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Effect of Different Levels and Split Application of Potassium on Growth and Yield of Maize (*Zea mays* L.)

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ABSTRACT

A field experiment was conducted during *kharif 2019* at Junjanahalli village of Hassan district to study the effect of different levels and split application of potassium on growth and yield of maize. The experiment was laid out in RCBD design with nine treatments replicated thrice. The results revealed that application of RDF (150:75 kg/ha of N & P) + K_2O@25 kg ha^{-1} at basal+K_2O@25 kg ha^{-1} at knee height stage+K_2O @25 kg ha^{-1} at tasseling significantly increased the plant height (173.78 cm), number of leaves (17.01), cob length (16.55 cm), number of rows per cob (17.73), number of kernels per cob (713.08), test weight (36.78 g), kernel yield (7880kg ha^{-1}) and stover yield (14350 kg ha^{-1}) at harvest. The concentration of nitrogen (0.75 and 1.21%), phosphorus (0.12 and 0.28%) and potassium (0.91 & 1.54%) was significantly higher in stover and kernel, respectively over other treatments. Similarly, higher uptake of nitrogen and potassium (202.96 kg ha^{-1} and 251.93g ha^{-1}, respectively) were recorded in RDF of N:P_2O_5 and K_2O@25 kg ha^{-1} at basal+K_2O@25 kg ha^{-1} at 30 DAS+K_2O @ 25 kg ha^{-1} 60 DAS. The nutrient status after harvest of crop differed significantly due to different levels and split application of potassium. However, significantly higher nitrogen (274.86 kg/ha), phosphorus (57.04 kg/ha) and potassium (206.25 kg/ha) were recorded in treatment receiving RDF N:P_2O_5 (150:75 kg/ha) +K_2O@25 kg ha^{-1} at basal+K_2O@25 kg ha^{-1} at knee height stage+K_2O @25 kg ha^{-1} at tasseling. Higher gross returns (160835 Rs.ha^{-1}), net returns (112241.66 Rs.ha^{-1}) and cost benefit ratio (3.28) were obtained for recommended dose of N,P_2O_5+K_2O@25 kg ha^{-1} at basal+K_2O@25 kg ha^{-1} at knee height stage+K_2O @25 kg ha^{-1} at tasseling.

Keywords : Potassium, Kernels, Tasseling stage, Split application

THE dawn of twenty-first century is facing very tough challenges for agriculture such as climate change, urbanization and non judicious use of resources. These problems get more intensified since the world population is increasing at an alarming rate and is likely to reach 9.6 billion by the year 2050. Due to a shift in diet habits and a rising demand for bioenergy crops, an increasing demand for global food production has been seen in the last twenty years. The status of already shrunken cultivable land would be a tough task for agricultural scientists and the only choice is vertical growth in agriculture through increased production per unit time. Further, enhancing the production, productivity and quality another challenge for the agricultural scientists. Indian population is now 1.2 billion and expected to attain 1.9 billion in 2030. To attain food security, we need to produce nearly 400 mt of food grain. Maize (*Zea mays* L.) is one of the important cereal crops alongside wheat and ricein the world. In India, it is cultivated in an area of 9.89 m ha with a production of 25.90 mt and it contributes to nearly 9 per cent of the national food basket (Dass *et al*., 2012).Worldwide potassium fertilizer use has grown, while the estimated fertilizer use efficiency has decreased. Maize being an exhaustive crop, requires potassium which is a macro nutrient applied in combination with nitrogen (N) and phosphorus (P) in equal amounts for optimum growth, development and yield of plant. However, imbalanced application of major nutrients without consideration of soil testing results leads to poor growth and yield of crop. Potassium is an essential nutrient for plant growth. It is classifiedas a macronutrient because plants take up higher amount of potassium during their lifecycle. Potassium is associated with the movement of carbohydrates, nutrients and water in plant tissue and it is involved in enzyme activation, which affects starch, protein and ATP production. It also helps to regulate the opening and closing of the stomata. It improves drought resistance, increases root growth, reduces water loss and crop diseases. If potassium is deficient or not applied in appropriate amounts, it reduces plant growth, development and finally yield. In order to obtain high quality products, the optimum dose of fertilizer for corn needs to be calculated. With this view, the research work was carried out on 'Effect of different levels and split application of potassium on growth and yield of maize' with the following objectives :

1. To study the effect of different levels and split application of potassium on growth and yield of maize crop
2. To study the effect of different levels of potassium on nutrient up take by maize crop and
3. To work out the economics of different levels and split application of potassium

Material and Methods

A field experiment was conducted during early *kharif* 2019 to study the 'Effect of different levels and split application of potassium on growth and yield of maize' in farmer's field at Junjanahalli village of Hassan district, Karnataka. The detailed physico-chemical properties of experimental site was analysed using standard procedure and presented in Table 1. The experiment was laid out in Randomized Complete Block Design with nine treatments replicated thrice. The size of each plot was 4 m x 3 m (gross). Treatments were distributed randomly in the plots within the blocks.

