Scientific Papers. Series A. Agronomy, Vol. LIX, 2016
ISSN 2285-5785; ISSN CD-ROM 2285-5793; ISSN Online 2285-5807; ISSN-L 2285-5785

EFFECT OF NUTRIENTS SUPPLY WITH FOLIAR APPLICATION ON GROWING DEGREE DAYS, PROTEIN AND FATTY YIELD OF CORN IN MEDITERRANEAN CONDITIONS

Yakup Onur KOCA

Adnan Menderes University, Faculty of Agriculture, Department of Crop Science,
Aydın – 09100, Turkey

Corresponding author email: koca2002@hotmail.com

Abstract

Nutrients are essential for plant growth and soil that was found with high pH levels in alkaline character regions negatively affected the uptake of micronutrients (Zn, B, Mn, Cu, Co, Mg, Se, and Fe) with the exclusion of molybdenum. Current practices in attempts to solve this problem is to add nutrient fertilizers and natural hormone combinations via foliar. In this study nutrients and natural hormone combinations that could not be taken by roots were applied to the leaf and the effects on corn analyses. The experiment carried out in 2010 and 2011 was under in the field conditions in Aydın. Plant materials used in this experiment were: NK-Arma, 31G98, Kermes and 31D24 hybrid corn varieties which is cultivated commercially in Turkey. The fertilizer solutions included: a solution (1) containing auxin and zinc (Zn) foliar and a solution (2) containing boron (B) fertilizers were used. At the end of the final study it was determined that the yield of 168.8-260.0 g in cob had been obtained. Protein measurement revealed between 826-1505 kg.ha^{-1}, fatty yield was determined between 359-574 kg.ha^{-1} in the total yield. We observed that solution 1 (auxin and Zn) and solution 2 (B) applications positively affected both the corn yield and the quality in this study. Additionally it was found that foliar applications prolonged corn's vegetative period and increased GDD average values of the vegetative period with Auxin, Zn and B applications. The highest cob yield, protein yield and fatty yield values were found in 31D24 and this genotype stood out from all other genotypes in the research.

***Key words**: corn, foliar application, GDD, zinc, auxin, boron.*

INTRODUCTION

FAO estimations state that by 2050 the human population will have increased by 34% from today (Anonymous, 2011a). It is emphasized that to meet the expected increase in population, agricultural production must be increased by 70% (Anonymous, 2011b). This demand necessitates not only bigger cultivated areas, but more efficient sustainable usage of the cultivated areas already in production. Current agriculture practices have utilized non-arable fields (high pH, defective drainage, inadequate structure etc.). However high yield is only achieved when optimum conditions are put into practice (Fageria, 2002).

Corn's primary production is for human consumption that is utilized fresh and for processed products starch, flour, cooking syrup and crisp. Corn's secondary production is for animal feed and industrial uses such as ethanol (Remison, 2005). High corn yield is possible by providing sufficient water and nutrients during the short growing stage. We know that large cultivated areas of current agricultural soils are alkali characterized (pH up to 7 or more) and that this soil type negatively affects uptake of micronutrients by plants in Mediterranean areas (Cakmak et al., 1999). It is observed that there are decreases in uptakes of micronutrients (Zn, B, Mn, Cu, Co, Mg, Se, and Fe) with the exception of molybdenum at high pH levels (Basta and Tabatabai, 1992; Alcântara and Camargo, 2001; Fageria, 2002). These micronutrients are essential (Benett, 1993; Marschner, 1995) for many vital activities in plants from protein synthesis to carbohydrate and oil cycle, from photosynthesis and chlorophyll to chloroplast structures and energy cycle (Welch, 1995; Rodriguez et al., 2000; Ceylan et al., 2009). Insufficient presence of one or more of these elements negatively impacts on yield and quality (Genç et al., 2002; Yassen et al, 2010; Zayed et al., 2011). The relationship between micronutrient application on crops in terms of

