



Effect of Different Levels of Potassium on Yield and Economics of Kharif Maize (*Zea mays* L.)

**Mohd. Zakir Hussain¹, Ashok Kumar¹, Devendra Mandal¹,
Rajeev Singh^{1*} and R. K. Sohane²**

¹Krishi Vigyan Kendra, Manpur, Gaya, India.

²Bihar Agricultural University (BAU), Sabour, Bhagalpur, India.

Authors' contributions

This work was carried out in collaboration among all authors. Author MZH designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors AK and DM managed the analyses of the study. Authors RS and RKS managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted during Kharif season at Crop Research Farm of Tirhut College of Agriculture, Dholi in 2017 to observe the effect of different levels of potassium on yield and economics of Kharif maize. The experiment was laid out in Randomized block design with four replications and nine treatments at a different level of potassium (0, 30, 60, 90, 120 and 150 kg ha⁻¹) in which three treatments T₇, T₈ and T₉ were along with 5 tons of FYM. There were no marked effect of different treatments on the number of cob plant⁻¹, length of cob, the girth of cob and test weight. However, the number of grains cob⁻¹ was found significantly higher in treatment T₉ (T₄ + 5 t FYM ha⁻¹). Grain yield, stover yield and stone yield were significantly influenced by different treatments. The maximum grain yield (63.19 q ha⁻¹), stover yield (101.61 q ha⁻¹) and stone yield (14.61 q ha⁻¹) were recorded under treatment T₉ (T₄ + 5 t FYM ha⁻¹). Economics of different treatments indicated that by higher grain yield, treatment T₉ (T₄ + 5 t FYM ha⁻¹) exhibited maximum gross returns, net returns and B:C ratio of Rs 90,046 ha⁻¹, Rs 47,987 ha⁻¹ and 1.14, respectively.

*Corresponding author: E-mail: singhrajeev79@gmail.com;

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1. INTRODUCTION

In India, Maize is emerging as third most important cereal crop after rice and wheat that occupies an area of 9.60 million ha with the production of 27.15 million tonnes, having average productivity of about 2.8 tonnes ha⁻¹. Maize is grown throughout the year (Kharif, Rabi and Zaid season) in Bihar. The area, production and average productivity under maize crop in Bihar is about 0.72 million ha, 3.8 million tonnes and 5.3 tonnes ha⁻¹, respectively. Begusarai, Khagaria, Samastipur, Katihar, Purnea and Madhepura is the major maize growing districts of Bihar [1].

Maize, a crop of worldwide economic importance, provides approximately 30 per cent of the food calories to more than 4.5 billion people in 94 developing countries. Demand for maize is expected to double worldwide by 2050. Maize in India contributes nearly 9 per cent of the national food basket and more than Rs 100 billion to the agricultural GDP at current prices apart from generating employment to over 100 million man-days at the farm and downstream agricultural and industrial sectors [2].

Maize provides food, feed, fuel and fodder. Further, it also serves as a source of basic raw material for the number of industrial products, viz. starch, oil, alcoholic beverages, food sweeteners, cosmetics and bio-fuel, etc. According to Daas et al. (2008), it contributes for food (25%), animal feed (12%), poultry feed (49%), starch (12%), brewery (1%) and seed (1%). Maize grains are a very good source of starch (72%), protein (10%), fibre (8.5%), oil (4.8%), sugar (3%) and ash (1.7%) with significant quantities of vitamin A, nicotinic acid and vitamin E [3]. Calorie yield content in maize is two and half times more than that in paddy and wheat [4].

Potassium has important functions in plant water relations where it regulates ionic balances within cells and also play a significant role in the activation of more than 60 enzymes which catalyze various metabolic process and uptake and translocation of nitrates from root to aerial parts of plants [5]. The physiological role of potassium is indispensable for the maintenance of cell turgor pressure that is required for cell expansion. Potassium also plays a key role in osmoregulation of plant cell and regulates the opening and closing of stomata. Potassium is not constituent of organic structure but regulates

enzyme activities and translocation of photosynthates [6]. Since high input agriculture had degraded soil productivity and environmental quality, the use of organic sources is one of the options in crop production and FYM is a good source. Farmyard manure is bulky and supplies a large quantity of organic matter, increase soil tilth, aeration, water holding capacity and activity of microorganisms.

