Bulgarian Journal of Agricultural Science, 18 (No 1) 2012, 42-48
Agricultural Academy

EFFECT OF NITROGEN LEVELS ON GRAIN YIELD AND SOME ATTRIBUTES OF SOME HYBRID MAIZE CULTIVARS (*ZEA MAYS INDENTATA* STURT.) GROWN FOR SILAGE AS SECOND CROP

A. KARASU[1]

[1]*Uludag University, Mustafakemalpasa Vocational School, 16500, Bursa, Turkey*

Abstract

KARASU, A., 2012. Effect of nitrogen levels on grain yield and some attributes of some hybrid maize cultivars (*Zea mays indentata* Sturt.) grown for silage as second crop. *Bulg. J. Agric. Sci*., 18: 42-48

This study was carried out in order to determine the effects of nitrogen fertilizer on yield and yield components and some technological attributes of 3 dent maize cultivars grown under irrigated conditions in Mustafakemalpasa, Bursa, Turkey in 2005 and 2006 years. The plant height, the first ear height, ear length, ear diameter, ear number per plant, seed number per ear, 1000 seed weight, protein content, and grain yield (kg ha^{-1})were investigated. In the experiment three cultivars as LG 2687, 34 M 43 and GH 2547 and 4 rates of nitrogen (0, 150, 300, 450 kg ha^{-1}) were used. When the nitrogen levels increased, grain yield also significantly increased up to 300 kg N ha^{-1}. The highest grain yield (13323 kg ha^{-1}) was obtained from 300 kg N ha^{-1} nitrogen doze, and the lowest yield (9805 kg ha^{-1}) was produced the control plant (0 kg N ha^{-1}).

The effects of different nitrogen rates were not significant on plant height, first ear height, ear diameter, seed number per ear, and 1000 seed weight characters but significant on ear length, ear number per plant, seed yield and crude protein content. It was determined that 300 kg N ha^{-1} was suitable for seed yield. The seed yield of cultivars ranged between 11649 kg ha^{-1} to 11918 kg ha^{-1}.

Key words: fertilization, protein content, seed yield, yield components

Introduction

Maize, with its high yield potential and wide adaptation capability, is the most promising crop as warm season crop in the Word. The maize is a vital source of nutrition in forage and a widely used as industrial plant in Turkey, as well as in other countries. Maize ranks third, following wheat and rice, in the world production of cereal crops (FAO, 2010) and is one of the most important cereal crops grown principally during the summer season as first crop or second crop in Turkey. Maize grain is used for both human consumption and poultry feed. The total production of the maize is not sufficient to meet the continuous increase of consumption. Because of this the attempts to increase maize production are of great importance. To increase the maize production, there are needs

[1]*E-mail: akarasu@uludag.edu.tr*

for the adequate supply of irrigation water, N, P, K fertilizers, high yielding cultivars, agronomical practices done on time etc. affecting directly the growth and productivity.

There are large populations of cattle in Mustafakemalpasa. In some years, some farmers who raise the maize for silage as a main crop or second crop when the prices of silage are comparatively lower and there are more production than the need of farmers, they leave the remaining product for grain productions. Namely, the maize grown for silage is kept waiting to obtained maize grain. Some farmers who do not practice suitable rotation have not obtained high seed yield for maize. Due to the low yield, some farmers use excessive fertilizer and irrigation water to obtain high forage and grain yield. The excessive amount of fertilizers to reach the highest yield is common among both forage and seed groves at this region. However, excessive fertilization provides no increase in yield but increases environmental pollution. Yet they have continued to excessive fertilization and irrigation on different levels of nitrogen and nutrition elements all soil with the expectation of high yield. Especially low-cost fertilizers for some years encourage excessive fertilization.

Nitrogen plays a vital role in nutritional and physiological status of plants, promotes changes in mineral composition of plant, and is the most important element for plant growth and development. The optimal amounts of plant nutrients in the soils cannot be utilized efficiently if nitrogen is deficient in plants. Nitrogen deficiency or excess can result in reduced maize yields. Maize nitrogen requirement can be as high as 150-200 kg N per hectare. However, the amount of optimum nitrogen fertilizer varies cultivars and ecological conditions (Kececi et al., 1987; Sencer, 1988; Sezer and Yanbeyi, 1997; Kirtok, 1988).

The objective of this study was to determine the effect of four nitrogen levels on seed yield and some yield components some maize cultivars which sown as second crop grown for herbage under irrigated conditions.