Table 1

Physico-chemical properties of soil at the experimental site

Parameters	Value
Physical Properties	
Sand (%)	76.10
Silt (%)	4.90
Clay (%)	17.00
Textural class	Sandy loam
Chemical Properties	
pH (1:2.5) soil water suspension	8.21
EC1:2.5 (dSm^{-1}) soil water extract	0.27
Organic carbon (%)	0.67
Available N (kg ha^{-1})	270.04
Available P2O5 ($kgha^{-1}$)	52.17
Available K2O ($kgha^{-1}$)	195
Exchangeable Ca (cmol (p^+) kg^{-1})	3.4
Exchangeable Mg (cmol (p^+) kg^{-1})	1.6
Available S (mg kg^{-1})	8.7
DTPA Fe ($mgkg^{-1}$)	7.65
DTPA Zn (mg kg^{-1})	0.62
DTPA Mn (mg kg^{-1})	8.89
DTPA Cu (mg kg^{-1})	0.62

The treatment details of the research are as follows:

Treatments	**Details**
T_1	Control
T_2	RDF of N:P_2O_5+K2O@25 kg ha^{-1} at basal
T_3	RDF of N:P_2O_5+K_2O@50 kg ha^{-1} at basal
T_4	RDFof N:P_2O_5+K_2O@75 kg ha^{-1} at basal
T_5	RDF ofN:P_2O_5+K_2O@25 kg ha^{-1} [K_2O@12.5 kg ha^{-1} at basal+K_2O@12.5 kg ha^{-1} at knee height stage
T_6	RDF of N:P_2O_5+K_2O@25 kg ha^{-1} at basal + K_2O@25 kg ha^{-1} at knee height stage
T_7	RDF of N:P_2O_5+K_2O@25 kg ha^{-1} at basal+K_2O@12.5 kg ha^{-1} at knee height stage+K_2O@12.5 kg ha^{-1} at tasseling stage.
T_8	RDF of N:P_2O_5+K_2O @ 25 kg ha^{-1} at basal + K_2O@50 kg ha^{-1} at knee height stage

Treatments	Details
T9	RDF of N:P_2O_5+K_2O@25 kg ha^{-1} at basal+K_2O@25 kg ha^{-1} at knee height stage+K_2O@25kg ha^{-1}at tasseling stage

RDF: 150:75:50 N,P_2O_5+K_2O (kg/ha)
*Note:*For all treatment except control $ZnSO_4$@ 10 kg ha^{-1} was applied

A maize hybrid, Hema (NAH 1137) was used for the experimental study. It is a single cob bearer, grown throughout the year because of its photo insensitivity, greenness at the time of harvest and having a duration of 110 - 120 days. It is resistant to turcicum leaf blight and downy mildew.

Fertilizer Application

Half of the recommended dose of N, full recommended dose of P_2O_5 and different levels of K_2O was applied based on the treatments at the time of sowing. Remaining amount of N was applied on the 30th day after sowing and different levels of potassium

TABLE 2
Methods adopted for soil analysis

Particulars	Method adopted
Soil textural	International pipe the method (Piper, 2002). The textural class was determined using textural triangle
Soil pH	pH meter was used for the estimation of soil pH in 1 : 2.5 soil : water suspension (Jackson, 1973)
Electrical conduc-tivity (dS m^{-1})	EC was determined by using EC bridge (Jackson, 1973). Soil-water suspension was made and left overnight to get the supernatant in which the conductivity cell was dipped and then readings were taken
Soil organic carbon (gkg^{-1})	The soil organic carbon was determined by Walkely and Black wet oxidation method as given by Jackson, (1973)
Available nitrogen (kg ha^{-1})	The soil available nitrogen was estimated by following alkaline permanganate method of Subbaiah and Asija (1956)
Available phosphorus (kg ha^{-1})	As pH of the soil was neutral, Olsen's reagent was used for extraction of phosphorus. The extracted phosphorus was the nestimated by chloromolybdic acid blue colour method (Jackson, 1973)
Available potassium (kg ha^{-1})	Neutral normal ammonium acetate was used for the extraction of potassium. The estimation was carried out using flame photo meter as described by Jackson (1973)
Exchange able calcium and magnesium (cmol (p^+) kg^{-1})	Calcium and magnesium were extracted with neutral normal ammonium acetate and estimation was carried out by Versenate titration method using Patton & Reeder's reagentand EBT indicators, for calcium and calcium plus magnesium respectively. The difference between the calcium plus magnesium value and calcium gives the amount of exchangeable magnesium. (Jackson, 1973)
Available Sulphur (mg kg^{-1})	Calcium chloride (0.15%) was used for the extraction of sulphur and the content was determined by developing turbidity using barium chloride which was read at 420n min as pectro photometer (Black, 1965)
DTPA extractable micro nutrients (mg kg^{-1})	Available micronutrients from the post-harvest soil were extracted by DTPA extractant, the contents of micro nutrient were analyzed in AAS (Lindsay and Norvell, 1978)

were applied as per the treatments.

