülger et al. (1996), Gözübenli (1997), Flesch and Viera (2000), Turgut (2000), El Hattab et al. (1980), Ülger et al. (1986) and Ogunlela et al. (1988) reported increasing plant heights with increasing nitrogenous fertilizer doses. Zinc doses did not have significant effects on plant heights. The greatest plant height was obtained from Zn<sub>5</sub> (149.4 cm), it was followed by Zn<sub>0</sub> (149.1cm) treatment and the lowest plant height (143.6 cm) was obtained from Zn<sub>10</sub> treatment.

**Table 1. Effects of nitrogen and zinc doses on plant height, the first cob height, cob thickness and cob length**

Nitrogen Doses (kg/da)	Plant Height (cm)	First Cob Height (cm)	Cob Thickness (mm)	Cob Length (cm)
N 0	141.4 b	51.58 c	42.41 b	14.91 c
N15	149.2 a	53.67 b	46.04 a	17.30 b
N30	151.6 a	55.34 a	45.53 a	17.84 a
LSD	7.71	1.33	1.35	0.32
Zinc Doses (ppm)				
Zn0	149.1 a	55.60 a	45.87 a	16.51 b
Zn5	149.4 a	52.60 b	44.78 a	16.70 ab
Zn10	143.6 a	52.41 b	43.38 b	16.84 a
LSD	7.71	7.72	1.35	0.32
CV (%)	5.09	2.42	2.94	1.90

\*\* Significant at P<0.01, \* Significant at P<0.05, CV: Coefficient of Variation

Effects of different nitrogen and zinc doses on the first cob height were found to be significant. In terms of nitrogen doses, the greatest first cob height (53.67 cm) was observed in N<sub>30</sub> treatment, it was followed by N<sub>15</sub> treatment (53.67 cm) and the lowest first cob height (51.58 cm) was observed in N<sub>0</sub> treatment. The first cob heights increased with increasing nitrogen doses. Gözübenli (1997), Sezer and Yanbeyi (1997), Kara et al. (1999), Saruhan and Şireli (2005), Turgut (2000), Ülger et al. (1986), Uslu (1999) and Çokkızgın (2002) reported increasing cob heights with increasing nitrogen doses. In terms of zinc doses, the greatest first cob height (55.60 cm) was obtained from Zn<sub>0</sub>

treatment, it was followed by Zn<sub>5</sub> treatment (52.60 cm) and the lowest value (52.41 cm) was obtained from Zn<sub>10</sub> treatment. The first cob heights decreased with increasing zinc doses.

Effects of different nitrogen and zinc doses on cob thickness were found to be significant. In terms of nitrogen doses, the greatest cob thickness (46.04 mm) was observed in N<sub>15</sub> treatment, it was followed by N<sub>30</sub> treatment (45.53 mm) and the lowest cob thickness (42.41 mm) was observed in N<sub>0</sub> treatment. Sezer and Yanbeyi (1997), Kara et al. (1999), Nimje and Seth (1988), Kaplan and Aktaş (1993), Çokkızgın (2002), Saruhan and Şireli (2005) and Turgut (2000) reported increasing cob thickness with increasing nitrogen doses. Ülger et al. (1996) reported that nitrogenous fertilizer treatments increased cob thickness as compared to the control treatment, but differences in cob thickness of 10, 20 and 30 kg/da nitrogen treatments were not found to be significant. Aydın (1991) indicated that nitrogen doses of up to 20 kg/da increased cob thickness and further increase in nitrogen doses did not have significant effects on cob thickness. In terms of zinc doses, the greatest cob thickness (45.87 mm) was obtained from Zn<sub>0</sub> treatment, it was followed by Zn<sub>5</sub> treatment (44.78 mm) and the lowest cob thickness (43.58 mm) was obtained from Zn<sub>10</sub> treatment. Cob thickness decreased with increasing zinc doses.

