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Original Research Article

Effect of Different Levels of Potassium on Growth of *Kharif* Maize (*Zea mays* L.)

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Potassium levels, FYM, Growth

A B S T R A C T

A field experiment entitled was conducted on sandy loam soil, which was low in organic carbon, available nitrogen, available phosphorus and available potassium during *kharif* season of 2017 at Crop Research Farm of Tirhut College of Agriculture, Dholi. Experiment was laid out in Randomized block design with four replications and nine treatments at different level of potassium (0, 30, 60, 90, 120 and 150 kg ha^{-1}) in which three treatments T_7, T_8 and T_9 along with 5 tons of FYM. The plant population recorded at different stages of growth was found to be non significant due to different treatments. Application of 5 tons FYM ha^{-1} with recommended dose of nitrogen, phosphorous and 90 kg potassium ha^{-1} (T_9) resulted in production of tallest plant (191.29 cm), higher number of leaves (12.65) and higher dry matter accumulation (228.82 g plant^{-1}) as compared to recommended dose of nitrogen and phosphorous with 0 kg potassium ha^{-1} (165.04 cm height, 10.38 number of leaves and 20.84 g plant^{-1}), respectively. T_9 treatment had taken less number of days (53.5 and 56.9 days) for 50 % tasseling and silking compared to other treatments.

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 are the major maize growing districts of Bihar (Anonymous, 2017). The major maize producing countries are USA, China, Brazil, Argentina, Mexico, South Africa, Yugoslavia and India (Anonymous, 2018).

Potassium is one of the principal plant nutrient under pinning crop yield and quality determination. It is an important major element for plant growth and accumulated in abundant amount during the vegetative growth period Chaudhary *et al.,* (2017). 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.

Time of potassium uptake and its translocation to reproductive parts varies from plant to plant. However, plants generally absorb most of their potassium requirement during an early growth stage. Maize absorbs 70-80% potassium at silking stage and 100% potassium is absorbed three to four weeks after silking and it removes around 50 lb/acre K_2O from soil when grown for grain (Anonymous, 2018).

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 growth of *kharif* maize. The treatment comprised of nine treatments *viz*., RD of N and P + 0 kg K ha^{-1} (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), T_4 + 5 t FYM ha^{-1} (T_9). 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 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 growth parameters were plant population, plant height, number of leaves, dry matter accumulation, tasseling and silking were collected using standard procedures.

The plant population was counted by excluding the border row at 30 DAS and at the time of harvesting. The plant height of randomly selected, labelled five plants were measured at 30, 60 DAS and at harvest from the base of the plant to the youngest fully opened top leaf/silk and expressed in centimetre (cm). For dry matter accumulation randomly three plants were chosen from observation rows of every plot and cut simply over the ground level with the assistance of a sickle. These plants were sun dried for 48 hours. After sun drying, these plants were dried in the oven at 65±5ºC temperature for 48-72 hours till the sampled accomplished a constant weight and weighed. The dry matter was expressed in gram per plant. The numbers of fully opened green leaves produced were counted in randomly selected, labelled five plants and their average was taken as number of green leaves per plant at 30, 60 DAS and at harvest. Days to 50 % tasseling and silking were calculated after emergence of first tassel/silk, the periodic counts on the no. of plant bearing a tassel/silk was made. The day by which 50% of the plants in the each plot area bearing tassel/silk was recorded. The days taken for 50% tasseling and silking were calculated by taking difference in days between the date of sowing and date at which 50% tasseling and silking. 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 growth parameters

Plant height and number of leaves

Application of 5 tons FYM ha^{-1} with recommended dose of nitrogen, phosphorous and 90 kg potassium ha^{-1} resulted in production of tallest plant (191.29 cm) with higher number of leaves (12.65) as compared to recommended dose of nitrogen and phosphorous with 0 kg potassium (165.04 cm height and 10.38 number of leaves), respectively.

This might be due to higher nutrient concentration as a result of FYM application in treatment T_9 (RD of N and P + 90 kg K along with 5 t FYM ha^{-1}). This was because of the influence of favourable nutrition, growth of crop would be triggered to produce elevated stature of growth components. FYM has predominant role in the improvement of soil fertility, physio-chemical properties and biological activity, besides its nutrient combinations (Sushila and Giri, 2000) and (Borin and Sartori, 1989). Similarly, potassium plays a vital role in plant growth and development (De Boer, 1999). As a consequence of active uptake of potassium and its accumulation in the cell, osmotic potential decreases, water moves in and increases the turgor pressure in the cell which is responsible for growth. Similar findings were reported by Finck (1998) and Iqbal (2015).

Dry matter accumulation

The photosynthetic activities of the plants were well reflected in their dry matter accumulation. Plant dry matter showed an increasing trend upto harvesting stage of the crop. Dry matter accumulation was significantly influenced by levels of potassium with combination of FYM at all the growth stages. At 30 DAS treatment T_9 yielded highest (21.65 g plant^{-1}) dry matter accumulation which was statistically at par with T_5 (19.91 g plant^{-1}), T_6 (19.02 g plant^{-1}), T_7 (18.73 g plant^{-1}) and T_8 (20.84 g plant^{-1}) and significantly superior over rest of the treatments while significantly higher dry matter accumulation (98.22 g plant^{-1} and 228.82 g plant^{-1}, respectively) at 60 DAS and at harvest were recorded in treatment T_9 which was statistically at par with T_4 (91.91 g plant^{-1} and 211.31 g plant^{-1}), T_5 (94.73 g plant^{-1} and 220.62 g plant^{-1}), T_6 (94.14 g plant^{-1} and 217.87 g plant^{-1}), T_7 (93.17 g plant^{-1} and 213.21 g plant^{-1}) and T_8 (96.12 g plant^{-1} and 225.11 g plant^{-1}) respectively and significantly superior over rest of the treatments.