The seeds of maize at the rate 15 kg ha^{-1} were sown at a spacing of 60 cm between rows and 30 cm between plants. Furrows were opened through bullock drawn desi plough and seeds were sown manually at a depth of 4-5 cm.

Each plot was irrigated separately to avoid movement of nutrients from one plot to another plot. Irrigations were given once in 7-8 days and whenever necessary to maintain good soil moisture. Two hand weeding were carried out in order to keep the plots free from weed competition and there by soil moisture and nutrient losses were minimized. Intercultivation was done at 25 days after sowing which loosens the top soil and there by forming soil mulch which minimizes the soil moisture loss. Two earthing ups were carried out at 30 DAS and 60 DAS to minimize the soil moisture loss and to avoid weed competition.

The crop was harvested when the cobs became nearly dry and plants showed physiological maturity (yellowing). First, the cobs were removed from the standing crop and the stover was harvested later. The harvested cobs from respective plots were kept inseparate gunny bags and dried in the sun. After drying the yield kg plot^{-1} were recorded from each plot and then converted into kg ha^{-1} at 15 per cent moisture level. Biometric observations on plant height, number of leaves per plant, kernel yield, stover yield and test weight were recorded after harvest of the crop. The soil samples and the plant samples were collected after harvest of crop were analysed for various nutrients using standard procedure as mentioned in Table 2. The uptake of nutrient was determined based on kernel yield, stover yield and their nutrient concentration. The data collected from the experiment at different growth stages were subjected to statistical analysis as described by Gomez and Gomez (1984). Statistical analysis was carried out by taking the average of five plants from each plot. The level of significance used in 'F' was P = 0.05. Critical difference (CD) values were calculated for the P = 0.05 whenever 'F' test was found significant.

Results and Discussion

Growth Parameters

Plant Height (cm) and Number of Leaves Per Plant

Significantly higher plant height and number of leaves per plant (173.78 cm and 17.01) were recorded at harvest in the treatment which received recommended dose of N:P_2O_5+K_2O@25 kg ha^{-1} at basal + K_2O@ 25 kg ha^{-1} at knee height stage + K_2O@ 25 kg ha^{-1} at tasseling stage (T9) and was on par with recommended dose of N:P_2O_5+K_2O@25 kg ha^{-1} at basal+K_2O@ 50 kg ha^{-1} at knee height stage (171.55 cm). Significantly lower plant height was observed in absolute control (138.63cm and 12.09) over other treatments.

The higher plant height and number of leaves per plant may be attributed to higher uptake of potassium due to split application of potassium which increased the available potassium in the soil for plant absorption. These results were in agreement with findings of Delwar *et al*. (2010).

Yield and Yield Parameters

The yield and yield parameters of maize differed significantly due to different levels and split application of potassium (Table 4 & Fig. 1). Significantly higher cob length (16.55 cm) , test weight (36.78g), number of rows per cob (17.73), number of kernels per cob (713.08), kernel yield (7880 kg/ha) and stover yield (14350 kg/ha) of maize were recorded in the treatment received recommended dose of N: P_2O_5+K_2O@25 kg ha^{-1} at basal + K_2O@ 25 kg ha^{-1} at knee height stage + K_2O@ 25 kg ha^{-1} at tasseling

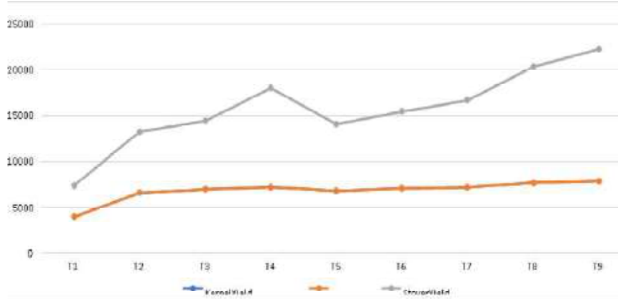

Fig.1 : Kernel and stover yield of maize as affected by different levels and split application of potassium

TABLE 3

Influence of different levels and split application of potassium on plant height (cm) and number of leaves plant^{-1} of maize

