Research Article

Influence of split nitrogen application on yield and yield components of various maize varieties

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Citation

Muhammad Mehran Anjum, Muhammad Shafi, Haseeb Ahmad, Nawab Ali, Muhammad Owais Iqbal, Saif Ullah, Shafiullah, Muhammad Faheem Jan and Waqas Liaqat. Influence of split nitrogen application on yield and yield components of various maize varieties. Pure and Applied Biology. Vol. 7, Issue 2, pp721-726.
<http://dx.doi.org/10.19045/bspab.2018.70090>

Received: 04/03/2018

Revised: 04/06/2018

Accepted: 19/06/2018

Online First: 25/06/2018

Abstract

Maximum soils of the Pakistan are N deficient. The Nitrogen applied to the soil can be leached down in soil below the root zone of the crop while some of the Nitrogen gets volatilized in the atmosphere which can adversely affect the crop growth and development of corn plants so application timing of nitrogen in maize has a great importance and considered the best and appropriate for production of maize. Nitrogen application is required by the maize plants when needed and is taken at higher rates could improve nitrogen use effectiveness by diminishing the denitrification and immobilization. The study entitled "Influence of split nitrogen application on yield and yield components of maize" was carried out during 2016 at the Research Farms of Agronomy, The University of Agriculture Peshawar. Four split nitrogen applications were assigned to main plots while the varieties were assigned to sub plots. Experimental results exhibited that application of nitrogen in three split, 60 kg ha⁻¹ before sowing + 60 kg ha⁻¹ at knee height stage + 60 kg ha⁻¹ before tasseling stage has produced taller plants, maximum ear length, thousand grains weight, biological yield, grain yield, shelling percentage and harvest index. Among various varieties, Azam has produced maximum thousand grains weight, biological yield and grain yield. It is concluded that nitrogen applied in three splits (60 kg ha⁻¹ before sowing + 60 kg ha⁻¹ at knee height stage + 60 kg ha⁻¹ before tasseling stage) and Azam variety of maize crop has produced maximum grain yield.

Keywords: Azam; Biological yield; Grain yield; Nitrogen; Split; Varieties

Introduction

Maize (*Zea mays* L.) is an important grain crop in the world. Maize ranked 3rd in term of area and production. Maize is an essential food crop with high nutrition value. Maize is also used as feed for livestock and it contains 4.8% oil, 8.5% fiber, 72% starch, 10% protein, 3% sugar and 1.7% ash [1]. In Pakistan maize was

cultivated on an area 1.114 and 0.447 million hectares with an average yield of 4301 and 1985 kg ha⁻¹ and in Khyber Pakhtunkhwa respectively with production was 4.920 and 0.887 million tons ha⁻¹ [2]. Nitrogen deficiency is the yield restricting factor which reduces grain yield [3, 4] reported that application of nitrogen with greater amount increases total production

cost and it increases leaching, volatilization and immobilization. However, split application of N can nourish the crop better through optimum N uptake and thus protects the environment from the adverse effect of these chemical inputs. Likewise when deficiency of N occur in the crop plant so the leaf area of the plant get decreases and thus the interception of light is adversely affected due to vegetative growth [5]. Application timing of nitrogen in maize has a great importance and considered the best and appropriate for production of maize. Nitrogen application is required by the maize plants when needed and is taken at higher rates could improve nitrogen use effectiveness by diminishing the denitrification and immobilization [6, 7]. Maximum soils of the Pakistan are N deficient [8]. In order to get maximum and appropriate yield, increasing the nitrogen use efficiency by crop could be achieved through best management practices of nitrogen [9].

Keeping in view the importance of nitrogen application in splits doses on yield performance of maize, the present research studied was planned to study the effects of split N application on yield and yield components of maize.

