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Effects of plant density and nitrogen levels on yield and yield components in corn

Fardad Helali[1*], Jalil Ajli[1] and Mohammad-Bagher Khorshidi[2]

1. Department of Agronomy and Plant Breeding, Mianeh branch, Islamic Azad University, Mianeh, Iran
2. East Azerbaijan agriculture and natural resources research center

Corresponding author: Fardad Helali

ABSTRACT: In the present research the effects of different levels of nitrogen fertilizer and plant density on yield and yield components in corn in field conditions was under investigation.A factorial experiment was conducted in Moghan area as a complete randomized block design with 3 replicates in year 2010. The first factor was four levels of nitrogen fertilizer (225 and 150, 75, 0) and the second factor was plant density (12, 10, and 8) p/ m^2 within 60 cm row spaces. In this study number of grains per row, number of grains per corn, 1000 grain weight and grain yield were evaluated. Results from variance analysis indicated that there were significant differences between interactional effects of nitrogen fertilizer and plant density for all traits. In fertilizing treatment of 225 kilogram nitrogen per hectare and plant density of 10 plants per square meter more yield was obtained and in fertilizing treatment of 225 kilogram nitrogen in hectare and also minimum yield in fertilizing treatment of 75 kilogram per hectare and plant density of 12 plants per square meter was observed.

***Keywords*:** Corn, Nitrogen, Plant density, Yield

INTRODUCTION

Corn belongs to Poaceae family, Zea breed, Mays species and it is a one year old plant composed of a stalk with internodes similar to other cereals but solid and without splits. The stalk height in different varieties is quite varied from 50 cm to 8 m sometimes. The average height of corn and fodder corn varies from 2.5 to 3.5 m (Khodabande, 2005). To meet the objective of preserving current food consumption for the world's population in year 2001, food production must increase to 25 percent and to fight against starvation and malnutrition, amount of food production has to increase up to 55 percent (anonymous, 2003). In order to feed the world's population agricultural production has to increase per area unit or if possible more profitable crops with shorter growing period should be used. Corn is a profitable plant with a relatively short growing period whose amount of grain yield per area unit is far more than similar plants and it can satisfy part of human need in the world. Furthermore, all plant parts (grains, leaves and stems) of corn are used to feed livestock, produce meat and milk. Other corn products can also fulfill part of human nutritional requirements directly. As a result, the significance of corn in feeding livestock and poultry, producing starch, sugar and oil and due to high yield potential (more than 15 ton per hectare) is very high and it requires more attention to be devoted to (Khajehpour, 1999).

Corn plants a member ofcereal family which is in dire need of nitrogen. Nitrogen is a dynamic nutrition and the time of its use is considerably important, if it is not provided on time, it will be out of plant's reach and it contributes to the tension caused by lack of nitrogen and production decrease and environmental pollution. Maximum nitrogen absorption by corn is the emergence of male and female organs and in development stages ofgrain it is transported from leaves to grain.Corn requires some amounts of mineral materials for its efficient yield and that these materials have to be transferred to the plant via organic and chemical fertilizers, in addition the access to the suitable plant density with the aim of obtaining desirable yield and yield increase per area unit is an inevitable matter. Therefore,

such fertilizers must be applied in certain amount and appropriate way and the number of suitable plants per area unit has to be taken into consideration in order to develop a consistent agriculture (halali, 2013).

Other researchers, who have also investigated the effect of plant density and planting arrangement on the growth of corn, reported that increased density and selection of appropriate planting arrangement of the crops enhance crop competitiveness in control of weeds. These two factors can be used as effective tools for yield increase. Through a research investigated the effect of plant density of planting arrangement in corn under competitive situation and concluded that increased corn density under the condition of presence or absence led to increased corn biomass comparing to less density (Tharp and Kells, 2001).

In this regard, the present study was to investigate the individual effects of different nitrogen fertilizer in four levels (0-75-150-225) kg/ ha and plant density in three levels (8-10-12) plant per square meter on yield and yield components in corn in this experiment which was conducted in Moghan.

MATERIALS AND METHODS

The trial was conducted in the village of QareDashlou of Moghan plain located in Ardabil Province. Moghan plain is situated in the north of Ardebil Province in the vicinity of Azerbaijan border and Aras river. Moghan plain which is a result of the alluvium of Aras river and its branches, with an average height of 100 meters is regarded as one of the most important areas of agriculture and animal husbandry in the country. To conduct this experiment at first an area of 3,500 square meters of land that was fallow the previous year, was selected. A common operation of land preparations includingfertilizing and etc. was carried out in April 2009. Fertilizer consumption amount based on the estimation of soil test was 100 kg/ ha ammonium phosphate fertilizer as a basis at the time of land preparation and was 250 kg per hectare urea fertilizer as an excess duringplant's growth. In any fertilizing period as an excess, proportion of 50 kg/ ha urea fertilizer was considered. Factorial experiment in complete randomized block design with 3 replicateswas conducted for one crop year in the plains of Moghan. For this reasonfarm land was prepared. The examined factors were as follows: nitrogen levels in four levels (zero, 75, 150 and 225 kg per ha) and density at three levels (8, 10, and 12 plants per square meter). Rows werelocated at 60 cm intervals and the space between each experimental unit was specified with a stack or separate rows and interval spacesfrom each other were considered 5.1 m. Traitsunder evaluation include: number of grains per row, number of grain rows per ear, 1000 grain weight and grain yield respectively. In order to analyze and assess data, initially the average of measured traits for 10 plants was calculated after that variance analysis of data with the advantage of SPSS-18 program and comparison of the averages using Duncan test at probability level of 5 percent was estimated. Excel software was used to plot the graphs.

