

Effect of crop-establishment methods and nitrogen levels on productivity and profitability of maize (*Zea mays*) in semi-arid region of Afghanistan

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ABSTRACT

A field experiment was carried out at the Afghanistan National Agricultural Sciences and Technology University (ANASTU), Kandahar, during the rainy (*kharif*) season (April–August) of 2015, to study the yield and profitability responses of maize (*Zea mays* L.) to different crop-establishment methods and nitrogen (N) levels in semi-arid region of Afghanistan. The treatments consisted of 3 crop-establishment methods, viz. broadcast, line sowing and ridge sowing, allotted to main plots and 4 N levels, viz. 0, 120, 160, 200 kg N/ha, in subplots. The experiment was conducted in a three-time replicated split plot. The results revealed that crop-establishment methods did not influence yield attributes like number of cobs/plant, cob length, cob girth, rows/cob, grains/row significantly; however numerically higher magnitude of these yield attributes was observed under ridge planting. Moreover, ridge planting recorded significantly higher number of grains/cob (390.1) and 1,000-grain weight (272.6 g), which finally resulted in significantly higher grain yield (6.30 t/ha). Owing to higher yield, Net returns and benefit: cost ratio were also higher with ridge planting. Among the N levels, an application of 200 kg N/ha resulted in the maximum values of all yield attributes, which led to significantly higher grain yield (5.77 t/ha) and benefit: cost ratio (2.43) compared to all other N-levels.

Key words : Crop-establishment methods, Grain yield, Maize, N, Yield attributes

Maize is one of the most important cereal crops of Afghanistan, holding third position after wheat and barley. It can be grown as spring and summer maize after the harvesting of first crop either wheat or legumes. Maize is grown throughout the Afghanistan in different ecological zones. Helmand, Paktia and Nangarhar are the provinces where maize is extensively cultivated. In Afghanistan, maize is grown on 1.27 lakh ha with an annual production 3.16 lakh tonnes and average yield 2.5 t/ha (MAIL, 2014). The average yield of maize is far lower than the biological potential of the existing maize cultivars for want of appropriate production technologies like improved seed, planting methods, proper nutrient management, irrigation management weed-control measures. Among the different agro-management practices, proper N management, and planting methods are of prime significance to realize optimum yield potential of maize, as maize crop is highly responsive to planting methods, and rate and time of N ap-

plication (Kumar *et al.*, 2007; Dass *et al.*, 2015). Mahamed and Sirdon (2013) reported that various doses of nitrogen had significant effect on number of grains/cob and length of cobs. Similarly, Sanjeev *et al.* (1997) reported a significant increase in grain and stover yield with the application of 240 kg N/ha. However, Arif *et al.* (2010) concluded that increase in N level improved grain and biological yield of maize significantly up to 120 kg/ha. These results indicate that response of maize to variable N levels is location specific. However, no research work has been done on maize with respect to its responses to different planting methods and N application rates in Afghanistan. Hence the current investigation was carried out to evaluate the effect of different planting methods and N levels on performance of maize in Kandahar region of Afghanistan.

A field experiment was carried out during the rainy (*kharif*) season (April–August) of 2015 at the Afghanistan National Agricultural Science and Technology University (ANASTU), Kandahar, (31°30' N, 65°50' E and 1,010 m above mean sea-level). Soil of the experiment field was sandy clay loam, with pH 8.3. The climate of Afghanistan is semi-arid to sub-tropical with extreme cold and hot situ-

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ations. The hottest month is July, with the mean temperature of 31.9°C, whereas the mean minimum temperature of the coldest month falls in the range of 5.1°C. The average monthly temperature of Kandahar hovers around 26.8°C, which is a moderate range. The average annual relative humidity is 38% and average monthly relative humidity ranges from 23% in June to 59% in February. Average normal annual rainfall of Kandahar is about 190.6 mm. The experiment consisted of combinations of 3 methods of planting—broadcast, line sowing and ridge planting in mainplots and 4 levels of N i.e. control, 120, 160 and 200 kg N/ha, in sub plots, set in a 3 time replicated split-plot design.

Seeds of maize var. 'CS 200' were sown manually on 4 April 2015 in broadcast (no-row arrangement), ridges and lines keeping line to line distance of 70 cm and plant-to-plant distance of 20 cm as per planting method treatments, using a seed rate of 25 kg/ha for each planting method. Two seeds/hill in ridge and line sowing were planted manually. In broadcast method, seeds were uniformly spread on a well-prepared field and buried in to soil with planking, later 1 plant/hill was maintained after thinning. Recommended doses of phosphorus and potassium were applied after preparation of a good seedbed, whereas N was applied in 2 equal splits, viz. half basal and half at knee-high stage. Weeding was done twice, 30 and 50 days after sowing (DAS) to keep the crop free from weeds and earthing-up was done with spade at 45 DAS to prevent lodging of plants. At the early growth stage (after 12 days of emergence), the plants were attacked by maize borer, which was removed by spraying crop with Cypermethrin @ 1.5 l/ha. The data on various yield-contributing charac-

ters and yield were recorded at harvesting of crop using standard procedures. Gross returns, net returns, and benefit: cost ratio were calculated on basis of prevailing market prices of inputs and produce. All data were analysed statistically by using analysis of variance technique for a splitplot design. Critical differences were worked out at 5% probability level.

