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Effects of density and nitrogen fertilizer on number of ear, number of grains and grain weight in maize cultivars

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Abstract

In this study, the "Effects of density and nitrogen fertilizer on number of ear, number of grains and grain weight in maize cultivars" an experiment was carried out at Research Station of Agriculture and Natural Resources of Miandoab during 2011 and 2012. The experiment was conducted as split-plot factorial based on completely randomized block design with four replications. Cultivars hybrids included SC370 (early hybrid of corn) and SC704 (late hybrid of corn) were in main plot. The sub plots included plant densities (60000, 70000, 80000 and 90000 plants ha^{-1}) and nitrogen fertilizer (200, 300, 400 and 500 kg ha^{-1}). In this study indicated that number of grains, number of ear per square meter (ear/ m^2) and 1000-grain weight (g) of SC704 was significantly higher than SC370. It was found that increasing density significantly increased the number of ears per unit area. The increasing density decreased one thousand grain weight but The highest seed weight was observed at the highest levels of nitrogen. interaction of plant density and nitrogen effects on Number of grains per ear was significant and highest number of grains per ear obtained from the density of 70 thousand plants ha^{-1} with 500 kg N ha^{-1}.

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Introduction

Maize (*Zea mays* L.) is the world's most widely grown cereal, and it is ranked third among major cereal crops (Ayisi and Poswell, 1997). In developed countries maize is mainly grown for animal feed, industrial products such as glucose, dextrose, and starch and specialized foods (Tollenaar *et al*, 1994; Malvar *et al*., 2008).

Plant density affects yield by influencing yield components such as number of ears, number of kernels per ear, and kernel mass (Carruthers *et al*, 2000; Ahmadi *et al*., 1993). Low plant density results in unnecessary sacrifice of yield and higher density results in unnecessary sacrifice of yield and higher density also lead to unnecessary stress on the plants. Plant density is dependent on both row width and intra-row spacing, and under dry land conditions row width plays an important role in determining plant density. Intra-row spacing should not be too narrow as this can increase competition between plants and results in yield detrimentally affected. However, under optimum water and nutrient supply, high plant density can result in an increased number of cobs per unit area, with eventual increase in grain yield (Bavec and Bavec, 2002). Liu *et al* (2004) reported that maize yield differs significantly under varying plant density levels due to difference in genetic potential. ((Plant populations affect most growth parameters of maize even under optimal growth conditions and therefore it is considered a major factor determining the degree of competition between plants (Sangakkara *et al*, 2004; Fageria and Baligar, 2005). Maize plant population for maximum economic grain yield varies from 30,000 to 90,000 plants ha^{-1} depending on planting date, water availability, soil fertility and maturity (Sangoi, 2001). Improved endurance in high stands has allowed maize to intercept and use solar radiation more efficiently, contributing to the remarkable increase in grain yield potential. At low densities, many modern maize varieties do not tiller effectively and quite often produce only one ear per plant. Whereas, the use of high population increases interplant competition for light, water and nutrients, which may be detrimental to final yield because it stimulates apical dominance, induces barrenness, and ultimately decreases the number of ears produced per plant and kernels set per ear (Poorter and Garnier, 1996; Sangoi, 2001).

Nitrogen plays an essential role in the growth and development of the crop. It enhances the yield of the crop. Lack of nitrogen results in stunted growth, pale yellow color, small grain size and reduced yield. It is an essential component of amino acid and protein. The growth of plant primarily depends on nitrogen availability in soil solution and its utilization by crop plants. Jalali *et al* (2010) with perform tow experiment in two years about effect of nitrogen fertilizer and organic matters on yield component of maize was recorded that, the highest grain yield, number of grains per ear, 100 grain weight from 250 kg/ha ura fertilizer. Sanjeev *et al* (1997) reported a significant increase in grain and stover yield with the application of 240 kg N ha-1. Number of grains ear-1, 1000-seed weight, and grain weight ear-1 increased significantly with the application of 180 N ha-1 and grain yield $plant^{-1}$ with the application of 240 kg N ha-1.

Similarly, Mahmood *et al.* (2001) while studying the effects components of maize revealed that nitrogen had a significant effect on plant height, number of grains cob and 1000 grain weight. Jalali *et al* (2010) with perform tow experiment in two years about effect of nitrogen fertilizer and organic matters on yield component of maize was recorded that, the highest grain yield, number of grains per ear, 100 grain weight from 250 kg/ha ura fertilizer.

The study, therefore examined the effects of varying planting densities and nitrogen fertilizer on seed weight, number of grains and number of ear in maize cultivars.

