

Response of corn to different levels of nitrogen and sowing methods

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ABSTRACT

A field experiment was conducted at the Agronomy Research Farm of the Agricultural Faculty of Albieroni University in Kapisa Province, Afghanistan, to study the response of maize to sowing methods and nitrogen fertilizer levels during the spring season of 2022 and 2023. Three sowing methods (broadcast sowing, ridge sowing, and line sowing) and four levels of nitrogen (0, 120, 160, and 200 kg N ha⁻¹) were applied. The experiment was laid out in a well-prepared field using a Randomized Complete Block Design with a split arrangement, having three replications. Sowing methods were assigned to the main plots, while nitrogen levels were assigned to the split plots. Maximum plant height, leaf area index, number of green leaves, 1000-seed weight, grain yield, Stover yield, and biological yield were recorded in the ridge sowing method along with the application of 200 kg N ha⁻¹ when compared with other treatments. It can be concluded from these results that the ridge sowing method and nitrogen fertilizer at the rate of 200 kg ha⁻¹ produced an economical crop of maize under the climatic conditions of Kapisa Province, Afghanistan

Keywords: Maize, sowing methods, nitrogen, growth, yield.

INTRODUCTION

Maize needs an abundance of readily available plant nutrients and a soil pH reaction between 5.5 and 8.0 for optimal production. While the soil and climatic conditions of Afghanistan are highly favorable and high-yielding varieties are available, the yield of maize in farmers' fields is very low compared to other maize-producing countries such as the U.S.A, Canada, and Egypt. To increase maize production, the adoption of modern agro-management practices seems imperative, and one of the major techniques is the proper method of sowing. Fertilizer impact is one of the major issues for raising crop yield, contributing about 50% to yield performance. Many farmers in our country do not apply fertilizer in the proper amount or use the correct method of fertilizer application. Hence, the efficiency of fer-

tilizer may be adversely affected. While studying the effects of different sowing methods, it was shown that 1000-grain weight and grain yield were maximized with ridge sowing, which also reduced the days to tasseling, silking, and maturity. It was calculated that biomass and grain yields of maize crops increased with increasing nitrogen rates. Other studies found that grain yield increased significantly up to 240 kg N ha⁻¹. It was reported that plant height, 1000-grain weight, and grain weight per cob increased significantly with 100 kg N ha⁻¹, although the tillering period generally decreased with increasing nitrogen rates. Nitrogen application had a significant influence on plant height, grain number per cob, thousand grain weight, and harvest index. Additionally, it was reported that nitrogen and phosphorus had a significant effect on grain yield, nitrogen uptake at flowering, maturity, and in grain,

while a non-significant effect of nitrogen and phosphorus was recorded for the harvest index. It was found that plots fertilized with a combination of nitrogen and phosphorus at 150:90 kg ha⁻¹ produced higher grain yields. Given the importance of planting methods and nitrogen management in corn crop production, the present experiment was conducted to determine the effect of different planting methods with varying nitrogen levels on corn plant yield.

MATERIALS AND METHODS

An experiment titled effect of nitrogen levels and sowing methods on growth and yield of maize was conducted at the agricultural research farm of Albieroni University, Afghanistan, during the spring seasons of 2022-2023 which is located in the northern part of the central region of Afghanistan, characterized by warm summers

and moderate climates in spring and autumn. It is situated about 1,500 meters above sea level, with annual rainfall estimated at about 400 mm, and summer temperatures varying from 25 to 40 °C. Data pertaining to rainfall and temperature recorded during the experimental period are depicted in Fig. 1 and Fig. 2. The soil of the experimental field had a sandy loam texture and was relatively alkaline in reaction (pH = 8.10). The soil contained organic matter (humus) at a content of 1.9%, nitrogen at 0.11%, phosphorus at 14.0 mg/kg, potassium at 95.5 g/kg, and had a medium water holding capacity of 34.99%. Data regarding the soil properties of the experimental field are presented in Table 1. Nitrogen fertilizers were applied in a split manner, in equal portions, on the surface, at a distance of 8-10 cm from the seeds, followed by irrigation according to the BBCN scale of corn development. One third of the nitro-

