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RESEARCH PAPER

Potassium fertilization effects on growth and yield of hybrid maize under semi-arid conditions of Kandahar province of Afghanistan

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Abstract: A field experiment was carried out at the main block of Tarnak Farm of Afghanistan National Agricultural Sciences and Technology University (ANASTU) Kandahar, Afghanistan during the summer season of 2015, to determine the effects of different potassium fertilizer levels on growth and yields parameters of hybrid maize. The experiment consisted eight potash fertilizer levels viz. 0, 30, 60, 90, 120, 150, 180 and 210 kg K_2O/ha in a randomized complete block design (RCBD) and replicated thrice. Results showed that application of 60 kg K_2O/ha significantly improved plant height, leaf area index and gains/cob over control and statistically on par with other higher K levels. The highest dry matter accumulation, grains/row and 1000-grains weight were recorded with the application of 210 kg K_2O/ha, which was statistically at par with all other treatments except control. Cob length and grain yield were significantly highest with 180/210 kg K_2O/ha which was on par with nutrient level of up to 90 kg K_2O/ha. The yield obtained with application of 90 kg K_2O/ha was on par with 60 kg K_2O/ha. Therefore, it is concluded that application of 60 kg K_2O/ha to be recommended for enhancing productivity of hybrid maize under semi-arid condition of Kandahar province of Afghanistan.

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Introduction

In Afghanistan, maize is grown on 0.142 million hectares area. The total production is 0.312 million tonnes with an average productivity of 2.2 tonnes/ha which is less than half of the global productivity. Out of this, 0.055 m tonnes is used as human food and 0.2 m tonnes for animal feed. Afghanistan imports large quantities of maize from neighboring countries, as domestic production is not sufficient for 30 million populations. Currently, the main constraints to maize production for small-scale farmers in Afghanistan are the lack of improved adapted varieties, and shortage of high-quality fertilizer (Jilani *et al.,* 2013). Due to the poor inherent soil fertility in Afghanistan, the use of fertilizer is quite common. After nitrogen and phosphorus, potassium (K) is the nutrient most likely to limit plant growth. It is needed for energy metabolism, starch synthesis, photosynthesis, nitrogen fixation, and sugar degradation and it is not currently considered a threat to water quality (Anonymous, 2022); however, K fertility management is important because plants with optimum K levels are more resistant to environmental stresses, including drought. Application of potassium @ 375 kg/ha increased grain weight/cob, 1,000-grains weight, grain yield and biological yields of different maize hybrids (Ali *et al.,* 2004). Maize yield parameters like cob weight, cob length, cob girth and grain yield increased steadily with increasing potassium doses and reached optimum values at 155.8 and 144.8 kg K/ha (Kenyanya *et al*., 2014). Therefore, it is necessary that suitable amount of potassic fertilizer should be applied to enhance

crop productivity in a cost-effective manner. Keeping these aspects in view an experiment was undertaken to study the effect of potassic fertilizer levels on growth and yield of hybrid maize.

Materials and methods

The experiment was conducted in the main block of Tarnak Farm of Afghanistan National Agricultural Sciences and Technology University (ANASTU) Kandahar, Afghanistan during the summer season of 2015. The rainfall received during crop growing period from May to August was 9.6 mm. The soil of the experimental site was sandy clay loam with 7.4 pH and was low in nitrogen, medium in available phosphorus and high in available potassium. The experiment was laid out in randomized block design with three replications. The potassium treatments were 0, 30, 60, 90, 120, 150, 180 and 210 kg K_2O/ha, applied as basal dose through muriate of potash. Nitrogen and phosphorus were applied equally to all plots as per recommended dose of 150 and 60 kg/ha, respectively. Maize cultivar CS-200 was sown using seed rate 25 kg/ha at 70 cm × 20 cm spacing. Due to subtropical and arid climate of experimental area, irrigation were given based on soil moisture condition, the crop was irrigated nine times during growing season. First irrigation was done at 13 days after sowing (DAS) and subsequently, eight irrigation were applied as and when required at different plant growth stages, until the crop attained its physiological maturity. Growth parameters were recorded from three randomly selected plants from each plot using a standard procedure. The data were collected at 30, 60, 90 DAS and at harvest (115 DAS). The data for yield parameters such as grains/cob, grains/row, cob girth, cob diameter, cob length and 1000-grains weight were recorded from six randomly sampled plants in each experimental unit. The data recorded for different parameters were analyzed statistically by the method of analysis of variance (ANOVA) in complete randomized block design by using SAS 9.3 software. The standard error of means was calculated in all the cases. Wherever the 'F' test was found significant at 5 per cent level of significance correspondence least significant differences (LSD) values were calculated to compare the significance of results. The correlation analysis was performed using the MS excel.

