Research Article

Planting densities and Nitrogen level impact on yield and yield component of maize

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Citation

Kashif Akhtar, Muhammad Zahir Afridi, Mansoor Akbar, Sajjad Zaheer and Shah Faisal. Planting densities and Nitrogen level impact on yield and yield component of maize. Pure and Applied Biology. Vol. 4, Issue 2, 2015, pp 217-225

Received: 19/02/2015

Revised: 07/04/2015

Accepted: 23/04/2015

Abstract

An experiment was conducted to find out “Effect of planting densities and nitrogen levels on yield and yield components of maize” at Toru Mardan, Khyber Pakhtunkhwa, Pakistan, during Kharif season 2014. The experiment was laid out in randomized complete block design with four replications. Treatments of the experiment were three plant population (46000, 56000, 66000 plants ha⁻¹) and three Nitrogen level (200, 250, 300 kg N ha⁻¹). For sowing purpose Azam variety was used and all other agronomic practices were used. The finding of study revealed that planting densities had significant influence on grain ear⁻¹, grain row⁻¹, number of rows ear⁻¹, thousand grain weight, biological yield, grain yield, and harvest index. The influence of nitrogen was found significant in all parameter. Interaction was found non-significant for all parameters. Application of 300 kg ha⁻¹ nitrogen showed higher grain ear⁻¹ (492), grain row⁻¹ (38), number of rows ear⁻¹ (17) thousand grain weight (299 g), biological yield (14861 kg ha⁻¹), grain yield (6119 kg ha⁻¹) and harvest index (41%). Planting densities of 66000 plants ha⁻¹ had more grain ear⁻¹ (475), grain row⁻¹ (37), number of rows ear⁻¹ (17), thousand grain weight (276g), biological yield (14395 kg ha⁻¹) and high grain yield (5775 kg ha⁻¹). It is concluded from the result that plant population with 66000 plants ha⁻¹ with 300 kg N ha⁻¹ produced higher grain yield of maize in the agro ecological climate of Mardan.

Keyword: Nitrogen; maize; yield and yield components

Introduction

Maize (*Zea mays* L.) is a very important cereal crop of Pakistan. It belongs to the family Poaceae. It is widely grown in temperate and tropic regions with well drained and fertile soil. Maize is the third

crop after wheat and rice. In Pakistan About 36% of maize is grown on rain-fed areas, while 64% is grown under irrigated condition. In Pakistan maize is grown on an area of 990.2(thousand) hectares with

the annual production of 3734 (metric) tons and average yield of 3839 kg ha⁻¹ while, in Khyber Pakhtunkhwa maize is cultivated on an area of about 446.9(000) hectares with a total production of 760.5 metric tons and the average yield 1751kg ha⁻¹ [1].

In Pakistan, Punjab, Sindh and Khyber Pakhtunkhwa are the main growing provinces of maize. There are two seasons of maize production; the spring season crop is sown from mid-February to the end of March and the main summer crop from June to mid-July. Mostly open pollinated maize cultivars are sown [2].

Nitrogen plays an important role in crop life, it is one of the most essential mineral nutrient needed by plants in large quantities. The application of nitrogen increase plant height, stem diameter and leaf area index of maize crop [3]. The use of nitrogen reduces the tasseling duration up to 50% and also improve tasseling and dry forage yield (Amin, 2010). The application of nitrogen fertilizer also improved the grain per ear, grain yield and biological yield of maize crop [4]. The application of nitrogen is also necessary for cob and kernel production in maize [5]. The grain yield of maize was continuously increased by increasing nitrogen rate up to 250 kg N ha⁻¹ [6]. Sufficient quantity of nitrogen improves vigorous vegetative growth and deep green color. It also increases the plumpness of grain and their protein content. Deficiency of nitrogen result stunted growth, pale yellow color, small grain size and reduce yield [7].

The 180 kg N ha⁻¹ application improve grain yield, [8]. Higher yield and better ear characters with 120kg N ha⁻¹ [9]. The rate of nitrogen up to 240 kg ha⁻¹ significantly increase grain yield The highest plant height, number of grain rows per cob, cob diameter, harvest index, biological yield, and grain yield and seed

protein with application of 300 kg N ha⁻¹. The use of N up to 350 kg ha⁻¹ increase grain yield of maize [10].

Plant population plays an important role in grain yield. If population is thick then most plant bear ears, smaller ears increase plant height become susceptible to lodging and pest attack, while in case of low planting densities yield per unit area is low because of lesser than optimum planting densities. Maize differs in its responses to plant density [11]. Higher plant population leads to lodging of maize plants.