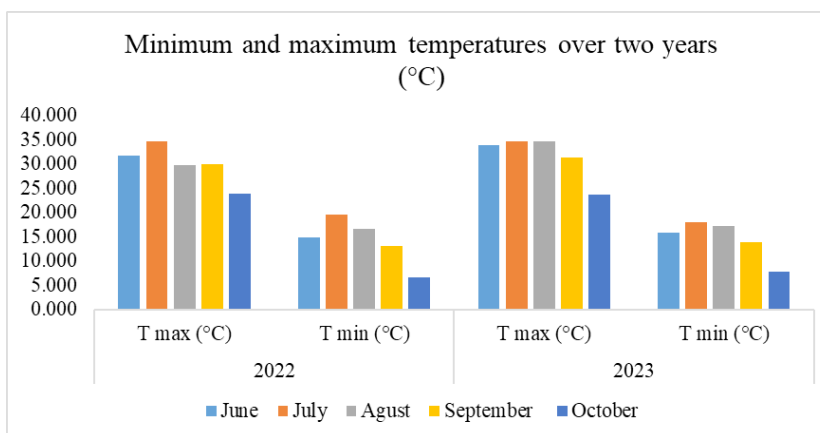


Fig. 1. Maximum and minimum temperatures of two years

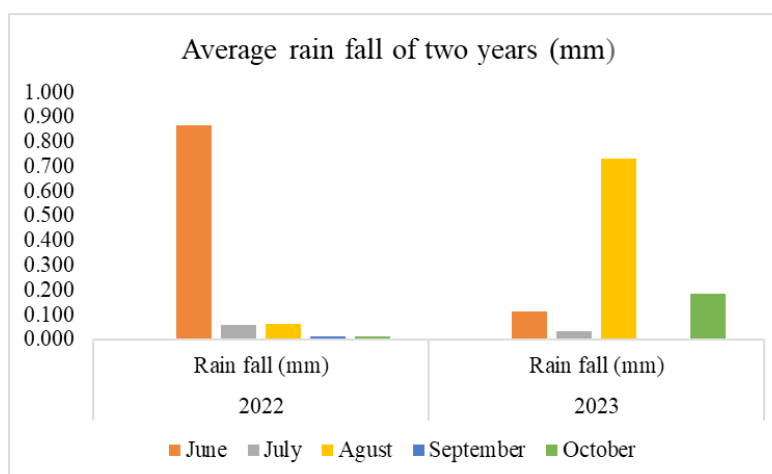


Fig. 2. Average rain fall of two years.

gen was applied at BBCH 11 (1st leaf stage: the 1st true leaf is unfolding, the tip of the 2nd leaf is visible), one third of the nitrogen was applied at BBCH 31 (beginning of stem elongation, 1st node visible), and the remaining third was applied at BBCH 51 (beginning of panicle formation, panicle visible at the top of the stem). The experiment was laid out in a Randomized Complete Block Design (RCBD) with a split-plot arrangement, having three replications, four levels of nitrogen fertilizer (0, 120, 160, and 200 kg N ha⁻¹), and three sowing methods (ridge sowing, broadcasting, and line sowing). Sowing methods were allocated to the main plots, and nitrogen levels were allotted to the subplots. The area of each subplot was 3 × 4 m, which was composed of five rows spaced 70 cm apart. All standard agronomic practices were followed during the experiment. The following parameters were considered during the course of the experiment: plant height, leaf area index, number of green leaves, 1000-grain weight (g), grain yield (t ha⁻¹), biological yield (t ha⁻¹), and straw yield (t ha⁻¹). Plant height was recorded by measuring the height of six randomly selected plants from the two central rows of each subplot and then averaging the results. Leaves from the six plants were randomly selected from the two central rows of each subplot, counted, and their average calculated. Leaf area was determined by multiplying (leaf length × maximum breadth × 0.75 × number of leaves per plant). The 1000-grain weights were counted from the cobs of the two central rows of each subplot, and their weight was noted using an electronic balance. Grain yield was obtained from each subplot after husking and cleaning, and their weight was recorded and converted

to grain yield (t ha⁻¹). Biological yield was noted in each subplot after adequate sun drying and converted to t ha⁻¹. Straw yield was recorded from each subplot when grains were separated from the cobs of each plant. The recorded data were analyzed statistically using analysis of variance techniques appropriate for the Randomized Complete Block Design with a split-plot arrangement. Critical differences (CD) were obtained using OPSTAT online software.