Results and discussion

Growth attributes

The growth parameters viz., plant height, dry matter accumulation (DMA) and leaf area index (LAI) at various crop growth stages responded to potassium application in maize up to 60 kg K_2O/ha (Table 1). The application of 30 kg K_2O/ha resulted in the increase of maize plant height by 29.3, 21.8, 16.4 and 12.3 per cent over control at 30, 60, 90 DAS and at harvest, respectively. The similar increase was also reported in leaf area index. The application of 30 kg K_2O/ha increased dry matter accumulation by 30.0, 11.7, 32.8 and 26.9 per cent at 30, 60, 90 DAS and at harvest, respectively which was at par

Table 1. Effect of potassium levels on plant height, leaf area index and dry matter accumulation of maize at different growth stages

K levels	Plant height (cm)				Leaf area index			Dry matter accumulation (g/plant)			
(kg K_2O/ha)	30 DAS*	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	At harvest
0	16.7	75.3	145.5	154.9	0.32	3.05	3.46	2.0	91.3	124.4	179.5
30	21.6	91.7	169.4	174.0	0.42	3.18	3.72	2.6	102.0	165.2	227.7
60	25.6	102.4	187.7	188.2	0.45	3.70	3.88	2.8	109.8	173.7	237.9
90	26.8	103.9	188.3	188.8	0.44	3.77	3.95	2.9	110.7	175.0	239.4
120	27.0	104.1	189.0	189.7	0.44	3.78	4.01	3.0	112.8	177.8	242.7
150	27.0	104.8	190.1	190.8	0.44	3.85	4.06	3.2	114.2	179.9	245.0
180	28.0	106.3	191.0	191.2	0.47	3.90	4.08	3.3	115.1	185.8	252.2
210	28.3	106.7	191.7	192.3	0.47	3.93	4.11	3.3	115.4	187.2	253.9
SEm(±)	1.61	5.19	7.11	5.88	0.022	0.145	0.114	0.11	4.44	11.8	11.76
LSD (P=0.05)	4.88	15.75	21.58	17.82	0.068	0.439	0.347	0.35	13.46	35.7	35.66

DAS*= Days after sowing

up to 210 kg K_2O/ha over control. The similar findings of increased plant height and leaf area and leaf area index (LAI) in maize were reported by many workers in South Asia (Tabri and Akil, 2010; Ahmad *et al.,* 2015). Mastoi *et al.* (2013) also found that potassium application at 60 kg/ha by integrating organic and inorganic K fertilizers increased plant height (2 to 15 per cent), and fresh biomass (13 to 60 per cent) in Pakistan. Similarly, the fertilizer level of 30 K_2O kg/ha resulted in significant increase in growth characters i.e. plant height, leaf area index and dry matter production at different growth stages in Kashmir, Budgam in India (Khuspe *et al.,* 2016). It might be due to potassium @ 60 kg/ha as basal application improved the root system in hybrid maize (Gul *et al.,* 2015). Moreover, the potassium application improves utilization of water, its application accelerates photosynthesis process, water uptake through roots and reduces the per cent of senescent stalks, lodging and increased crushing strength and rind thickness (Bukhsh *et al*., 2012).

As a result, the application of potassium improves leaf area index, dry matter accumulation and other allometric parameters. The enhanced growth due to potassium application was due to several roles of K in crop plants that might help in increasing plant height and leaf area index over control. The important reasons might be increased root growth (Valadabadi and Farahani, 2009), improved stalk strength (Sala *et al*., 2014), increased photosynthesis (Hussain *et al*., 2015) and balancing the internal nutrient status specially Na: K ratios in saline soils (Wang *et al*., 2013), and significant improvement in most of the physiological processes (Wang *et al*., 2013).

Yields attributes and yield of maize

The yield attributes and yield of maize increased significantly with potassium application in our study (Table 2). Significantly higher cob length in maize was recorded by the application of potassium over control. The highest cob length of maize (20 cm) was recorded by the application of 210 kg K_2O/ha and was at par with higher levels of potassium application beyond 90 kg K_2O/ha (18.6 cm) in our study. The cob length increased due to K nutrition (175 kg/ha) which corroborates with our findings as reported earlier by Ijaz *et al.* (2014). The enhancement in the growth parameters resulted in the generation of the better sink which might have increased the sink strength and hence improved the cob length significantly. The positive correlation estimated in our study for cob length with growth parameters further affirmed our assumption (Figure 1 and 2). Thus, the better source is a key for the best sink in maize.