The objective of the study was to evaluate the effect of different levels of potassium on the yield and economics of maize production.

2. MATERIALS AND METHODS

A field experiment was conducted at the Crop Research Centre of Tirhut College of Agriculture, Dholi, Muzaffarpur, Bihar during Kharif 2017. The soil of the experimental plot was calcareous alluvium in nature developed on the sediments of the river Burhi Gandak mainly by the deposition of sediments through the ages. The chief characteristics of this soil is the high content of free calcium carbonate ranging from 10 to 45 per cent which is distributed throughout the depth of the profile. The experiment was laid out in a randomized block design with four replications. The treatment comprised of nine treatments viz., RD of N and P + 0 kg K ha⁻¹ (T₁), RD of N and P + 30 kg K ha⁻¹ (T₂), RD of N and P + 60 kg K ha⁻¹ (T₃), RD of N and P + 90 kg K ha⁻¹ (T₄), RD of N and P + 120 kg K ha⁻¹ (T₅), RD of N and P + 150 kg K ha⁻¹ (T₆), T₂ + 5 t FYM ha⁻¹ (T₇), T₃ + 5 t FYM ha⁻¹ (T₈), T₄ + 5 t FYM ha⁻¹ (T₉). Pioneer-3377 variety of maize was sown according to the dates decided in the treatment, maintaining 60 cm row-to-row and 20 cm plant to plant distance with the seed rate of 20 kg ha⁻¹ at 3-4 cm depth. The results were analyzed taking consideration of grain yield, harvest index, cost of cultivation, gross return, net return and B:C ratio were collected using standard procedures. The data obtained from this study were analyzed statistically following Randomized Block Design as per the procedure is given by Gomez and Gomez [7]. CD values at P = 0.05 were used to determine the significance of the difference between treatment means.

3. RESULTS AND DISCUSSION

3.1 Effect of Different Treatments on Yield Attributes and Yield

Yield attributes: The data presented in Table 1 showed that there was no significant effect of

treatment on the number of cob plant-1 because the number of cobs is more or less a genetic character. However, the different treatments exhibited a significant influence on yield attributes. Application of recommended dose (RD) of N and P + 90 kg K along with 5 t FYM ha⁻¹ (T₉) recorded significantly the higher length of cob (16.12 cm), cob girth (13.52 cm), number of grains per cob (356.84) and test weight (241.75 g).

Yield attributing characters viz. length of cob, the girth of cob, and the number of grains cob-1 increased with the progressive increase in potassium application. Among the treatments, T₉ (RD of N and P + 90 kg K along with 5 t FYM ha⁻¹) recorded maximum yield attributes and was comparable to the rest of the treatments. The availability of the required quantity of nutrients for a longer period coinciding with the critical phases of the plant was probably responsible for higher values of yield components. The further continued availability of K contributed to the partitioning of biomass to the reproductive parts. Effective translocation of assimilates to the sink might have resulted in the sound filling of grains as revealed by the maximum number of grains cob⁻¹. These findings were supported by Akhtar et al. [8] and Hussain et al. [9]. Another important component determining the final yield of maize was 1000-grain weight. It is a partially genetic character, however, may be influenced by management practices. The maximum value (241.75 g) was recorded in treatment T₉ which might be due to better nutrient translocation to sink under higher potassium doses and FYM. These findings were supported by Irfanullah et al. [10].

