



Evaluation of Different Levels of Nitrogen Fertilizer on Agronomic Traits of Corn (*Zea mays* L.) Genotypes

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RESEARCH ARTICLE

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ABSTRACT

Corn production management including nitrogen consumption will be different at different circumstances. In order to investigate the effect of different levels of nitrogen fertilizer on yield and yield components of seed corn hybrids in Khuzestan weather conditions, this research was carried out in the summer of 2013 in the lands of Safi Abad Agriculture and Natural Resources Research Center Dezful (Seed Control and Certificate Unit) in Northern Khuzestan Province. The experiment was conducted as the split plot in the form of randomized complete block design with three replications. The main factor included two levels of seed corn hybrids (S.C. 704 and Karun) and the sub plot included four levels of nitrogen fertilizer consumption (200, 300, 400, and 500 kg.ha⁻¹). The results showed that there was a significant difference between the hybrids just in terms of the number of seeds per row and biological yield. The difference between different levels of nitrogen consumption was significant in terms of seed yield, biological yield, 1000-seed weight, number of seeds per row, and harvest index. The interactive effects of treatments on the studied traits were not significant. According to the results of the research, consumption of 500 kg.ha⁻¹ nitrogen and the use of S.C 704 hybrid is highly recommended to achieve maximum yield.

Keywords: *Harvest index, Maize, Seed Yield, Urea.*

INTRODUCTION

Gramineae are one of the most important sources of human food supply that need the highest need to chemical fertilizers (Zahir *et al.*, 1989). Corn is a four-carbon plant from the seed family which is the third most important food crop in the world after wheat and rice and which is the main food of millions of people. It is one of the most important crops cultivated in 700000 hectares of the lands in Iran and allocates the production of 2.8% of the total seeds to itself. Among seeds, corn due to high genetic diversity, easier method of planting, growing, and harvesting, palatability, controlling erosion and weeds, expecting less soil nutrients, having high sugar and starch in comparison to other crops is particularly important although the corn yield in most arid and semiarid areas of Iran is low due to low amount of soil organic matters and lack of nitrogen. This problem should be resolved by nitrogen fertilizers, but unfortunately such fertilizers are not used effectively and their efficiency is low (Malakoti and Nafisi, 1992). Khuzestan is one of the most important provinces in Iran, which has very hot and sunny summers due to specific climatic conditions. One of the crops widely cultivated in this province in recent years is corn. However, despite the availability of suitable climatic conditions in this province, corn production in Khuzestan is not more than that of other provinces. Among various types of management that can be used to enhance crop per area unit, supplying sufficient nutrients for crops in a proper way is highly significant among which nitrogen has a special stand. According to the wide studies conducted on the management and consumption of chemical fertilizers, particularly nitrogen, it can be concluded that timely and sufficient distribution of nitrogen can significantly in-

crease the yield and improve the efficiency of nitrogen. Timely distribution of nitrogen when the plant greatly needs it improves the yield and efficiency of nitrogen (Ghahraman and Sepaskhah, 1998). Like developed countries, the corn varieties planted in Iran are hybrids. Therefore, introducing new hybrids with decent properties is an important issue in corn planting management in hot and arid climates because in case of delay in planting, the farmer is able to choose proper hybrids that match the time. Moreover, due to differences between corn hybrids in terms of resistance to other probable stresses, the wider the hybrid selection options for the farmer is, the better hybrids can be selected by the farmer in proportion with his farm conditions. Therefore, introducing and planting appropriate hybrids of corn can not only solve the above problem but also prevent damage to farmers and loss of production in country. This research was conducted to investigate the effect of application of different levels of nitrogen fertilizer on yield and yield components of seed corn hybrids.