Treatments	No.of Leaves				Plant height (cm)			
	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest
T_1 : Control	4.01	10.89	10.93	12.09	54.25	114.79	128.76	138.63
T_2 : RDF of N:P_2O_5+K_2O@25 kg ha^{-1} at basal	4.67	11.36	12.45	12.92	55.32	127.68	142.68	151.73
T_3 : RDF of N: P_2O_5+K_2O@50 kg ha^{-1} at basal	4.33	12.99	13.22	13.75	58.46	133.64	148.64	157.46
T_4 : RDF of N: P_2O_5+K_2O@75kg ha^{-1} at basal	5.32	13.72	13.99	15.55	61.65	148.35	163.35	170.35
T_5 : RDF of N:P_2O_5+K_2O@25 kg ha^{-1} [K_2O@12.5 kg ha^{-1} at basal + K_2O @12.5 kg ha^{-1} at knee height stage	4.33	12.72	12.99	13.55	56.21	131.82	145.82	154.36
T_6 : RDFo fN:P_2O_5+K_2O@25 kg ha^{-1}atbasal+K_2O@25kg ha^{-1} at kneeheight stage	4.32	12.89	13.39	14.95	58.72	143.52	157.68	164.35
T_7 : RDF of N: P_2O_5 + K_2O @ 25 kg ha^{-1} at basal + K_2O @ 12.5 kg ha^{-1} at knee height stage+K_2O@12.5 kg ha^{-1}at tasseling stage	5.00	13.60	13.79	14.98	59.75	146.54	160.54	167.54
T_8 : RDFof N:P_2O_5+K_2O@25 kg ha^{-1} at basal+K_2O@50 kg ha^{-1} at knee height stage	5.32	14.60	14.92	16.55	63.21	149.55	164.68	171.55
T_9 : RDFof N:P_2O_5+K_2O@25 kg ha^{-1} at basal+K_2O@25 kg ha^{-1} at knee height stage+K_2O@25 kg ha^{-1} at tasseling stage	5.66	14.69	15.89	17.01	64.34	151.78	166.58	173.78
SEm±	0.10	0.28	0.29	0.31	1.26	2.95	3.26	3.43
CD@ 5%	0.31	0.83	0.86	0.94	3.76	8.86	9.78	10.27

TABLE 4

Cob length, test weight, number of rows per cob and number of kernels per row of maize as influenced different levels and split application of potassium

Treatments	Yield Parameters			
	Cob length (cm)	Test weight (g)	Number of rows per cob	Number of kernels per cob
T_1 : Control	9.65	24.60	11.40	346.90
T_2 : RDF of N : P_2O_5+K_2O @ 25 kg ha^{-1} at basal	11.39	29.72	12.85	406.57
T_3 : RDF of N : P_2O_5+K_2O @ 50 kg ha^{-1} at basal	12.43	30.63	13.89	454.89
T_4 : RDF of N : P_2O_5+K_2O @ 75 kg ha^{-1} at basal	14.67	32.83	15.35	574.85
T_5 : RDF of N : P_2O_5+K_2O @ 25 $kgha^{-1}$ [K_2O @ 12.5 kg ha^{-1} at basal + K_2O @ 12.5 kg ha^{-1} at knee height stage	11.45	30.45	13.30	433.71
T_6 : RDF of N:P_2O_5+K_2O@25 kg ha^{-1} at basal +K_2O@25 kg ha^{-1} at knee height stage	14.45	31.54	14.42	477.30
T_7 : RDF of N:P_2O_5+K_2O@25 kg ha^{-1} at basal + K_2O @12.5 kg ha^{-1} at knee height stage+ K_2O@12.5 kg ha^{-1} at tasseling stage	14.55	31.86	14.45	513.40
T8 : RDF of N:P_2O_5+K_2O@25 kg ha^{-1} at basal +K_2O@50 kg ha^{-1} at knee height stage	16.28	34.45	17.21	658.97
T9 : RDF of N:P_2O_5+K_2O@25 kg ha^{-1} at basal +K_2O@25 kg ha^{-1} at knee height stage + K_2O@25 kg ha^{-1} at tasseling stage	16.55	36.78	17.734	713.08
SEm±	0.29	0.67	0.31	11.11
CD@ 5%	0.87	2.02	0.93	33.30

stage (T_9). However, similar results were also recorded in the treatment which received recommended dose of N: P_2O_5 + K_2O @25 kg/ha at basal + K_2O @ 50 kg/ha at knee height stage.

