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Effect of Potassium Level on Growth, Yield, Nutrient Uptake and Economics of Hybrid Maize

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ABSTRACT

Potassium is indeed one of the major essential nutrients required for optimal plant growth and development. It plays a crucial role in various physiological and biochemical processes within plants. In order to investigate the effect of different level of potassium on growth, yield, nutrient uptake and economics of hybrid maize a experiment was conducted at District Seed Farm of Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia and West Bengal, India. In experiment Randomized Block Design was employed and consisted of six treatment levels of potassium : T_1 (0 kg K_2O ha^{-1}), T_2 (30 kg K_2O ha^{-1}), T_3 (60 kg K_2O ha^{-1}), T_4 (90 kg K_2O ha^{-1}), T_5 (120 kg K_2O ha^{-1}) and T_6 (150 kg K_2O ha^{-1}) with recommended dose of nitrogen and phosphorus (120:60 N : P_2O_5 kg ha^{-1}). Result indicated that plant height, grain yield, stover yield, net return and benefit : Cost ratio showed significant response upto 90 kg K_20 ha^{-1}. The total uptake of N, P and K showed significant response upto 90 kg K_20 ha^{-1}. Based on the results of the experiment, it was found that the application of potassium up to 90 kg K_2O ha^{-1} is necessary to ensure a continuous supply of potassium to maize plants. This optimal potassium level was associated with higher maize yields and economic benefits, particularly when cultivating hybrid maize varieties.

Keywords Potassium level, Yield, Nutrient uptake, Economics, Hybrid maize.

INTRODUCTION

Maize (*Zea mays* L.), commonly known as corn, is indeed one of the most important cereal crops in the global agricultural economy. It is cultivated on a large scale in various regions around the world, making significant contributions to food security, livestock feed, and various industrial applications. According to FAOSTAT data from 2020, maize production worldwide amounted to approximately 1,147.7 million metric tons (MT). This production was achieved across more than 170 countries, utilizing a total land area of about 193.7 million hectares (ha). The average productivity of maize crops globally was recorded at 5.75 metric tons per hectare (t/ha).Indeed, maize crops possess a high yield potential and can respond positively to various agro-management practices. However, several constraints can contribute to low maize yields. Indeed, maize crops possess a high yield potential and can respond positively to various agro-management practices. However, several con-

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straints can contribute to low maize yields.

Potassium, being one of the macronutrients, is indeed vital for plants. It plays numerous roles in plant physiology, such as regulating water balance, osmotic potential and activating enzymes involved in various metabolic processes (Gnanasundari *et al.* 2018). In many agricultural fields, potassium availability can be limited, which can lead to reduced crop yields and lower quality. Therefore, it is crucial to focus on improving the efficiency of potassium uptake, transport, and utilization in plants to enhance agricultural sustainability (Shin 2014). Maize has a relatively high demand for potassium (K) comparable to nitrogen (N). For maize production of approximately 6 metric tons per hectare, it is estimated that maize plants remove approximately 120 kg of nitrogen, 50 kg of phosphorus (P) and 50 kg of potassium per hectare from the soil. (White 2000). During the period of 38 to 52 days after sowing, maize plants have a relatively high demand for potassium (K). It is estimated that during this period, maize plants require approximately 38% of the total potassium needed for their entire growing season. . It also helps plant to regulate the movement of stomata (Ali *et al*. 2020). Potassium (K) plays a significant role in various physiological processes in plants (Marschner 2012). Keeping in mind the experiment was conducted to study the effect of levels of potassium on growth, yields, nutrient uptake and economies of hybrid maize.