MATERIALS AND METHODS

Field and Treatment Information

This research was carried out to investigate the effect of different levels of nitrogen fertilizer on yield of Corn hybrids (SC. 704 and Karun 701) in Safi Abad Research Center in Dezful in the summer of 2013. The experiment was carried out as split plot in the form of randomized complete block design (RCBD) with three replications. The main factor included two levels of seed corn hybrids (H1: 704 hybrid and H2: Karun hybrid) and the sub factor included four levels of nitrogen fertilizer ($N_1=200$, $N_2=300$, $N_3=400$, $N_4=500$ kg/ha). The chemical fertilizer of urea was used as the source of nitrogen.

Crop Management

In order to prepare the land, it was first irrigated and after leveling, it was plowed at the depth of 30 cm by the plowshare and in order to crush the hunks resulting from plowing, it was disked twice or three times. A few days after the disk, the land was stroked by the loader as left and right and corner-to-corner. Then, base fertilizers were added to the land including urea (25% of the total amount each treatment + 25% at the 5-leaf stage + 25% of in the soil break Crust + at the reproductive stage), the ammonium phosphate (100 kg.ha⁻¹ all as base) and potassium sulfate (150 kg/ha all as base) as fertilizing recommendation and according to the soil test. Afterward, the final disk was applied to bury the chemical fertilizers. Then, the streams were made by the furrower. The distance between the stacks and the streams in this study was 75 cm. After that, the rows were made by the furrower with the distance of 75 cm from each other. There were 24 plots, each sub plot containing 5 planting rows as long as 5 m. the distance between every two sub plots was 1.5 m and the distance between every two main plots was 3 m and the distance between two blocks was 2 m. after thorough preparation of the land, the seeds of corn hybrids were planted manually and as piles (3 seeds in each pile at a distance of 17 cm from each other). In order to prevent the interference and contamination of chemical fertilizers, two non-planting lines were considered between sub plots and the additional water was removed from each plot by a stream. Irrigation was done immediately after planting. In order to fight the weeds, selective pesticides (2.4. D) were used and for the margins and furrows, the non-selective pesticide (Parquet) was used. No measures were taken to fight pests and diseases. The

entire farm note taking was done during the growing stage. The first irrigation was done concurrent with planting date and the next irrigations were done every three or four days and after the plant establishment every seven to ten days until the end of growth season as leaving the stream and stack.

Traits measure

Given the different physiological maturity of the plots, the final harvest was done on November 16, 2013. 10 plants were taken from the middle planting lines of each plot and after packing and labeling the harvested plants, they were carried to the laboratory to examine the desired traits. The studied traits included seed and biological yield, harvest index, 1000-seed weight, number of ears per area unit, number of seeds per row and number of rows per ear.

Statistical analysis

SAS software was used for analysis of variance of the data and Duncan's multi range test was used to compare the means at 5% probability level.

RESULTS AND DISCUSSION

Number of ears per area unit

The difference between hybrids in terms of the number of ears per area unit was not significant. Different levels of nitrogen fertilizer or the interactive effect of the treatments did not affect this trait (Table 1). The results were not consistent with the findings of Rozati *et al.*, (2011) who stated that greater number of ears per area unit was produced as the nitrogen consumption increased.

Number of seed rows per ear

According to obtained results number of rows per ear was not affected by the difference between hybrids, different levels of nitrogen fertilizer, or interaction effect of treatments (Table 1).

Table 1. The ANOVA results effect of nitrogen and hybrid on measured traits

S.O.V	df	Number of ears per area unit	Number of seed rows per ear	Number of seeds per row	1000-seed weight	Seed yield	Biological yield	Harvest index
Replication	3	0.622	0.50	4.29	300.12	954734.88	18026.8	55.4
Hybrid (H)	1	4.34 ^{ns}	4.16 ^{ns}	13.5 ^{**}	5046 ^{ns}	33544.65 ^{ns}	70265.2 [*]	762.4 ^{ns}
Error I	2	3.03	1.16	0.12	885.12	71757.17	29651.8	240.95
Nitrogen (N)	3	4.90 ^{ns}	1.05 ^{ns}	11.88 [*]	3547.72 ^{**}	26708.69 ^{**}	40295.4 ^{**}	185.64 [*]
H × N	3	4.01 ^{ns}	0.61 ^{ns}	5.61 ^{ns}	77.55 ^{ns}	15612.49 ^{ns}	23590.8 ^{ns}	28.20 ^{ns}
Error II	12	1.64	0.833	2.04	194.18	13453	15237.7	46.32
CV	-	14.4	6.18	7.45	4.86	15.68	7.03	16.39

^{ns, *, **}: non difference, significant difference at 5% and 1% probability level, respectively.