Cobs/plant, cob length, cob girth, rows/cob, grains/row were not influenced significantly by planting methods; however, grains/cob and 1,000-grain weight were affected (Table 1). Ridge planting performed relatively better for almost all yield-contributing parameters compared to the other crop-establishment methods. The better proliferation of roots in ridge-planting method must have resulted in better performance of yield-contributing characters. Among N levels, the maximum number of cobs/plant was recorded with the application of 200 kg N/ha, followed by 160 kg N/ha and 120 kg N/ha, and it was significantly better to control treatment. Application of 200 kg N/ha resulted in the maximum cob girth, grain rows/cob, grains/cob also, but was at par with 160 kg N/ha, and significantly superior to 120 kg N/ha. However, the highest 1,000-grain weight recorded with 200 kg N/ha was significantly superior to both 160 and 120 kg N/ha levels. Obviously, the lowest values of yield attributes were recorded in the control treatment. These results are in close conformity with those of Rasheed *et al.* (2003), Mahamed and Shirton (2013) and Ghosh *et al.* (2016)

Ridge-planting method resulted in 37.3 and 63.6% higher grain yield than line sowing and broadcast method of planting respectively (Table 2). Amin *et al.* (2006) reported that the highest grain yield (3.5 t/ha) of sweet corn

Table 1. Effect of crop establishment methods and nitrogen levels on yield attributes, yield and profitability of maize

| Treatment | Cobs/ plant | Cob length (cm) | Cob girth (cm) | Rows/ cob | Grains/ row (No) | Grains/ cob (No) | 1,000- grain weight (g) | Grain yield (t/ha) | Stover yield (t/ha) | Gross returns ($\times 10^3$ ₹/ha) | Net returns ($\times 10^3$ ₹/ha) | Benefit: cost ratio |
|-----------------------------------|----------------|-----------------------|----------------------|--------------|------------------------|------------------------|----------------------------------|--------------------------|---------------------------|--|--|---------------------------|
| <i>Crop-establishment methods</i> | | | | | | | | | | | | |
| Broadcast | 1.6 | 16.5 | 12.4 | 13.2 | 27.08 | 347 | 263.4 | 3.85 | 12.0 | 148.9 | 94.3 | 1.75 |
| Line sowing | 1.6 | 16.7 | 12.7 | 13.2 | 28.28 | 373 | 269.2 | 4.59 | 13.0 | 169.8 | 114.0 | 2.04 |
| Ridge planting | 1.7 | 16.8 | 12.7 | 13.4 | 28.3 | 390 | 272.6 | 6.3 | 14.1 | 210.8 | 154.97 | 2.91 |
| SEm \pm | 0.03 | 0.069 | 0.12 | 0.095 | 0.3 | 1.4 | 0.65 | 0.061 | 0.26 | 4.87 | 4.87 | 0.03 |
| CD (P=0.05) | NS | NS | NS | NS | NS | 5.56 | 2.63 | 0.245 | 1.07 | 19.64 | 19.63 | 0.16 |
| <i>Nitrogen levels (kg/ha)</i> | | | | | | | | | | | | |
| 0 | 1.5 | 16.3 | 12.2 | 12.8 | 25.97 | 349 | 260.9 | 3.78 | 12.4 | 150.2 | 101.4 | 2.015 |
| 120 | 1.7 | 16.5 | 12.5 | 13.0 | 27.52 | 364 | 266.5 | 4.77 | 12.7 | 172.2 | 115.1 | 2.16 |
| 160 | 1.7 | 16.7 | 12.7 | 13.5 | 28.11 | 378 | 270.9 | 5.33 | 13.1 | 185.1 | 127.7 | 2.20 |
| 200 | 1.8 | 17.1 | 12.8 | 13.8 | 29.94 | 389 | 275.3 | 5.77 | 13.9 | 198.7 | 139.0 | 2.43 |
| SEm \pm | 0.04 | 0.12 | 0.07 | 0.12 | 0.39 | 1.8 | 0.85 | 0.13 | 0.25 | 4.64 | 4.64 | 0.07 |
| CD (P=0.05) | 0.13 | 0.36 | 0.21 | 0.35 | 1.18 | 5.4 | 2.56 | 0.40 | 0.76 | 13.91 | 13.91 | 0.21 |

was recorded with ridge-planting method with the highest N and P fertilizer level of 300 and 150 kg/ha and 4 seeds/hill, and lowest grain yield (3.49 t/ha) in flat sowing with 120 and 75 kg/ha of N and P and 2 seeds/hill seed density. Nitrogen being an important component of chlorophyll, protein and nucleic acid is the major yield-determining factor in maize. Significantly higher grain yield (5.77 t/ha) was recorded with application of 200 kg N/ha, being 8.3, 20.8 and 52.7% higher than 160, 120 kg N/ha and the control respectively. Better source and sink development and congenial micro-environment under ridge planting and with higher N dose resulted in better translocation of not only reserved but also concurrent photosynthates for filling the sink to its capacity for higher grain yield compared to other treatments. Ridge planting recorded 8.7 and 17.8% higher stover yield than line sowing and broadcast methods respectively. Among levels of N, the highest stover yield was recorded with 200 kg N/ha, which was 5.9, 8.6 and 11.6% higher than 160, 120 kg N/ha and the control respectively. It is well established fact that higher dose of N increases the vegetative growth of crop which must have resulted in higher stover yield (Ghosh *et al.*, 2016).

The highest gross returns, net returns and benefit: cost ratio were recorded in ridge planting method owing to higher grain and stover yield with this planting method. These results are in agreement with the finding of Amin *et al.* (2006), who reported that highest grain yield, net income, and benefit: cost ratio were recorded when crop was planted on ridges. Similarly, application of 200 kg N/ha recorded higher gross returns, net returns and benefit: cost ratio than rest of the N levels.

From the above study, it could be concluded that in the semi-arid regions of Afghanistan maize can be successfully grown by planting on the ridges and application of

200 kg of N/ha could be done for higher growth, productivity and profitability.

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