Materials and Methods

The purpose of the research was to determine adequate nitrogen doses and the best maize cultivars for these lands as second crops. The research was conducted at experimental field of Mustafakemalpasa Vocational School in 2005-2006 years. The experimental fields is situated at a latitude of 40^{o} 02/ North, and a longitude of 28^{o} 23/ East, 80 km to Bursa, Turkey, 22 m above sea level. This climatic zone is characterized by a Mediterranean type climate.

The soil was a clay loam, slightly alkaline (pH 7.8), rich in extractable K (142.3 mg kg^{-1} soil) and poor in extractable P (7.9 mg kg^{-1} soil), and medium in organic matter (2.5%). The soil of the trial site has no salt problem and the level of organic matter is low.

The local climate is temperate, summers are hot and dry and winters are mild and rainy. According to long-term meteorological data (1975- 2007), annual mean rainfall, temperature and relative humidity are 679 mm, 14°C, and 68% respectively. A sub-humid climate prevails in the region according to mean rainfall amount (from 600 to 700 mm of annual precipitation) (Jensen, 1980). Temperature, rainfall and relative humidity during the experimental period (June-November) are shown in Table 1. The first year of the study was rainier than long-term average (293.2 vs. 315.4 mm.). The second year had drought, and rainfall during the growing period was much below than long-term average (286.0 vs. 293.0 mm). The climate of Bursa where the research has been held is quite suitable area for maize cultivation. However, irrigation is necessary in the vegetation period of maize.

In the study, four nitrogen levels (0, 150, 300 and 450 kg ha^{-1}) were applied to three hybrid maize cultivars (LG 2687, 34 M 43 PIONEER and GH 2547). 34N43 PIONEER is short; it is widely

Table 1
Some meteorological registrations of experimental years (2005, 2006) and long periods (1990-2007)

Months	Temperature, °C			Precipitation, mm			Relative humidity, %		
	2005	2006	1990-2007	2005	2006	1990-2007	2005	2006	1990-2007
June	21.6	22.4	22.5	20.8	62.8	33.9	58.3	59	58.8
July	24.9	24.2	24.9	54.8	2	18.2	62.3	56	57.8
August	25.4	26.8	24.8	3.4	3.3	24.8	63.9	58.9	60.4
September	20.4	20	20.2	94.1	91	59.9	68.8	70.9	66
October	13.2	15.9	15.8	33	25.8	72.9	72.2	73.6	71.4
November	9.3	7.2	10.2	109.3	101.1	83.5	74.6	74.3	67.9
Total	-	-	-	315.4	286	293.2	-	-	-

grown as second crop in Marmara region. This cultivar period is early in maturity (90-100 days) and it is resistant drought conditions. The interior of ear is red. Another cultivar GH 2547 (Gold Daste) is short; it is produced as both the main crop and second crop in Marmara region. The vegetation period is middle early (112-115 days), it is resistant to the soils having high pH. It is highly tolerance to drought. The interior of ear is white. Its FAO group is 550-590. Third cultivar, LG 2687 is also advised as second crop at the same region. The vegetation period of this cultivar is middle early (112-115 days) and it is resistant to drought conditions. There is no selectivity of soil. The interior of ear is red. Its FAO group is 550. The experiments were conducted in a randomized complete block design with three replications.

The plant height, ear height, ear length, ear diameter, seed number per ear, 1000 seed weight, ear number per plant , protein content, grain yield (kg ha^{-1}) were investigated.

The experimental field was prepared after the rapeseed (*Brassica napus* ssp. oliefera) harvest in July and the plots were seeded by hand at double rate at 8 July 2005 and 10 July 2006 as second crops. Each plot consistent of four rows; 5 m long with 0.70 m between rows and 0.15 m intra-row spacing. All rows were thinned by hand after emergence to the required intra-row spacing.

Nitrogen doses were split up two parts, one-half was applied in sowing and the other half was applied when plants became 30-40 cm height as urea (46% N). Besides, 100 kg ha^{-1} phosphorus was applied to each plot in sowing. Weed control and irrigation were performed as needed.

For morphological measurements, randomly 10 plants from each replication were taken just before cutting for seed production. The plant height, ear height, ear length, ear diameter, seed number per ear, ear number per plant was measured individually. Two rows of the each plot were harvested for seed yield (when the humidity percentage of seed was 15%) when plants were full maturity stage. Then, the grain was separate from ear by hand after harvest. Seed yields of ten plants selected for measure were added to seed yield per plot. In addition, protein contends were obtained from seeds of each plot. Analysis of variance was performed on morphological measurements and seed yield data using MINITAB (University of Texas, Austin) and MSTAT-C (Version 2.1 Michigan State University, 1991) programs. Differences between treatment means were detected by the LSD test at the 0.05 level.

