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Effect of phosphorus and potassium levels on growth and yield of baby corn (*Zea mays* L.)

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Abstract
A field experiment was conducted during *Zaid* 2021 at Crop Research Farm, Effect of Phosphorus and Potassium levels on growth and yield of Baby corn (*Zea mays* L.) Department of Agronomy, SHUATS, Prayagraj (U.P) to study Treatments consists of 3 levels of Phosphorus *viz,* 45 kg, 60 kg, 75 Kg P2O5/ha and 3 levels of Potassium *viz,* 20, 30 and 40 kg K2O/ha as basal. There were 10 treatments each being replicated thrice treatments included, 45 kg P/ha + 20 kg K/ha, 45 kg P/ha + 30 kg K/ha, 45 kg P/ha + 40 kg K/ha, 60 kg P/ha + 20 kg K/ha, 60 kg P/ha + 30 kg K/ha, 60 kg P/ha + 40 kg K/ha, 75 kg P/ha + 20 kg K/ha, 75 kg P/ha + 30 kg K/ha, 75 kg P/ha + 40 kg K/ha, Control Plot (90:40:20) NPK Kg/ha and laid out in Randomized Block Design. The results revealed that treatment T9: (75 kg P/ha + 40 kg K/ha) recorded highest plant height (95.40), maximum on no of leaves (10.83), dry weight (77.33), no of cobs (2.77), cob length (12.97), cob weight with husk (28.03), cob weight without husk (9.70), corn yield (5214 Kg/ha), Stover yield (20.18 t/ha), B.C ratio (2.50) in Baby corn.

Keywords: Baby corn, phosphorus, potassium

Introduction

Baby corn is the young, finger-length de-husked corn young ear of female inflorescence, harvested within 2-3 days of silk emergence but prior to fertilization and is crisp and sweet in taste. (Pandey *et al*. 2000). We can say the shank with un-pollinated silk is baby corn. Baby corn ears are light yellow color with regular row arrangement, 10-12 cm long and a diameter of 1.0-1.2 cm are preferred in the market. (Muthukumar *et al.* 2005). Baby corn is a vegetable crop that can potentially improve the economic status of farmers (Das *et al.* 2008). It is a profitable crop that allows a diversification of production, aggregation of value, and increased income (Pandey *et al*. 2002). It is highly remunerative and farmers can get a high return in a short period of 45-60 days. Its short duration, adoptability in different cropping systems, suitability to cultivate in all the seasons and ecofriendly cultivation practices made it a special choice for cultivation in non-traditional corn growing areas. The other advantage of growing baby corn is its remaining biomass (green fodder) after harvesting. These green products can be used as feed for animal and aquaculture raising (Bindhani Anita *et al.,* 2007). The succulent green fodder of high quality adds enormously to the total returns to the farmers, resulting in higher profit per unit area per unit time compared to grain maize. Another benefit of baby corn consists of utilizing husk, silk, and Stover as green herbage for feeding ruminants and swine; only 13 to 20% of fresh ear weight is for human use (Aekatasanawan 2001).

The baby corn is highly nutritious and its nutritive value is comparable with several high priced vegetables like cauliflower, cabbage, French beans, spinach, lady finger, tomato, radish etc. It is a low caloric, low cholesterol and high fibre product which is free from residual effect of pesticides because it is harvested as young cob wrapped up tightly with husk and well protected from disease and insect pest attack. Further nutritious green fodder is the most valuable by-product of baby corn crop.

Phosphorus is second major nutrient after nitrogen for high crop yield especially for maize, because it is frequently deficient for crop production and is required by crops in relatively large amounts. In plants, P is necessary for photosynthesis, respiration, cellular function, gene transfer and reproduction. Once aware of the critical link between P and life itself, it becomes apparent that "Without P, there is no cell, plant and grain and without adequate P, there is a lot of hunger". Lack of phosphorus is as important as the lack of nitrogen limiting maize performance (Gul *et al*., 2015) [4]. It is a constituent of ADP and ATP which plays a key role in energy transformation ad also helps in assimilation of photosynthates into other metabolites and hence acts as an activity zone for CO; assimilation.