MATERIALS AND METHODS

The experiment was carried out at the District Seed Farm (AB Block), Kalyani, Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal. The specific geographical coordinates provided are latitude 22°57'N and longitude 88°20'E. The elevation of the location is approximately 9.75 meters above sea level. The experiment took place during the *kharif* seasons of 2016, 2017 and 2018. The soil of experimental plots was silty clay loam in texture having pH neutral in reaction (7.20) with medium in organic carbon (0.52%) and available nitrogen (259 kg/ha), high in available phosphorus (35 kg/ha) and medium in available potassium (210 kg/ha).The experiment was designed using the Randomized Block Design (RBD) and replicated thee times having six treatments viz. potassium levels as 0 (T_1), 30 (T_2), 60 (T_3), 90 (T_4), 120 (T_5) and 150 (T_6) kg K_2O ha^{-1} with recommended dose of nitrogen and phosphorus (120:60 N: P_2O_5 kg ha^{-1}). As per the treatment, nitrogen was applied in three split, viz., as basal, 30 and 60 days after sowing. The entire dose of 20 units of phosphorus (P) and potassium (K) was applied as a basal application. The sources of fertilizers were urea, single super phosphate and muriate of potash, respectively. Maize hybrid was COH (M) 8 sown with a spacing of 60 cm × 20 cm and using 20 kg ha^{-1} seed rate. Biometric observations likes plant height, grain yield and stover yield were recorded at harvest. Nutrient uptake by crop was calculated by using following formula -Nutrient uptake (kg/ha) = (Percent of nutrient concentration / 100) × yield (kg/ha). Economics of crop was calculated depend on local market prices of the inputs and outputs. The collected data of the one season was statistically analyzed according to the analysis of variance (ANOVA) by using MSTAT-C computer software packages.

RESULTS AND DISCUSSION

Yield (kg ha^{-1}) as affected by different potassium levels

Statistical analysis of the data showed that potash (K) application significantly affected grain and Stover yield (Table 1). The higher grain yield (10.38 t ha^{-1}, 10.62 t ha^{-1} and 10.13 t ha^{-1} during 2016, 2017 and 2018 respectively) and Stover yield (9.72 t ha^{-1}, 9.35 t ha^{-1} and 9.49 t ha^{-1} during 2016, 2017 and 2018 respectively) were obtained with 90 kg K_2O ha^{-1}. While no application of potash (T_1) resulted in lower grain and Stover yield. The results indicated that an increase in grain yield was observed as the potassium level increased up to 90 kg K_2O per hectare (ha). However, when the potash level was further increased above 90 kg K_2O ha^{-1}, there was no significant additional increase in grain yield. It is possible that the observed increase in grain yield up to 90 kg K_2O ha^{-1} could be attributed to the stimulation of prolific root growth, enhanced water and nutrient absorption (Ramachandrappa *et al.* 2013).Therefore, the findings of this study indicate that regular potassium additions, up to the point of achieving the optimal level (90 kg K_2O ha^{-1} in this case), are necessary to maintain soil

Table 1. Effect of potassium levels on yield and plant height of maize.

Treatment	Grain yield (t/ha)			Stover yield (t/ha)			Plant height (cm)		
	2016	2017	2018	2016	2017	2018	2016	2017	2018
T_1	7.33	6.84	6.51	9.29	8.83	8.82	233.0	199.3	267.0
T_2	7.73	7.47	7.35	9.72	9.35	9.49	244.5	202.7	277.7
T_3	10.26	7.62	7.53	12.41	9.70	9.55	255.5	209.7	286.7
T_4	10.38	10.62	10.13	12.21	12.79	11.94	259.1	257.7	295.0
T_5	8.14	9.33	8.02	10.10	11.17	10.11	247.0	211.7	282.0
T_6	8.90	8.45	8.47	11.19	10.47	10.34	248.8	204.0	284.3
SEm ±	0.03	0.38	0.52	0.05	0.51	0.48	0.77	11.92	4.51
CD at 5%	0.10	1.14	1.56	1.56	1.53	1.46	2.3	35.7	13.5

productivity and maximize crop yield. Application of potassium was found to increase the shoot dry weight of maize due to selective and adequate potassium uptake in the plant tissue (Kaya *et al.* 2009) therefore increased the stover yield of maize. The similar results are also found by Bereez *et al.* (2005) and Chaudhary and Malik (2000).

Plant height (cm) as affected by different potassium levels

Potash (K) application significantly influenced plant heights (Table 1) at harvest. Application of potassium @ 90 kg ha^{-1} (T_4) recorded the highest plant height of 259.1 cm, 257.7 cm and 295.0 cm during 2016, 2017 and 2018, respectively. Lower plant height (233.0 cm, 199.3 cm and 267.0 cm during 2016, 2017 and 2018, respectively) was recorded in control plot (T_1). The increase in plant height of maize in treatment T_4, because higher potassium doses promoted plant growth, increased the number and length of the internodes due to more cell division and cell elongation which in turn resulted higher plant height. However, the findings from Swetha *et al*. (2017) suggest that potassium fertilization can have beneficial effects on delayed leaf senescence, sustained photosynthesis and vegetative growth, leading to improved crop performance. Throughout the crop growth period, the plant under graded level of potassic fertilizers performed better when compared to control (Gnanasundari *et al.* 2018). Findings of this study are in line with Ayub *et al.* (2002), Hussain *et al.* (2011), Bukhsh *et al.* (2011) and Aslam *et al*. (2004) who also found improvement in growth parameters in different cultivars by the potash application.