There are a number of biotic and a biotic factors those affect maize yield however, it is more affected by variations in planting densities than other member of the grass family [12]. The biological yield increased with increase in plant density. Keeping in view the impact of nitrogen and plant population on maize yield and its components an experiment was conducted to determine the optimum level of nitrogen for higher grain yield of maize and also find out the optimum planting densities for higher yield of maize.

Materials and Methods

A field experiment entitled was conducted at village Toru District Mardan, Khyber Pakhtunkhwa, Pakistan, during kharif season 2014. The experiment was designed in randomized complete block design (RCBD) having four replications. Maize cultivar Azam from New developmental form was sown on 26th May. The plot size of 6 x 2m² with row length of 2m, width of 6m, row to row distance of 70 cm and 9 rows in each plot were maintained. Three nitrogen levels (200, 250 and 300 kg ha⁻¹) were applied at sowing time, while (20, 25, and 30 cm per plant) plant density were maintaining. Maize is adapted to wide variety of soil but to get more yields it requires fertile deep and well-drained soils. Soils with a pH range of 6.5 – 7.5 are most favorable. Well drained, heavy soils with

high organic matter content and good water holding capacity give high production. Waterlogged soil is most harmful for its cultivation.

The fertilizer NPK was applied at the rate of 120:90:60 kg ha⁻¹. Urea and DAP and SOP were used as source of nitrogen and phosphorus and potassium respectively. The irrigation about 5-6 interval were applied and 2-3 times weeding were also done. All other agronomic practices were carried out as needed.

For the control of common Broad leaf weeds & sedges Primextra Gold 720SC herbicide at 400 – 800 ml per acre after 1st irrigation in moist field is effective to control these weeds. Dual Gold at 800 ml per acre is used as pre-emergence herbicide. A hand hoeing about 25 days after sowing provides satisfactory weed Control at small scale.

The details of experimental treatment were as follow:

T1=control, T2= N1P1=200 kg N ha⁻¹ + 20cm, T3= N1P2=200 kg N ha⁻¹ +25cm

T4= N1P3=200 kg N ha⁻¹ +30cm, T5= N2P1=250 kg N ha⁻¹ +20cm

T6= N2P2=250 kg N ha⁻¹ +25cm, T7= N2P3=250 kg N ha⁻¹ +30cm

T8= N3P1=300 kg N ha⁻¹ +20cm, T9= N3P2=300 kg N ha⁻¹ +25cm

T10=N3P3=300 kg N ha⁻¹ +30cm

Note: The planting densities was maintained by plant to plant distance denoted by “P” whereas nitrogen denoted by “N”.

The data of grains ear⁻¹ was collected by counting the grains of five randomly selected cobs from each plot and was converted to grains ear⁻¹. The data of grain row⁻¹ was recorded by selecting five randomly plants from each plot counts the grains per row and then average. The data of number of rows ear⁻¹ was recorded by selecting five plants from each plot and count number of row sin each plant and

then average. Data of thousand grain weight was measure by counting thousand grains and weight with electronic balance from each plot threshed grain. The biological yield data was collected by harvesting two central rows of each plot and tied into bundles. The bundles were sun dried for ten days and then weighted by spring balance for calculating biological yield data and then will convert into kg ha⁻¹.

Finding of grain yield, cobs were collected from the sample harvested for biological yield. Threshed and grains were weighed with the help of an electronic balance and then converted into kg ha⁻¹.

$$\text{Biological yeild} = \frac{\text{Grain Yield of plot}}{\text{Biological yield of plot}} \times 10000$$

$$\text{Grain Yield} = \frac{\text{Grain Yield of plot}}{\text{R-R distance} \times \text{number of rows} \times \text{row lenght}} \times 10000$$

$$\text{Harvest Index(\%)} = \frac{\text{Grain Yield of plot}}{\text{Biological yield of plot}} \times 100$$

Data was analyzed statistically according to the procedure relevant to RCB design. Upon significant F test, least significance difference (LSD) test was used for mean comparisons [13].

Results and Discussion

Grain Ear⁻¹

Data regarding grain ear⁻¹ were showed in table 1. Statistical analysis of the data revealed that the nitrogen and Planting densities had significant effect on grain ear⁻¹ of Maize. While control vs rest were also found significant. The interaction was found non-significant. The application of 300kg ha⁻¹ Nitrogen increase grain ear⁻¹ (496), while the decrease (437) in grain ear⁻¹ was obtained when 200kg ha⁻¹ nitrogen was used. Grain ear⁻¹ was increased by decreasing Planting densities.