Thus, adequate supply of phosphorus helps in rapid growth of plant. It is important for seed and fruit formation and crop maturation. Phosphorus hastens ripening of fruits thus counteracting the effect of excess nitrogen application to the soil. Moreover, as an integral part of chromosomes, it stimulate cell division and necessary for meristematic growth. Thus, adequate supply of phosphorus helps in rapid growth of plant.

Phosphorus required for plant growth and development, plays not only an essential role in energy transfer and metabolic regulation, but also an important structural constituent of many molecules, such as nucleotides, phospholipids, and sugar phosphates and so phosphorus is a major yield determining factor required for crop production (Holford, 1997). It is an essential nutrient both as a part of several key plant structure compounds and as a catalyst in the conversion of numerous key biochemical reactions in plants (Griffith, 2004).

Potassium is one of the principal plant nutrient under pinning crop yield and quality determination which also activates many enzymes and plays an important role in the maintaining of potential gradients across cell membranes and the generation of turgor pressure in plants. It regulate photosynthesis, protein synthesis and starch synthesis (Mengel and Kirkby, 1996).

The application of potassium activates a number of enzymes, including those involved in the synthesis of carbohydrates and resistance to disease, adverse environmental conditions and also enhances utilization of N and P. It is the most abundantly available cation and found in cytoplasm that regulates osmotic potential of cells and tissues of glycophytic plant species (Marschner, 1995), Potassium nutrition in maize has positively affected dry matter production as well as plant height (Brar and Singh, 1995).

Materials and Methods

The experimental trial was carried out during *Zaid* 2021 at Crop Research Farm (CRF), Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj (U.P) located 25 ◦39″42″ North latitude, 81˚67”56” East longitude and 98 m altitude above the mean sea level. The experiment was laid out in Randomized Block Design consisting of ten treatments which are T_1: 45 kg P/ha + 20 kg K/ha, T_2: 45 kg P/ha + 30 kg K/ha, T_3: 45 kg P/ha + 40 kg K/ha, T_4: 60 kg P/ha + 20 kg K/ha, T_5: 60 kg P/ha + 30 kg K/ha, T_6: 60 kg P/ha + 40 kg K/ha, T_7: 75 kg P/ha + 20 kg K/ha, T_8: 75 kg P/ha + 30 kg K/ha, T_9: 75 kg P/ha + 40 kg K/ha, T_{10}: Control Plot (90:40:20) NPK Kg/ha. The soil of the trial plot was sandy loam in texture nearly neutral in soil reaction (pH 7.1), low in organic carbon (0.36%), available N (171.48 kg/ha), medium in available P and K (15.2 kg/ha and 232.5 kg/ha respectively). G-5414 was the variety used for experimentation and the nutrient sources were Urea, SSP, MOP to fulfill the requirement of N, P2O5, and K2O. The dose of nitrogen i.e. 90 kg N through Urea, whereas 45, 60, 75 kg P2O5 and 20, 30, 40 kg K2O was applied according to the treatment details as basal at the time of sowing through SSP and MOP but nitrogen was applied in 3 split doses ½ dose of N as basal, ¼ dose as top dressing at 30 DAS and last ¼ dose as top dressing at 45 DAS. Thinning & Gap filling was done within 10 DAS to maintain the plant population according to treatment in order to attain recommended plant population for proper growth and yield of crop. Pre-harvest observations which includes Plant height (cm), No. of leaves per plant, Plant Dry Weight(g/plant), Crop Growth Rate(g/m2/day), Relative Growth Rate(g/g/day) were observed at 15,30,45,60 DAS (Days After Sowing) and Post-harvest observations like No. of cobs/plant, Cob length(cm), Cob weight(g) (with husk and without husk, Stover Yield(t/ha) and Corn yield(kg/ha) were also observed.

The raw data was subjected to appropriate statistical procedure as suggested by Gomez and Gomez (1984). The data from the experiments were analyzed statistically, wherever treatment differences were found significant, the critical differences were worked out at 5% level of probability (P=0.05).

Results and Discussion

Effect on growth of baby corn

The statistical data regarding growth parameters are presented in Table 1.

