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EFFECTS OF NITROGEN FERTILIZER AND PLANT DENSITY MANAGEMENT IN CORN FARMING

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ABSTRACT

In order to study the effect of nitrogen fertilizer and row spacing in yield and yield components of corn, an experiment in split plot format based on randomized complete block design with three replicates in Lahijan Township (north of Iran), during 2010 was conducted. Experiment was carried out by applying 4 levels of pure nitrogen as main plots consist of (n_1: 50, n_2: 100, n_3: 150 and n_4: 200 kg/ha pure nitrogen from source of urea (46 % pure N) chemical fertilizer) and 3 row spacing levels as sub plots (r_1:30, r_2:40 and r_3:50 cm). In maturity time, grain yield, straw yield, harvest index, plant height, ear length, number of ears per plant, number of rows per ear and 1000 grain weight was measured. Results showed that the effect of nitrogen fertilizer on grain yield, straw yield, harvest index, plant height, number of ear per plant and 1000 grain weight in 1 % and on ear length in 5 % probability level was significant. But on number of rows per ear was non significant. Effect of row spacing on straw yield, harvest index and number of ears per plant in 1% and on grain yield and 1000 grain weight in 5 % was significant. But on plant height, ear length and number of rows per ear was non significant. Interaction effect of nitrogen and row spacing on grain yield, straw yield, harvest index, ear length, number of rows per ear and 1000 grain weight 1n 1 % and on plant height in 5 % was significant. But on number of ears per plant was non significant. Between nitrogen treatments, use of 200 kg/ha pure nitrogen (n_4) resulted highest grain yield with 10.53 t/ha. Among row spacing levels, the highest grain yield was obtained by 40 cm row spacing (r_2) with 6.15 t/ha. Also, between interaction effect levels the n_4r_2 (200 kg/ha pure nitrogen along with 40 cm row spacing) with 11.65 t/ha was recorded the highest grain yield.

Keywords: corn farming, nitrogen fertilizer, row spacing, yield and yield components, Iran.

INTRODUCTION

Corn (*Zea mays* L.) is one of the important cereal crops in the world and Iran after wheat and rice (Gerpacio and Pingali, 2007). Nitrogen is required by plants in comparatively larger amounts than other elements (Marschner., H. 1995). Nitrogen deficiency generally results in stunted growth and chlorotic leaves caused by poor assimilate formation that leads to premature flowering and shortening of the growth cycle. The presence of N in excess promotes development of the above ground organs with abundant dark green (high chlorophyll) tissues of soft consistency and relatively poor root growth. This increases the risk of lodging and reduces the plants resistance to harsh climatic conditions and to foliar diseases (Lincoln and Edvardo, 2006). Nitrogen (N) fertilizer use has played a significant role in increase of crop yield (Modhej *et al*., 2008). Yield reduction in corn due to nitrogen deficiency is more than of other elements deficiency (mohammadi *et al*., 2008). Uhart and Andrade (1995) were found that nitrogen deficiency decreases grain weight and grain yield of corn respectively 9-25 % and 14-80 % than to control treatment. Alizade *et al*., (2007) was found that the highest grain yield, biological yield, grain weight, number of grains per ear, number of grains per row, and harvest index was obtained by 450 kg/ha nitrogen fertilizer consumption in corn. Jalali *et al*., (2010) with perform tow experiment in tow years about effect of nitrogen fertilizer and organic matters on yield and yield components of corn was recorded that, the highest grain yield, number of grains per ear, 1000 grain weight and harvest index resulting from 250 kg/ha urea fertilizer. Improved cultural practices can play an important role in augmenting yield of corn crop. For an optimal yield, the nitrogen supply must be available according to the needs of the plant. On the other hand, Suitable plants densities for optimum leaf growth by controlling water, fertilizer and chemical inputs is essential for improving the growth variables responsible for high yield. Optimum plant densities ensure the plants to grow properly both in their aerial and underground parts through different utilization of solar radiation and nutrients. When the plant density exceeds an optimum level, competition among plants for light above ground or for nutrients below the ground become severe, consequently the plant growth slows down and the grain yield decreases (Hasanuzzaman *et al*., 2009). Yield can be increased with increased plant density up to a maximum for some corn genotypes grown under a set of particular environmental management conditions and declines when plant density is increased further (Tollenaar *et al*., 1994). Sezer and Yanbeyi (1997) demonstrated that ear characteristics were negatively affected by increases in plant densities, although plant height, ear height and grain yield increased with increases in plant densities. Tian *et al*., (2004) with study effect of plant density on two cultivars of pop corn were recorded that maximum yield was obtained from 52500 Pl/ha. Tahmasbi and Rashed Mohasel (2009) were showed that increase plant density significantly cause to grain yield growth and highest grain