More (473) grain per ear⁻¹ was obtained when 46000 plants ha⁻¹ were maintained, while lower (465) grain ear⁻¹ was obtained from 66000 plants ha⁻¹. These results were also in agreement with those of [4] who obtained higher grain ear⁻¹ with higher N application. These results are similar with the finding of [14] who report that decreasing plant density increase grains ear⁻¹.

Grains row⁻¹

Data concerning grains row⁻¹ of maize were presented in Table 2. The nitrogen and planting densities were significantly affected on number of grains row⁻¹. Control vs Rest were also found significant, while the interaction had no significant effect on grains row⁻¹ maize. The Nitrogen application at the rate of 300kg ha⁻¹ had higher number of grains row⁻¹ (38) while the lower number (35) was obtained from 200 kg N ha⁻¹. Decreasing planting densities increase grains row⁻¹ of maize. Higher grain row⁻¹ (38) was obtained when 46000 plants ha⁻¹ plant population were maintained, while lower numbers (37) was obtained from 66000 plants ha⁻¹. Control vs Rest showed that grains row⁻¹ were higher in rest plot as compare to control plot. These results were similar to [14] reported that decreasing planting densities increased grain row⁻¹.

Number of rows ear⁻¹

The number of rows⁻¹ ear of maize showed in table 3. Data concerning number of rows ear⁻¹ was significantly affected by nitrogen and planting densities had. Control vs rest had also significant effect on number of rows ear⁻¹, while the interaction effect was found non-significant. Higher (18) number of rows ear⁻¹ were obtained from 300kg N ha⁻¹ while lower (16) number of rows ear⁻¹ obtained when 200 kg ha⁻¹ nitrogen were used. Decreasing plant density increase number of rows ear⁻¹. Number of rows ear⁻¹ were more (18) when 46000 plant

population were maintained and lower (16) rows ear⁻¹ obtained from 66000 plants ha⁻¹ were used. Control vs Rest showed that there was a difference in control plot and rest plot. The results are in lined with [15] reported that increased planting densities increased number of rows ear⁻¹.

1000 Grain Weight (g)

Data about thousand grain weight of maize were presented in table 4. The Nitrogen and Planting densities had remarkable effect on thousand grain weight of maize. Control Vs rest had also significant effect on maize, while the interaction found non-significant. Higher (303g) 1000 grain were obtained when 300kg N ha⁻¹ was used and lower weight (253g) was obtained from 200kg N ha⁻¹. More (278g) 1000 Grain Weight was obtained when the plant population was 46000 plants ha⁻¹, while lower (270g) was found when plant population was 56000 plants ha⁻¹. Control vs rest showed that 1000 grain weight was high in rest plot and low in control plot. These results are supported by [11] and [7] who also reported increased nitrogen levels increases thousand grain weight of maize. These results were similar to [16], who reported that increase plant density significantly decreased thousand grain weight of maize.

Biological yield (kg ha⁻¹)

Data concerning biological yield of maize were showed in table 5. Statistical analysis of the data revealed that the nitrogen and planting densities was significantly affected on biological yield of maize. Control vs rest also found significant, while interaction had non-significant effect on biological yield of maize.

Table 1. Effect of planting densities and nitrogen application on grain ear⁻¹ of maize.

Planting densities (Plants ha ⁻¹)	Nitrogen (kg ha ⁻¹)			Mean
	200	250	300	
66000	437	464	493	465
56000	432	454	488	458
46000	437	469	507	473
Mean	437	462	496	
Control	383			
Rest	465			

LSD (0.05) for Nitrogen = 1.2, LSD (0.05) for planting densities = 1.2, Interaction = ns

Table 2. Effect of planting densities and nitrogen on grains row⁻¹ of maize.

Planting densities (Plants ha ⁻¹)	Nitrogen (kg ha ⁻¹)			Mean
	200	250	300	
66000	35	37	38	37
56000	35	37	38	37
46000	36	38	39	38
Mean	35	37	38	
Control	33			
Rest	37			

LSD (0.05) for Nitrogen = 0.171, LSD (0.05) for planting densities = 0.171, Interaction = ns

Table 3. Effect of planting densities and nitrogen on number of rows ear⁻¹ of maize.

Planting densities (Plants ha ⁻¹)	Nitrogen (kg ha ⁻¹)			Mean
	200	250	300	
66000	16	16	17	16
56000	16	16	17	16
46000	18	18	19	18
Mean	16	17	18	
Control	14			
Rest	17			

LSD (0.05) for Nitrogen = 0.161, LSD (0.05) for planting densities = 0.161, Interaction = ns

Table 4. Effect of planting densities and nitrogen on 1000 Grain weight of maize.