Materials and methods

The experiment was conducted at Research Farm of Agronomy, the University of Agriculture Peshawar during kharif season 2016. The research comprised main plot factor (Split Nitrogen Application) i.e. Control, 180 kg ha⁻¹ before sowing, 90 kg ha⁻¹ before sowing, + 90 kg ha⁻¹ at knee height stage, 60 kg ha⁻¹ before sowing +60 kg ha⁻¹ at knee height stage + 60 kg ha⁻¹ before tasseling stage, 45 kg ha⁻¹ before sowing + 45 kg ha⁻¹ at knee height stage +45 kg ha⁻¹ before tasseling stage+45kg ha⁻¹ before silking stage and sub plot factor (varieties) i.e. (Pahari, Azam, Jalal and Iqbal). The trial was carried out in Randomized Complete Block Design (RCB) with Split Plot arrangement comprised of four replications.

The sub plot was 12m² (3m x 4m) in size having five rows. Nitrogen was applied from the source of Urea. Phosphorous was applied from the source of DAP. Crop was cultivated on proper moisture condition. During the crop growth & developmental stages weeds were controlled manually as well as chemically. Haywer, herbicide was sprayed at 4-5 leaf stage for weeds (25 days after sowing) of maize crop to control both broad leaf and grassy weeds. For all treatments, agronomic practices were kept uniform. At the physiologically maturity stage, height of the five representative plants from the soil surface till the tip of tassel in each sub unit were measured by using meter rod and then averaged. Ear length was measured by the help of meter rod by the selection of 10 representative samples in each subplot and averaged. Thousand grains weight was recorded through the random selection of sample from the grains of each unit, weighed through sensitive electronic balance. Biomass yield for all experimental unit was measured through the harvesting of four central rows in each experimental unit, placed on floor for sun drying, weighed through balance and converted to kg ha⁻¹. Plants, which were harvested for biomass yield, were dehusked, dried, threshed then weighed through electronic balance for grain yield and converted to grain yield per kg ha⁻¹. Data on shelling percentage was calculated for each experimental unit by the following formula:

Shelling (%) = Grain wt. of ten ears/ total wt. of 10 ears x 100

Harvest index (%) for each experimental unit was calculated through their respective grain yield and biomass yield by formula given below.

HI% = $\frac{\text{Grain Yield (Kg/ha)}}{\text{Biological Yield (Kg/ha)}} \times 100$

Statistical analysis

The recorded data was statistically analyzed by the technique of ANOVA (analysis of variance) using Statistix 8.1 package for RCBD (randomized complete

block design) with split plot arrangement by using least significant difference (LSD) 5% significance level ($P \leq 0.05$) upon significant F-test by the procedure of [10].

Results and discussion

Plant height (cm)

Different varieties of maize and split nitrogen application had significantly ($P \leq 0.05$) affected plant height of maize crop (Table 1). Interaction of varieties and split nitrogen application had non-significantly affected the plant height of maize. Maximum plant height was recorded from treatment of nitrogen application in three split 60 kg ha^{-1} before sowing + 60 kg ha^{-1} at knee height stage + 60 kg ha^{-1} before tasseling stage. Application of nitrogen in two split, 90 kg ha^{-1} at sowing + 90 kg ha^{-1} at knee height stage and single application of nitrogen 180 kg ha^{-1} before sowing ranked 2nd and 3rd in term of plant height. Lowest value for plant height was recorded from the treatment of control (No nitrogen was applied). The plant height increased with more nitrogen splits application i.e. 3 splits. It may be due to supply of proper amount of N at different growth stages of maize. The N promotes plant growth, increase the number and length of internodes which resulted in taller plants of maize crop [11]. Highest plant height was recorded from maize variety Azam followed by Iqbal. Lowest plant height was recorded from Pahari variety. The difference in plant height of different maize varieties may be due to diverse genetic background of the varieties which resulted in varying plant height. Our results are in line with [12] who reported that different varieties have different plant height.