The results showed that Karun hybrid produced greater number of rows per ear (15.6). Although the difference between different levels of the nitrogen was not significant, the highest number of rows per ear belonged to the treatment with consumption of 500 kg.ha⁻¹ nitrogen which was not significantly different from S.C 704 hybrids by 14.33 rows per ear (Table 2). Since the number of rows per ear is a heritable trait, it can be said that these hybrids genetically have the same potential for producing the number of rows per ear and are not significantly different from each other. The mentioned results were consistent with the findings of Moser *et al.*, (2006).

Number of seeds per row

The difference between hybrids and the effect of nitrogen fertilizer on the number of seeds per rows were significant (Table 1). The highest number of seeds per row belonged to Karun hybrid by 19.91 seeds per row and the lowest number of seeds per row belonged to 704 hybrid by 18.41 (Table 2). This reflects the higher potential of Karun hybrid in the absorption of nutrients and the use of growing space and nutrients compared with 704 hybrid. The results showed that the highest and the lowest number of seeds per row belonged to the treatments with consumption of 500 and 200 kg.ha⁻¹ nitrogen by 21 and 17.83 seeds per row, respectively.

Table 2. Mean comparison effect of different levels of nitrogen and hybrid on studied traits

Treatments	Number of ears per area unit	Number of seed rows per ear	Number of seeds per row	1000-seed weight (g)	Seed yield (Kg.ha ⁻¹)	Biological yield (Kg.ha ⁻¹)	Harvest index (%)
Hybrid							
SC.704	8.47 ^{*a}	14.33 ^a	18.41 ^b	271.75 ^a	6211.3 ^a	17016.6 ^b	47.15 ^a
Karun	9.32 ^a	15.16 ^a	19.91 ^a	300.75 ^a	8575.8 ^a	18098.8 ^a	35.88 ^a
Nitrogen levels (Kg.ha⁻¹)							
200	8.15 ^a	14.66 ^a	17.83 ^b	261.33 ^b	5673 ^b	15100.5 ^b	37.2 ^b
300	8.96 ^a	14.33 ^a	18.33 ^b	275.67 ^{ab}	6606 ^{ab}	16347.2 ^b	40.34 ^{ab}
400	8.33 ^a	14.66 ^a	19.5a ^b	289.67 ^{ab}	6828 ^{ab}	17671.2 ^{ab}	38.90 ^b
500	10.15 ^a	15.33 ^a	21.0 ^a	318.33 ^a	10468 ^a	2111.8 ^a	49.64 ^a

*According to Duncan test, the means of treatments with similar letters are not significantly different at 5% level.

Nitrogen has caused the increase of the number of seeds per row possibly by affecting flowers productivity in each ear and increasing the number of seeds and thus has increased the production of seeds per ear in some treatments and the rate of baldness in produced ears was lower than the other treatments (Table 2). The interactive effect of the treatments on this trait was not significant (Table 1). Hamidi *et al.*, (2000) examined corn hybrids and stated that difference between the hybrids in terms of the number of seed rows was significant (Table 1).