grain yield and quality of product is undeniable. (Hossain et al., 2008; Potarzycki and Grzebisz, 2009; Safyan et al., 2012).
Micronutrient deficiencies observed in plants in regions under the effect of Mediterranean climate have high alkaline characterized soil structure due to high pH and low organic substance (Cakmak, 2010). In these situations due to saltiness and high pH nutrient fertilizers can ensure uptake of micronutrients. The addition of Zn, Mn, Cu, Co and B treated from leaf increase grain yield and protein rates. It is observed that Zn has maximum effect especially on protein amount and fractions (Toma et al., 1973). B element has significant roles in carbohydrate and protein metabolism, tissue differentiation, auxin and phenol metabolism, membrane permeability, pollen germination and pollen tube growth (Marschner, 1995). It is also proven that B has positive effects in improving the ratio of K/Na (in favor of plant) which is a significant parameter in decreasing Na uptake, increasing K uptake of plants from soil and tolerance to salt (Muhammed et al., 1987; Maathuis and Altmann, 1999).
The plants response to auxin changes the effect on cell metabolism to coordination of the physical structure decreasing falling leaves and plant aging with cellular effects being inclusive of increase in proton exchange and membrane load (Marre, 1977). Numerous experimental results have indicated that cell expansion occurs in acid medium with auxins being considered as the promoter of this acidification (Mounla et al., 1980; Rayle and Cleland, 1992; Yang et al., 2000). The numerous experiments show that cereal yield is influenced positively with auxin (Ahmad et al., 2007: Ahmad et al., 2008a; Ahmad et al., 2008b; Karimi et al., 2012).
The importance of micronutrients in crop production with increase of population demands is for high yielding cultivars and intensive cropping systems (Ernani et al., 2002). Nutrient interaction in extern soil characteristics is the most important factor affecting yields (Fageria and Baligar, 1997). For example retention of Zn is strongly influenced by pH, the higher the pH the greater the retention (Alcântara and Camargo, 2001) influenced by the metal concentration in the soil, (Basta and Tabatabai, 1992) the organic matter content and by the soil mineralogical characteristics. Nutrient insufficiencies cause plants' ions to become unbalanced (Lewitt, 1980).
The aim of this study is to investigate nutrient mixture impact using leaf composted in the condition of Western Turkey (Mediterranean climate) agricultural activities with alkaline soil on the growth, development periods of corn plant, cob yield and protein yield and fatty yield.

MATERIALS AND METHODS

The research was carried out 2010 and 2011 during the main crop period for the region selected in what was considered a typical Mediterranean climate, hot summers and mild winters. Aydin, is located in west Turkey at 37° 44' N 27° 44' E and is 65 m above sea level. Initial results of soil analysis are shown in Table1.
The experimental soil of the studied field contained a sandy loamy structure with alkaline characteristic and it was mixed with quite low amounts of organic matter. In terms of the micronutrients, soil had a high P level.
Table 2 indicates the pattern of soil micronutrient levels in this experiment. As it is shown in this table, the highest levels of microelements were determined for Ca (2978 ppm) and Mg (594 ppm) of all investigated microelements. K with 176ppm and Na with 101ppm took the next place in the ranking. Further studies revealed Fe, Zn, Mn, Cu and B in lower amounts in the experimental soil respectively. Aydin region`s climate hot and dry in summers, warm and rainy in winters was selected and found to present the best average for a typical Mediterranean climate. Monthly temperature average and rainfall values were taken into account and these for the years 2010 and 2011 are presented in Table 3.
Monthly temperatures were recorded during the corn growth, April-August as shown in the data in Table 3. This data indicates that the temperature was higher in the first year of experiment in comparison to the second year during the corn growth period. The exception for the across the board lower temperature during the second year was the month of July

2011. Gathered precipitation data for both years, during the months January through July showed higher precipitation in the first year in comparison to the second year.

Experimental design

The experiment was based on 4 repetitions inclusive of two factors using a split plot experimental design plan. The area of the Parcel used was determined to be 28 m^2 for each genotype. In addition parcels were set up as a control feature and not applicable for treatment.

Table 1. Results of experimental soil texture and chemical analysis

Soil texture[1] (%)			pH[2]	Organic mater[3]	P[4]
Sand	Silt	Clay		(%)	(ppm)
72,0	16,7	11,3	8,4	1,2	21
[1] :Bouyoucos; [2]: 1:2.5 Saturasyon; [3]:Walkley-Black; [4]:Olsen					

(Bouyoucos G.J. 1962; Ayers and Westcot 1989; Walkley and Black 1934; Olsen et al. 1954).

Table 2. Some mineral content of soil.

K[5] (ppm)	Ca[5] (ppm)	Mg[5] (ppm)	Cu[6] (ppm)	B[7] (ppm)	Zn[6] (ppm)
176	2978	594	1.8	0.25	1.1
[5]:A. Asetat; [6]:DTPA; [7]:Azomethin-H					

(Li et all 2004; Lindsay and Norvell 1978; Sah and Brown 1997)

4 hybrid corn varieties were used as experiment material. The varieties nominated were 31G98, 31D24, Kermes and NK-Arma. We cultivated these varieties on 04/May/2010 and 20/May/ 2011. Our first seed emergence observation was conducted on: May 13th 2010 and the following year May 27th 2011. The irrigation plan considered and used (5 times) for the corn plants was based on the standard (5x100 mm) taking climate conditions and plant necessity into consideration. Standard fertilizer application for the soil was applied as 200 $kg.ha^{-1}$ pure nitrogen (80 $kg.ha^{-1}$ with 15-15-15 composite was applied immediately at the beginning of cultivation – 120 $kg.ha^{-1}$ with urea (H_2NCONH_2) before first water), 80 $kg.ha^{-1}$ phosphor (P_2O_5) and 80 $kg.ha^{-1}$ potassium (K_2O).

