Original Research Article

Effect of phosphorus levels on growth and yield of Maize Hybrids

Abstract

A field experiment was conducted at the Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj during *Rabi* season 2022 on Maize crop. The experiment was laid out in randomized block design with ten treatments and three replication. The treatment consisted of Maize hybrids (Govinda 111, Hybrid corn 4226, DKC 9133) with soil application of phosphorus (40 kg/ha, 60 kg/ha and 80 kg/ha) and a control (120:60:40 kg NPK/ha). The results of the experiment showed that, plant height (125.65 cm), dry weight (96.59 g/plant), crop growth rate (39.91 g/m^2/day), No. of cob/plant (1.33), No. of grains/row (21.36), seed index (23.44 g), grain yield (5.90 t/ha) and stover yield (9.91 t/ha) and harvest index (37.12%) were significantly highest recorded in 'Hybrid DKC 9133' with the application of phosphorus 80 kg/ha. Maximum gross returns (1,32,865.00 INR/ha), net returns (89,392.55 INR/ha), and B:C (2.06) were also obtained with the same treatment.

Keywords: Economics, Growth, Maize hybrids, Phosphorus and Yield

INTRODUCTION

Maize (*Zea mays* L.) is one of the most significant cereal crops and plays a significant role in world agriculture. In India, it comes in third place behind rice and wheat. The nutritional breakdown of maize (per 100 g) is as follows: 4 g protein, 30 g of carbohydrates, 3.5 g of dietary fibre, 1.5 g of fat, 3.6 g of sugar, 4 mg of calcium, 0.72 mg of zinc, and other nutrients **(Dragana *et al*., 2015)**. In India, maize is emerging as the third most important cereal crop after rice and wheat which occupies an area of 9.86 M/ha with a production of 31.51 MT, having average productivity of about 3.19 t/ha

(Agricultural Statistics at a Glance, 2021). About 28% of produced maize is used as food, 11% for livestock feed, 48% as poultry feed, 12% in wet milling industry and 1% as seed **(AICRP on Maize, 2008)**.

A deficiency in phosphorus causes crooked and missing rows in maize, which results in undersized ears. It serves a crucial function in boosting root ramification and strength, giving plants vigour and the ability to withstand illness. Without phosphorus, there is no cell, plant, and grain and without adequate phosphorus, there is a lot of hunger" once one is aware of the crucial relationship between P and life itself. 90% of soils have phosphorus deficiencies, hence adding phosphatic fertilizers is thought to be necessary for crop development **(Rashid and Memon, 2012)**. In comparison to hybrids, local cultivars from Uttar Pradesh generally failed to provide higher yields. The productivity and quality of hybrid maize cultivars, which is utilised for feed, fibre, and aesthetic value, were significantly improved. These single cross hybrids have advantages including a higher potential grain yield, resistance to biotic and abiotic stress, early maturity, etc. **(Anonymous, 2015)**.

MATERIALS AND METHODS

During the *Rabi* season of 2022, a field experiment was conducted in alluvial soil at the Crop Research Farm of the Department of Agronomy, SHUATS, Prayagraj, U.P. The soil of experimental plot was sandy loam, having a nearly neutral soil reaction (pH 6.9), electrical conductivity (0.296 ds/m), medium in available Nitrogen (278.93 kg/ha) and available potassium (206.4 kg/ha), and low in available phosphorous (10.8 kg/ha). The experiment was conducted in a Randomized Block Design consisting of 10 treatment combinations and 3 replications. The treatments consist of 3 levels of Maize hybrids (Govinda 111, Hybrid corn 4226 and DKC 9133) and 3 levels of phosphorus (40, 60 and 80 kg/ha). The treatment combinations are as follows, T_1 : DKC 9133 + Phosphorus 40 kg/ha, T_2 : Hybrid Corn 4226 + Phosphorus 40 kg/ha, T_3 : Govinda111 + Phosphorus 40 kg/ha, T_4 : DKC 9133 + Phosphorus 60 kg/ha, T_5 : Hybrid Corn 4226 + Phosphorus 60 kg/ha, T_6 : Govinda111 +

Phosphorus 60 kg/ha, T_7 : DKC 9133 + Phosphorus 80 kg/ha, T_8 : Hybrid Corn 4226 + Phosphorus 80 kg/ha, T_9 : Govinda111 + Phosphorus 80 kg/ha and T_{10} : (control). The nutrient sources were Urea, Single Super Phosphate (SSP) and Muriate of Potash (MOP), applied as per the recommended dose of 120:60:40 kg NPK/ha. As per the treatment, Maize hybrids varieties along with application of phosphorus. Plant growth parameters, such as plant height (cm), dry weight (g/plant) were measured at a regular intervals from germination till harvest and yield and yield attributes, such as No. of cobs/plant, No. of rows/cob, No. of grains/row, seed index (g), seed yield (t/ha), stover yield (t/ha) and harvest index (%) were measured at harvest. The observed data were statistically analysed using analysis of variance (ANOVA) as applicable to randomized block design **(Gomez and Gomez, 1984)**.