Planting densities (Plants ha ⁻¹)	Nitrogen (kg ha ⁻¹)			Mean
	200	250	300	
66000	252	258	301	270
56000	247	258	299	268
46000	259	265	308	277
Mean	253	260.0	303.3	
Control		Control vs. Rest		247
Rest				272

LSD (0.05) for Nitrogen = 1, LSD (0.05) for planting densities = 1, Interaction = ns

Table 5. Effect of planting densities and nitrogen on Biological yield of maize.

Planting densities (Plants ha ⁻¹)	Nitrogen (kg ha ⁻¹)			Mean
	200	250	300	
66000	13415	14369	15400	14395
56000	13270	13905	14744	13973
46000	13150	13541	14440	13710
Mean	13278	13938	14861	
Control	Control vs. Rest			12646
Rest				14026

LSD (0.05) for Nitrogen = 213, LSD (0.05) for planting densities = 213, Interaction = ns

Table 6. Effect of planting densities and nitrogen on Grain yield of maize.

Planting densities (Plants ha ⁻¹)	Nitrogen (kg ha ⁻¹)			Mean
	200	250	300	
66000	5317	5860	6150	5775
56000	5306	5800	6098	5735
46000	5176	5648	6108	5644
Mean	5266	5769	6119	
Control		Control vs. Rest		4618
Rest				5718

LSD (0.05) for Nitrogen = 79, LSD (0.05) for planting densities = 79, Interaction = ns

Table 7. Effect of planting densities and nitrogen on Harvest index of maize

Planting densities (Plants ha ⁻¹)	Nitrogen (kg ha ⁻¹)			Mean
	200	250	300	
66000	40	41	40	40
56000	40	42	41	41
46000	39	42	42	41
Mean	40	41	41	
Control	Control vs. Rest			37
Rest				41

LSD (0.05) for Nitrogen = 0.199, LSD (0.05) for planting densities = 0.199, Interaction = ns

Figure 1. Average monthly temperature for Peshawar in 2014

Figure 2. Average monthly rainfall for Peshawar in the 2014

Higher (14861 kg ha⁻¹) biological yield was obtained by using 300kg N ha⁻¹. While lower (13278 kg ha⁻¹) was obtained from 200 kg N ha⁻¹. Increasing planting densities increase biological yield of maize. More biological yield (14395 kg ha⁻¹) was obtained when plant population was 66000 plants ha⁻¹, while lower biological yield (13710 kg ha⁻¹) was obtained from 44000 plants ha⁻¹. Control vs rest showed that biological yield was higher in rest plot as compare to control. These results are supported by the finding of [10] who reported significant influence of different nitrogen rate on biological yield of maize. The results of planting densities were similar with the finding of [17] who reported higher biological yield with higher plant density.

Grain yield (kg ha⁻¹)

Data concerning grain yield of maize were shown in table 6. Analysis of the data showed that the nitrogen and planting densities had significant influence on grain yield of maize. Control vs rest was also found significant. Interaction between N and PD was found non-significant. Higher (6119 kg ha⁻¹) was obtained by application of 300 kg N ha⁻¹ whereas lower grain yield (5266 kg ha⁻¹) was achieved when N was applied at 200 kg ha⁻¹. As planting densities increase the grain yield of maize also increases. Higher grain yield (5776 kg ha⁻¹) was recorded when planting densities was maintained at 66,000plants ha⁻¹ whereas lower grain yield (5644 kg ha⁻¹) was recorded when the density was kept at 46000plants ha⁻¹. Control vs rest showed that grain yield was higher in rest of the plots as compared to control. These results were similar with finding of [4] reported higher level of nitrogen enhances the grain yield on account of increased yield component of maize. The result of planting densities were supported by [17] reported

improved yield with increase plant population.

Harvest Index (%)

Data regarding harvest index of maize was shown in table 7. The application of Nitrogen and planting densities had significant effect on Harvest Index of maize.

The increase (41%) in harvest index was obtained from 300Kg N ha⁻¹ and the decrease (40%) harvest index was obtained from 200Kg N ha⁻¹. Higher (41%) harvest index was obtaining when plant population was 44000 plants ha⁻¹ while lower harvest index was obtain from (40%) when plant population was 66000plants ha⁻¹. Control vs.rest showed that harvest Index was higher in rest of plot as compare to control. These results are in line with the finding of [10] and [11] who reported that harvest index was significantly influenced with increase in nitrogen application.

Conclusion and Recommendation

It is concluded from the results that the application of 300 kg ha⁻¹ with 66000 plants ha⁻¹ plant population produced higher grain yield and biological yield of maize. Therefore it is recommended that for the farmers of mardan region that use 300 kg N ha⁻¹ with plant population 66000 plants ha⁻¹ which is suitable for agro ecological condition of Mardan.

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