In this experiment the fertilization plan was carried out using foliar forms when 6-8 leaves where observed on each plant. Fertilizer was supplied using 0.150% of total mixed nutrients. Furthermore, actual leaves compost fertilizing was applied through the experiment. Fertilizer application was performed June 6th 2010 in the first year and June 28th 2011 the second year. Foliar fertilizers were used in the study. The utilized fertilizer in this study was procured from a local company: Biokim Company (Izmir, Turkey).

Table 3

Months	Temperature ^oC			Precipitation (mm)		
	2010	2011	Long term	2010	2011	Long term
Janua.	10.1	8.1	8.2	138.9	147.2	121.0
Februa	12.2	9.6	8.9	156.5	68.6	95.5
March	14.2	11.4	11.7	23.3	26.1	71.1
April	17.2	14.6	15.7	15.9	51.5	45.5
May	22.3	19.6	20.9	30.4	44.7	33.5
June	25.4	25.1	25.9	32.2	14.6	14.0
July	31.0	31.0	28.4	0.0	0.0	3.5
August	31.7	28.8	27.2	0.0	0.2	2.2
Septe.	26.7	26.2	23.2	0.8	32.2	14.4
Octob.	18.3	16.3	18.4	95.7	69.8	43.8
Nove	17.4	11.3	13.0	37.9	-	87.5
Dece	11.8	9.6	9.4	143.8	87.8	110.2

Fertilizer combinations:

Solution 1 (containing auxin (growth hormone) and 8% soluble Zn): Increases membrane permeability and promotes the uptake of nutrients. Additionally these conditions increase the resistance of plants to pests and diseases. The nutrient mixture has a positive effect on the plant enzyme system and was found to encourage amino acid and carbohydrate synthesis.

Solution 2 (containing 10% soluble B): It is recommended against boron deficiency in the soil. Boron deficiency can cause to reduction in spike and grain. It is suggested these nutrient mixture can use boron deficiency conditions in the soil.

Zachary (1999) noted that plant development subjected to stress of certain extreme temperature ranges either too high or too low results in stress during the period of development. It was reported that the value of temperature in the range of: 10°C and 30°C for corn plants created optimum conditions with rapid development of the plant at temperatures around 30°C. Many researchers have developed the following formula to calculate GDD values for corn and determined using the following equilibriums according to Cross and Zuber (1972) and in Germany et al. (1996) in their previous studies.

GDD = [(Tmax. + Tmin.)/2] – Tbase

Tmax.: Daily maximum temperature (up limit 30°C)

Tmin.: Daily minimum temperature (down limit 10°C), **Tbase**: for corn 10°C

In order to understand the interactive effects of daily temperature variations on plant growth we observed and recorded the temperature during the two years to better understand the relationship between corn plant growth and daily effective temperature, GDD values. These were calculated to clearly explain how the daily range of temperature of both upper and lower limits affects growth and ultimately yield.

Table 4. The number of days which temperatures down to 10°C and up to 37.5°C and 40°C

Months	2010			2011		
	10	37	40	10	37	40
May	-	-	-	2	-	-
June	-	4	-	-	1	-
July	-	13	-	-	12	1
August	-	12	7	-	9	-
September	-	-	-	-	2	-
Aggregate (total)	0	29	7	2	24	1

The number of days that temperature values exceeded the limit value for C4 plant (Stewart et al., 1998; Crafts-Brandner and Salvucci, 2002) is presented in Table 4. Data showed lower restricted pointed at10°C, whereas upper point indicated at 37.5°C and critical upper at 40°C.

Table 4 indicated of number of days that temperature exceeded the limit of range during the two years of this experiment. The lower limit in temperature of 10 °C, the upper limit of 37.5°C and 40°C is taken as the critical upper limit (Stewart et al, 1998; Crafts-Brandner and Salvucci 2002).

Per cob yield was measured by taking their average of 20 cobs from parcel. Protein and oil content of corn grain were analysed by using NIRS-FT (Bruker MPA) (Gislum et al., 2004). Plant samples were gathered by weighing (90 g) as uniformly as possible in mini sample cups with a depth of approximately 2.8 cm and a diameter of 9 cm. Samples were analysed and outcome results were used to calculate protein and oil yield by the following formulas.

Oil yield (kg ha^{-1}) = [Oil content (%) × Grain yield (kg.ha^{-1})]/100

Protein yield (kg ha^{-1}) = [Protein content (%) × Grain yield (kg.ha-1)]/100

Statistical Analyses of Data

All the plant data collected from all treatments were statistically analysed using the TARİST package software (Açıkgöz et al., 1994). Data was used in attempt to determine the interactive effects of foliar fertilizers on varieties.

RESULTS AND DISCUSSIONS

Least Square means of measured parameters was calculated through variance analysis for each. It was found that genotype and fertilizer application provided significant different results in all varieties. We observed however a significant difference in interaction effects between the individual genotype, fertilizer application and the interaction effects of years of application on protein yield. Data is separated according to years and evaluated in Table 6, 7 and 8. LSD values of the important ones among variation resources are presented under the Tables.