RESULTS AND DISCUSSION

Growth parameters

The presented data on plant height, leaf area index, and number of green leaves, as affected by sowing methods and nitrogen levels, are recorded and indicated in Table 1. Different sowing methods significantly influenced plant height, leaf area index, and number of green leaves. The tallest plant heights (256.3 and 272 cm) were observed in both years (2022 and 2023) from the ridge sowing method, which were significantly higher than those of the broadcast and line sowing methods. Additionally, plant height was affected by increasing nitrogen levels; the highest plant heights (299.4 and 304 cm) were obtained with the application of 200 kg N/ha, which was statistically higher than that of 160, 120, and 0 kg N/ha in both years, respectively. This could be attributed to the fact that higher rates of nitrogen may have caused rapid cell division and elongation (Sarwargaonkar *et al.*, 2008). Earlier, Amin *et al.* (2006) also reported higher plant heights of maize under the ridge sowing method due to enhanced water and nutrient availability. The ridges significantly increased the time for the crop to reach different phenological stages. This could be attributed to better nutrient uptake, especially nitrogen, in the loose, fertile soil of the ridges, as nitrogen is known to lengthen the vegetative period of crops, thereby delaying maturity. In fact, ridges provide loose, fertile soil with more aeration and moisture availability; therefore, improved soil conditions, along with better nutrient uptake, might have created a better environment for the crop, resulting in improved plant height. Khan *et al.* (2014) also reported maximum plant height under the ridge sowing method.

Table 1. Soil properties of the experimental field.

Soil properties	Indicator
Sand	44.11 %
Silt	10.29 %
Clay	45.58 %
Soil texture class	Sandy loam
pH	8.10
Organic matter (humus) (%)	1.9
Nitrogen (%)	0.11
Phosphorus mg/kg	14.0
Potassium g/kg	95.5
Water holding capacity (%)	34.99

Maximum leaf area index (3.10 and 3.15) was recorded in the ridge sowing method, which was significantly higher than that of the line sowing and broadcast sowing methods, respectively, in the 2022-2023 years. Additionally, a higher leaf area index (3.71 and 3.75) was observed with the use of 200 kg N/ha, which was significantly different from that of 160, 120, and 0 kg N/ha in both years. Singha and Chakravorty (2013) also found an improvement in leaf area index with increasing levels of nitrogen. A better and more developed root system in the loose, fertile soil of ridges might have improved water availability and nutrient uptake, resulting in a maximum leaf area index. Earlier, Amin *et al.* (2006) also reported a higher leaf area index of maize under ridge sowing due to enhanced water and nutrient availability.

The highest number of green leaves (14.9 and 14.6) was noted from the ridge sowing method, which was significantly better than that of the line sowing and broadcast sowing methods. Additionally, the maximum number of green leaves (15.6 and 15.8) was observed by applying 200 kg N/ha, which was significantly higher than other nitrogen levels, including the control, in both years. The study also revealed a significant increase in dry matter production. The large assimilatory system produced by a higher leaf area index, due to increased photosynthesis, along with greater plant height and a higher number of functional

leaves under the ridge system, might have contributed to increased dry matter production. These results are consistent with those of Hussain *et al.* (2010) and Khan *et al.* (2012). Abdullah (2007) and Ghaffar *et al.* (2012) also reported similar findings. These results are in accordance with the findings of Raymond *et al.* (2009), who reported the maximum number of green leaves from the ridge sowing method and nitrogen fertilizer.

Yield and yield parameters

The noted data on thousand grain weight, as affected by sowing methods and nitrogen fertilizer, is recorded and indicated in Table 2. The data revealed that the highest thousand grain weight (282.6 g and 291.7 g) was obtained in both years (2022 & 2023) from the ridge sowing method, which was significantly higher than that of the line and broadcast sowing methods. Thousand grain weight was considerably affected by nitrogen fertilizer. Each increase of 40 kg of nitrogen per hectare significantly improved the thousand grain weight. The maximum 1000-grain weight (275.3 g and 309.89 g) was noted with 200 kg of nitrogen per hectare, which was remarkably higher than 160, 120, and 0 kg of nitrogen per hectare. The lowest thousand grain weight was noted in control plots (260.9 g and 255.67 g) in both years. These findings are similar to those of Majid *et al.* (1986), who reported that the maximum thousand grain weight and grain yield were obtained with

Table 2. Effect of nitrogen levels and sowing methods on plant height (cm), leaf area index and number of green leaves.

Treatments	2022			2023		
	Plant height (cm)	Leaf area index	Number of green leaves	Plant height (cm)	Leaf area index	Number of green leaves
Sowing methods						
Broadcast planting	256.3	2.83	13.2	272.0	2.87	13.7
Line sowing	268.5	2.98	13.9	277.4	3.02	13.8
Ridge planting	279.7	3.10	14.9	287.0	3.15	14.6
SEm±	2.16	0.03	0.26	1.99	0.030	0.25
CD (P= 0.05)	6.50	0.090	0.80	5.97	0.091	0.76
Nitrogen levels (kg/ha)						
0	235.2	2.35	12.6	243.8	2.36	12.6
120	267.0	2.66	13.4	276.6	2.69	13.4
160	285.2	3.18	14.5	290.8	3.23	14.4
200	299.4	3.71	15.6	304.0	3.75	15.8
SEm±	2.50	0.034	0.3	2.3	0.035	0.29
CD (P= 0.05)	7.51	0.104	0.93	6.90	0.105	0.88

ridge sowing. Mahamed. (2013) Also reported that different sowing methods and various levels of nitrogen significantly affected the number of grains per cob, cob length, and thousand seed weight.