yield was recorded from 85000 Pl/ha with 11.13 to/ha. Mohammadian Roshan *et al*. (2010) with study effect of different nitrogen fertilizer levels and plant density on yield and yield components of corn cultivar SC704, showed that using of 100 kg/ha urea fertilizer in 35 cm row spacing obtained the highest grain yield, 1000 grain weight, ear length, number of grains per ear, number of grain per rows and plant height. Saadat *et al.* (2010) with study effect of three plant density included 40000, 80000 and 120000 pl/ha on six hybrid corn cultivars included 704, 504, 666, Maxima, Zola and Jeta was showed that the highest number of rows per ear and number of grains per ear was found from 704 cultivar in 40000 pl/ha. The aim of this experiment was to study the effect of different amounts of nitrogen fertilizer under different row spacing levels on yield and yield components of corn and determine the optimum nitrogen fertilizer dose and plant density for introduce to farmers.

MATERIALS AND METHODS

The experiment was conducted in split plot format based on randomized complete block design (RCBD) with three replicates during the farming year of 2010 in Lahijan Township bested on Guilan province (north of Iran) with 37°11' N latitude and 50°0' E longitude and 20 m above sea level. The climate of the area is mild and Mediterranean. The experiment was carried out by applying 4 levels of pure nitrogen as main plots consist of (n_1: 50, n_2: 100, n_3: 150 and n_4: 200 kg/ha pure nitrogen from source of urea (46% pure N) chemical fertilizer) and 3 row spacing levels as sub plots (r_1:30, r_2:40 and r_3:50 cm). For study effect of different nitrogen fertilizer amounts and various row spacing on yield and yield components of corn cultivar SC704. Soil texture was loam clay and pH 7.1. The results of soil analysis are shown in Table-1.

Table-1. Some physical and chemical properties of experimental filed soil.

Depth	0-30cm	Soil texture	Loam clay
Clay (%)	46.58	pH	7.1
Silt (%)	29.97	Total nitrogen (%)	0.193
Sand (%)	23.45	P (ppm)	9.1
E.C. (mmhos/cm)	1.31	K (ppm)	197

The seeds were sown on 10th of May. All options consist of weeding, fighting with pests and diseases up to harvest stage have been done. In maturity time, grain yield, straw yield, harvest index, plant height, ear length, number of ears per plant, number of rows per ear and 1000 grain weight was measured. The data was analyzed using MSTATC software. The SPSS software was used for correlation calculate. The Duncan's multiple range tests (DMRT) was used to compare the means at 5% of significant.

RESULTS AND DISCUSSIONS

Effect of nitrogen fertilizer

With attention to variance analysis table (Table-2), the effect of nitrogen fertilizer on grain yield, straw yield, harvest index, plant height, number of ear per plant and 1000 grain weight in 1 % and on ear length in 5 % probability level was significant. On the other hand, effect of nitrogen fertilizer treatments on number of rows per ear was non significant. Comparison of mean between nitrogen levels show that (Table-3), the highest grain yield with 10.53 t/ha, straw yield with 16.65 t/ha, harvest index with 38.88%, length of ear with 15.69 cm, number of ear per plant with 2.05 and 1000 grain weight with 254.44 g was obtained by use of 200 kg/ha pure nitrogen (n_4). The n_3 level (150 kg/ha pure nitrogen) with 34.71% harvest index and 13.93 cm ear length and 242.22 g 1000 grain weight was placed in same statistically level with n_4 treatment. On the other hand, the highest plant height was found from n_3 treatment with 200.4 cm. n_1 treatment (50 kg/ha pure nitrogen), was recorded the lowest amounts of grain yield, straw yield, harvest index, plant height, ear length, number of ears per plant and 1000 grain weight respectively with 2.14 t/ha, 11.61 t/ha, 16.22 %, 143.9 cm, 10.17 cm, 1.20 and 204.44 g. Similar results were obtained by Girardin *et al.* (1987) Nagy (1997) and Özkan (2007).