Results and Discussions

Growth parameter

The data pertaining to growth attributes presented in Table 1, At 100 DAS, significantly higher plant height (125.65 cm) was recorded in 'Hybrid DKC 9133' variety with the application of phosphorus 80 kg/ha, However, it was followed by the treatment with Hybrid corn 4226 + Phosphorus 60 kg/ha, DKC 9133 + Phosphorus 60 kg/ha, Govinda111 + Phosphorus 80 kg/ha and Hybrid corn 4226 + Phosphorus 80 kg/ha (116.99, 122.59, 120.30, and 122.30 cm) were statistically at par with treatment 9. Significant and higher plant height was recorded in Hybrid DKC-9133 variety might be due to competitive environments, light interception, carbon and nutrient capture, and weed competition increased in plant height provides more areas for photosynthetic activities and assimilates. Similar result was also reported by **Kandel and Kumar, (2020)**. Further, significant and higher plant height was recorded with Phosphorus (80 kg/ha) might be due to phosphorus encourage formation of new cells, promote plant vigoursly and hastens leaf development, which help in harvesting more solar energy and better utilization of nitrogen, which help towards higher growth attributes. Similar results also found by **Alias *et. al.* (2003)**. At 100

DAS, significantly highest plant dry weight (96.59 g) was recorded in 'Hybrid DKC 9133' variety with the application of phosphorus 80 kg/ha. Whereas, treatments 7 and 8 (88.52 and 92.31 g, respectively) were statistically at par with treatment 9 (Hybrid DKC 9133 + phosphorus 80 kg/ha). Significant and higher plant dry weight was recorded in Hybrid DKC 9133 variety might be due to specific varietal and environmental factors such as climate, soil, water, topography. Similar result was also reported by **Mege *et. al.* (2021)**. Further, Significant and higher plant dry weight was recorded with phosphorus (80 kg/ha) might be due to an adequate supply of phosphorus, which is associated with the enhancement of more photosynthetic surface, thus contributing to more dry matter production. Similar result was also reported by **Kumari *et. al.* (2018)**. At 80 -100 DAS, highest crop growth rate (30.00 g/m^2/day) was recorded with treatment 9 (DKC 9133 + Phosphorus – 80 kg/ha) as compared to rest of the treatments. However, treatment 4 (Govinda111 + Phosphorus – 60 kg/ha), treatment 5 (Hybrid corn 4226 + Phosphorus 60 kg/ha), treatment 6 (DKC 9133 + Phosphorus 60 kg/ha), treatment 7 (Govinda111 + Phosphorus 80 kg/ha) and treatment 8 (Hybrid corn 4226 + Phosphorus 80 kg/ha) were statistically at par with treatment 9 (DKC 9133 + Phosphorus 80 kg/ha). Significant and higher crop growth rate was recorded with Phosphorus (80kg/ha) might be due to increase in leaf area, photosynthesis improvement resulting in higher dry matter accumulation and increase in crop growth rate. Similar result was also reported by **Thakur *et. al*. (2022)**.

Yield attributes

The data of yield attributes and yield (Table 2), Significant and maximum number of cobs/plant (1.33) was recorded with treatment 9 (DKC 9133 + Phosphorus 80kg/ha) as compared to rest of the treatments and there was no significance difference. Significant and maximum number of grains/row (21.40) was recorded with treatment 9 (DKC 9133 + Phosphorus 80kg/ha) as compared to rest of the treatments. However, treatment 5 (Hybrid corn 4226 + Phosphorus 60kg/ha), treatment 7 (Govinda111 + Phosphorus 80kg/ha) and treatment 8 (Hybrid corn 4226 + Phosphorus 80kg/ha)