Results and Discussion

Plant height

The main and interaction effects of cultivar and nitrogen fertilizer on the plant height of maize were found insignificant (Table 2). The average plant heights ranged between 268.6 and 280.9 cm for cultivars and between 269.0 and 276.8 cm for nitrogen fertilizer levels. The similar results were reported by other researchers (Turgut, 1998; Kara et al., 1999; Yilmaz et al., 2007).

First ear height

The first ear heights of maize cultivars were significantly different and the highest value (144.1 cm) was obtained from LG 2687 cultivar. The first ear heights of the other two cultivars were low and similar. On the other hand, the first ear heights of maize plants were not affected by nitrogen fertilizer levels, and the first ear height in term of nitrogen levels ranged between 132.3 and 134.7 cm. The interaction effects of cultivar and nitrogen fertilizer on first ear height were also significant and the highest value (152.8 cm) was produced by the 150 kg N ha^{-1} and LG 2687 cultivar while the lowest value was produced by 300 kg N ha^{-1} and 34M43 PIONEER cultivar (Table 2). Turgut (1998) reported results, which were in, conform to our findings.

Ear length

Ear lengths of maize plants significantly varied depending on cultivar and nitrogen fertilizer. The highest ear length obtained from GH 2547 (16.2 cm), which was followed by LG 2687 (15.7 cm) and 34M43 PIONEER (15.5 cm) (Table 2). The effect of nitrogen fertilizer levels on ear length of maize plants were negative direction and as nitrogen rates were increased, ear length was decreased. Interaction effects of cultivar and nitrogen fertilizer were also significant. The highest ear lengths were determined at O N ha^{-1} X LG 2687 (17.0 cm) and 450 N ha^{-1} X GH 2547 (17.2 cm) combination. Turgut (1998) reported some similar results.

Ear diameter

There were no relationships between cultivar and nitrogen rates in term of ear diameter (Table 2). However, the interactions effects of cultivar and nitrogen fertilizer significantly affected the ear diameter values. The lowest ear diameter value (4.04) was obtained from 450 kg N ha^{-1} and 34M43 PIONEER cultivar. The other combinations yielded somewhat higher but similar ear diameter values. These results are in agreement with the results reported by Turgut (1998), Yilmaz and Karaaltun (2005). However, some researchers reported different results and they found that the nitrogen fertilizer appreciation increased the ear diameter values (Kara et al., 1999; Saruhan and Sireli, 2005).

Ear number per plant

This component was statistically affected by both cultivars and nitrogen rates. Ear number per plant values of LG 2687 (0.92 ear per plant) and 34M43 PIONEER (0.91 ear per plant) were similar but higher than those of GH 2547(0.87 ear per plant). Ear number per plant were low because of dense planting for silage making (Approx. 95000 plant/ha). Control plots (0 kg N ha^{-1}), 150 kg N ha^{-1} and 300 kg N ha^{-1} nitrogen levels had the higher ear number values (respectively 0.92, 0.92, 0.89 number ear per plant) than 450 kg N ha^{-1} (0.87 ear number per plant) .These results are in accordance to those of Keskin et al. (2005) and Saruhan and Sireli (2005).

Seed number per ear

Seed number per ear of maize cultivars was significantly different. Seed number per ear values of GH 2547 (0.611 seed per ear) and LG 2687 (595.8 seed per ear) were similar and best higher than these of 34M43 PIONEER (556.2 seed per ear). Seed number per ear of maize plants were not affected by nitrogen fertilizer levels and seed number per ear of nitrogen levels ranged between 574.8 and 604.4 seed number per ear. The interaction effects of cultivar and nitrogen fertilizer on seed number per ear were also significant and the

Table 2
Effect of hybrid and nitrogen levels on some morphological traits and seed yield (average for two years)