Effect of row spacing

Results of variation analysis show that (Table-2), the effect of row spacing on straw yield, harvest index and number of ear per plant in 1 % and on grain yield and 1000 grain weight in 5 % was significant. Effect of row spacing on plant height, ear length and number of rows per ear was non significant. Comparison of mean between row spacing levels show that (Table-3), the highest grain yield and 1000 grain weight respectively with 6.15 t/ha and 240.8 g was found from 40 cm row spacing (r_2). Maximum straw yield was recorded from 30 cm row spacing (r_1) with 16.87 t/ha. The r_3 level (50 cm row spacing); with 31.33 % harvest index and 1.93 ears per plant was recorded highest amounts of this traits. The lowest grain yield with 5.40 and harvest index with 22.12 % was recorded by r_1 (30 cm row spacing) level. The lowest straw yield and 1000 grain weight respectively with 10.77 t/ha and 220 g was found from r_3 level. Minimum number of ears per plant with 1.30 ears was recorded from r_2 level (40 cm row spacing). Similar results were obtained by Andrade *et al.* (1993), Tollenaar and Aguidera (1992) and Lack *et al.* (2006).

Interaction effects

The interaction effects of nitrogen fertilizer and row spacing on grain yield, straw yield, harvest index, ear length, number of rows per ear and 1000 grain weight in 1% and on Plant height in 5% probability level was significant. Also, on number of ear per plant was non significant (Table-2). Comparison of mean between interaction effects levels show that (Table-3), The highest grain yield, harvest index and plant height was obtained by

n_4r_2 (200 kg/ha pure nitrogen along with 40 cm row spacing) treatment respectively with 11.65 t/ha, 43.67% and 208.6 cm. Maximum number of rows per ear and ear length was found from n_4r_3 (200 kg/ha pure nitrogen along with 50 cm row spacing) treatment respectively with 16.96 and 16.12 cm. the highest 1000 grain weight similarly with 270 g was recorded by n_4r_1 (200 kg/ha pure nitrogen along with 30 cm row spacing) and n_3r_2 (150 kg/ha pure nitrogen along with 40 cm row spacing). Maximum straw yield with 15.83 t/ha was found from n_1r_1 (50 kg/ha pure nitrogen along with 30 cm row spacing). The lowest grain yield with 1.45 t/ha was recorded from n_1r_2 treatment. The n_1r_3 (50 kg/ha pure nitrogen along with 50 cm row spacing) and n_3r_3 (150 kg/ha pure nitrogen along with 50 cm row spacing) treatments similarly with 9 t/ha straw yield was recorded minimum amount of this trait. Also, the lowest plant height with 138.5 cm and 1000 grain weight with 163.33 g was found from n_1r_3 (50 kg/ha pure nitrogen along with 50 cm row spacing)c treatment. The n_1r_1 (50 kg/ha pure nitrogen along with 30 cm row spacing) was recorded lowest harvest index and ear length respectively with 9.26% and 9.15 cm. on the other hand the lowest number of rows per ear with 12.57 was found from n_2r_2 (100 kg/ha pure nitrogen along with 40 cm row spacing) treatment. Similar results were reported by Liang *et al*. (1992), Gökmen *et al*. (2001) and Gözübenli and Konuskan (2010).

Results of correlation and stepwise regression

The results of correlation between yield and yield components presented in Table-5. Result of correlation coefficients showed that, grain yield with number of rows per ear, number of ears per plant, harvest index, plant height and ear length had a positive and significant correlation. Also, Straw yield with number of rows per ear and on the other hand Number of rows per ear with number of ear per plant, harvest index and ear length had a positive and significant correlation. Also, Number of ears per plant with harvest index, plant height and ear length and on the other hand, Harvest index with plant height and ear length showed a positive and significant correlation.

The highest positive, direct and significant correlation coefficient (0.962^{**}) was related to correlation between grain yield with ear length. Similar results were reported by Shalygina (1990), Mohammadian Roshan *et al*. (2010) and Shoa hosseini *et al*. (2009). Obtained results for grain yield showed that, ear length had more effect in grain yield. If ear length showed with letter of X, its stepwise regression relation as following:

Y= -13900.202 + 1538.528 (X)

Table-2. Analysis of variance studied traits of corn under different levels of nitrogen fertilizer and row spacing.