GDD values of corn varieties were calculated at the end of different foliar fertilizer applications and are presented in Table 5. It was found that averages of varieties were close to each other. 31G98 genotype was found to have 1904 varieties which make it the highest number of varieties. This is followed by NK-Arma (1874), 31D24 (1865) and Kermes (1854) varieties. It was found that Auxin and Zn addition (1894) application was higher than Control (1881) and Boron (1856) applications were found to be lower than control. Obtained values which were found to be higher than the values determined by Kara (2011), in accordance with the values determined by Koca et al. (2010), and lower than the values determined by Roth and Yocum (1997).

Based on results, we would suggest that only auxin and Zn addition extended vegetation period of corn in this study. Fertilizer impact increased both vegetative and generative periods of corn. Boron application only increased in vegetative period. Our data indicated that GDD in corn was related with some growth parameters in many researches (Teal et al., 2006; Warrington and Kanemasu, 1983a; Warrington and Kanemasu, 1983b; Warrington and Kanemasu, 1983c) directly with grain yield in many studies (Baez-Gonzalez et al., 2002; Bollero et al., 1996) and it can change dramatically with the effect of environmental factors (Koca, 2009).

Application of some nutrients and hormones from leaf ensured the reduction of stress conditions and reactions. To attain a more positive result a more optimum environment was attempted to be created. In some applications, the period for a plant to reach the growing stage was extended. This result is in parallel with the result obtained by Thomason et al. (2007). When the results are analysed in terms of years, it revealed that 2010 was warmer than 2011. Heat sum of all of the varieties were higher in the first year. However, we determined that the second year was cooler than the year before, temperature values presented in Table 4 supports these findings. While daily minimum temperature was never below 10^{o}C during application months, it fell below this level twice in 2011 and maximum temperature values were over limit values even more often.

Cob yield was analysed and it was indicated that the differences between first year varieties and applications were significant. 31D24 genotype products the highest yield value with Auxin, and Zn addition and B applications. There was also demonstrated the higher means values of solution 1 and solution 2 than control. Difference between these two applications was found to be insignificant. Therefore, the highest grain yield in the first year was obtained in 31D24 genotype, from B (260.0 g) application. This is followed Kermes genotype by auxin and Zn addition applications on (255.1 g).

Differences between varieties and applications were determined to be insignificant in the second year (2011). All applications provided greater cob yield than control in 31D24 genotype. Differences between the applications weren't significant. The highest value was obtained from 31D24 genotype auxin and Zn addition (248.6 g) applications in the second year (2011). This is followed by B (232.9 g) applications. Results of the two years showed that 31D24 had high yield averages in comparison to the other studied genotypes.

In the first two years of the study, almost all of the applications resulted in high yields in control parcels. In particular B, auxin and Zn addition applications had significant positive effects on corn. It is stated that as a result of the soil analysis in the study, B element was deficient (Table 2). B deficiency is common in this soil. In terms of higher pH (8.4) plants are not able to uptake certain nutrients from these types of soil conditions despite sufficient nutrients being present in the soil. This decrease in ability to take in nutrients from soil through plant roots (Basta and Tabatabai, 1992; Alcântara and Camargo, 2001; Fageria, 2002) explains the reason why all the applications gave higher yields than control and it is in parallel with the results of the studies of Toma et al. (1973), Wojcik (2006), Usenik and Stampar (2007), Hossain et al. (2008), Potarzycki and Grzebisz (2009) and Safyan et al. (2012).

The GDD values indicated that fertilizer applications extended the plant's vegetation period. However Auxin and Zn application ensured increase in both vegetative and generative periods, B application was found to increase only in vegetative period.

All these applications ensured yield values can be called high. It can be suggested that there is relationship between GDD values and grain yield (Bollero et al. 1996; Baez-Gonzalez et al. 2002). This obtained result is in parallel with the study of Bauder and Randall (1982) and Duchon (1986).

Both two years of the experiments were compared. It was found that the first year's (2010) temperature values were higher than the second year (2011). It could be reason for the first year's GDD values (1885) being higher than the second year (1864). It can be suggested that the difference between the two years may be due to an emerged generative period. The first year average in yield value (222.4 g) was higher than the second year (212.5 g). These results were calculated to be due to increased temperature's effect on grain yield of corn (Fraisse et al., 2001).

Protein yield values of corn varieties after different foliar fertilizer applications are presented in Table 7. Almost all of the applications in the first year increased protein yield. 31D24 showed the highest value in auxin and Zn addition application. The value was found to be higher and statistically more significant than the other applications (solution 2 and control). Increase of protein yield by auxin and Zn application and amino acid application was an expected result. This result is in parallel with the studies of Toma et al. (1973), Ahmad et al. (1994), Tejada and Gonzalez (2003), Delfine et al. (2005).

31D24 showed the highest value similar with the first year. Genotype was found to be different from others. Whereas 31G98 genotype in the second line only auxin and Zn applications demonstrated high protein yield average in the second year. Auxin and Zn application had positive effects in both years. This result is in parallel with the results of Özer (1994) andCeylan et al. (2009).