Plant Height

Phosphorus and Potassium application on baby corn significantly influenced plant height at harvest. Plant height (95.40 cm) was observed significantly highest with application of 75 kg/ha Phosphorus + 40 kg/ha Potassium which was significantly superior over rest of the treatments and remained on par with application of 75 kg P/ha + 30 kg K/ha (94.37 cm), 60 kg P/ha + 40 kg K/ha (93.29 cm), 75 kg P/ha + 20 kg K/ha (92.46 cm). With increase in the levels of phosphorus morphological characters increased which might be attributed to a stronger role of phosphorus in cell division, cell expansion, and enlargement which ultimately led to the vegetative growth (Bose *et al.,* 2009). Whereas, the higher plant height with potassium application might affect cell metabolism, enzymes activity, regulate cell osmosis and increased absorption of water and photosynthesis which promote the more plant growth (Yadav *et al.,* 2014) and (Maleki *et al.*, 2014).

No. leaves per plant

Significantly highest no of leaves (10.83) was recorded with application of 75 kg P/ha + 40 kg K/ha which was significantly superior over rest of the treatments and remained on par with application of 75 kg P/ha + 30 kg K/ha(10.74), 60 kg P/ha + 40 kg K/ha(10.67).The highest number of functional leaves per plant under higher nitrogen, phosphorous and potassium levels may be due to increase in cell division, assimilation rate and metabolic activities in plant Similar, results were reported by Patil (1997), Thakur *et al.* (1997) and Bindhani *et al.* (2007). Interaction between soil moisture levels and potassium had a significant effect on leaf number. Potassium nutrition increases number of leaves. (Kubar *et al.*, 2013).

Dry Weight

Dry weight was significantly influenced at harvest with the application of Phosphorus and Potassium seed inoculation on baby corn. Significantly higher dry weight (77.33 g/plant) was recorded in application of 75 kg P/ha + 40 kg K/ha which was significantly superior over rest of the treatments and remained on par with application of 75 kg P/ha + 30 kg K/ha (76.15), 60 kg P/ha + 40 kg K/ha (75.67). The effect of potassium was significant on the plant dry weight accumulation per plant at different stages. The highest plant dry weight was recorded with application of 75 kg P/ha + 40 kg K/ha in all growth stages. Potassium associated with the movement of water, nutrients and carbohydrates in plant tissue these results similar to Shrama *et al.,* (2018).

Crop Growth Rate

Highest Crop Growth Rate (22.34) was recorded with application of 45 kg P/ha + 40 kg K/ha and minimum plant dry weight was recorded with application of 60 kg P/ha + 30 kg K/ha (21.05) . There was no significant difference between different treatment combinations. Significant increase in CGR in 30-45 DAS was found with increasing levels of phosphorus due to increase in leaf area (Kar *et al.*, 2014) [7].

Relative Growth Rate

Highest Relative Growth Rate (0.04) was recorded with 45 kg P/ha + 20 kg K/ha, 45 kg P/ha + 30 kg K/ha, 45 kg P/ha + 40 kg K/ha, 60 kg P/ha + 20 kg K/ha, 60 kg P/ha + 30 kg K/ha, 75 kg P/ha + 20 kg K/ha, control. There was no significant difference between different treatment combinations.

