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

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A B S T R A C T

The present experiment entitled "Effect of different levels of potassium on performance of *Kharif* maize (*Zea mays* L.)" was carried out at the Crop Research Centre of Tirhut College of Agriculture, Dholi under Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar during *Kharif* 2017. The experiment was laid out in Randomized Block Design with four replication taking variety 'Pioneer-3377' as a test crop. The soil of the experimental field was sandy loam in texture, calcareous in nature with pH 8.2 and low in organic carbon (0.44%). The soil contained 210, 16.32 and 122 kg ha^{-1} available N, P_2O_5 and K_2O, respectively. The treatment comprised of nine treatments *viz*., RD of N and P + 0 kg K (T_1), RD of N and P + 30 kg K ha^{-1} (T_2), RD of N and P + 60 kg K ha^{-1} (T_3), RD of N and P + 90 kg K ha^{-1} (T_4), RD of N and P + 120 kg K ha^{-1} (T_5), RD of N and P + 150 kg K ha^{-1} (T_6), T_2 + 5 t FYM ha^{-1} (T_7), T_3 + 5 t FYM ha^{-1} (T_8) and T_4 + 5 t FYM ha^{-1} (T_9). There was no marked effect of different treatments on number of cob plant^{-1}, length of cob, girth of cob and test weight. However, number of grains cob^{-1} was found significantly higher in treatment T_9 (T_4 + 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 T_9 (T_4 + 5 t FYM ha^{-1}).

Introduction

Maize is one of the most versatile crops having wider adaptability under diverse soil and climatic condition. Globally, maize is known as the "Queen of cereals" because it has the highest genetic yield potential amongst the cereals owing to its better dry matter accumulation efficiency in a unit area and time particularly up to 30^0 North and 30^0 South latitude. It is cultivated in an area of about 184 million ha into 160 countries in diverse soil types, climate and management practices with wider plant biodiversity, which occupies about 36 per cent towards the global food grain production. The major maize producing countries are USA, China, Brazil, Argentina, Mexico, South Africa, Yugoslavia and India (Anonymous, 2018).

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 are the major maize growing districts of Bihar (Anonymous, 2017).

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 ₹ 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 (Jat *et al*., 2013).

Maize provides food, feed, fuel and fodder. Further, it also serves as a source of basic raw material for number of industrial products, *viz*. starch, oil, alcoholic bevereges, food sweetners, 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 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 (Chaudhary, 1983).

Potassium is one of the principal plant nutrient under pinning crop yield and quality determination. It is an important major element for plant growth. It is needed to larger amount than phosphorus within the live plant tissue and average percentage of K is approximately 8 to 10 times more than phosphorus. It also found that hay or dry matter contains up to four times as much potassium as phosphorus. It is accumulated in abundant amount during the vegetative growth period. Potassium activates many enzymes and plays an important role in the maintenance of potential gradients across cell membranes and the generation of turgor pressure in plants. It regulates photosynthesis, protein synthesis and starch synthesis (Mengel and Kirkby, 1996). It is also the major cation for the maintenance of cation-anion balances. Potassium aids plant in resisting disease, insect, cold weather and drought.

FYM is the principle source of organic matter in our country and it is a source of primary, secondary and micronutrients to the plant growth. It is a constant source of energy for hetrotropic microorganisms, help in increasing the availability of nutrient and crop produce quality. The entire amount of nutrients present in farmyard manure is not available immediately but about 30 per cent of nitrogen, 60 to 70 per cent of phosphorus and 70 per cent of potassium are available to the first crop, while remaining amount of nutrients will be available to succeeding crop (Kaihura, 1999). The application of FYM also enhanced the availability of plant nutrient present in soil. While, FYM applied with Zn and K increased the uptake of deficient nutrients as well as improving the soil chemical, biological and physical properties of soil. FYM is a store house of nutrient, which contain all essential plant nutrients. It is beneficial as apply fertilizer like K in combination with FYM (Nawab *et al*., 2011).