Significantly higher number of grains/rows (35.5) was recorded by the application of potassium 210 kg K_2O/ha. The application of 30 kg K_2O/ha resulted increased in grains/row by 15.5 per cent and 1,000-grains weight by 11.7 per cent over control which was at par with all K levels in our study. The highest number of grains/cobs (463) was recorded with the application of 210 kg K_2O/ha, however it was not significant with higher doses beyond 60 kg K_2O/ha. The yield attributes of maize viz., cob length, gains/cob, increased with application of 90 and 60 kg K_2O/ha, respectively over no K application. The yield obtained in 90 kg K_2O/ha was on par with 60 kg K_2O/ha. The enhancement in the growth parameter which

Table 2. Effect of potassium levels on yield attributes and yield of maize

K levels (kg K_2O/ha)	Grains/row	Grains/cob	Cob length (cm)	1,000-grains weight (g)	Grain yield (t/ha)
Control	28.3	377	15.8	213	4.3
0	32.7	410	17.3	238	5.7
30	33.0	438	17.6	255	7.5
60	33.2	442	18.6	258	7.8
90	35.0	443	18.9	260	8.0
120	35.2	452	19.0	262	8.4
150	35.4	457	19.7	262	8.6
180	35.5	463	20.0	263	8.6
SEm±	1.43	15.4	0.52	10.16	0.32
LSD (P=0.05)	4.33	46.6	1.58	30.80	0.96

acted as a source for better photosynthesis and accumulation of more sugars for generation of the better sink and ultimately enhanced the yield attributing characters in maize. However, more genetic controlled attributed like cob girth, cobs/plant and grain rows/cob were not significantly influenced by K fertilization (data not reported). This shows that the parameters like cob length, grains/cob, grains/row and 1,000-grains weight can be increased in maize by K fertilization. The better source and good sink with the continued supply of nutrients and

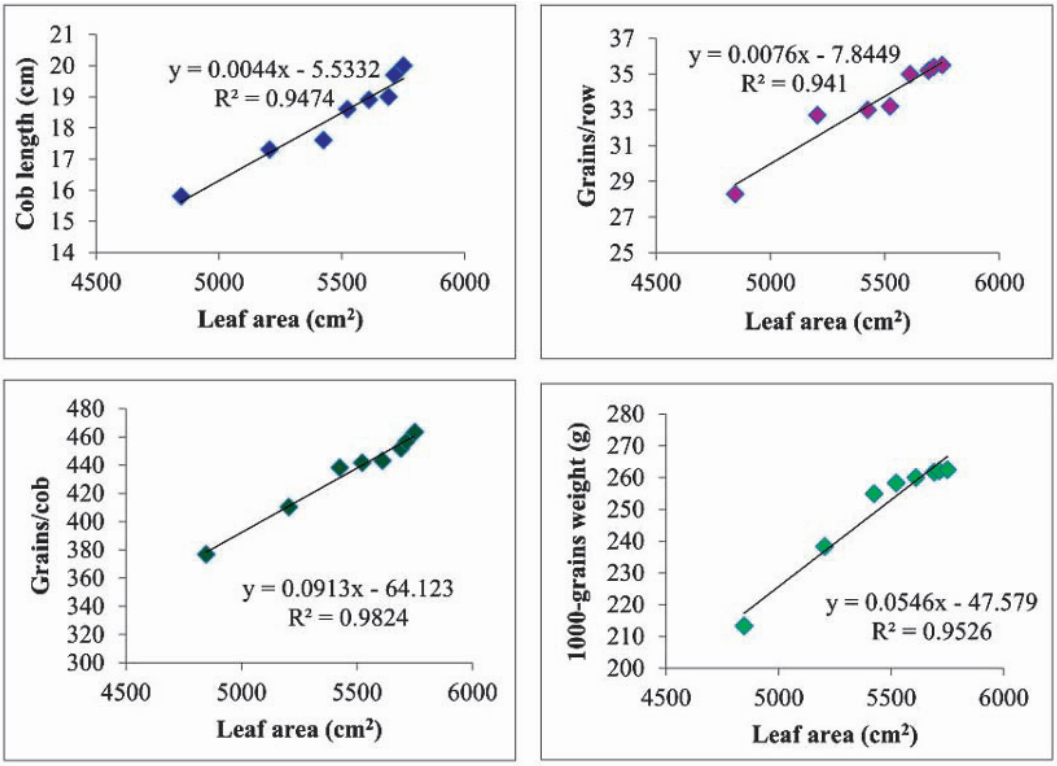

Figure 1. Correlation among the various yields attributes with the leaf area at 90 DAS in maize