were statistically at par with treatment 9 (DKC 9133 + Phosphorus 80kg/ha). Significant and maximum number of grains/row was recorded with Phosphorus (80kg/ha) might be due to physiological process occur within a developing and maturing stages of plant and also involved in enzymatic reaction in plant which is essential for cell division and cell development. Similar result was also reported by **Sharma *et. al*. (2018)**. Highest number of rows/cob (11.73) was recorded with treatment 9 (DKC 9133 + Phosphorus 80kg/ha) as compared to rest of the treatments and there was no significance difference between them. Significant and higher seed index (23.44g) was recorded with treatment 9 (DKC 9133 + Phosphorus 80kg/ha) as compared to rest of the treatments. However, treatment 4 (Govinda111 + Phosphorus - 60kg/ha), treatment 5 (Hybrid corn 4226 + Phosphorus - 60kg/ha), treatment 6 (DKC 9133 + Phosphorus - 60kg/ha), and treatment 8 (Hybrid corn 4226 + Phosphorus 80kg/ha) were statistically at par with treatment 9 (DKC 9133 + Phosphorus - 80kg/ha). Significant and higher seed index was recorded with DKC 9133 variety might be due to more canopy of plant contributing higher photosynthetic activity to accumulate more biomass leads to bold grain. Similar result was also reported by **Kripa *et. al*. (2021)**. Further, significant and higher seed index was recorded with Phosphorus (80 kg/ha) might be due to efficient absorption and utilization of other required plant nutrients which ultimately increased the grain. Similar result was also reported by **Reddy *et. al*. (2018).** Significant and higher grain yield (5.90 t/ha) was recorded with treatment 9 (DKC 9133 + Phosphorus 80 kg/ha) as compared to rest of the treatments. However, treatment 8 (Hybrid corn 4226 + Phosphorus 80 kg/ha) was statistically at par with treatment 9 (DKC 9133 + Phosphorus 80 kg/ha). Significant and higher seed yield was recorded with DKC 9133 variety might be due to more canopy of plant contributing higher photosynthetic activity to accumulate more biomass leads to bold grain and increases yield. Similar result was also reported by **Kripa *et. al*. (2021)**. Further, significant and higher yield was recorded with Phosphorus (80 kg/ha) might be due to excess assimilates stored in the leaves and later translocated in to seed at the time of senescence, enhanced the yield potential and reproductive parts and the fraction of the total duration grain filling

ultimately led to higher grain yield. Similar result was also reported by **Khan *et. al*. (2005)**. Significant and higher stover yield (9.91 t/ha) was recorded with treatment 9 (DKC 9133 + Phosphorus 80 kg/ha) as compared to rest of the treatments. However, treatment 6 (DKC 9133 + Phosphorus 60 kg/ha), 7 (Govinda111 + Phosphorus 80 kg/ha) and 8 (Hybrid corn 4226 + Phosphorus 80 kg/ha) were statistically at par with treatment 9 (DKC 9133 + Phosphorus – 80 kg/ha). Significant and higher stover yield was recorded in DKC-9133 variety light interception, nutrient uptake increases growth and development of crop and provides more areas for photosynthetic activities and assimilates, which leads to increase in stover yield. Similar result was also reported by **Kandel and Kumar, (2020).** Further, This might be due to phosphorus enhance better root growth, which promotes plant height and dry matter accumulation, early growth of seedling and increases the photosynthetic efficiency and greater accumulation of photosynthates in vegetative parts results in superior vegetative growth and led to increase in stover yield. Similar result was also reported by **Kumari *et. al*. (2018)**. Significant and higher harvest index (37.12 %) was recorded with treatment 9 (DKC 9133 + Phosphorus 80 kg/ha) as compared to rest of the treatments. However, treatment 6 and 8 (DKC 9133 + Phosphorus 60 kg/ha) and (Hybrid corn 4226 + Phosphorus 80 kg/ha) was statistically at par with treatment 9 (DKC 9133 + Phosphorus 80kg/ha). Significant and higher harvest index was recorded with Phosphorus (80 kg/ha) might be due to adequate supply of phosphorus enhanced carbohydrate synthesis, cell division and elongation which leads to increase in biological yield. Similar result was also reported by **Kumari *et. al*. (2018)**.

Economics

The data pertaining to the economics of different treatments presented in Table 3 showed that the maximum gross return (₹ 1,32,865.00/ha), net return (₹ 89,392.55/ha), and benefit-cost ratio (2.06) was obtained in the treatment of DKC 9133 + Phosphorus - 80kg/ha, and the minimum gross return (₹ 92,800.00/ha), net return (₹ 51,027.55/ha), and lowest benefit-cost ratio (1.22) were recorded in treatment 10 (control).