While nitrogen doses have significant effects on cob lengths, effects of zinc doses on cob lengths were not found to be significant. In terms of nitrogen doses, the greatest cob length (17.84 cm) was observed in N<sub>30</sub> treatment, it was followed by N<sub>15</sub> treatment (17.30 cm) and the lowest cob length (14.91 cm) was observed in N<sub>0</sub> treatment. Gözübenli (1997), Sezer and Yanbeyi (1997), Kara et al. (1999), Nimje and Seth (1988), Kaplan and Aktaş (1993), Uslu (1999), Saruhan and Şireli (2005) and Turgut (2000) reported increasing cob lengths with increasing nitrogen doses. In terms of zinc doses, the greatest cob length (16.84 cm) was obtained from Zn<sub>10</sub> treatment, it was followed by Zn<sub>5</sub> treatment (16.70 cm) and the lowest cob length (16.51 cm) was obtained from Zn<sub>0</sub> treatment. Cob lengths increased with increasing zinc doses.

The greatest number of rows per cob (34.33 rows) was observed in N<sub>15</sub> treatment, it was followed by N<sub>30</sub> treatment (33.58 rows) and the lowest value (27.71 rows) was observed in N<sub>0</sub> treatment. Köycü and Yanıkoğlu (1987), Ogunlela et al. (1988), Çokkızgın (2002), Sağlamtimur and Okant (1987) and Öktem (1996) indicated that cob lengths, a vegetative component of the plant, may vary based on nitrogenous fertilization. Uslu (1999) reported that nitrogen increased number of rows per cob, but differences in number of rows per cob of N<sub>25</sub> and N<sub>35</sub> treatments were not significant. In terms of zinc doses, the greatest number of rows per cob (32.26 rows) was obtained from Zn<sub>5</sub> treatment, it was followed by Zn<sub>10</sub> treatment (32.07 rows) and the lowest value (31.28 rows) was obtained from Zn<sub>0</sub> treatment. Number of rows per cob increased up to Zn<sub>5</sub> dose.

As can be inferred from Table 2, the greatest number of kernels per cob (583.5 kernels) was observed in N<sub>15</sub> treatment, it was followed by N<sub>30</sub> treatment (583.4 kernels) and the lowest number of kernels per cob (461.5 kernels) was observed in N<sub>0</sub> treatment. With increasing nitrogen doses, plant growth and development were improved, thus cob length, diameter and yield components including number of kernels per cob were positively influenced (Kün, 1994; Turgut, 2000). Similar with the present findings, Weinhold et al. (1995), Gözübenli (1997), Suphot and Kitima (1977), Nimje and Seth (1988), Aydın (1991), Kaplan and Aktaş (1993), Ülger et al. (1997), Turgut (2000), Gökmen et al. (2001) and Presterl et al. (2003) reported increasing number of kernels per cob with increasing nitrogen doses. Uslu (1999) also reported increasing number of kernels per cob with increasing nitrogen treatments, but the differences between N<sub>25</sub> and N<sub>35</sub> treatments were not significant. In terms of zinc doses, the greatest number of kernels per cob (555.8 kernels) was obtained from Zn<sub>10</sub> treatment, it was followed by Zn<sub>5</sub> treatment (538.0

kernels) and the lowest number of kernels per cob (534.6 kernels) was obtained from Zn<sub>0</sub> treatment. Increasing zinc doses increased number of kernels per cob, but the differences in number of kernels per cob values of the zinc treatments were not found to be significant.

**Table 2. Effects of nitrogen and zinc doses on number of rows per cob, number of kernels per cob, thousand kernel weight and kernel yield**

Nitrogen Doses	Number of Rows per Cob	Number of Kernels per Cob	Thousand Kernel Weight (g)	Kernel Yield (kg/da)
N <sub>0</sub>	27.71 b	461.5 b	302.2 b	829.0 c
N <sub>15</sub>	34.33 a	583.5 a	339.5 a	1000.9 a
N <sub>30</sub>	33.58 a	583.4 a	311.8 b	879.8 b
LSD	0.80	24.10	0.24	0.12
<b>Zinc Doses</b>				
Zn <sub>0</sub>	31.28 b	534.6 a	331.1 a	944.9 a
Zn <sub>5</sub>	32.26 a	538.0 a	306.8 b	923.7 a
Zn <sub>10</sub>	32.07 ab	555.8 a	315.5 ab	841.2 b
LSD	0.80	24.10	0.24	0.12
CV (%)	2.4	4.32	13.58	6.55