Fatty yield values of different corn varieties, obtained from different foliar fertilizer applications are presented in Table 8. Generally all of the applied nutrient mixtures increased fatty yield of corn. But only genotype was determined to be significant on fatty yield. The highest yield value was showed from 31D24 genotype auxin and Zn applications.

31D24 genotype was determined as the genotype that had the highest fatty yield as well as the protein yield.

The second year all of the applications increased fatty yield. Auxin and Zn addition and B applications gave the higher than control values. In terms of varieties, 31G98 genotype produced highest fatty yield on average. However, all of the varieties except Kermes showed high fatty yield values. The Kermes genotype throughout the experiment suggested that application of B has a very positive effect on fatty yield in all genotypes. It was emphasized in many researches that B had positive effects on grain quality (Rerkasem and Jamjod 1997 and Soylu et al. 2004).

CONCLUSIONS

Regardless to cultivars auxin, added Zn and B have positive effects to grain yield and quality of corn. At the end of soil analysis, it was determined that B level was insufficient; this explains the positive effect of 10% water-soluble B (solution 1) on yield and quality. Zn contributed to increasing grain yield and quality values with auxin and Zn (solution 2).

Calculated GDD values showed that Zn only with auxin extends vegetation period. Application increased both vegetative and generative periods for a few days. Boron application increased vegetative period.

31D24 genotype became prominent in terms of grain yield (crop yield) and quality (protein and fatty yield). The genotype gave positive reactions to almost all of the applications. It especially gave high values in auxin, Zn addition and B applications. The genotype showed high values in control application which indicates their quick and positive responses to given nutrients.

We noted however that especially in quality parameters, varieties gave different reactions to applications in different years. It is clear that many environmental, physiological, cellular, metabolic and molecular processes contribute to the relative deposition of protein and fatty in the developing corn kernel (Douglas and Robert, 1991). Obtained results were in accordance with this.

As a result, it can be said that increase in soil pH has negative effects on plant's taking nutrients. It was seen that even though nutrients (Zn, B, Mn, Cu, Co, Mg, Se and Fe) exist in soils that have high pH, they cannot be taken up by the plant. It can be said that, application of nutrients that cannot be taken from soil that application to the leaf has a positive effect.

Table 5. Result of GDD (Growing Degree Days) value for different nutrient application in 2010 and 2011

	Year	NK-Arma			31G98			Kermes			31D24			Average		
		Veg	Gen	WGP	Veg	Gen	WGP	Veg	Gen	WGP	Veg	Gen	WGP	Veg	Gen	WGP
solution (1)	2010	732	1203	1935	705	1244	1949	732	1173	1905	695	1180	1875	716	1200	1916
	2011	740	1172	1912	697	1215	1912	740	1145	1885	692	1175	1867	717	1177	1894
Average		736	1188	1924	701	1230	1931	736	1159	1895	694	1178	1871	717	1189	1905
solution (2)	2010	718	1128	1846	732	1244	1976	680	1152	1832	695	1184	1879	706	1177	1883
	2011	740	1080	1820	756	1240	1996	681	1167	1848	700	1188	1888	719	1169	1888
Average		729	1104	1833	744	1242	1986	681	1160	1840	698	1186	1884	713	1173	1886
Control	2010	718	1172	1890	718	1231	1949	692	1170	1862	692	1184	1876	705	1189	1894
	2011	723	1139	1862	697	1215	1912	681	1153	1834	697	1165	1862	700	1168	1868
Average		721	1156	1876	708	1223	1931	687	1162	1848	695	1175	1869	703	1179	1881
	2010	723	1168	1890	718	1240	1958	701	1165	1866	694	1183	1877	709	1189	1898
	2011	734	1130	1865	717	1223	1940	701	1155	1856	696	1176	1872	712	1171	1883
Year average		729	1149	1878	718	1232	1949	701	1160	1861	695	1179	1875	711	1180	1891
Veg.: Vegetative period, Gen.: Generative period, WGP: Whole growth period																

Table 6. Result of cob yield (g) value for different nutrient application in 2010 and 2011

	2010					2011				
	NK-Arma	31G98	Kermes	31D24	Average	NK-Arma	31G98	Kermes	31D24	Average
solution (1)	225.6	231.3	255.1	246.6	239.7	208.7	213.5	230.2	248.6	225.3
solution (2)	237.4	231.8	207.9	260.0	234.3	228.4	211.5	206.9	232.9	219.9
Control	201.6	191.2	199.1	211.4	200.8	188.1	168.8	185.0	197.9	185.0
Average	221.5	218.1	220.7	239.3	224.9	208.4	197.9	207.4	226.5	210.0
LSD (0.05)	Genotype*Application: 12,7									

Table 7. Result of protein yield ($kg.ha^{-1}$) value for different nutrient application in 2010 and 2011

