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Response of maize (*Zea mays* L.) cultivars to different levels of nitrogen fertilizer

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Abstract

In order to study the effects of nitrogen levels on yield and yield components in maize cultivars, a split plot experiment based on randomized complete block design with three replications was conducted in 2008 at the Research Farm of Islamic Azad University, Branch of Ardabil. Treatments were arranged in a split plot design with three replicates. N levels (N 0, 80, 160 and 240 kg/ha) as urea were in the main plots (control =N 0 kg/ha), and maize cultivars (SC-301, DC-370 and SC-404) were allocated at random in the sub-plots. Results indicated that nitrogen levels had significant effects on yield and yield components in maize hybrids. Maize cultivars had different response to this characteristic. The highest grain yield was obtained from the highest levels of nitrogen fertilizer. The highest number of kernel per ear, the number of grains per ear row, ear diameter, cob length, grain per plant, plant height, the number of grains per ear row and number of kernels per ear were recorded at the highest levels of nitrogen fertilizer. The number of grain row and number of cobs per plant were not affected in maize cultivars by levels of nitrogen fertilizer. Effect of cultivar × nitrogen levels was significant on grain yield. Maximum grain yield (7.76 ton/ha) was obtained in the plots with N 240 kg ha^{-1} and SC-404 cultivar and minimum of it (5.12 ton/ha) was obtained in the plots with 0 kg nitrogen ha^{-1} and SC-301 cultivar. It can be suggested that SC-404 hybrid should be applied with N 240 kg/ha in conditions of Ardabil Plain.

Key words: Nitrogen fertilizer, *Zea mays*, yield, yield components.

Introduction

Corn (*Zea mays* L.) is one of the most important cereal crop grown in Iran. Maize grain is used for both human consumption and poultry feed. It has a great utility in agro-industry. This crop has much higher grain protein content than our staple food rice. Based on area and production, maize is the 3th most important cereal crop after wheat and rice in world [15]. The yield of maize in Iran is very low as compared to other maize producing countries. One of the most important effective factors is non-application of optimal amounts of nitrogen fertilizer per hectare and maize hybrids differ in their response to different levels of nitrogen fertilizer.

Nitrogen is the key element in increasing productivity. It is an integral component of many compounds essential for plant growth processes including chlorophyll and many enzymes [19]. Nitrogen also mediates the utilization of potassium, phosphorus and other elements in plants [1]. The optimum amounts of these elements in the soil cannot be utilized efficiency if nitrogen is deficient in plants. Therefore, nitrogen deficiency or excess can result in reduced maize yields. Maize nitrogen requirement can be as high as 150 to 200 kg per hectare. However, nitrogen requirement and utilization in maize also depend on environmental factors like irrigation, varieties and expected yield. Application of nitrogen fertilizer has also been reported to have significant effect on grain yield and quality of maize [6, 11, 14]. Hardas and Aragiaanne-Hrestos[5] reported that N 180 kg/ha was optimum for maize. Singh *et al.* [12] also reported that application of N 200 kg/ha increased grain yield of maize. However, a substantial percentage of applied nitrogen is lost due to volatilization, leaching, denitrification ect. Therefore, nitrogen should be applied in such a way that would maximize its utilization for grain production. Many investigators found that N application increased grain yield and its components of maize. Samira *et al.* [10] and Torbert *et al.* [16] found that yield and yield component of maize were increased by increasing the rate of applied nitrogen. El-Sheikh [3] reported that applying N 160 kg/ha significantly increased ear characters and grain yield of maize. The purpose of the present investigation was to determine the effects of different levels of nitrogen application on yield and yield components of maize hybrids in conditions of Ardabil Plain.

Material and Methods

A split plot experiment based on randomized complete block design with three replications was conducted in 2008 at the Research Farm of Islamic Azad University, Branch of Ardabil, (lat. 38ú 5´N; long. 48ú 5´E; alt. 1350 m). Climatically, the area is placed in the semi-arid temperate zone with cold winter and hot summer. Average rainfall is about 368 mm and most rainfall is concentrated between winter and spring. The soil was loamy salty with EC about 2.34 dS/m, pH about 7.2. Before sowing of the crop the field was well prepared by plowing twice with tractor followed planking to make a fine seed bed. Treatments were arranged in a split plot design with three replicates. N levels (0, 80, 160 and 240 kg/ha) as urea were in the main plots (control = N 0 kg/ha), and maize cultivars (SC-301, DC-370 and SC-404) were allocated at random in the sub-plots. Row spacing was 75 cm and distance between plants in the rows was 13.3 cm. Plot size was 5× 3.75 m^2 with five rows per plot. Plots and blocks were separated by 1.5 m unplanted distances. The area was mold board-ploughed and disked before

planting. Corn seeds were planted in the third week of May. Two seeds were sown per hill and later thinned to one plant per hill. Thinning was done at 4-5 leaves stage. The field was immediately irrigated after planting. All other agronomic operations except those under study were kept normal and uniform for all treatments. Harvest sample was taken of 3 m long from the three middle rows for measuring grain yield. Mature plant heights of 10 random plants/plot were measured in cm as the distances from ground level to the lowest branch of the panicle. The number of kernels in 10 ears was counted after they had been shelled and divided by the number of ears. The grain of the same 10 ears mentioned above was weighed and divided by the number of ears.