Grain yield of maize was significantly influenced by different sowing methods in 2022 and 2023. The ridge sowing method produced significantly higher grain yield (6.3 t/ha and 6.5 t/ha), which was 37.3%, 63.6%, 14%, and 42% higher than row sowing and broadcast methods in both years, respectively. A significant increase in grain yield was noted with the subsequent increase of nitrogen levels from 120 to 200 kg N/ha in both years. Significantly higher grain yield (5.8 t/ha and 5.9 t/ha) was recorded with the application of 200 kg N/ha, which was 8.3%, 20.8%, 52.7%, 11.3%, 25.5%, and 47.5% higher than 160, 120 kg N/ha, and control, in both years, respectively. These results are in agreement with the findings of Shrestha *et al.*, (2018), who reported that the maximum grain yield was obtained with ridge sowing. Khan *et al.*, (2014). Also reported that on the ridges, grain yields were 3.19 and 7.7 tons/ha, respectively. These results are consistent with the findings of Anju and Mehran (2017), who also reported a significant effect of nitrogen levels on grains per cob, cob length, biological yield, grain yield, and harvest index.

Different sowing methods significantly affected straw yield during the 2022-2023 years. Among the different sowing methods, ridge sow-

ing recorded a significantly higher straw yield (14.15 t/ha and 14.9 t/ha) than line sowing and broadcasting, being 8.7%, 17.8%, 7.89%, and 17.14% higher than line sowing and broadcasting in both years, respectively. These results are similar to those of Akmal *et al.*, (2017), who reported that sowing methods had a significant effect on straw yield and revealed that the highest straw yields were recorded in plots sown using the ridge sowing method. Among the different nitrogen rates, 200 kg N/ha noted a significantly higher straw yield each year, followed by 160 kg N/ha (13.1 t/ha, 15.48 t/ha) and 120 kg N/ha (12.8 t/ha and 13.50 t/ha), respectively. At 200 kg N, straw yield produced (13.9 t/ha and 16.03 t/ha) was 5.87%, 8.59%, 11.55%, 6.06%, 16.6%, and 25.8% higher compared to 160 kg N/ha, 120 kg N/ha, and control, respectively, with the minimum straw yield obtained in the control treatment (12.44 t/ha and 12.47 t/ha). These findings are consistent with the results of Shrestha *et al.*, (2018), who reported that sowing methods improved the grain and straw yield of maize. Akmal *et al.*, (2017), also reported a significant effect of nitrogen rate on grains per cob, cob length, grain yield, straw yield, and harvest index. These findings are similar to those of Anwar *et al.*, (2017), who indicated that nitrogen levels had a significant effect on grain and straw yield of maize.

CONCLUSION

It can be concluded from these results that the

Table 3. Effect of planting methods and nitrogen levels on 1000-seed weight grain yield and Stover yield

Treatments	2022			2023		
	1000-seed weight (g)	Grain yield (t/ha)	Straw yield (t/ha)	1000-seed weight (g)	Grain yield (t/ha)	Straw yield (t/ha)
Sowing methods						
Broadcast planting	263.4	3.9	12.0	278.33	4.0	13
Line sowing	269.2	4.6	13.0	282.67	5.0	14.2
Ridge planting	282.6	6.3	14.2	291.67	6.5	14.9
SEm±	0.65	0.06	0.27	1.64	0.06	0.28
CD (P= 0.05)	5.56	0.25	1.07	6.61	0.26	1.08
Nitrogen levels (kg/ha)						
0	260.9	3.8	12.4	255.67	4.0	12.47
120	266.5	4.8	12.8	278.11	4.7	13.50
160	270.9	5.3	13.1	291.78	5.3	15.48
200	275.3	5.8	13.9	309.89	5.9	16.03
SEm±	1.483	0.14	0.26	1.56	0.15	0.28
CD (P= 0.05)	5.45	0.40	0.77	4.6	0.50	0.78

ridge sowing method and nitrogen levels at the rate of 200 kg ha⁻¹ significantly increased yield of

maize under the climatic conditions of Kapisa province.

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