	2010					2011				
	NK-Arma	31G98	Kermes	31D24	Average	NK-Arma	31G98	Kermes	31D24	Average
solution (1)	943	1174	1223	1505	1211	1000	1232	1131	1387	1188
solution (2)	1076	1264	1041	1218	1150	1086	1113	961	1236	1099
Control	1075	1080	862	1303	1080	1092	1126	1004	1138	1090
Average	1031	1173	1042	1342	1147	1059	1157	1032	1254	1126
LSD (0.05)	Genotype x Application: 164,0									

Table 8. Result of fatty yield ($kg.ha^{-1}$) value for different nutrient application in 2010 and 2011

	2010					2011				
	NK-Arma	31G98	Kermes	31D24	Average	NK-Arma	31G98	Kermes	31D24	Average
solution (1)	507	520	483	566	519	515	568	489	570	536
solution (2)	515	574	453	491	508	519	534	449	553	514
Control	490	462	359	508	455	497	498	450	488	483
Average	504	519	432	522	494	510	533	463	537	511
LSD (0.05)	Genotype: 39,0									

REFERENCES

Açıkgöz N., Aktaş M.E., Mokhaddam A.F., Özcan K., 1994. TARİST an Agrostatistical Packageprogramme for Personel Computer. E.Ü.Z.F. Tarla Bitkileri Kongresi, 1994. İzmir. Turkey.

Ahmad N., Abbasi Y.Z., Mir S., 1994. Effect of Pakistani lignitic derived humic acids on the agricultural growth. II. Studies on the effect of humic acids on the growth, yield and protein content of maize. Science International (3): 245-247.

Ahmad R., Khalid M., Naveed M., Shahzad S.M., Zahir Z.A., Khokhar S.N., 2008b. Comparative efficiency of auxin and its precursor applied through compost for improving growth and yield of maize. Pak. J. Bot., 40(4): 1703-1710.

Ahmad R., Arshad M., Khalid A., Zahir Z.A., 2008a. Effectiveness of organic-/bio-fertilizer supplemented with chemical fertilizers for improving soil water retention, aggregate stability, growth and nutrient uptake of maize (*Zea mays* L.). J. Sustain. Agri., 31(4): 57-77.

Ahmad R., Jilani G., Arshad M., Zahir Z.A., Khalid A., 2007. Bio-conversion of organic wastes for their recycling in agriculture: an overview of perspectives and prospects. Annals Microbiol., 57 (4): 471-479.

Alcântara M.A.K., Camargo O.A., 2001. Fator de retardamento e coeficiente de dispersão-difusão para crômio (III) em solos muito intemperizados, influenciados pelo pH, textura e matéria orgânica. V:25, p. 209- 216,

Ayers R.S., Westcot D.W., 1989. Water quality for agriculture. FAO Irr. and Drain Paper No:29:1-174, Rome.

Baez-Gonzalez A.D., Chen P., Tiscareno-Lopez M., Srinivasan R., 2002. Using satellite and field data with crop growth modeling to monitor and estimate corn yield in Mexico. Crop Science 42:1943-1949.

Basta N.T., Tabatabaı M.A., 1992. Effect of cropping systems on adsorption of metals by soils. II. Effect of pH. Soil Science, V:153, p.195-204.

Bauder J.W., Randall G.W., 1982. Regression models for predicting corn yields from climatic data and management practices. Soil Science Society of America Journal 46:158-161.

Bollero G.A., Bullock D.G., Hollinger S.E., 1996. Soil temperature and planting date effects on corn yield, leaf area, and plant development. Agronomy Journal 88:385-390.

Bouyoucos G.J., 1962. Hydrometer method improved for making particle size analysis of soil. Agron. J., 54:464-465.

Cakmak I., 2010. Biofortification of cereals with zinc and iron through fertilization strategy. 19th World Congress of Soil Science, Soil Solutions for a Changing World, Brisbane, Australia.

Cakmak, I., M Kalayci, H, Ekiz, H.J. Braun, A. Yilmaz, 1999. Zinc deficiency as an actual problem in plant and human nutrition in Turkey: A NATO-Science for Stability Project. Field Crops Res 60:175–188.

Ceylan S., Soya H., Budak B., Akdemir H., Çolak Esetlili B., 2009. Effect of Zinc on Yield and Some Related Traits of Alfalfa. Turkish J. of Field Crops 14(2): 136-143.

Crafts-Brandner S.J., Salvucci E.M., 2002. Sensitivity of Photosynthesis in A C4 Plant, Maize, to Heat Stress. American Society of Plant Physiologists. 129 (4): 1773-1780.

Cross H.Z., Zuber M.S., 1972. Prediction Of Flowering Date İn Maize Based On Differint Methods Of Estimating Thermal Units. Agronomy Journal 64: 351-355.

Delfine S., Tognetti R., Desiderio E., Alvino A., 2005. Effect of foliar application of N and humic acids on growth and yield of durum wheat. Agronomy in Sustainable Development. 25: 183-191.