	Components								
	Plant height, cm	First ear height, cm	Ear length, cm	Ear diameter, cm	Ears/ plant	Seed/Ear	1000 seed weight, g	Seed yield, kg ha^{-1}	Crude Protein Content, %
Hybrids									
LG 2687	280.9	144.1 a	15.7 ab	4.38	0.92 a	595.8 a	258.0 b	11649 b	11.3 b
34M43 PIONEER	268.6	124.9 b	15.5 b	4.28	0.91 a	556.2 b	296.0 a	11918 a	11.9 a
GH 2547	273	131.5 b	16.2 a	4.33	0.87 b	611.9 a	260.4 b	11895 a	11.5 b
Nitrogen levels, kg ha^{-1}									
0	269	132.7	16.08 a	4.31	0.92 a	577.9	273.7	9805 d	10.7 c
150	274.3	134.3	16.10 a	4.31	0.92 a	574.8	265.6	12364 b	11.5 b
300	276.8	132.3	15.69 ab	4.37	0.89 ab	604.4	269.8	13323 a	11.9 a
450	276.5	134.7	15.311 b	4.34	0.87 b	594.6	276.8	11790 c	12.1 a
Hybrid x Nitrogen levels									
0 x LG 2687	274	145.8 ab	17.0 a	4.37 a	0.95	573.4 bcd	260.3	9615 ı	10.3
0 x 34M43 PIONEER	262	121.5 de	15.5 cd	4.26 ab	0.93	565.1 cd	297.3	10055 h	11.2
0 x GH 2547	271.1	130.8 cde	15.8 bcd	4.30 ab	0.9	595.3 bc	263.4	9745 ı	10.7
150 x LG 2687	285.6	152.8 a	15.4 cd	4.31 ab	0.93	581.8 bc	258	11803 e	11.4
150 x 34M43 PIONEER	276	125.3 de	16.6 ab	4.33 a	0.94	555.6 cd	294.6	12872 b	11.8
150 x GH 2547	261.2	124.8 de	16.4 abc	4.30 ab	0.9	586.9 bc	244.2	12419 d	11.5
300 x LG 2687	284	133.6 bcd	15.2 d	4.39 a	0.9	638.8 ab	246.9	13550 a	11.5
300 x 34M43 PIONEER	270	118.5 e	16.3 abc	4.47 a	0.9	595.7 bc	302.1	13619 a	12.2
300 x GH 2547	276.3	144.7 abc	15.5 bcd	4.26 ab	0.85	578.8 bc	260.5	12800 b	12
450 x LG 2687	280	144.3 abc	15.3 cd	4.51 a	0.88	589.2 bc	267.1	11629 f	12.1
450 x 34M43 PIONEER	266.3	134.3 bcd	13.5 e	4.04 b	0.89	508.2 d	290	11126 g	12.5
450 x GH 2547	283.2	125.6 de	17.2 a	4.46 a	0.85	686.5 a	273.4	12615 c	11.8
F -Test									
Years	**	**	**	**	**	**	**	**	*
Hybrid (H)	ns	**	*	ns	*	**	**	**	**
Nitrogen levels (N)	ns	ns	*	ns	*	ns	ns	**	**
H x N	ns	**	**	*	ns	**	ns	**	ns

1:Means of the same column followed by the same letter was not significantly different at the 0.005 level using LSD test *, **: F-test significant at p ≤0.05 and p≤0.01, respectively. ns: not significant.

highest value (686.5 seed per ear) was produced by the 450 kg N ha^{-1} and GH 2547 cultivar combination while the lowest value (508.2 seed per ear) was produced by 450 kg N ha^{-1} and 34M43 PIONEER cultivar combination (Table 2). Yilmaz and Karaaltun (2005) reported results, which were in, conform to ours.

1000 Seed Weight

The 1000 seed weight of maize cultivars was significantly different and the highest value (296 g) was determined in 34M43 PIONEER cultivar. 1000 seed weight of the other two cultivars GH 2547 and LG 2687 were low and similar (260.4 and 258 g). The 1000 seed weight of maize cultivars were not affected by nitrogen fertilizer levels and the 1000 seed weight levels ranged between 265.6 - 276.8 g. Turgut (1998) reported the similar results.