Source of variance	df	Grain yield (kg/ha)	Straw yield (kg/ha)	Harvest index (%)	Plant height (cm)	Ear length (cm)	No. of ears per plant	No. of rows per ear	1000 grain weight (g)
		MS							
Replicate	2	263701.73^{ns}	3.81^{ns}	0.03^{ns}	16.7^{ns}	41.50^{*}	0.033^{ns}	1.53^{ns}	19.44^{ns}
Nitrogen (N)	3	139418662^{**}	51.13^{**}	1081.83^{**}	5936.69^{**}	58.43^{*}	1.233^{**}	11.12^{ns}	4076.85^{**}
Error (N)	6	183063.27	4.03	6.35	26.81	7.53	0.044	2.02	326.85
Row spacing (R)	2	1894808.53^{*}	130.52^{**}	279.52^{**}	41.39^{ns}	0.9^{ns}	1.177^{**}	11.13^{ns}	1169.44^{*}
N×R	6	6826591.263^{**}	5.25^{**}	56.68^{**}	333.30^{*}	1.15^{**}	0.026^{ns}	2.42^{**}	5310.18^{**}
Error (R)	16	422147.42	7.06	9.92	110.59	3.34	0.032	0.5	862.5

Ns, ** and * respectively: non significant, significant in 1% and 5% area

Table-3. Comparison of mean effect of nitrogen fertilizer and row spacing levels.

Treatments	Grain yield (t/ha)	Straw yield (t/ha)	Harvest index (%)	Plant height (cm)	Ear length (cm)	No. of ears per plant	No. of rows per ear	1000 grain weight (g)
Nitrogen								
N_1	2.14c	11.61b	16.22b	143.9c	10.17b	1.20d	13.29a	204.44b
N_2	2.86c	12.17b	20.3b	184.1b	11.09b	1.48c	13.43a	233.33a
N_3	7.26b	11.95b	34.71a	200.4a	13.93a	1.78b	13.87a	242.22a
N_4	10.53a	16.65a	38.88a	195.7ab	15.69a	2.05a	15.66a	254.44a
Row spacing								
R_1	5.40b	16.87a	22.12b	179a	12.41a	1.65b	14.3a	240a
R_2	6.15a	11.65b	29.05a	182.6a	12.82a	1.30c	13.7a	240.8a
R_3	5.55b	10.77b	31.33a	181.6a	12.93a	1.93a	14.2a	220b

Within each column, means followed by the same letter do not differ significantly at $P<0.05$

Table-4. The interaction effect of nitrogen fertilizer and row spacing levels on studied traits.

Treatments	Grain yield (t/ha)	Straw yield (t/ha)	Harvest index (%)	Plant height (cm)	Ear length (cm)	No. of rows per ear	1000 grain weight (g)
N_1R_1	1.62f	15.83a	9.26e	145b	9.150d	13.70b	260ab
N_1R_2	1.45f	10b	14e	148b	10.28cd	13.01b	190cd
N_1R_3	3.07ef	9b	24cd	138.5b	11.08 bcd	13.15b	163.33d
N_2R_1	3.69e	17.5a	17.72de	188a	10.91bcd	13.97b	180d
N_2R_2	1.90f	9.68b	18.38de	182.33a	11.14bcd	12.57b	260ab
N_2R_3	2.99ef	9.33b	25.41cd	182a	11.23bcd	13.73b	260ab
N_3R_1	7.24c	15a	29.49c	204.73a	14.30ab	14.13b	250b
N_3R_2	9.31b	11.87a	40.17ab	191.5a	14.21ab	14.63b	270a
N_3R_3	5.23d	9b	34.48abc	205.1a	13.30abc	12.93b	206.66b
N_4R_1	9.03b	19.16a	32.03bc	178a	15.30a	15.46a	270a
N_4R_2	11.65a	15.06a	43.67a	208.6a	15.66a	14.66b	243.33b
N_4R_3	10.92a	15.75a	40.94ab	200.6a	16.12a	16.96a	250b

Within each column, treatments that carry the same superscript letter are not significantly different at $P<0.05$

Table-5. Correlation of yield and yield components of corn under nitrogen fertilizer and row spacing levels.

	Grain yield	Straw yield	No. of rows per ear	No. of ears per plant	1000 grain weight	Harvest index	Plant height	Ear length
Grain yield	1							
Straw yield	0.480	1						
No. of rows per ear	0.803**	0.669*	1					
No. of ears per plant	0.610**	0.288	0.631*	1				
1000 grain weight	0.401	0.291	0.415	0.226	1			
Harvest index	0.918**	0.125	0.615*	0.658*	0.305	1		
Plant height	0.682*	0.223	0.399	0.619*	0.366	0.728**	1	
Ear length	0.962**	0.385	0.746**	0.717**	0.392	0.926**	0.735**	1

** and * respectively significant in 1% and 5%

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