Ear length (cm)

Nitrogen application in split and different varieties of maize have significant ($P \leq 0.05$) effect on ear length. The combined effects of split nitrogen application and varieties have non-significantly effect. Maximum ear length was observed from treatment of nitrogen in three split application (60 kg ha^{-1} before

sowing + 60 kg ha^{-1} at knee height stage + 60 kg ha^{-1} before tasseling stage) followed by two splits. Lowest ear length was recorded from control plots. Maximum ear length at 3 split application of nitrogen has decreased nitrogen losses and provided an adequate amount of nitrogen to the plant which showed more increase in vegetative growth and hence increased length of ear. Similar results were reported by [13] who reported that highest cob length in nitrogen fertilized plots and smallest cob length in the plots where nitrogen was not applied. Highest value for ear length was recorded from Azam variety followed by Iqbal and Jalal variety. Pahari variety showed lowest ear length. The variation in ear lengths of maize varieties might be due to the genetic potential of these varieties.

Thousand grains weight (g)

Data concerning thousand grains weight of maize was significantly affected by split nitrogen application as well as varieties, is shown in (Table 1). Interaction of split nitrogen application and varieties had non-significant impact. Maximum thousand grains weight was recorded from treatment of nitrogen in three equal splits i.e. 60 kg ha^{-1} before sowing + 60 kg ha^{-1} at knee height stage + 60 kg ha^{-1} before tasseling stage followed by nitrogen application in four splits i.e. 45 kg ha^{-1} before sowing + 45 kg ha^{-1} at knee height stage + 45 kg ha^{-1} before tasseling stage + 45 kg ha^{-1} at silking stage. Minimum thousand grains weight was recorded from control. It may possibly be due to the availability of optimum nitrogen in three equal splits throughout the growing season. Similar results were declared by [14, 15] who reported that application of nitrogen at critical growth stages significantly affected thousand grains weight in maize. Highest thousand grains weight was recorded from Azam variety followed by Iqbal. Minimum thousand grains weight was documented for Pahari variety of maize. The possible reason for difference among varieties for grains weight might be the genotypic characteristic of the varieties [16].

Biological yield (kg ha⁻¹)

Biological yield of maize varieties as affected by split nitrogen application is presented in (Table 1). The interaction between split nitrogen application and varieties had non-significant effect. Maximum biological yield was recorded from nitrogen applied in three splits i.e. 60 kg ha⁻¹ before sowing + 60 kg ha⁻¹ at knee height stage + 60 kg ha⁻¹ before tasseling stage followed by application of nitrogen in two splits. Lowest value for biological yield was observed from control plots. The highest biological yield may be due to application of nitrogen in splits doses and hence nitrogen was efficiently utilized by crop according to its requirements. [17, 18] reported that nitrogen application at vegetative stage of maize prolonged growth phases and produced more assimilates that resulted in higher biological yield of maize crop. Highest biological yield was recorded from Azam variety as compared to other tested maize varieties while lowest biological yield was harvested from Pahari variety.

Grain yield (kg ha⁻¹)

Grain yield of maize was significantly influenced by split nitrogen application as well as varieties are presented in (Table 1). Interaction of split nitrogen application and varieties had non-significant effect. Maximum grain yield was recorded from nitrogen in three split application i.e. 60 kg ha⁻¹ before sowing + 60 kg ha⁻¹ at knee height stage + 60 kg ha⁻¹ before tasseling stage followed by application of nitrogen in four splits i.e. 45 kg ha⁻¹ before sowing + 45 kg ha⁻¹ knee height stage + 45 kg ha⁻¹ before tasseling stage + 45 kg ha⁻¹ at silking stage. Lowest grain yield was observed from control. The application of nitrogen in three equal splits has ensured the availability of nitrogen at all the essential

growth stages of the maize crop. The losses of nitrogen were reduced due to split application which facilitated efficient uptake of nitrogen during growing season of maize crop. [19, 20] reported that split nitrogen application has ensured high yield performance in maize crop. Maximum grain yield was harvested from Azam variety of maize followed by Jalal and Iqbal. Lowest grain yield kg ha⁻¹ was recorded from Pahari variety. The higher grain yield recorded for Azam variety could be due to maximum ear length and thousand grains weight that ultimately increased grain yield.