1000-Seed weight

According to the obtained results, 1000-seed weight was affected by different levels of nitrogen fertilizer at 1% probability level, but the effect of different hybrids and the interaction effect of the treatments on this trait were not significant (Table 1). The results showed that the Karun hybrid produced the highest weight of 1000-seed by 300.75 gr although it was not significantly different from 704 hybrid in terms of 1000-seed weight. Accordingly, it can be said that Karun hybrid through the optimal use of the environmental and nutritional conditions has been able to mobilize more assimilates into seeds and increase 1000-seed weight. The results also showed that the highest and the lowest 1000-seed weight by 318.33 g and 261.33 g respectively, belonged to the treatments with consumption of 500 and 200 kg.ha⁻¹ nitrogen (Table 2). Noori Azhar and Ehsan Zadeh (2007) stated in a report that the difference between the hybrids (704, 700, 647, 604, 301) was significant in terms of 1000-seed weight at 5% probability level and 1000-seed weight was high in hybrids with the low number of seeds.

Seed yield

According to the results, seed yield was not affected by hybrids and the interactive effect of the treatments, but the effect of different levels of nitrogen fertilizer on seed yield was significant at 1% probability level (Table 1). Among different levels of nitrogen fertilizer, the highest and the lowest seed yield by 10468 kg.ha⁻¹ and 5673 kg.ha⁻¹ respectively belonged to the treatments with consumption of 500 and 200 kg.ha⁻¹ nitrogen (Table 2). Several studies have approved of the positive effect of nitrogen on the increase of seed yield, number of seeds per ear, and 1000-seed weight in different corn hybrids (Osborne *et al.*, 2002; Uhart and Andrade, 1995). Evans (1997) believes that number of seeds is one of the main components of seed yield and nitrogen fertilizer has a positive effect on the number of seeds. According to Ziaeeian and Malakooti (2001), in order to achieve the yield of 8-9 tons of seed per hectare, the use of 200-250 kg.ha⁻¹ nitrogen equal to 400-500 kg/ha urea is recommended.

Biological yield

Unlike the interactive effect of treatments, the difference between hybrids and different levels of nitrogen fertilizer had a significant effect on biological yield (Table 1). Comparison of the means showed that the highest and the lowest biological yield by 18098.8 and 17016.6 kg.ha⁻¹ respectively belonged to Karun hybrid and 704 hybrid. Mean comparison of the simple effects of different levels of nitrogen fertilizer showed that the highest and the lowest biological yield by 21111.8 kg.ha⁻¹ and 15100.5 kg.ha⁻¹ respectively belonged to the treatments with consumption of 500 and 200 kg.ha⁻¹ nitrogen (Table 2).

The results indicate greater potential of Karun hybrid to absorb nutrients in comparison to 704 hybrid. Moreover, Karun hybrid is morphologically bigger than 704 hybrid and is able to make the maximum use of current situation in terms of nutritional space and weather conditions and produce more dry matter. Majdian and Ghadiri (2002a) reported that the increase of nitrogen fertilizer would lead to the increase of biological yield via improving traits such as ear length and ear diameter. A shortage of nitrogen or inhibiting the growth of shoots can have a negative effect on production factors (Noor Mohammadi *et al.*, 2001).

Harvest Index

Harvest index was not affected by the hybrids and the interactive effects of the treatments, but the effect of different

levels of nitrogen fertilizer on harvest index was significant at 5% probability level (Table 1). Since there was no significant difference between the hybrids in terms of seed yield and biological yield, the harvest index is also expected not to be affected by the treatment. The mean comparison results of the simple effects of different levels of nitrogen fertilizer on harvest index showed that the highest harvest index by 49.64% belonged to the treatment with consumption of 500 kg.ha⁻¹ nitrogen fertilizer and the lowest harvest index by 37.2% belonged to the treatment with consumption of 200 kg.ha⁻¹ nitrogen fertilizer (Table 2). According to Sadeghi (2010) the effect of nitrogen application on the increase of harvest index was positive.