Seed Yield

Seed yield of maize plants significantly changed depending on cultivar and nitrogen fertilizer. Seed yield of 34M43 PIONEER (11918 kg ha^{-1}) and GH 2547 (11895 kg ha^{-1}) cultivars were similar and higher than these of LG 2687 were (11649 kg ha^{-1}). Control plots (0 kg N ha^{-1}) produced lower seed yield (9805 kg ha^{-1}) than other plots. When the nitrogen levels increased, grain yield increased up to 300 kg ha $^{-1}$ nitrogen level. The highest grain yield (13323 kg ha^{-1}) was obtained from 300 kg ha^{-1} nitrogen doze, while the lowest yield was obtained (9805 kg ha^{-1}) 0 kg ha^{-1} N doze. 150 kg ha^{-1} (12364 kg ha^{-1}) and 450 kg ha^{-1} nitrogen levels (11790 kg ha^{-1}) fallowed 300 kg ha^{-1} nitrogen applied parcels (13323 kg ha^{-1}), 450 kg N ha^{-1} nitrogen applied parcels had lower yield (11790 kg ha^{-1}) than other nitrogen levels (Table 2). The seed yield decreased at high nitrogen doses.

The interaction effects of cultivar and nitrogen fertilizer on seed yield were also significant. The highest value were produced by the 300 kg N ha^{-1} X 34M43 PIONEER (13619 kg ha^{-1}) and 300 kg N ha^{-1} X LG 2687 (13550 kg ha^{-1}) combinations while the lowest value were produced by 0 kg N ha^{-1} X LG2687 (9615 kg ha^{-1}) and 0 kg N ha^{-1} X GH 2547 (9745 kg ha^{-1}) combinations (Tab. 2). Cv. 34M43 PIONEER had lower yield (11126 kg ha^{-1}) at 450 kg ha^{-1} than 150 kg ha^{-1} and 300 kg ha^{-1} nitrogen doses (12872 kg ha^{-1} and 13619 kg ha^{-1} respectively). Cultivar GH 2547 had higher yield at 450 kg ha^{-1} nitrogen dose (12615 kg ha^{-1}) than 150 kg ha^{-1} and 300 kg ha^{-1} nitrogen doses (12419 kg ha^{-1} and 12800 kg ha^{-1} respectively). Turgut (1998) reported results, which were in, conform to ours. This result showed that the amount of optimum nitrogen level which are applied to maize vary between cultivar, soil structure and ecological conditions. Kececi et al. (1987), Sencer (1988), Sezer and Yanbeyi (1997) reported that, the amount of optimum nitrogen level vary according to cultivars and ecological conditions. However, Hills et al. (1983), Eck (1984), Soltner (1990) and Kirtok (1998) reported that the amount of nitrogen doses might vary 80 - 250 kg N ha^{-1}. These differences might be due to differences in nitrogen uptake by genotypes.

Crude Protein Content, %

Crude protein content of maize plant significantly changed depending on cultivars and nitrogen fertilizer. The highest value was determined in Cv. 34M43 PIONEER (11.9 %).Crude protein content of other two cultivars (GH 2547 and LG 2687) were low or similar (11.5 % and 11.3%). Crude protein rates increased with increasing nitrogen rate. Control plots (0 kg N ha^{-1}) had the lower crude protein content (10.7%) than other plots. As the nitrogen levels increased, crude protein increased also. The highest crude protein was obtained from 450 and 300 kg ha^{-1} nitrogen dozes (12.1% and 11.9%) respectively, while the lowest crude protein content was obtained from 0 kg ha^{-1} nitrogen doze (10.7%). 150 kg ha^{-1} nitrogen doze had 11.5% crude protein content.

Conclusion

The aim of the research was to determine the effect of nitrogen levels on grain yield, some agronomical characters and crude protein contents some hybrid maize cultivars sown as second crop. These results showed that for highest yield, yield components, nitrogen level vary between cultivars, and the amount of optimum nitrogen level shows differences between cultivars. 300 kg ha^{-1} nitrogen dose is optimum dose for growing maize cultivars these ecological conditions. The highest seed yield was obtained from 300 kg ha^{-1} nitrogen dose (13323 kg ha^{-1}) while the lowest seed yield (9805 kg ha^{-1}) was obtained from 0 kg ha^{-1} nitrogen dose (control plots). When the nitrogen levels increased, grain yield increased up to 300 kg ha^{-1} nitrogen level. 450 kg ha^{-1} nitrogen applied plots had lower yield than other nitrogen applied plots (Table 2).

The interaction comparison show that cv. 34M43 PIONEER and cv. LG 2687 cultivars proved to be more responsive to N application than GH 2547 cultivar against application of 300 kg N kg ha^{-1}. It was found that the 300 kg N kg ha^{-1} was optimum dose for maize cultivars which sowing for silage but harvested as grain under ecological conditions of Mustafakemalpasa, Bursa.

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Received April, 2, 2011; accepted for printing December, 2, 2011.