Yield (q ha⁻¹): The data obtained on the grain yield of maize as influenced by different treatments were statistically analysed and have been presented in Table 2. From the perusal of mean data, different treatments have significantly affected the yield of maize. Each incremental dose of potassium recorded higher grain yield, stover yield and stone yield than its preceding one⁻¹ except for treatment T₆ (RD of N and P + 150 kg K ha⁻¹). Significantly, the highest grain yield (63.19 q ha⁻¹), stover yield (101.61 q ha⁻¹) and stone yield (14.61 q ha⁻¹) was recorded in treatment T₉ which was followed by treatment T₈, T₅, T₆, T₇, T₄, T₃, T₂ and least in T₁ respectively.

The higher benefits from the combined application of FYM and potassium might be attributed, in part, to enhanced nutrient uptake

due to increased physio-chemical and microbiological properties of soil as a result of increased soil organic matter and releasing of bonded P from the soil due to the release of acids by decomposition of FYM. Besides it, provide macro and micronutrient organic manure improved the crop production by providing a better source-sink relationship enabling greater synthesis and translocation of metabolites to reproductive organs resulting in improved yield attributing characters and grain yield of maize. The results are in agreement with the findings of Ahmad et al. [11], Berez et al. [12], Choudhary and Malik [13] and Daniel et al. [14].

Stover and stone yield also followed a similar trend as grain yield. Stover and stone yield is the number of photosynthates that did not contribute to grain yield. These results have been supported by workers Hidayatullah et al. [15].

3.2 Harvest Index (%)

Among the treatments harvest index did not vary significantly have been presented in Table 2. The higher value of harvest index (35.22%) was obtained when applied the recommended dose of N and P + 90 kg K ha⁻¹ along with 5 t FYM ha⁻¹ (T₉) followed by treatment T₈ (34.39%) and T₅ (34.27%), respectively and lower value (31.81%) was recorded under treatment T₁. It might be due to the increase in harvest index was attributed to the more dry matter accumulation into the reproductive parts (ears) of maize and therefore increased grain yield and higher harvest index. The results are in line with the finding of Mahadi et al. [16] and Fallah et al. [17].

3.3 Effect of Different Treatments on Economics

Economics of maize production depends on several factors such as input cost, labour requirement and above all the weather conditions prevailing during the crop period. The economics of maize production was worked out by calculation cost of cultivation item-wise and deducting it from the price of different treatment cost to get the net return. Gross and net return increased significantly with the application of different levels of potassium have been presented in Table 3. Highest gross return (Rs 90046 ha⁻¹), net return (Rs 47987 ha⁻¹) and B:C ratio (1.14), respectively of maize was recorded

Table 1. Number of cob plant⁻¹, length of cob, the girth of cob, number of grains cob-1 and test weight of maize as affected by different treatments

Treatments	Number of cob/plant	Length of cob (cm)	Girth of cob (cm)	Number of grains/ cob	Test weight (g)
T ₁ - RDF of nitrogen and phosphorus + 0 kg potassium per ha	1.0	14.49	12.01	300.14	216.12
T ₂ - RDF of nitrogen and phosphorus + 30 kg potassium per ha	1.0	14.73	12.55	315.25	222.48
T ₃ - RDF of nitrogen and phosphorus + 60 kg potassium per ha	1.0	14.96	12.87	322.68	227.35
T ₄ - RDF of nitrogen and phosphorus + 90 kg potassium per ha	1.0	15.15	13.10	326.15	229.84
T ₅ - RDF of nitrogen and phosphorus + 120 kg potassium per ha	1.0	15.84	13.45	342.53	236.13
T ₆ - RDF of nitrogen and phosphorus + 150 kg potassium per ha	1.0	15.67	13.43	335.34	234.24
T ₇ - T ₂ + 5.0 t/ha FYM	1.0	15.50	13.32	330.22	232.44
T ₈ - T ₃ + 5.0 t/ha FYM	1.0	15.92	13.49	348.45	238.15
T ₉ - T ₄ + 5.0 t/ha FYM	1.0	16.12	13.52	356.84	241.75
SEm±	0.03	0.47	0.40	10.17	7.07
CD(P=0.05)	NS	NS	NS	29.85	NS