The split application of K @ 25 kg/ha at basal and 50 kg/ha at knee height stage along with recommended dose of N and P_2O_5 recorded significantly higher cob length, (16.28), test weight (34.45 g), number of rows per cob (17.21), number of kernels per cob (658.97), kernel yield (7690 kg/ha) and stover yield (12650 kg/ha) of maize than the treatment receiving 75 kg/ha of K as basal application (T_4). Significantly lower cob length (9.65 cm), test weight (29.72g), number of rows per cob (12.85), number of kernels per cob (406.57), kernel yield (3730 kg/ha) and stover yield (3950 kg/ha) were recorded for absolute control. The higher yield and yield parameters recorded due to split application of potassium along with recommended dose of N and P_2O_5 were attributed to higher uptake of potassium at different growth stages as the available K increased in soil compared to application of same amount of potassium at basal only which resulted in leaching loss of potassium and resulted in lower availability in soil, lower uptake of K by plant and lower yield attributes of maize. These results are in agreement with findings of Ahmed *et al.,* 2012.

Nutrient Content of Stover and Kernel

The nutrient content (NP&K) of stover and kernel differ significantly (Table 5) due to different levels and split application of potassium. Significantly higher nitrogen concentration of 0.75 and 1.21 per cent, respectively were recorded in stover and kernel (Table 3) respectively at harvest of crop in the treatment (T_9) which received recommended N:P_2O_5+K_2O@25 kg ha^{-1} at basal+K_2O@25 kg ha^{-1} at

TABLE 5

Influenced of different levels and split application of potassium on NPK content of stover and kernel of maize

Treatments	Nitrogen (%)		Phosphorus (%)		Potassium (%)	
	Stover	Kernel	Stover	Kernel	Stover	Kernel
T_1 : Control	0.38	0.95	0.10	0.282	0.45	0.85
T_2 : RDF of N : P_2O_5 + K_2O @ 25 kg ha^{-1} at basal	0.43	1.01	0.14	0.290	0.55	0.89
T_3 : RDF of N : P_2O_5 + K_2O @ 50kg ha^{-1} at basal	0.52	1.07	0.16	0.294	0.72	0.97
T_4 : RDF of N : P_2O_5 + K_2O @ 75kg ha^{-1} at basal	0.67	1.17	0.22	0.306	0.82	1.01
T_5 : RDF of N : P_2O_5 + K_2O @25 kg ha^{-1} [K2O @ 12.5 kgha^{-1} at basal + K_2O @ 12.5 kg ha^{-1} at knee height stage	0.48	1.03	0.15	0.292	0.65	0.95
T_6 : RDFof N:P_2O_5 + K_2O@25 kg ha-1 at basal+K_2O @25 kg ha^{-1} at knee height stage	0.59	1.07	0.19	0.296	0.74	0.99
T_7 : RDFof N:P_2O_5+K_2O@25 kg ha^{-1} at basal + K_2O	0.63	1.13	0.20	0.302	0.77	1.01
T_8 : RDFof N:P_2O_5+K_2O@25kg ha^{-1}at basal+K_2O @50 kg ha^{-1} at knee height stage	0.72	1.19	0.13	0.285	0.85	1.23
T_9 : RDFof N:P_2O_5+K_2O@25 kg ha^{-1} at basal+K_2O @25 kg ha^{-1} at knee height stage + K_2O@25 kg ha^{-1} at tasseling stage	0.75	1.21	0.12	0.285	0.91	1.54
SEm±	0.01	0.02	0.003	0.006	0.02	0 .02
CD@ 5%	0.04	0.07	0.010	NS	0.05	0.07

knee height stage+K_2O@25 kg ha^{-1} at tasseling stage. It was followed by the application of (T_8) recommended dose of N:P_2O_5+K_2O@25 kg ha^{-1} at basal+K_2O@50 kg ha^{-1} at knee height stage. Lower nitrogen concentration of 0.38 and 0.95 per cent was recorded at harvest in stover and kernel, respectively in the absolute control treatment compared to other treatments.

Significantly higher phosphorus concentration of 0.22 per cent and 0.306 per centwere observed in stover and kernel respectively in the treatment (T_4) receiving recommended N:P_2O_5+K_2O@75 kg ha^{-1} at basal which was on par with the recommended dose of N:P_2O_5+K_2O@25 kg ha^{-1} at basal +K_2O @12.5 kg ha^{-1} at knee height stage+K_2O@12.5 kg ha^{-1} at tasseling stage and (T_6) receiving recommended N:P_2O_5+K_2O@25 kg ha^{-1} at basal+K_2O@25 kg ha^{-1} at knee height stage. However, lowest phosphorus content was recorded (0.10 %) and 0.282 %) in stover and kernel respectively in the absolute (T_1) control. Potassium concentration in stover (0.91 %) and kernel (1.54 %) at harvest was significantly higher in treatment (T_9) that received N: P_2O_5+K_2O@25 kg ha^{-1} at basal +K_2O@25 kg ha^{-1} at knee height stage + K_2O@25 kg ha^{-1} at tasseling, which was followed by application of recommended N: P_2O_5 + K_2O@25 kg ha^{-1} at basal + K_2O@50 kg ha^{-1} at knee height stage with the potassium content of stover (0.85%) and kernel (1.23%) at harvest. Significantly lower potassium content of stover (0.45 %) and kernel (0.85 %) were noticed in the control compared to other treatments.