Material and methods

In order to study the "Effects of density and nitrogen fertilizer on number of ear, number of grains and grain weight in maize cultivars" an experiment was carried out at Research Station of Agriculture and

Natural Resources of Miandoab during 2011 and 2012. The experiment was conducted as split-plot factorial based on completely randomized block design with four replications. Cultivars hybrids included SC370 (early hybrid of corn) and SC704 (late hybrid of corn) were in main plot. The sub plots included plant densities (60000, 70000, 80000 and 90000 plants ha^{-1}) and nitrogen fertilizer (200, 300, 400 and 500 kg ha^{-1}).

Number of ear per square meter (ear/ m^2)

Plants were selected in one square meter per plot; their ears were counted and recorded (Abouziena *et al*, 2007).

Number of grains per ear

Five plants were selected randomly from each plot; their grains per ear were counted, averaged and recorded (Akmal *et al*, 2010).

1000-grain weight (g)

Two samples of thousand grains were taken at random from each treatment, weighed by digital balance in the laboratory and average was recorded (Sanjeev *et al*, 1997).

Analysis of variance (ANOVA) method was applied to determine the significance of the results among different treatments and then Duncan test (Duncan's multiple range test) were evaluated. All the statistical analyses were done using the SPSS and MSTATC softwares (Poorter and Garnier, 1996).

Results and discussion

Number of ear per square meter (ear/ m^2)

Effects of cultivar, plant density, nitrogen fertilizer, interaction in cultivar and nitrogen fertilizer, interaction effect of plant density and nitrogen fertilizer and interaction effect of cultivar and plant density and nitrogen fertilizer were significant on number of ear (Tab 1). Cultivar of SC704, number of ear was significantly higher than SC370 (Tab 2). With increasing plant density is increased the number of ears per square meter. The density of 90 thousand plants ha^{-1} obtained the highest number of ears per square meter (Tab 3).

Increasing nitrogen fertilizer did not cause a significant increase in the number of ear in hybrid of SC370 but were significantly increased in the number of ear in hybrid of SC704 (Tab 5)**.** Combination of 90 thousand plants ha^{-1} and 400 kg N ha^{-1} accounted for the highest number of ears per square meter (Tab 6). Mock and Heghin (1976) and Hashemi-Dezfouli and Herbert (1992) reported a significantly higher number of ears per square meter (ear/ m^2) at higher plant density compared to lower plant density.

Number of grains per ear

Effects of cultivar, plant density, nitrogen fertilizer, interaction effect of plant density and nitrogen fertilizer were significant on number of grains per ear (Tab 1). number of grains of SC704 was significantly higher than SC370 (Tab 2).

minimum and maximum number of grains per ear obtained from the density of 90 thousand and 60 thousand plants per hectare, respectively (Tab 3). The highest number of grains were seen in combination with a density of 70 thousand plants ha^{-1} with fertilizer level of 500 kg N ha^{-1} (Tab 6).Increased to 376 kg N ha^{-1} caused a significant increase in the number of grains per ear, grain weight in maize of SC704 (Akmal *et al*, 2010).The highest number of grains per ear was obtained with the use of 180 kg N ha^{-1} (Izadi and Imam, 2010). Increasing the number of grains per ear increased fertilizer use has also been reported by other researchers (Vanderlip *et al*, 1988; Sadeghi, 2000).

1000-grain weight (g)

Effects of cultivar, plant density and interaction effect of plant density and nitrogen fertilizer were significant on 1000 - grain weight (Tab 1). Thousand grain weight of SC370 was significantly lower than SC704 (Tab 2). The increasing density decreased one thousand grain weight (Tab 3). The highest seed weight was observed at 500 kg N ha^{-1} (Tab 4). Density of 60 thousand plants ha^{-1} in each of the four levels of

nitrogen fertilizer, 1000-grain weight was higher than the other densities (Tab 6).

Reported that increasing density is significantly reduced grain weight in maize (Blumenthal *et al*, 2003). Izadi and Imam (2010) reported the interaction of plant density and nitrogen effects on grain weight was significant and highest Thousand grain weight obtained from the density of 80 thousand plants ha^{-1} with 180 kg N ha^{-1}.

Table 1. Mean square analysis variance of traits.