Table 2. Grain yield, stover yield, stone yield and harvest index of maize as affected by different treatments

Treatments	Grain yield q/ha)	Stover yield (q/ha)	Stone yield (q/ha)	Harvest index (%)
T ₁ - RDF of nitrogen and phosphorus + 0 kg potassium per ha	42.63	81.81	9.59	31.81
T ₂ - RDF of nitrogen and phosphorus +30 kg potassium per ha	47.4	87.62	10.71	32.53
T ₃ - RDF of nitrogen and phosphorus +60 kg potassium per ha	53.08	93.61	11.78	33.50
T ₄ - RDF of nitrogen and phosphorus +90 kg potassium per ha	56.26	96.69	12.60	33.98
T ₅ - RDF of nitrogen and phosphorus +120 kg potassium per ha	58.3	98.58	13.23	34.27
T ₆ - RDF of nitrogen and phosphorus +150 kg potassium per ha	57.45	97.72	12.98	34.17
T ₇ - T ₂ + 5.0 t/ha FYM	56.91	96.97	12.65	34.17
T ₈ - T ₃ + 5.0 t/ha FYM	59.23	99.42	13.56	34.39
T ₉ - T ₄ + 5.0 t/ha FYM	63.19	101.61	14.61	35.22
SEm±	2.17	3.73	0.49	1.32
CD(P=0.05)	6.37	10.96	1.44	NS

Table 3. Economic analysis of maize cultivation as influenced by different treatments

Treatments	Cost of cultivation (/ha)	Gross return (/ha)	Net return (/ha)	B:C ratio
T ₁ - RDF of nitrogen and phosphorus + 0 kg potassium fertilizer	35477	60748	25271	0.71
T ₂ - RDF of nitrogen and phosphorus + 30 kg potassium per ha	36943	67545	30602	0.83
T ₃ - RDF of nitrogen and phosphorus + 60 kg potassium per ha	37793	75639	37846	1.00
T ₄ - RDF of nitrogen and phosphorus + 90 kg potassium per ha	38643	80170	41527	1.07
T ₅ - RDF of nitrogen and phosphorus + 120 kg potassium per ha	39493	83077	43584	1.10
T ₆ - RDF of nitrogen and phosphorus + 150 kg potassium per ha	40343	81866	41523	1.03
T ₇ - T ₂ + 5.0 t/ha FYM	40359	81097	40738	1.01
T ₈ - T ₃ + 5.0 t/ha FYM	41209	84403	43194	1.05
T ₉ - T ₄ + 5.0 t/ha FYM	42059	90046	47987	1.14
SEm±	-	2866	1724	0.04
CD(P=0.05)	-	8,415	5,062	0.11

Where, DAS: Days after sowing, CD: Critical difference, FYM: Farmyard manure, RDF: Recommended dose of fertilizer, SEm: Standard error of the mean, NS: Not significant

in treatment T9 among all treatments. It was due to higher grain, stover and stone yield, while lowest gross return (Rs 60748 ha⁻¹), net return (Rs 25271 ha⁻¹) and B:C ratio (0.71), respectively was recorded under treatment T1.

These results are in agreement with Shah and Ahmad [18] and Sharma and Singh [19].

4. CONCLUSION

It was concluded from the experiment that application of potassium increased yield, yield components and economics. Application of recommended dose of N and P + 90 kg K ha⁻¹ along with 5 t FYM ha⁻¹ was found beneficial in terms of higher yield, yield components and economics of maize than control (recommended dose of N and P + 0 kg K fertilizer). Thus, the use of potassium with FYM increased productivity and quality of grains by maintaining soil health. Remunerative economic returns play a key role to convince the farmers for adoption of any refined version of agro-techniques. In the present study, gross and net returns as well as a benefit: cost ratio was found to be comparatively higher with the application of a recommended dose of N and P + 90 kg K ha⁻¹ along with 5 t FYM ha⁻¹. Thus, use of proportionate level of potassium for increased productivity and quality of grains by maintaining soil health is being recommended by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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