Douglas C.D., Robert J.L., 1991. Metabolic Characteristics Associated With Starch, Protein and Oil Deposition in Developing Maize Kernels. Journal of Crop Sciences, 31:151-157.

Duchon C.E., 1986. Corn yield prediction using climatology. Journal of Climatology and Applied Meteorology 25:581-590.

Ernani P.R., Bayer C., Maestri L., 2002. Corn yield as affected by liming and tillage system on an acid Brazilian Oxisol. Agronomy Journal, Madison, V. 94, p. 305-309.

Fageria N.K., 2002. Influence of micronutrients on dry matter yield and interaction with other nutrients in annual crops. Pesq. agropec. bras., Brasília, v. 37, n. 12, p. 1765-1772, dez. 2002.

Fageria N.K., Baligar V.C., 1997. Response of common bean, upland rice, corn, wheat and soybean to fertility of an Oxisol. Journal of Plant Nutrition, New York, V. 20, p. 1279-1289.

Fraisse C.W., Sudduth K.A., Kitchen N.R., 2001. Calibration of the CERES-Maize model for simulating site-specific crop development and yield on claypan soils. Applied Engineering in Agriculture 17:547-556.

Genc Y., Mcdonald G.K., Graham R.D., 2002. A soil-based method to screen for zinc efficiency in seedlings and its ability to predict yield responses to zinc deficiency in mature plants. Australian Journal of Agriculturel Research 53 (4): 409-421.

German A.B., Donald G.B., Steven E.H., 1996. Soil Temperature and Planting Date Effects On Corn Yield, Leaf Area, and Plant Development. Agronomy Journal 88:385-390.

Gislum R., Micklander E., Nielsen J.P., 2004. Quantification of nitrogen concentration in perennial ryegrass and red fescue using near-infrared reflectance spectroscopy (NIRS) and chemometrics. Field Crops Research 88: 269–277.

Hossain, M. A., M. Jahuriddin, M.R. Islam. 2008. The requirement of zinc for zinc improvement of crop yield and mineral nutrition in the maizemung beanrice system. Plant Soil. 306; 13-22.

Kara B., 2011. Fresh Ear Yield and Growing Degree-Days of Sweet Corn in Different Sowing Dates in Southwestern Anatolia Region. Turkish Journal of Field Crops, 16(2): 166-171.

Karimi A., Tajbakhsh M., Amirnia R., Eivazi A.R., Karimi K., 2012. Effects of Inducing Plant Growth on performance and performance Components of Corn (*Zea mays* L.). Life Science Journal 9(4): 223-229.

Koca Y.O., 2009. The Determination of Differences Between Yield, Yield Characteristics, Physiological and Some Parameters in the Main and Second Crop of Hybrid Corn (*Zea mays* L.) Grown in Aydın. Adnan Menderes University, Graduate School of Natural and Applied Sciences, Ph.D Thesis.

Koca Y.O., Turgut İ., Erekul O., 2010. The Determination of Performance at the First and Second Crop Productions in Maize Grain Cultivation. The Journal of Agricultural Faculty of Ege University 47 (2): 181-190.

Lewitt J., 1980. Salt Stresses in: Responses of Plants to Environmental Stresses. Voll II, P. 365-454. Academic Press.

Li D.C., Muta T., Zhang L.Q., Yoshio M., Noguchi H., 2004. Effect of synthesis method on the electrochemical performance of LiNi1/3Mn1/3Co1/3O2 Journal of Power Sources 132: 150-155.

Lindsay W.L., Norvell W.A., 1978. Development of a DTPA soil test for zinc, iron, manganese, and copper. Soil Science Society of America Journal 42, 421-428.

Maathuis F.J.M., Altmann A., 1999. K+ Nutrition and Na + Toxicity: The Basis of Cellular K+/ Na + Ratios. Ann. Bot., 10: 123-133.

Marre E. 1977. In plant Growth Regulatores, ed. P. E. Pilet. New York: Springer-verlag.

Marschner H. 1995. Mineral nutrition of higher plants. London: Academic Press.

Mounla M.A.K., Bangerth F., Stoy V., 1980. Gibberellin-like subdtances and indol type auxins in developing grains of normal- and highlysine genotypes of barley. PhysiologiaPlantarum, 48(4): 568-573.

Muhammed S., Akbar M., Neue H.U., 1987. Effect on Na/Ca and Na/K Ratios in Saline Culture Solition on the Growth and Mineral Nutrition of Rice (Oryza sativa). Plant and Soil, 104:57-62.

Olsen S., Cole C., Watanabe F., Dean L., 1954. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. USDA Circular Nr 939, US Gov. Print. Office, Washington, D.C.

Özer A., 1994. The Effect of different phosphorus and zinc doses on the grain yield morphological and chemical characters of "TTM-813" hybrid corn genotype (*Zea mays* L. *indentata* S.). Selcuk University, Institute of Natural And Applied Sciences, MSc Thesis.