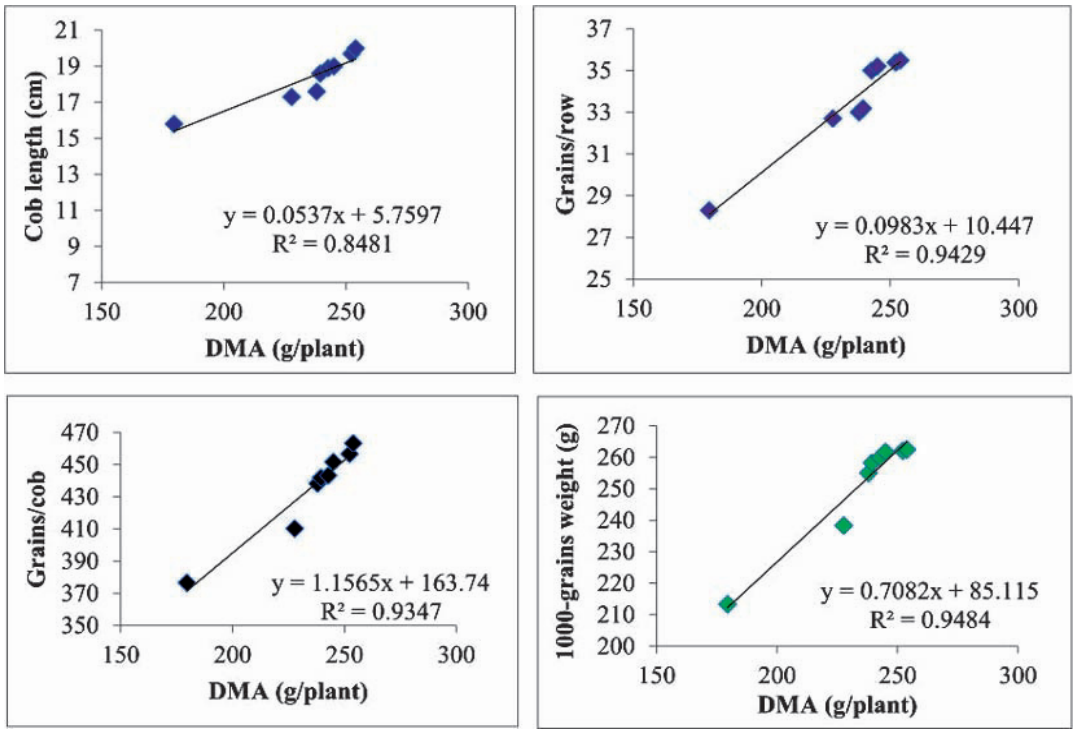

Figure 2. Correlation among the various yields attributes with the dry matter accumulation (DMA) at harvest in maize

photosynthetic might have helped in the production of bolder grains and thus, enhanced the grain weight/cob as well as 1,000-grains weight in our study. However, Tabri and Akil (2010) reported that K application had no significant effect on 1,000-seed weight and weight of cobs.

Significantly higher grain yield (8.6 t/ha) were recorded with the application of 180 and 210 kg K_2O/ha over control (4.3 t/ha). The application of lower doses of potassium @ 30 and 60 kg K_2O/ha resulted in increased grain yield (t/ha) to the tune of 32.6 and 74.6 per cent compared to control, respectively. The enhanced growth attributes like dry matter, plant height and leaf area increased the yield attributes of maize in our study. The strong significant positive correlation among these parameters confirms that these are linked and enhancement in growth led to increased yield attributes in maize in Kandahar conditions (Figure 1 and 2).

Application of potassium with little dose of 30 kg K_2O/ha could enhance the dry matter accumulation, grains/rows and 1000-grains weight while 60 kg K_2O/ha enhances plant height, leaf area index and gains/cob of maize and further increase in level up to 90 kg K_2O/ha increased key parameters of cob length and grain yield. The application of potassium up to 60 kg K_2O/ha significantly enhanced most of the growth parameters and yield attributes of maize, while application of 90 kg K_2O/ha resulted in significantly higher grain yield of maize under semi-arid conditions of Kandahar province of Afghanistan. It is concluded that application of 60 kg K_2O/ha could enhance key yield attributes and yield of hybrid maize under semi-arid condition of Kandahar province of Afghanistan.

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