The application of nitrogen through chemical fertilizers along with organic manures has increased the availability of nutrients for the crop due to enhanced mineralization process. These results are in conformity with the findings of Nakashagir (1992). Higher potassium application has antagonistic effect on phosphorus content, soleast phosphorus content was recorded with the application of (T_9) RDF of N: P_2O_5+K_2O@25 kg ha^{-1} at basal + K_2O@25 kg ha^{-1} at knee height stage + K_2O@25 kg ha^{-1} at tasseling

TABLE 6

Uptake of NPK (kg ha^{-1}) as influenced by application of different levels and split application of potassium in maize.

Treatments	Nitrogen (%)			Phosphorus (%)			Potassium (%)		
	Kernel (kg ha^{-1})	Stover (kg ha^{-1})	Total (kg ha^{-1})	Kernel (kg ha^{-1})	Stover (kg ha^{-1})	Total (kg ha^{-1})	Kernel (kg ha^{-1})	Stover (kg ha^{-1})	Total (kg ha^{-1})
T_1 : Control	35.43	15.01	50.44	10.44	3.95	14.39	31.70	17.77	49.47
T_2 : RDF of N : P_2O_5 + K_2O @ 25 kg ha^{-1} at basal	66.45	28.59	95.04	19.08	9.31	28.39	58.56	36.57	95.13
T_3 : RDF of N : P_2O_5 + K_2O @ 50 kg ha^{-1} at basal	74.68	38.63	113.31	20.52	11.88	32.40	67.70	53.49	121.19
T_4 : RDF of N : P_2O_5 + K_2O @ 75kg ha^{-1} at basal	84.70	71.95	156.65	22.15	23.62	45.78	73.12	88.06	161.18
T_5 : RDF of N : P_2O_5 + K_2O @ 25kg ha^{-1} [K_2O @ 12.5 kg ha^{-1} at basal + K2O @ 12.5 kg ha^{-1} at knee height stage	70.14	34.80	104.94	19.88	10.87	30.76	64.69	47.12	111.81
T_6 : RDFof N:P_2O_5+K_2O@25kg ha^{-1} at basal+K_2O@ 25 kg ha^{-1} at knee height stage	75.86	49.08	124.94	20.98	15.80	36.79	70.19	61.56	131.75
T_7 : RDFof N:P_2O_5+K_2O@25 kg ha^{-1} at basal + K_2O @12.5 kg ha^{-1} at knee heigh tstage+K_2O@ 12.5 kg ha^{-1} at tasseling stage	81.47	59.53	141.0	21.77	18.90	40.67	72.82	72.76	145.58
T_8 : RDFof N:P_2O_5+K_2O@25 kg ha^{-1} at basal+K_2O@ 50 kg ha^{-1} at knee height stage	91.51	91.08	182.59	21.91	16.44	38.36	94.58	107.52	202.10
T_9 : RDFof N:P_2O_5+K_2O@25 kg ha_{-1} at basal+K_2O@ 25 kg ha^{-1} at knee height stage + K_2O@ 25 kg ha^{-1} at tasseling stage	95.34	107.62	202.96	22.45	17.22	39.67	121.35	130.58	251.93
SEm±	1.64	1.34	2.95	0.43	0.35	0.77	1.60	1.64	3.23
CD@5%	4.90	4.01	8.83	1.29	1.04	2.31	4.80	4.91	9.68

TABLE 7

Available nitrogen, phosphorus and potassium content of soil (kg ha^{-1}) after harvest of maize as influenced by different levels and split application of potassium

Treatments		Avail. N (kg ha^{-1})	Avail. P_2O_5 (kg ha^{-1})	Avail. K_2O (kg ha^{-1})
T_1 :	Control	252.55	46.68	184.51
T_2 :	RDF of N : P_2O_5 + K_2O @ 25 kg ha^{-1} at basal	270.31	54.45	193.82
T_3 :	RDF of N : P_2O_5 + K_2O @ 50 kg ha^{-1} at basal	298.84	65.89	217.15
T_4 :	RDF of N : P_2O_5 + K_2O @ 75 kg ha^{-1} at basal	300.67	82.15	228.31
T_5 :	RDF of N : P_2O_5 + K_2O @ 25 kg ha^{-1} [K_2O @ 12.5 kg ha^{-1} at basal + K_2O @ 12.5 kg ha^{-1} at knee height stage	286.04	67.24	216.94
T_6 :	RDFof N:P_2O_5+K_2O@25 kg ha^{-1} at basal+K_2O @25 kg ha^{-1} at knee height stage	290.45	80.12	224.56
T_7 :	RDFof N:P_2O_5+K_2O@25 kg ha^{-1} at basal+K_2O @12.5 kg ha^{-1} at knee height stage+K_2O@12.5 kg ha^{-1} at tasseling stage	300.48	74.21	227.31
T_8 :	RDFofN:P_2O_5+K_2O@25 kg ha^{-1} at basal+K_2O@50 kg ha^{-1} at knee height stage	279.54	59.85	207.34
T_9 :	RDFof N:P_2O_5+K_2O@25 kg ha^{-1} at basal+K_2O@25 kg ha^{-1} at knee height stage+K_2O@25 kg ha^{-1} at tasseling stage	274.86	57.04	206.25
	S.Em±	6.04	1.45	4.53
	CD(P=0.05)	18.11	4.34	13.58