Materials and Methods

A field experiment was conducted during kharif season 2017 at the Crop Research

Centre of Tirhut College of Agriculture, Dholi under Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar (25.98º North latitude and 85^0 East longitudes with an altitude of 52.3 m above the mean sea level). This zone possesses typical sub-tropical climatic conditions characterized by too cold winter and hot-dry summer associated with high relative humidity during the months of July to September. The mean average annual rainfall is 1270 mm out of which nearly 80-90 % is received between June to October. The day length varied from 10 hours 12 minutes to 13 hours 43 minutes. The experiment was laid out in a Randomized Block Design with four replications with objectives to study the effect of potassium levels on yield and yield attributes of maize crop. The treatment comprised of nine treatments *viz*., RD of N and P + 0 kg K (T_1), RD of N and P + 30 kg K ha^{-1} (T_2), RD of N and P + 60 kg K ha^{-1} (T_3), RD of N and P + 90 kg K ha^{-1} (T_4), RD of N and P + 120 kg K ha^{-1} (T_5), RD of N and P + 150 kg K ha^{-1} (T_6), T_2 + 5 t FYM ha^{-1} (T_7), T_3 + 5 t FYM ha^{-1} (T_8) and T_4 + 5 t FYM ha^{-1} (T_9). Pioneer-3377 variety of maize was sown by 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 with a fixed dose of nitrogen (120 kg ha^{-1}) and phosphorus (60 kg ha^{-1}) and quantity of FYM required for plot was calculated as per treatment details. Source of nutrients were urea for nitrogen, Di ammonium Phosphate for phosphorus, muriate of potash for potassium. One third dose of Nitrogen, full dose of Phosphorus and Potash was applied as basal dose. The remaining two third of the Nitrogen was applied in equally two half split at knee high stage and before emergence of tassel. The results were analyzed taking consideration of post-harvest parameters were on number of cob $plant^{-1}$, length of cob, girth of cob, number of grains cob^{-1}, test weight (g) (1000 seed weight), grain yield (kg ha^{-1}), stover yield (kg ha^{-1}) stone yield(kg ha^{-1}) and harvest index (%). Number of cob $plant^{-1}$was calculated from total number of cobs per plot divided by total number of effective plants per plot. Length of the cobs of five labelled plants were measured from base to the tip of the cob after de-husking and the mean value of five randomly selected cob was worked out to expressed in centimetre (cm). The girth of five labelled cob was measured with the help of vernier calliper and the mean value was expressed in cm. After shelling five labelled cobs, the numbers of grains were counted and the mean value was worked out to obtain the number of grains cob^{-1}.The weight of thousand grains were recorded from the grain samples drawn from the produce obtained from each of the net plot and expressed in grams (g). The cobs were dehusked and moisture taken from the sample of each plot. Grain weight were taken from each plot in kg $plot^{-1}$ converted into q ha^{-1} by using following formula-

Grain Yield (q ha^{-1}) =

$$\text{Grain weight}\left(\frac{Kg}{plot}\right) \times \frac{100-\text{Moisture \% in grains}}{100} \; \frac{1.176\times0.8\times1000}{\times Plot\ size\ (m^2)\times100}$$

Where,

1.176 = Constant used for 15 % moisture level

0.8 = Shelling per cent

The plants of each plot were cut from ground level after removal of the cobs. The Stover was allowed to sun dry to obtain a constant weight which gave the Stover yield in kg $plot^{-1}$ and converted into q ha^{-1}. The cobs after shelled remain stone were sun dried to obtain a constant weight which gave the stone yield in kg $plot^{-1}$ and converted into q ha^{-1}.Harvest index is defined as the ratio of economic yield (grain yield) to total biological yield (stover yield + stone yield) and expressed in percentage. The harvest index for maize was worked out as indicated below.

$$\text{Harvest Index (HI)} = \frac{\text{Economic yield (q ha}^{-1}\text{)}}{\text{Biological yield (q ha}^{-1}\text{)}} \times 100$$

The data obtained from this study were analyzed statistically following Randomized Block Design as per the procedure given by Gomez and Gomez (1984). CD values at P=0.05 were used to determine the significance of difference between treatment means.