Table 1: Effect of Phosphorus and Potassium on growth parameters of baby corn

	Treatments	Plant height (cm) (60 DAS)	Number of leaves/plant (60 DAS)	Dry weight (g/plant) (60 DAS)	CGR ($g/m^2/day$) (45-60 DAS)	RGR (g/g/day) (45-60 DAS)
1	45 kg/ha Phosphorus + 20 kg/ha Potassium	86.93	9.98	69.72	21.14	0.04
2	45 kg/ha Phosphorus + 30 kg/ha Potassium	87.41	10.05	70.57	21.52	0.04
3	45 kg/ha Phosphorus + 40 kg/ha Potassium	89.27	10.36	73.20	22.34	0.04
4	60 kg/ha Phosphorus + 20 kg/ha Potassium	88.15	10.22	72.18	22.03	0.04
5	60 kg/ha Phosphorus + 30 kg/ha Potassium	90.33	10.45	73.34	21.05	0.04
6	60 kg/ha Phosphorus + 40 kg/ha Potassium	93.29	10.67	75.67	21.98	0.03
7	75 kg/ha Phosphorus + 20 kg/ha Potassium	92.46	10.56	74.35	21.50	0.04
8	75 kg/ha Phosphorus + 30 kg/ha Potassium	94.37	10.74	76.15	21.44	0.03
9	75 kg/ha Phosphorus + 40 kg/ha Potassium	95.40	10.83	77.33	21.70	0.03
	Control (90:40:20) NPK Kg/ha	85.10	9.82	67.19	21.15	0.04
	F test	S	S	S	NS	NS
	SEm(+)	1.04	0.07	0.88	1.10	0.00
	CD (5%)	3.08	0.20	2.62	-	-

Effect on yield and yield attributes of baby corn

The highest number of cobs/plant was observed in 75 kg P/ha + 40 kg K/ha(2.77) which is significantly superior over rest of the treatments and remained on par with application of 60 kg P/ha + 40 kg K/ha(2.65), 75 kg P/ha + 20 kg K/ha(2.60), 75 kg P/ha + 30 kg K/ha(2.70). Increase in cobs per plant by potassium application was probably due to its influence on various enzymatic activities which controlled the flowering and seed formation. These results are in accordance with those of Gamboa *et al.,* (1990) who stated that K application increased prolificacy probably due to availability of more nutrients to plant.

The highest cob length was observed in 75 kg P/ha + 40 kg K/ha (18.56) which is significantly superior over rest of the treatments and remained on par with application of 60 kg P/ha + 30 kg K/ha (16.57), 60 kg P/ha + 40 kg K/ha(17.81), 75 kg P/ha + 20 kg K/ha (17.25), 75 kg P/ha + 30 kg K/ha(17.98). Increase in cob length with potash fertilization might be due to the role of potassium in increasing cell division, improved plant growth conditions in water use efficiency and also results in quick transportation towards grain. The continuous filling of grains due to sufficient photosynthesis might have resulted in increased length and size of the cob. Gnanasundari *et al.*, (2018).

The highest cob weight (with husk) was observed in 75 kg P/ha + 40 kg K/ha (28.03) which is significantly superior over rest of the treatments and remained on par with application of 60 kg P/ha + 30 kg K/ha (26.10), 60 kg P/ha + 40 kg K/ha (27.37), 75 kg P/ha + 20 kg K/ha (26.60), 75 kg P/ha + 30 kg K/ha (27.57).

The highest cob weight (without husk) was observed in 75 kg P/ha + 40 kg K/ha (9.70) which is significantly superior over rest of the treatments and remained on par with application of 60 kg P/ha + 40 kg K/ha(9.30), 75 kg P/ha + 20 kg K/ha(9.13), 75 kg P/ha + 30 kg K/ha(9.47).

Potassium is essential for physiological processes such as photosynthesis and which functions as electron transporter in photosynthesis, translocation of photosynthates into sink, activation of enzymes and it increases the NUE increase the metabolites and nutrients to develop reproductive structure seems to have resulted in increased cob girth, cob length, number of cobs, number of grains per cob, grain rows per cob, cob weight with and without husk, 100 grain weight and seed weight. The findings are close agreement with those obtained by Tariq *et al.,* (2011).

The highest corn yield was observed in 75 kg P/ha + 40 kg K/ha(7081.33) which is significantly superior over rest of the treatments and remained on par with application of 60 kg P/ha + 40 kg K/ha(6735.67), 75 kg P/ha + 30 kg K/ha(6843.67). These improved yield parameters mainly because of application of potassium overcome the harmful effects of water stress, retaining water in tissue and thus maintaining higher plant growth and regulating transpiration (Ram Rao, 1986).