Potarzycki J., Grzebisz W., 2009. Effect of zinc foliar application on grain yield of maize and its yielding components. Plant Soil Environ., 55, 2009 (12): 519-527.

Rayle D.L., Cleland R.E., 1992. The acid growth theory of auxin- induced cell elongation is alive and well. Plant Physiology, 99:1271-1274.

Remison S.U., 2005. Arable and vegetable crops. Gift-Press Associates, Benin City.

Rerkasem B., Jamjod S., 1997. Boron deficiency induced male sterility in wheat and implications for plant breeding. Euphytica (In Prees Ref. MS No EUPH4247).

Rodriguez D., Andrade F.H., Goudriaan J., 2000. Does Assimilate Supply Limit Leaf Expansion in Wheat Grown in The Field Under Low Phosphorus Availability. Field Crops Research 67: 227-238.

Roth G.W., Yocum J.O., 1997. Use of hybrid growing degree day ratings for corn in the northeastern USA. Journal of production agriculture, vol. 10, no2, P. 283-288.

Safyan N., Naderidarbaghshahi M.N., Bahari B., 2012. The effect of microelements spraying on growth, qualitative and quantitative grain corn in Iran. International Research Journal of Applied and Basic Sciences. V 3, S 2780-2784.

Sah R.N., Brown P.H., 1997. Boron Determination—A Review of Analytical Methods. Microchemical Journal 56; 285-304.

Soylu S., Topal A., Sade B., Akgun N., Gezgin S., Babaoglu M., 2004. Yield and yield attributes of durum wheat (*Triticum durum* Desf.) genotypes as affected by boron application in boron-deficient-calcareous soils: An evaluation of major Turkish genotypes for B efficiency. Journal of Plant Nutrition 27(6): 1077-1106.

Stewart D.S., Dwyer L.M., Carrigan L.L., 1998. Phenological Temperature Response of Maize. Agronomy Journal 90: 73-79.

Teal R.K., Tubana B., Girma K., Freeman K.W., Arnall D.B., Walsh O., Raun W.R., 2006. In-Season Prediction of Corn Grain Yield Potential Using Normalized Difference Vegetation Index. Agronomy Journal Vol. 98 No. 6, p. 1488-1494.

Tejada M., Gonzalez J.L., 2003. Effects of foliar application of a byproduct of the two-step olive oil mill process on maize yield. Agronomie. 23:617-623.

Thomason W.E., Phillips S.B., Raymond F.D., 2007. Defining Useful Limits for Spectral Reflectance Measures in Corn. Journal of Plant Nutrition, 30: 1263-1277.

Toma S.I., Shur V.P., Pailik I.S., 1973. Effect of trace element enrichment of seed on yield and quality of maize in Moldavia. Agrokhimiya. (No. 2): 111-114, 1973.

Usenik V., Stampar F., 2007. Effect of Late Season Boron Spray on Accumulation and Fruit Set of "Summit" and "Hedelfinger" Sweet Cherry (Prunus Avium L.), Acta Agriculturae Slovenica, 89-1:51-58.

Walkley A., Black I.A., 1934. An Examination of the Degtjareff Method for Determining Soil Organic Matter, and A Proposed Modification of the Chromic Acid Titration Method. Soil Science Vol:37(1):29-38.

Warrington I.J., Kanemasu E.T., 1983a. Corn Growth Response to Temperature and Photoperiod I. Seedling Emergence, Tassel Initiation, and Anthesis. Agronomy Journal Vol. 75 (5), p. 749-754.

Warrington I.J., Kanemasu E.T., 1983b. Corn Growth Response to Temperature and Photoperiod II. Leaf-Initiation and Leaf-Appearance Rates. Agronomy Journal Vol. 75 No (5), p. 755-761.

Warrington I.J., Kanemasu E.T., 1983c. Corn Growth Response to Temperature and Photoperiod. III. Leaf Number Agronomy Journal Vol. 75 No (5), p. 762-766.

Welch R.M., 1995. Micronutrient nutrition of plants. Critical Reviews of Plant Sciences 14: 49-87.

Wojcik P., 2006. "Schattenmorelle" Tart Cherry Response to Boron Fertilization. Journal of Plant Nutrition, 29: 1709-1718 p.

Yang J., Peng S., Visperas R.M., Sanico A.L., Zhu Q., Gu S., 2000. Grain filling pattern and cytokinin content in the grains and roots of rice plants. Plant Growth Regulation, 30: 261-270.

Yassen A., Abou El-Nour E.A.A., Shedeed S., 2010. Response of Wheat to Foliar Spray with Urea and Micronutrients. J. American Sci., 6(9): 14-22.

Zachary F., 1999. Minimizing Frost Risk in Corn Hybrid Selection (www.smallgrains.org).

Zayed B.A., Salem A.K.M., Sharkawy H.M., 2011. Effect of Different Micronutrient Applications on Rice (*Oryza sativa* L.) Growth and Yield under Saline Soil Conditions World J. Agric. Sci., 7(2): 179-184.