The other characteristics such as number of cobs per plant, cob length, ear diameter, number of grains per ear row and the number of grain rows were determined in the center three rows of each plot according to Ulger [18]. Analysis of variance was performed using SAS computer software packages. The main effects and interactions were tested using the LSD test.

Results and Discussion

Nitrogen levels: Nitrogen levels had significant effects on grain yield, plant height, number of kernels per ear, grains per plant, number of grains per ear row, number of cobs per plant, cob length and ear diameter. Maize hybrids had different response to these characteristics and the number of grains row (Table 1).

Plant height: Nitrogen levels significantly increased the plant height in maize hybrids. Data regarding the effect of maize hybrids and different levels of nitrogen on plant height are given in Table 2. In general, the maximum plant height (204.6 cm) was obtained with the highest nitrogen levels (240 kg/ha), while the least value (181 cm) was recorded at the lowest nitrogen levels (0 kg/ha). Similar results have been reported by Samira *et al.* [10] and Sanjeev and Bangarwa [11]. Comparisons of means for maize hybrids indicated the maximum (194.2 cm) plant height was recorded for SC-504 hybrid and minimum value (179.6 cm) for SC-301 hybrid (Table 2).

Number of kernels per ear: Data regarding the effect of maize hybrids and nitrogen levels on number of kernels per ear are given in Table 2. The response of number of kernels per ear to nitrogen levels was significant (Table 1). The number of kernels per ear ranged between 488.3 and 568.9. Across nitrogen levels maximum number of kernels per ear (668) was recorded at 240 kg/ha and minimum (300.3) at 0 kg/ha. On the other hand, the number of kernels per ear increased with increasing nitrogen level. Our results concur partly with observations made by Sanjeev and Bangarwa[11], who reported that the kernel number decreased with increasing nitrogen level. Similar results have been reported by Torbert *et al*.[16]. Increase in grains cob^{-1} from higher nitrogen levels might be due to the lower competition for nutrients that allowing the plants to accumulate more biomass with higher capacity to convert more photosynthesis into sink resulting in more grains cob^{-1}. These results are also in agreement with Zeidan *et al.* [20] who concluded that grain number per cob was highest at the highest nitrogen level. The response of maize hybrids was significant to number of kernels per ear. On the other hand, mean comparisons indicated that the maximum number of kernels per ear (568.6) was recorded for SC-504 hybrids and minimum (488.2) for SC-301 hybrid. Number of kernels per ear plays an important role in determining grain yield.

The number of grains rows: Data recorded on average number of grains rows of maize hybrids is represented in Table 2. Statistical analysis of the data revealed that nitrogen levels and their interaction of cultivar × nitrogen levels were not significant. Mean comparisons indicated that maximum number of grains rows (18.6) was observed for SC-504 hybrid and minimum value (16) for DC-370 hybrid. Similar results have been reported by Roy and Biswas[9] and Tetio Kargho and Gardner [13] who reported that the number of grains rows was significantly affected by maize hybrids.

The number of grains per ear row: Data regarding the effect of maize hybrids and nitrogen levels on the number of grains per ear row are given in Table 2. The response of the number of grains per ear row to nitrogen levels was significant. Maximum number of grains per ear row (37) was recorded at 240 kg/ha and minimum (26.89) at 0 kg/ha. Mean comparisons indicated that maximum number of grains per ear row (33.5) was observed for SC-504 hybrid and minimum value (25) for DC-370 hybrid. Similar results have been reported by Tetio Kargho and Gardner [13] who reported that the number of grains per ear row of corn was significantly affected by maize hybrids.

Cob length: Nitrogen levels influenced significantly the cob length of maize hybrids (Table 1). Cob length generally decreased with decrease in nitrogen levels. Nitrogen level 240 kg ha^{1} had the longest cob and the shortest one was at 0 kg ha^{1}. Similar trend was also reported by Turgut [17]. The longest cob (167.4 mm) was produced by SC-504 hybrid and the shortest one (152.2 mm) by SC-301 hybrid. The interaction of nitrogen levels and maize hybrids did not significantly affect the cob length (Table 2).

Number of cobs plant^{-1}: Nitrogen levels and maize hybrids did not show any significant variation in respect of number of cobs plant^{-1} (Table 1). The findings are in agreement with those of

Table 1. Analysis of variance for the effects of nitrogen levels on studied traits in maize hybrids.