The highest green fodder yield was observed in 75 kg P/ha + 40 kg K/ha(20.18) which is significantly superior over rest of the treatments and remained on par with application of 60 kg P/ha + 40 kg K/ha(18.76), 75 kg P/ha + 20 kg K/ha(17.62), 75 kg P/ha + 30 kg K/ha(19.53). Potassium application is the reason for the increase in green fodder yield due to higher plant height and dry matter production per plant. Plant hormones responsible for cell division and enlargement and higher facilitating optimum development of photosynthetic apparatus captures the incident light more efficiently Patil *et al.*, (2018) [12].

Table 2: Effect of Phosphorus and Potassium on yield attributes of Baby corn

	Treatments	Yield and yield attributes					
		No. of cobs/plant	Cob length (cm)	Cob weight with husk (g)	Cob weight without husk (g)	Corn yield (kg/ha)	Green fodder yield (t/ha)
1	45 kg/ha Phosphorus + 20 kg/ha Potassium	1.96	14.77	24.03	8.33	5556.00	14.04
2	45 kg/ha Phosphorus + 30 kg/ha Potassium	2.09	15.04	24.40	8.53	5711.33	14.79
3	45 kg/ha Phosphorus + 40 kg/ha Potassium	2.44	16.10	25.87	8.87	6079.67	15.69
4	60 kg/ha Phosphorus + 20 kg/ha Potassium	2.30	15.72	25.37	8.70	5879.00	15.20
5	60 kg/ha Phosphorus + 30 kg/ha Potassium	2.53	16.57	26.10	8.93	6241.00	17.17
6	60 kg/ha Phosphorus + 40 kg/ha Potassium	2.65	17.81	27.37	9.30	6735.67	18.76
7	75 kg/ha Phosphorus + 20 kg/ha Potassium	2.60	17.25	26.60	9.13	6568.00	17.62
8	75 kg/ha Phosphorus + 30 kg/ha Potassium	2.70	17.98	27.57	9.47	6843.67	19.53
9	75 kg/ha Phosphorus + 40 kg/ha Potassium	2.77	18.56	28.03	9.70	7081.33	20.18
10	Control(90:40:20) NPK Kg/ha	1.81	12.97	22.63	8.07	5214.00	12.60
	F test	S	S	S	S	S	S
	SEm (+)	0.06	0.81	0.69	0.24	141.94	0.50
	CD (5%)	0.17	2.40	2.06	0.70	421.73	1.49

Economics

Data in table 3- tabulated that experimental results revealed that application of 75 kg P/ha + 40 kg K/ha The highest cost of cultivation (56327.20), highest gross return (197213.25), and highest net return (140886.05), highest B:C ratio (2.50).

Table 3: Effect of Phosphorus and Potassium on economics of baby corn

	Treatments	Total cost of cultivation (INR/ha)	Gross returns (Cob yield+ Green fodder yield)(INR/ha)	Net returns (INR/ha)	B: C ratio (%)
1	45 kg/ha Phosphorus + 20 kg/ha Potassium	53112.85	152940.00	99827.15	1.87
2	45 kg/ha Phosphorus + 30 kg/ha Potassium	53362.90	157573.25	104210.35	1.95
3	45 kg/ha Phosphorus + 40 kg/ha Potassium	53603.80	167681.75	114077.95	2.12
4	60 kg/ha Phosphorus + 20 kg/ha Potassium	54472.23	162175.00	107702.77	1.97
5	60 kg/ha Phosphorus + 30 kg/ha Potassium	54722.28	173195.00	118472.72	2.16
6	60 kg/ha Phosphorus + 40 kg/ha Potassium	54972.18	187151.75	132.179.57	2.40
7	75 kg/ha Phosphorus + 20 kg/ha Potassium	55827.25	181820.00	125.992.75	2.25
8	75 kg/ha Phosphorus + 30 kg/ha Potassium	56077.30	190621.75	134544.45	2.39
9	75 kg/ha Phosphorus + 40 kg/ha Potassium	56327.20	197213.25	140886.05	2.50
10	Control(90:40:20) NPK Kg/ha	52659.73	142950.00	90290.27	1.71

Conclusion

On the basis of one year experimentation 75 kg P/ha + 40 kg K/ha was found to be more productive higher corn yield (7081.33 Kg/ha), green fodder yield (20.18 t/ha) as well as economic (2.50) B:C ratio also.

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