RESULTS AND DISCUSSION

Results of variance analysis for studied traits in Table 1 are presented. The results indicated there was a significant difference at probability levels of 1 and 5 percent between levels ofplant density with regard to traits ofnumber of grains per row, number of grains per ear, 1000 grain weight and grain yield. Moreover, concerning nitrogen fertilizer levels, excluding number of grains per row, in the rest of the studied traits significant differences at levels 5 and 1% were observed.

Number of grains per row

Regarding levels of plant density, level 10 of plant per square meter with the average of 49.7 allocated maximum number of grains to itself and was categorized in class and levels 8 and 12 of plants per square meter, respectively, with averages of 41.1 and 42.5 had minimum number of grains per row among levels of plant density and were categorized in class b (Table 2). Number of grains per ear was a static property of the hybrid and comparing to the number of rows per ear was more affected by environmental conditions. The increase in plant density per hectare and narrowing space between rows, increases the competitiveness of the plants in corn and the decrease in corn plant competitiveness with each other causes water, light and food absorption and biomass reduction and eventually due to that yield decreases.

Number of grain rows per ear

Regarding levels of plant density, levels 10 and 12 of plants, respectively, with averages 630.98 and 570.98 allocated maximum number of grain rows per ear to itself and was categorized in class a and level of 8 plants per square meter with the average of 416.02 had the minimum number of grain rows per ear among levels of plant

density and was categorized in class b (Table 2). In other words, these results indicated the fact that the maximum number of grain rows per earn high corn density is with 225 kg nitrogen and 150 kg nitrogen and also in average density is with 225 kg nitrogen. Number of grain rows per ear is a yield component in corn and over the last 50 years 340 percent increase in corn yield increase was achieved in America benefiting from devising and application of breeding methods and advanced agricultural techniques. High yield capacity is a complicated trait which is affected by emergence of genes which are connected with food absorption; photosynthesis, breathing, transfer and corn plant metabolism and the mutual effects of these genes exist in various environments (Arzani, 2004). With respect to nitrogen fertilizer level, level 225 kg per ha with the average of 637.1 had a significant difference with others and along with level 150 kg per ha allocated maximum number of grains per ear to itself and was categorized in class and level zero (variety), with the average of 368 had the minimum grain rows per ear among fertilizer levels and was categorized in class c (Table 3).

1000 grain weight

Regarding levels of plant density, level 12 of plant per square meter with the average of 271.64 grams allocated maximum 1000 grain weight to itself and was categorized in class a and level 8 of plant per square meter with the average of 249.07 grams had the minimum 1000 grain weight among levels of plant density and was categorized in class c (Table 2). With respect to 1000grain weight, levels of 150 and 225 kg per hawith the averages of 258.58 and 261.51 grams respectively had significant differences with others and along with level of 75 kg per ha were categorized in class a and level zero (variety) with the average of 242. 41 grams allocated the minimum 1000 grain weight to it self among fertilizing levels and was categorized in class b (Table 3).

Grain yield

Regarding levels of plant density, level 12 of plant per square meter with the average of 155.10 kg per ha allocated maximum grain yield to itself and along with 10 plants per square meter was categorized in class a and level 8 of plant per square meter with the average of 103.62 kg per ha had the minimum grain yield among levels of plant density and was categorized in class b (Table 2). With respect to grain yield level of 225 kg per ha with the average of 166.61 kg per ha had a significant difference with others and along with level of 150 kg per ha were categorized in class and level zero (variety) with the average of 83. 25 kg per ha allocated the minimum grain yield to itself among fertilizing levels and was categorized in class c (Table 3). Grain yield depends on yield components; every hybrid in terms of genetic has a specific potential that is more yield potential is obtained in a good environmental condition.

Table 1. Variance analysis of the evaluated traits

S.O.V	df	Mean of Squares			
		number of grains per row	number of grain rows per ear	1000 grain weight	grain yield
Rep	2	92.36	1078.06	319.73	1104.74
density levels	2	254.69*	110181.4**	4803.68**	11742.29*
nitrogen levels	3	64.73	203345**	2449.3**	33488.29**
density levels × nitrogen levels	6	51.11	5834.22	381.39	2443.36
Error	22	56.81	2333.69	271.3	633.17
CV%		16.9	21.6	6.57	23.23

* and ** Significantly at p < 0.05 and < 0.01, respectively.

Table 2. Comparison of the average ofplant density levels

density levels	Traits							
	number of grains per row		number of grain rows per ear		1000 grain weight (gr)		grain yield (Kg/ha)	
8 plants per square meter	41.1	b	416.02	b	249.07	b	103.62	b
10 plants per square meter	49.7	a	630.98	a	231.74	c	146.22	a
12 plants per square meter	42.5	b	570.98	a	271.64	a	155.10	a

Differences between averages of each column which have common characters are not significant at probability level of 5%.

Table 3. Comparison of the average of nitrogen levels

nitrogen levels (Kg/ha)	Traits					
	number of grain rows per ear		1000 grain weight (gr)		grain yield (Kg/ha)	
0	368	c	226.22	b	83.25	c
75	545.38	b	242.41	ab	132.63	b
150	581.1	ab	258.58	a	150.26	ab
225	637.1	a	261.51	a	166.61	a

Differences between averages of each column which have common characters are not significant at probability level of 5%

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