S.O.V	DF	MS								
		Grain yield	Plant height	No. of grains per ear row	No. of grains rows	Grains per plant	No. of kernels per ear	No. of cobs per plant	Cob length (mm)	Ear diameter (mm)
Replication	2	1.254	1093.12**	7.38	0.702	1115.32	191.68	0.082	9.26	0.0071
N levels	3	125**	876.4*	194.97*	2.9	853.63*	7129.15*	0.38	32.5*	0.52*
Error	6	20.63	981.03	95.43	3.154	156.63	21770.23	0.64	11.7	0.47
Cultivar	2	9.85**	644.2*	245.13**	12.89**	1272.47**	68210**	0.44	3.69*	0.33*
N level × cultivar	6	0.252	240.57	4.23	1.483	36.92	1261.2	0.072	0.425	0.0019
Error	16	165.0	269.29	5.72	1.827	26.19	2392.75	0.13	0.82	0.04

**, * and "s show significant differences at 0.05, 0.01 probability level and no significant, respectively.

Sanjeev and Bangarwa [11]. Bundy and Carter [2] reported that number of cobs plant^{-1} was not significantly affected by maize hybrids.

Grain yield: Grain yield is the main target of crop production. The grain yield was significantly affected by both maize hybrids and nitrogen levels. Nitrogen levels significantly increased the grain yield. The grain yield varied between 5.12 ton/ha in control treatment and 7.43 ton/ha in N 240 kg/ha treatment (Table 2). A similar trend in yield differences across nitrogen levels have been reported by Zeidan *et al.* [20] and Lawrence *et al.* [8]. Bundy and Carter [2] and Sanjeev and Bangarwa [11] reported that grain yield increased with increasing nitrogen level. Our findings are in agreement with observations made by many researchers [8, 14]. Maximum grain yield (7.05 ton /ha) was produced by SC-504 hybrid while minimum (6.58 ton/ha) by SC-301 hybrid. Interaction effects of nitrogen level and maize cultivar indicated that at each cultivar by adding nitrogen from 0 to 240 kg/ha, grain yield significantly increased (Fig. 1).

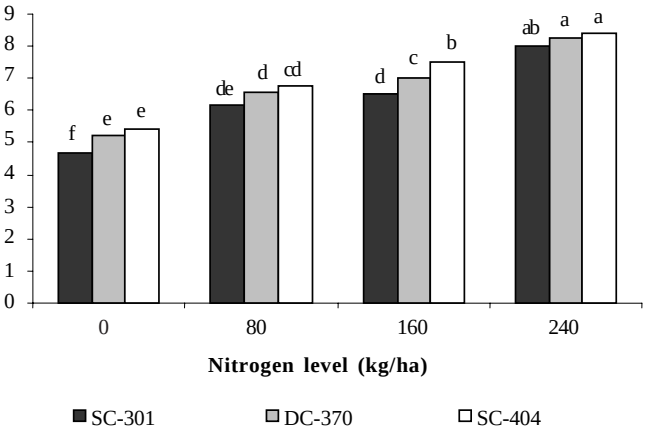

Figure 1. Mean comparison of interaction of various levels of nitrogen fertilizer on grain yield of maize cultivars.

Table 2. Means for yield components of maize hybrids at different densities.

Treatment	Grain yield (ton/ha)	Plant height (cm)	No. of grains per ear row	No. of grains rows	Grains per plant(g)	No.of kernels per ear	No.of cobs per plant	Cob length (mm)	Ear diameter (mm)
N (kg/ha)									
0	5.12 c	181.0 c	26.89 c	-	76.0 d	300.3 d	1.00 a	147.0 d	38.0 c
80	6.46 b	196.0 c	28.5 bc	-	95.0 c	506 c	1.01 a	153.0 c	40.0 b
160	7.43 a	199.8 b	31.16 b	-	105.2 b	665.2 b	1.00 a	160.1 b	42.2 ab
240	7.76 a	204.6 a	37.00 a	-	107.0 a	668 a	1.02 a	167.2 a	44.5 a
Maize hybrids									
SC-404	7.05 a	194.2 a	33.50 a	18.6 a	98.66 a	568.6 a	1.01 a	167.4 a	35.0 a
DC-370	6.91 b	188.2 b	29.27 b	16.0 b	93.95 b	528.6 b	1.00 a	158.0 b	31.2 b
SC-301	6.58 b	179.6 c	25.00 c	16.5 b	89.4 c	488.2 c	1.03 a	152.2 c	27.0 c

Values followed by the same letters are not significantly different at 1% level.

Ear diameter: Maize hybrids and nitrogen levels significantly affected ear diameter. Maximum ear diameter (35 mm) was recorded by SC-504 hybrid and minimum (27 mm) by SC-301 hybrid. Gozubenli *et al.* [4] and Konuskan[7] indicated that ear diameter was affected by genotypes. Ear diameter increased with the increasing nitrogen levels. The thickest ears (44.5 mm) were obtained at 240 kg/ha with and the thinnest ones (38 mm) at 0 kg/ha (Table 2). Torbert *et al.* [16] and Singh *et al.* [12] reported nitrogen levels affected ear diameter and thinner ears were obtained at high nitrogen level.

Conclusions

In this experiment, nitrogen levels showed significant effects on maize hybrid yield and its attributes. The highest grain yield was recorded at N 240 kg/ha. In conclusion, it can be suggested that SC-504 hybrid should be applied with N 240 kg/ha in conditions of Ardabil Plain.

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