Table 3. Mean comparison of the interactive effects of nitrogen and hybrid on studied traits

Treatments	Number of ears per area unit	Number of seed rows per ear	Number of seeds per row	1000-seed weight (g)	Seed yield (Kg.ha ⁻¹)	Biological yield (Kg.ha ⁻¹)	Harvest index (%)	
S.C.704	200 (Kg.ha ⁻¹)	7.27 ^b	14.67 ^a	21.67 ^b	284.7 ^b	6877 ^c	16072 ^b	42.67 ^b
	300 (Kg.ha ⁻¹)	8.13 ^{ab}	14.00 ^a	21.67 ^b	289.3 ^b	7333 ^b	16909 ^{ab}	42.33 ^b
	400 (Kg.ha ⁻¹)	9.13 ^a	14.67 ^a	18.67 ^c	329.7 ^a	7907 ^b	16906 ^{ab}	46.00 ^{ab}
	500 (Kg.ha ⁻¹)	9.37 ^a	14.00 ^a	23.00 ^a	289.7 ^b	9228 ^a	18683 ^a	49.00 ^a
Karun	200 (Kg.ha ⁻¹)	8.53 ^a	14.75 ^a	20.71 ^a	307.97 ^b	7701 ^{ab}	17378 ^b	44.37 ^a
	300 (Kg.ha ⁻¹)	8.94 ^a	14.58 ^a	21.79 ^a	309.05 ^b	7937 ^b	18068 ^{ab}	43.66 ^a
	400 (Kg.ha ⁻¹)	8.62 ^a	14.92 ^a	20.38 ^a	314.47 ^a	7668 ^{ab}	17416 ^b	44.70 ^a
	500 (Kg.ha ⁻¹)	9.12 ^a	14.58 ^a	21.63 ^a	315.22 ^a	8458 ^a	18545 ^a	45.54 ^a

*According to Duncan test, the means of treatments with similar letters are not significantly different at 5% level.

However some reports about the lack of the effect of different levels of nitrogen fertilizer on harvest index (Rashidi, 2005; Qasemi Pir Balooti, 2002; Majdian and Ghadiri, 2002 b).

Correlation between traits

The correlation results of experiment are displayed in Table 4. There is a positive and significant correlation between 1000-seed weight and seed yield

at 1% probability level, because this component is one of the most important factors and traits affecting economic yield and if the conditions are provided for storing nutrients after the formation, it can have a significant effect on seed yield. Moreover, there is a positive correlation between seed yield and the number of rows per ear. However, since this trait is more affected by genetic factors, it had a lower correlation coefficient than 1000-seed weight. There is also a positive correlation between the number of seeds per row and seed yield. As the number of seeds is one of the most important factors affecting the seed yield, attempts to improve it can influence the seed yield. The number of ears per area unit is also one of the factors affecting the seed yield and its increase or decrease can affect the yield per area unit. Correlation analysis

showed a high and positive correlation between this trait and seed yield. There is also a high correlation between harvest index and biological yield, which could be due to the increase of photosynthetic sources resulting from the increase of biological yield.

CONCLUSION

There is a positive and significant correlation between biological yield and 1000-seed weight. The emergence of more leaves particularly after the seed formation had a great effect on the weight of seeds. Therefore, the weight of seeds can be expected to increase due to the increase of biological yield. According to the results of the research, consumption of 500 kg.ha⁻¹ nitrogen and the use of 704 hybrid is highly recommended to achieve maximum yield.

Table 4. Correlation coefficients between measured traits

Traits	Seed yield	1000-seed weight	Number of rows per ear	Number of seeds per row	Number of ears per area unit	Harvest index
1000-seed weight	0.83921**	-	-	-	-	-
Number of rows per ear	0.47522*	0.41032*	-	-	-	-
Number of seeds per row	0.63726**	0.53799**	0.23268 ^{ns}	-	-	-
Number of ears per area unit	0.81376**	0.54239**	0.12747 ^{ns}	0.26567 ^{ns}	-	-
Harvest index	0.90508**	0.63823**	0.44524*	0.64378**	0.79305**	-
Biological yield	0.72742**	0.84098**	0.30001 ^{ns}	0.42486*	0.50524*	0.38413 ^{ns}

^{ns}, *, **: non difference, significant difference at 5% and 1% probability level, respectively.

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