Table.1 Plant height (cm) at different growth stages of maize as influenced by different treatments

Treatments	Plant height at		
	30 DAS	60 DAS	At harvest
T_1- RDF of nitrogen and phosphorus + 0 kg potassium fertilizer	73.36	151.93	165.04
T_2 -RDF of nitrogen and phosphorus + 30 kg potassium per ha	74.42	153.70	167.45
T_3 -RDF of nitrogen and phosphorus + 60 kg potassium per ha	75.06	156.75	170.31
T_4 -RDF of nitrogen and phosphorus + 90 kg potassium per ha	76.54	161.72	175.05
T_5 -RDF of nitrogen and phosphorus + 120 kg potassium per ha	78.12	168.72	184.17
T_6 -RDF of nitrogen and phosphorus + 150 kg potassium per ha	78.61	167.18	183.28
T_7 - T_2 + 5.0 t/ha FYM	77.52	164.01	180.26
T_8 - T_3+ 5.0 t/ha FYM	79.43	171.03	187.15
T_9 - T_4+ 5.0 t/ha FYM	80.31	174.09	191.29
SEm±	2.56	5.01	5.47
CD(P=0.05)	NS	14.72	16.07

Table.2 Number of leaves (plant^{-1}) at different growth stages of maize as influenced by different treatments

Treatments	Number of leaves /plant		
	30 DAS	60 DAS	At harvest
T_1- RDF of nitrogen and phosphorus + 0 kg potassium fertilizer	6.85	9.45	10.38
T_2 -RDF of nitrogen and phosphorus + 30 kg potassium per ha	6.95	9.76	10.96
T_3 -RDF of nitrogen and phosphorus + 60 kg potassium per ha	7.05	9.98	11.35
T_4 -RDF of nitrogen and phosphorus + 90 kg potassium per ha	7.15	10.26	11.53
T_5 - RDF of nitrogen and phosphorus + 120 kg potassium per ha	7.41	10.95	12.05
T_6 -RDF of nitrogen and phosphorus + 150 kg potassium per ha	7.34	10.72	11.84
T_7 - T_2 + 5.0 t/ha FYM	7.20	10.52	11.62
T_8 - T_3+ 5.0 t/ha FYM	7.70	11.21	12.31
T_9 - T_4+ 5.0 t/ha FYM	7.75	11.56	12.65
SEm±	0.24	0.38	0.36
CD(P=0.05)	NS	1.12	1.05

Table.3 Dry matter accumulation (g $plant^{-1}$) at different growth stages of maize as influenced by different treatments

Treatments	Dry matter accumulation (g/plant)		At Harvest
	30 DAS	60 DAS	
T_1- RDF of nitrogen and phosphorus + 0 kg potassium fertilizer	15.20	81.11	188.55
T_2 -RDF of nitrogen and phosphorus + 30 kg potassium per ha	17.25	85.73	203.24
T_3 - RDF of nitrogen and phosphorus + 60 kg potassium per ha	17.72	88.80	207.14
T_4 - RDF of nitrogen and phosphorus + 90 kg potassium per ha	18.12	91.91	211.31
T_5 - RDF of nitrogen and phosphorus + 120 kg potassium per ha	19.91	94.73	220.62
T_6 -RDF of nitrogen and phosphorus + 150 kg potassium per ha	19.02	94.14	217.87
T_7 - T_2 + 5.0 t/ha FYM	18.73	93.71	213.21
T_8 - T_3+ 5.0 t/ha FYM	20.84	96.12	225.11
T_9 - T_4+ 5.0 t/ha FYM	21.65	98.22	228.82
SEm±	0.68	3.07	6.82
CD(P=0.05)	1.99	9.03	20.04

Table.4 Days to 50 % tasseling and 50 % silking of maize as influenced by different treatments

Treatments	Days taken to	
	50% Tasselling	50%Silking
T_1- RDF of nitrogen and phosphorus + 0 kg potassium fertilizer	57.5	61.8
T_2-RDF of nitrogen and phosphorus + 30 kg potassium per ha	56.7	60.9
T_3 -RDF of nitrogen and phosphorus + 60 kg potassium per ha	56.2	60.3
T_4 -RDF of nitrogen and phosphorus + 90 kg potassium per ha	55.6	59.6
T_5-RDF of nitrogen and phosphorus + 120 kg potassium per ha	54.2	57.9
T_6 -RDF of nitrogen and phosphorus + 150 kg potassium per ha	54.7	58.6
T_7 - T_2 + 5.0 t/ha FYM	55.1	59.1
T_8 - T_3+ 5.0 t/ha FYM	53.6	57.2
T_9 - T_4+ 5.0 t/ha FYM	53.5	56.9
SEm±	1.66	1.78
CD(P=0.05)	NS	NS

The dry matter production is the cumulative effect of all the growth characters like plant height and number of leaves etc. which ultimately resulted, in higher dry matter production. Application of FYM might be attributed to the maximum availability of potassium that might have increased photosynthetic activities, resulted in better photosynthate and dry matter accumulation in plant. The result is in confirmation with Amanullah *et al.*, (2016), Hussain *et al.*, (2015) and Iqbal (2015).

Days to 50% tasseling and silking

Days to 50% tasseling and silking were observed earlier with the application of 90 kg potassium ha^{-1} along with 5 tons FYM ha^{-1} while delayed in treatment where low rate of potassium applied. The result is in confirmation with Khadem *et al.*, (2010).

It was concluded from experiment that application of potassium increased growth 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 plant height, number of leaves, dry matter accumulation of maize than control (recommended dose of N and P + 0 kg K ha^{-1}). Thus, use of potassium with FYM increased growth and productivity by maintaining soil health.

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