Shelling percentage (%)

Data on shelling percentage of maize was significantly affected by split nitrogen application is given in (Table 1). Varieties and interaction between nitrogen split application and varieties was found not significant. Highest value for shelling percentage was recorded from treatment of nitrogen in three split application followed by two splits. Lowest value for shelling percentage was recorded for control. Our results were strongly in agreement with [21] reported that highest shelling percentage can be obtained by the application of nitrogen in thrice splits.

Harvest index (%)

Harvest index of maize was significantly influenced by split nitrogen application (Table 1). Maize varieties and its interaction with split nitrogen application were non-significant. Maximum harvest index was recorded from treatment of nitrogen applied in three splits (60 kg ha⁻¹ before sowing + 60 kg ha⁻¹ at knee height stage + 60 kg ha⁻¹ before tasseling stage followed by two splits. Minimum harvest index was recorded from control. [22, 23] reported that harvest index increased when application of nitrogen in split is increased.

Table 1. Plant height (cm), ear length (cm), thousand grains weight (g), biological yield (kg ha⁻¹), grain yield (kg ha⁻¹), shelling percentage and harvest index of maize varieties as influenced by split nitrogen application

Nitrogen (Kg ha ⁻¹)	Plant height (cm)	Ear length (cm)	Thousand grains weight (g)	Biological yield (kg ha ⁻¹)	Grain yield (kg ha ⁻¹)	Shelling %age	Harvest index (%)
N ₀	179.7b	12.2c	224.9c	10239c	2563c	55c	25c
N ₁	183.3ab	13.2b	232.4bc	10552bc	2687c	55c	26c
N ₂	185.2ab	13.8ab	236.6b	11227a	3490b	70ab	31b
N ₃	189.2a	14.6a	246.1a	11247a	4197a	76a	37a
N ₄	180.9b	12.9bc	240.1ab	10914ab	3473b	66b	32b
Varieties							
Pahari	180.1b	12.4b	230.1c	10580b	3152b	68	30
Azam	188.2a	14.0a	241.7a	11223a	3393a	61	30
Jalal	182.6ab	13.0ab	234.3bc	10784b	3294ab	65	31
Iqbal	183.9ab	13.9a	238.0ab	10757b	3287ab	64	31
LSD for Nitrogen	6.99	0.95	7.82	459.6	164.7	7.67	2.19
LSD for Varieties	5.7	1.02	7.3	361.1	158.1	ns	ns
Interaction	ns	Ns	ns	ns	ns	ns	ns

N₀ = control (Zero nitrogen)

N₁ = 180 kg ha⁻¹ before sowing

N₂ = 90 kg ha⁻¹ before sowing + 90 kg ha⁻¹ at knee height stage

N₃ = 60 kg ha⁻¹ before sowing + 60 kg ha⁻¹ at knee height stage + 60 kg ha⁻¹ before tasseling stage

N₄ = 45 kg ha⁻¹ before sowing + 45 kg ha⁻¹ at knee height stage + 45 kg ha⁻¹ before tasseling stage + 45kg ha⁻¹ before silking stage

ns = non-significant

Conclusion

It can be concluded from the study that nitrogen application in three splits i.e. 60 kg ha⁻¹ before sowing + 60 kg ha⁻¹ at knee height stage + 60 kg ha⁻¹ before tasseling stage has produced maximum grain yield. Among varieties, Azam performed better in terms of grain yield. Thus, application of nitrogen in three splits to maize variety, Azam is recommended for higher grain yield under the agro-climatic conditions of Peshawar region.

Authors' contributions

Conceived and designed the experiments: MM Anjum & M Shafi, Performed the experiments: N Ali & H Ahmad, Analyzed the data: W Liaqat & MF Jan, Contributed materials/ analysis/ tools: MO Iqbal, Shafiullah & S Ullah, Wrote the paper: MM Anjum.

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