Effect of potassium levels on net return and B: C ratio

The potassium levels significantly influenced the net return and benefit cost ratio of maize (Table 2). Maximum net return (Rs 84,686/-, 1,00,338/- and 95, 451/- ha^{-1} during 2016, 2017 and 2018, respectively) and benefit cost ratio (3.11, 3.26 and 2.90 during 2016, 2017 and 2018, respectively) was obtained in T_4 treatment (90 kg K_2O ha^{-1}). The mean data revealed that net return and benefit cost ratio increased significantly with the higher potash level up to 90 kg K_2O ha^{-1}.

Table 2. Effect of potassium levels on net return and B:C ratio of maize.

Treatment	Net returns (Rs/ha)			B:C ratio		
	2016	2017	2018	2016	2017	2018
T_1	47830	57027	48062	2.19	2.15	2.01
T_2	52618	65911	58690	2.31	2.31	2.21
T_3	84563	68123	60245	3.07	2.35	2.22
T_4	84686	100338	95451	3.11	3.22	2.90
T_5	57618	92558	65566	2.43	2.80	2.29
T_6	66862	79343	70690	2.67	2.53	2.37
SEm ±	436.60	9236.12	7201.47	0.01	0.11	0.15
CD at 5%	1309.80	27708.3	21604.4	0.03	0.35	0.44

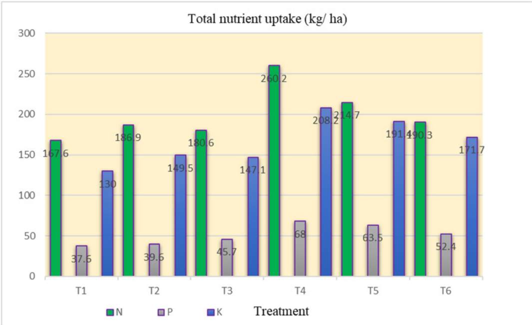

Fig. 1. Effect of potassium levels on nutrient uptake of maize.

This to higher grain and Stover yield of maize under these treatments. Lowest net return and benefit cost ratio of maize was obtained in T_1 treatment where recommended N and P applied only.

Nutrient uptake by plant as affected by potassium fertilization

The results in pooled data of three years Fig. 1 referred to the significant effect of potassium fertilizer on nutrient uptake of corn plant. Maximum nitrogen uptake (260.2 kg ha^{-1}), phosphorus uptake (68.0 kg ha^{-1}) and potassium uptake (208.2 kg ha^{-1}) was recorded at potassium level 90 kg K_2O ha^{-1}. The mean data revealed that nutrient uptake increased significantly with the increase in potash level up to 90 kg K_2O ha^{-1}. This might be due to improved utilization of applied nitrogen in the presence of sufficient potassium.The information from Thippeswamy (1995). According to their findings, there was a positive interaction between nitrogen (N) and potassium (K) in ragi (finger millet) crops. According to Kumar *et al.* (2015), increasing levels of potassium application resulted in an increase in the uptake of other nutrients, such as nitrogen and phosphorus. This effect is attributed to the synergistic influence of potassium and the translocation of other nutrients facilitated by the applied potassium. The increase in potassium uptake by maize can be attributed to the availability of potassium from both added fertilizer sources and native soil potassium, particularly during critical stages of the maize plant's growth. This is in conformity with the findings of Srinivasa (2013) and Thippeswamy (1995). Minimum uptake of nitrogen (167.6 kg ha^{-1}), phosphorus (37.6 kg ha^{-1}) and potassium (130 kg ha^{-1}) was recorded in control (T_1 treatment) plot compared with other treatments.

CONCLUSION

From the experimental results, it could be concluded that application of potassium up to 90 kg K_2O ha^{-1} is necessary for the continuous supply of K to maize and to obtaining the higher yield and economic benefit of hybrid maize.

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