SV	df	ear number (ear/m²)	grain number per ear	grain weight (g)
Year	1	3 ^{ns}.0	5 ^{ns}.1505	0.74 ^{ns}
repeat × year	6	857.8	2442.2	165.8
Cultivar	1	**14716.7	*19160.9	15773.7 **
year × cultivar	1	5 ^{ns}.16	3 ^{ns}.9759	44.7^{ns}
first error	6	7.1071	2.4332	8028.6
Density	3	**350.1	*24609.9	3649.5**
year × density	3	47.5 ^{ns}	6699.5 ^{ns}	248.8 ^{ns}
density × cultivar	3	**227.2	7767.3 ^{ns}	2142.8 ^{ns}
Nitrogen	3	**207.5	*28798.4	4727.6 ^{ns}
nitrogen × Year	3	17.1 ^{ns}	16095.3 ^{ns}	480.5 ^{ns}
nitrogen× cultivar	3	451.6 *	25537.4 *	6567.5 ^{ns}
nitrogen× density	9	**523.2	10071.2^{ns}	6809.6**
nitrogen×year×cultivar	3	29.4^{ns}	7405.5 ^{ns}	225.2 ^{ns}
nitrogen×year× density	9	25.5^{ns}	6251.1 ^{ns}	262.5 ^{ns}
nitrogen×cultivar× density	9	479.9 **	7195.4 ^{ns}	11937.5 **
nitrogen×year×cultivar× density	9	27.2 ^{ns}	7195.4 ^{ns}	343.1^{ns}
second error	180	160.3	10077.3	3167.1

ns, * and ** : non significant, significant at 5% and 1% respectively**.**

Table 2. Effect of cultivar on traits.

Treatment		ear number (ear/m²)	grain number per ear	grain weight (g)
Cultivar	SC370	48.19 a	398.36 b	293.22 b
	SC704	33.03 b	453.71 a	450.21 a

Means followed by similar letters in each column are not significantly different at the 5% level of probability according to Duncan**.**

Table 3. Effect of plant density on traits.

Treatment		ear number (ear/m²)	grain number per ear	grain weight (g)
plant density (plants ha^{-1})	60000	39.23 b	95.67 a	454.9 ab
	70000	38.96 b	84.07 a	498.73 a
	80000	40.34 ab	91.92 ab	386.5 b
	90000	43.9 a	86.45 b	363.94 b

Means followed by similar letters in each column are not significantly different at the 5% level of probability according to Duncan**.**

Table 4. Effect of nitrogen fertilizer on traits.

Treatment		ear number (ear/m²)	grain number per ear	grain weight (g)
Nitrogen (kg ha⁻¹)	200	42.92 a	93.39 a	382.03 b
	300	40.76 a	92.43 ab	367.92 b
	400	40.20 a	85.29 b	515.64 a
	500	38.56 a	87 ab	438.55 a

Means followed by similar letters in each column are not significantly different at the 5% level of probability according to Duncan**.**

Table 5. Iinteraction effect of cultivar and plant nitrogen fertilizer on traits.

Cultivar	Nitrogen (kg ha⁻¹)	ear number (ear/m²)	grain number per ear	grain weight (g)
SC370	200	48.78 a	386.56 a	300.00 a
	300	46.62 a	393.38 a	289.06 a
	400	47.84 a	375.94 a	285.16 a
	500	49.53 a	473.56 a	289.66 a
SC704	200	32.75 c	370.5 a	457.28 a
	300	39.21 b	637.91 a	470.25 a
	400	29.28 c	359.91 a	443.06 a
	500	30.78 c	439.54 a	430.25 a

Means followed by similar letters in each column are not significantly different at the 5% level of probability according to Duncan.

Table 6. Iinteraction effect of plant density and nitrogen on traits**.**

plant density (plants ha⁻¹)	Nitrogen (kg ha⁻¹)	ear number (ear/m²)	grain number per ear	grain weight (g)
60000	200	39.37 be	352.0 cd	400.75 ab
	300	42.62 ad	427.2 bd	368.80 bd
	400	40.18 be	389.6 cd	382.30 bd
	500	39.43 be	377.2 cd	430.00 a
70000	200	45.62 ad	427.0 bd	378.25 bd
	300	35.43 de	469.4 cd	387.04 bd
	400	32.68 e	349.7 cd	382.00 bd
	500	42.12 ad	312.1 d	393.00 ac
80000	200	39.25 be	353.7 bd	354.50 de
	300	46.00 ab	605.9 ad	368.20 bd
	400	36.06 ce	337.7 cd	329.50 de
	500	44.06 ac	527.2 ab	329.00 e
90000	200	40.18 be	394.7 cd	361.00 ce
	300	42.62 ad	659.7 a	374.50 bd
	400	49.31 a	402.9 bd	372.60 bd
	500	39.37 be	352.0 cd	400.75 ab

Means followed by similar letters in each column are not significantly different at the 5% level of probability according to Duncan.

Conclusion

Results presented in this study indicated that number of grains, number of ear per square meter (ear/ m²) and 1000-grain weight (g) of SC704 was significantly higher than SC370. It was found that increasing density significantly increased the number of ears per unit area. The increasing density decreased one thousand grain weight but The highest seed weight was observed at the highest levels of nitrogen. interaction of plant density and nitrogen effects on

Number of grains per ear was significant and highest number of grains per ear obtained from the density of 70 thousand plants ha^{-1} with 500 kg N ha^{-1}.

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