Results and Discussion

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 number of cob plant^{-1} because number of cob is more or less a genetic character. However the different treatments exhibited their significant influence on yield attributes.

Application of recommended dose (RD) of N and P+ 90 kg K along with 5 t FYM ha^{-1} (T_9) 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, girth of cob, and number of grains cob^{-1} increased with progressive increase in potassium application. Among the treatments, T_9 (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 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. 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 sound filling of grains as revealed by maximum number of grains cob^{-1}.These findings were supported by Akhtar *et al.*, (2003) and Hussain *et al.*, (2007). 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. Maximum value (241.75 g) was recorded in treatment T_9which might be due to better nutrient translocation to sink under higher potassium doses and FYM. These findings were supported by Irfanullah *et al.*, (2017).

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 persual of mean data different treatments were significantly affected the yield of maize. Each incremental dose of potassium recorded higher grain yield, stover yield and stone yield than its preceding one except treatment T_6 (RD of N and P + 150 kg K ha^{-1}). Significantly, 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 T_9 which was followed by treatment T_8, T_5, T_6, T_7, T_4, T_3, T_2 and least in T_1 respectively.

The higher benefits from 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.

Table.1 Number of cob plant^{-1}, length of cob, 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 phoshphorus + 0 kg potassium per ha	1.0	14.49	12.01	300.14	216.12
T_2 -RDF of nitrogen and phoshphorus + 30 kg potassium per ha	1.0	14.73	12.55	315.25	222.48
T_3 - RDF of nitrogen and phoshphorus + 60 kg potassium per ha	1.0	14.96	12.87	322.68	227.35
T_4 - RDF of nitrogen and phoshphorus + 90 kg potassium per ha	1.0	15.15	13.10	326.15	229.84
T_5 - RDF of nitrogen and phoshphorus + 120 kg potassium per ha	1.0	15.84	13.45	342.53	236.13
T_6 - RDF of nitrogen and phoshphorus + 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 (%)
T1- RDF of nitrogen and phoshphorus + 0 kg potassium per ha	42.63	81.81	9.59	31.81
T_2 -RDF of nitrogen and phoshphorus + 30 kg potassium per ha	47.4	87.62	10.71	32.53
T_3 - RDF of nitrogen and phoshphorus + 60 kg potassium per ha	53.08	93.61	11.78	33.50
T_4 - RDF of nitrogen and phoshphorus + 90 kg potassium per ha	56.26	96.69	12.60	33.98
T_5 - RDF of nitrogen and phoshphorus + 120 kg potassium per ha	58.3	98.58	13.23	34.27
T_6 -RDF of nitrogen and phoshphorus + 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

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.,* (2014), Bereez *et al.,* (2005), Choudhary and Malik (2000) and Daniel *et al*., (2008).

Stover and stone yield also followed the similar trend as grain yield. Stover and stone yield is the amount of photosynthates that did not contribute to grain yield. This results have been supported by workers Hidayatullah *et al.,* (2013).

Harvest Index (%)

Among the treatments harvest index did not vary significantly. The higher value of harvest index (35.22%) was obtained when applied recommended dose of N and P+ 90 kg K ha^{-1} along with 5 t FYM ha^{-1}(T_9) followed by treatment T_8 (34.39%) and T_6 (34.27%), respectively and lower value (31.81%) was recorded under treatment T_1. It might be due to the increase in harvest index was attributed to the more dry matter accumulation in to 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.,* (2012) and Fallah *et al*., (2007).

It was concluded from experiment that application of potassium increased yield and yield components. 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 and yield components of maize than control (recommended dose of N and P + no K fertilizer). Thus, use of potassium with FYM increased productivity and quality of grains by maintaining soil health.

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