stage. The results are inconformity with the findings of Singh *et al*. (2009) and Sangamesh *et al.* (2020).

The higher potassium content in stover and kernel due to split application of K has increased uptake of K by plant at basal, knee height stage and tasseling stage than application at basal only. This might be due to application of higher dose of potassium that resulted in increase in the nutrient uptake and their accumulation in kernel and stover of maize (Karim *et al.,* 2010).

Nutrient Uptake by Maize

Uptake by Stover (kg ha^{-1}) : Significantly higher (107.62 kg ha^{-1}) nitrogen uptake was recorded in the treatment receiving recommended N:P_2O_5+ K_2O@25 kg ha^{-1} at basal + K_2O@25 kg ha^{-1} at knee height stage + K_2O@25 kg ha^{-1} at tasseling stage followed by recommended N:P_2O_5+K_2O@25 kg ha^{-1} at basal + K_2O@50 kg ha^{-1} at knee height stage (91.08 kg ha^{-1}), Lower uptake of nitrogen by stover was recorded in the control (15.01 kg ha^{-1}) compared to the other treatments.

Uptake by kernel (kg ha^{-1}) Nitrogen uptake by maize kernel differed significantly due to application of different levels and split application of potassium (Table 6).

Highest nitrogen uptake by kernel (95.34 kg ha^{-1}) was registered in the treatment which received recommended N: P_2O_5+ K_2O@25 kg ha^{-1} at basal + K_2O@25 kg ha^{-1} at knee height stage + K_2O@25 kg ha^{-1} at tasseling stage, it was on par with the application of recommended N:P_2O_5+K_2O@25 kg ha^{-1} at basal+K_2O@50 kg ha^{-1} at knee height stage (91.51 kg ha^{-1}). However lower nitrogen uptake by kernel was recorded in the control (35.43kg ha^{-1}).

The split application of higher potassium levels increases the higher availability of nitrogen due to synergistic effect of K on N, so availability and uptake of N was more at high potassium levels.

Phosphorus uptake by Maize Stover (kg ha^{-1})

The uptake of phosphorus by maize stover at harvest as differed significantly due to split application of potassium (Table 6). Significantly higher phosphorus uptake was recorded in the treatment combination of RDF of N: P_2O_5+K_2O@75 kg ha^{-1} at basal (23.628 kg ha^{-1}) and it was on par with the treatment receiving RDF of N:P_2O_5+K_2O@25 kg ha^{-1} at basal+K_2O@ 12.5 kg ha^{-1} at knee height stage + K_2O@12.5 kg ha^{-1} at tasseling stage (18.90 kg ha^{-1}), whereas least uptake by maize stover was registered in absolute control (3.95kg ha^{-1}).

Phosphorus uptake by Maize Kernel (kg ha^{-1})

The uptake of phosphorus by maize kernel was significantly influenced by application of different levels and split application of potassium (Table 6). Significantly higher phosphorus uptake was recorded in the treatment T9 which receiving recommended N: P_2O_5+K_2O@25 kg ha^{-1} at basal + K_2O@25 kg ha^{-1} at knee height stage + K_2O@25 kg ha^{-1} at tasseling stage (22.458 kg ha^{-1}), However least uptake was noticed in the control (10.44 kg ha^{-1}) compared to other treatments.

The higher uptake of phosphorus recorded might be due to the higher phosphorus content in the stover and kernel. The phosphorus content in the fertilizers facilitated better absorption of phosphorus by the maize crop. The effect of phosphorus uptake by the organics (FYM) is attributed to there lease of P during mineralization hence higher uptake by maize was recorded. High potassium levels decreased the phosphorus uptake due to antagonistic effects. The results are in conformity with the findings of Baskar (2003),

Potassium uptake by Maize Kernel (kg ha^{-1})

Potassium uptake by kernel differed significantly due to the application of different levels and split application of potassium (Table 6). Significantly higher potassium uptake was recorded in the treatment combination with (T_9) recommended N: P_2O_5+ K_2O@25 kg ha^{-1} at basal + K_2O@25 kg ha^{-1} at knee height stage + K_2O@25 kg ha^{-1} at tasseling stage with the uptake of 121.35 kg ha^{-1} and it was on par with (T_8) receiving recommended dose of N:P_2O_5+K_2O @25 kg ha^{-1} at basal+K_2O@50 kg ha^{-1}at knee height stage (94.58 kg ha^{-1}). However, the lesser potassium uptake by kernel was in the control (31.70 kg ha^{-1}) compared to allother treatments.