\*\* Significant at P<0.01, \* Significant at P<0.05, CV: Coefficient of Variation

The greatest thousand kernel weight (339.5 g) was observed in N<sub>15</sub> treatment, it was followed by N<sub>30</sub> treatment (311.8 g) and the lowest thousand kernel weight (302.2 g) was observed in N<sub>0</sub> treatment. Nitrogenous fertilizers increase leaf area during the vegetative development, thus dry matter accumulation is greater during the grain fill period (Tolenaar et al., 1997). Such a case indicates that thousand kernel weight was positively influenced by increasing nitrogen doses. Present findings comply with the results of Ülger et al. (1986), Nimje and Seth (1988), Kaplan et al. (1993), Sade and Çalış (1993), Gözübenli (1997), Gökmen et al. (2001), Tüfekçi and Karaltın, (2001) and Amaral et al. (2005). Aydın (1991) also reported increasing thousand kernel weights with increasing nitrogen doses, but such an increase was quite low after 20 kg/da N dose. In terms of zinc doses, the greatest thousand kernel weight (311.1 g) was obtained from Zn<sub>0</sub> treatment, it was followed by Zn<sub>10</sub> treatment (315.5 g) and the lowest thousand kernel weight (306.8 g) was obtained from Zn<sub>5</sub> treatment. Increasing zinc doses did not have significant effects on thousand kernel weight.

In terms of nitrogen doses, the greatest kernel yield (1000.9 kg/da) was observed in N<sub>15</sub> treatment, it was followed by N<sub>30</sub> treatment (879.8 kg/da) and the lowest kernel yield (829.0 kg/da) was observed in N<sub>0</sub> treatment. With increasing nitrogen doses, plant vegetative organs exhibit better development, thus greater photosynthesis, dry matter production and kernel nutrients and yields are achieved. (Schussler and Westgate, 1995, Tolenaar et al., 1997). Similarly, Podalak (1984), Ülger et al. (1996), Gözübenli (1997), Sezer and Yanbeyi (1997), William and Randall (1997), Schmidt et al. (1998), Ülger (1998), Allen et al. (2000), Öktem et al. (2001), Tüfekçi and Karaltın (2001), Blumenthal et al. (2003), Kamara et al. (2003), Presterl et al. (2003) and Saruhan and Şireli (2005) reported increasing kernel yields with increasing nitrogen doses. Uslu (1999) also reported increasing kernel yields with increasing nitrogen doses, but the differences between N<sub>25</sub> and N<sub>35</sub> treatments were not significant. Çokkızgın (2002) indicated that nitrogen doses of greater than 25



kg/da N did not increase kernel yields. In terms of zinc doses, the greatest kernel yield (944.9 kg/da) was obtained from Zn<sub>0</sub> treatment, it was followed by Zn<sub>5</sub> treatment (923.7 kg/da) and the lowest kernel yield (841.2 kg/da) was obtained from Zn<sub>10</sub> treatment.

#### 4. CONCLUSIONS

Present findings revealed that nitrogen and zinc treatments had significant effects on the first cob height, cob length, cob thickness, number of rows per cob, number of kernels per cob and kernel yield of maize plants. Effects of nitrogen and zinc treatments on plant height and thousand kernel weight were not found to be significant.

Increasing nitrogen doses had significant positive effects on yield and yield components. However, differences in investigated parameters of N15 and N30 treatments were not found to be significant. Since the primary target of the present study was to find out proper nitrogen dose for better yields in maize, it was concluded that N15 dose could be sufficient to get high yields from maize plants.

It was observed that increasing zinc doses did not have muck significant effects on yield and yield components. In terms of zinc doses, greatest values were generally obtained from Zn<sub>0</sub> treatment.

#### 5. ACKNOWLEDGEMENTS

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