Conclusion

From the results of the experiment, It is concluded that hybrid DKC 9133 with combination of phosphorus 80 kg/ha (T_9) was found to be more desirable in terms of increasing growth, yield and economics of Maize.

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Table 1. Application of phosphorus on growth parameters of Maize hybrids

Sl. No.	Treatments	Plant height (cm) (100 DAS)	Dry weight (g/plant) (100 DAS)	Crop Growth Rate ($g/cm^2/day$) (During 60-80 DAS)
1.	Govinda111 + Phosphorus 40kg/ha	103.83	64.62	31.83
2.	Hybrid corn 4226 + Phosphorus 40kg/ha	106.12	67.61	35.40
3.	DKC 9133 + Phosphorus 40kg/ha	108.45	70.66	37.12
4.	Govinda111 + Phosphorus 60kg/ha	113.09	75.82	35.81
5.	Hybrid corn 4226 + Phosphorus 60kg/ha	116.99	79.44	36.75
6.	DKC 9133 + Phosphorus 60kg/ha	122.59	85.64	41.82
7.	Govinda111 + Phosphorus 80kg/ha	120.30	88.52	41.69
8.	Hybrid corn 4226 + Phosphorus 80kg/ha	122.30	92.31	43.70
9.	DKC 9133 + Phosphorus 80kg/ha	125.65	96.59	46.35
10.	Control (120-60-60 kg/ha NPK)	109.25	64.02	36.77
	SEm(±)	3.11	3.56	2.24
	CD (P=0.05)	9.27	10.60	6.67

Table 2. Application of phosphorus on yield and yield attributes of Maize hybrids

Sl.No.	Treatments	Cobs/ Plant (No.)	No. of Grains/row	No. of rows/cob	Seed index (g)	Seed yield (t/ha)	Stover yield (t/ha)	Harvest index
1.	Govinda111 + Phosphorus 40kg/ha	1.20	18.60	10.47	20.43	4.17	8.50	32.95
2.	Hybrid corn 4226 + Phosphorus 40kg/ha	1.20	17.93	10.87	20.76	4.14	8.52	32.67
3.	DKC 9133 + Phosphorus 40kg/ha	1.20	18.93	11.27	21.03	4.52	8.90	33.70
4.	Govinda111 + Phosphorus 60kg/ha	1.26	18.86	10.60	21.82	4.41	8.73	33.62
5.	Hybrid corn 4226 + Phosphorus 60kg/ha	1.20	19.80	11.07	22.53	4.70	8.95	34.44
6.	DKC 9133 + Phosphorus 60kg/ha	1.26	19.20	11.13	22.73	5.23	9.40	35.75
7.	Govinda111 + Phosphorus 80kg/ha	1.20	20.20	10.87	21.31	5.00	9.45	34.57
8.	Hybrid corn 4226 + Phosphorus 80kg/ha	1.26	21.00	11.07	23.10	5.57	9.60	36.71
9.	DKC 9133 + Phosphorus 80kg/ha	1.33	21.40	11.73	23.44	5.90	9.91	37.12
10.	Control (120-60-60 kg/ha NPK)	1.13	18.06	10.20	20.65	4.00	8.53	31.91
	SEm(±)	0.11	0.66	0.62	0.63	0.21	0.22	0.76
	CD (P=0.05)	-	1.98	-	1.87	0.63	0.67	2.25

Table 3. Application of phosphorus on economics of Maize hybrids

Sl. No.	Treatments	Gross returns (INR/ha)	Net returns (INR/ha)	B:C
1.	Govinda111 + Phosphorus 40kg/ha	96160.83	55388.38	1.36
2.	Hybrid corn 4226 + Phosphorus 40kg/ha	95447.67	54275.22	1.32
3.	DKC 9133 + Phosphorus 40kg/ha	103800.83	62328.38	1.50
4.	Govinda111 + Phosphorus 60kg/ha	101566.67	59794.22	1.43
5.	Hybrid corn 4226 + Phosphorus 60kg/ha	107432.00	65259.55	1.55
6.	DKC 9133 + Phosphorus 60kg/ha	118764.17	76291.72	1.80
7.	Govinda111 + Phosphorus 80kg/ha	114175.00	71402.55	1.67
8.	Hybrid corn 4226 + Phosphorus 80kg/ha	125733.33	82560.88	1.91
9.	DKC 9133 + Phosphorus 80kg/ha	132865.00	89392.55	2.06
10.	Control (120-60-60 kg/ha NPK)	92800.00	51027.55	1.22