Potassium uptake by Maize Stover (kg ha^{-1})

Potassium uptake by stover differed significantly due to different levels and split application of potassium (Table 6). Significantly higher potassium uptake was recorded with the application of recommended N: P_2O_5+K_2O@25 kg ha^{-1} at basal + K_2O@25 kg ha^{-1} at knee height stage+K_2O@25 kg ha^{-1} at tasseling stage (130.58 kg ha^{-1}), and it was found on par with recommended N: P_2O_5+K_2O@25 kg ha^{-1} at basal + K_2O@50 kg ha^{-1} at knee height stage (102.465 kg ha^{-1}), however lower potassium uptake was noticed in control (17.77 kg ha^{-1}).

Increase in the uptake of potassium by maize may be ascribed to more availability of potassium from the added fertilizer sources and native soil potassium and the solubility action of organic acids produced during the decomposition of FYM. The results are in conformity with the findings of Das *et al*. (2012).

Available Nutrient Status of Soil after Harvest of Maize

Available Nitrogen (kg ha^{-1})

The available nitrogen content of the soil after the harvest of maize varied significantly among the treatments (Table 7). Significantly higher available nitrogen content (300.67 kg ha^{-1}) was recorded with recommended N: P_2O_5 + K_2O@75 kg ha^{-1} at basal (T_4). Where as, it was on par with the treatments recommended N: P_2O_5+K_2O@25 kg ha^{-1} at basal + K_2O@12.5 kg ha^{-1} at knee height stage + K_2O@ 12.5 kg ha^{-1} at tasseling stage (300.48 kg ha^{-1}).

Increase in available nitrogen content may be due to combined application of FYM along with RDF of N:P_2O_5+K_2O@75 kg ha^{-1} was attributed to higher available nitrogen content in soil under FYM addition could be due to favourable microbial activity (Altaf Kuntoji and Subbarayappa, 2021) and improved physical condition of soil (as it is evident by the present study) higher soil nitrogen noticed may be due to the uptake of nitrogen by the treatment combination (Reddy and Reddy, 1999).

Available Phosphorus (kg ha^{-1})

The available phosphorus status of post-harvest soil was influenced by different levels and split application of potassium (Table 7). Significantly higher available phosphorus content (82.15 kg ha^{-1}) was observed in the treatment (T_4) with recommended dose of N:P_2O5+K_2O@75 kg ha^{-1} at basal and absolute control (T_1) (46.68 kg ha^{-1}), increase in available phosphorus may be due to the increase in organic carbon content also reported (Brar *et al.,* 2011) that the influence of FYM in increasing the phosphorus availability in soil. Organic manure application along with 100 per cent NPK increase phosphorus availability from native and applied sources over 100 per cent K cause antagonism to available. Similar results were also observed by Waigwa *et al.* (2003).

Available Potassium (kg ha^{-1})

The available potassium status of soil after the harvest of maize varied significantly among treatments. However, significantly higher available potassium (228.31 kg ha^{-1}) was recorded in the treatment receiving recommended N:P_2O_5+K_2O@75 kg ha^{-1} at basal and lowest available potassium (184.51 kg ha^{-1}) was recorded in control.

The higher available K was attributed to the less utilization of K by the crop due to fixation of K during initial period of crop growth and later K released at the time of harvest where the utilization was much lower than early growth period. These results are in accordance with the findings of Rahimi (2012).

Higher gross returns (160835 Rs.ha^{-1}), net returns (112241.66 Rs.ha^{-1}) and cost benefit ratio (3.28) were also found in recommended dose of N:P_2O_5+K_2O @25 kg ha^{-1} at basal+K_2O@25 kg ha^{-1} at knee height stage+K_2O @25 kg ha^{-1} at tasseling over other treatments.

The results of this investigation revealed that application of recommended dose of N:P_2O_5+K_2O @ 25 kg ha^{-1} at basal + K_2O@25 kg ha^{-1} at knee heightstage+K_2O@25 kg ha^{-1} at tasseling stage increased growth, yield and nutrient uptake of maize over all other treatments. Hence, split application of potassium at different growth stages increased the use efficiency of Potassium which resulted in increase in yield of maize.

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