International Journal of Environment and Climate Change

Volume 13, Issue 10, Page 2308-2313, 2023; Article no.IJECC.105507
ISSN: 2581-8627
(Past name: British Journal of Environment & Climate Change, Past ISSN: 2231–4784)

Effect of Phosphorus Levels on Growth and Yield of Maize Hybrids

Pooja Kumari [a++*] and Umesha C. [a#]

[a] Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj-211007, Uttar Pradesh, India.

Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJECC/2023/v13i102895

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/105507

Original Research Article

Received: 22/06/2023
Accepted: 27/08/2023
Published: 05/09/2023

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: Growth; maize hybrids; phosphorus; maize yield.

[++] *M.Sc. Scholar;*
[#] *Assistant Professor;*
**Corresponding author: E-mail: poojadbg20016@gmail.com;*

1. INTRODUCTION

Maize (*Zea mays* L.) is one of the most significant cereal crops and plays a significant nutrition role in the world for human being and animals. 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 [1]. 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 [2]. 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 [3].

A deficiency in phosphorus causes crooked and missing rows in maize, it causes ears to be too small. It serves a crucial function in boosting root ramification and strength, giving plants vigour and the ability to withstand illness. The P content in an average soil is about 0.05% (w/w) but only 0.1% of the total P is available to plant because of poor solubility and its fixation in soil. An adequate supply of phosphorus during early phases of plant development is important for laying down the primordial of plant reproductive parts. It plays significant role in increasing root ramification and strength thereby imparting vitality and disease resistance capacity to plant. 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. Phosphorus deficiency affects 90% of soils, hence adding phosphatic fertilisers is regarded to be essential for crop development [4]. Local cultivars from Uttar Pradesh often failed to produce superior yields when compared to hybrids. Hybrid maize varieties, which are used for feed, fibre, and aesthetic value, have considerably increased in productivity and quality. A higher potential grain production, resilience to biotic and abiotic stress, early maturity, and other benefits can be found in these single cross hybrids [5].

2. MATERIALS AND METHODS

During the *Rabi* season of 2022-2023, a field experiment was conducted in alluvial soil at the Crop Research Farm of the Department of Agronomy, SHUATS, Prayagraj, Uttar Pradesh. 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 treatments 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 combined treatments 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 T10 : 120:60:40 kg NPK/ha (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 treatments, Maize hybrids varieties along with application of phosphorus. Plant growth parameters, such as plant height (cm), plant dry weight (g/plant) were measured at 20 days 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 [6].

3. RESULTS AND DISCUSSION

3.1 Growth Parameter

The data pertaining to growth attributes presented in Table 1, has been significantly influenced with the Hybrid Maize and application of phosphorus. The data revealed that basal application of phosphorus 80 kg/ha along with Hybrid DKC 9133 variety recorded significantly higher plant height (125.65 cm). This 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 whereas, 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. These results are in conformity

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

S. 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 40 kg/ha	103.83	64.62	31.83
2.	Hybrid corn 4226 + Phosphorus 40 kg/ha	106.12	67.61	35.40
3.	DKC 9133 + Phosphorus 40 kg/ha	108.45	70.66	37.12
4.	Govinda111 + Phosphorus 60 kg/ha	113.09	75.82	35.81
5.	Hybrid corn 4226 + Phosphorus 60 kg/ha	116.99	79.44	36.75
6.	DKC 9133 + Phosphorus 60 kg/ha	122.59	85.64	41.82
7.	Govinda111 + Phosphorus 80 kg/ha	120.30	88.52	41.69
8.	Hybrid corn 4226 + Phosphorus 80 kg/ha	122.30	92.31	43.70
9.	DKC 9133 + Phosphorus 80 kg/ha	125.65	96.59	46.35
10.	Control (120:60:40 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

S. 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 40 kg/ha	1.20	18.60	10.47	20.43	4.17	8.50	32.95
2.	Hybrid corn 4226 + Phosphorus 40 kg/ha	1.20	17.93	10.87	20.76	4.14	8.52	32.67
3.	DKC 9133 + Phosphorus 40 kg/ha	1.20	18.93	11.27	21.03	4.52	8.90	33.70
4.	Govinda111 + Phosphorus 60 kg/ha	1.26	18.86	10.60	21.82	4.41	8.73	33.62
5.	Hybrid corn 4226 + Phosphorus 60 kg/ha	1.20	19.80	11.07	22.53	4.70	8.95	34.44
6.	DKC 9133 + Phosphorus 60 kg/ha	1.26	19.20	11.13	22.73	5.23	9.40	35.75
7.	Govinda111 + Phosphorus 80 kg/ha	1.20	20.20	10.87	21.31	5.00	9.45	34.57
8.	Hybrid corn 4226 + Phosphorus 80 kg/ha	1.26	21.00	11.07	23.10	5.57	9.60	36.71
9.	DKC 9133 + Phosphorus 80 kg/ha	1.33	21.40	11.73	23.44	5.90	9.91	37.12
10.	Control (120:60:40 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

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

with Kandel and Kumar, [7] and Alias et al. [8]. Significantly highest plant dry weight (96.59 g) was recorded in 'Hybrid DKC 9133' variety with the application of phosphorus 80 kg/ha, might be due to specific varietal and environmental factors such as climate, soil, water, topography increase in leaf area, photosynthesis improvement resulting in higher dry matter accumulation and increase in crop growth rate while an adequate supply of phosphorus, which is associated with the enhancement of more photosynthetic surface, thus contributing to more dry matter production. Similar results were also reported by Mege et al. [9] and Kumari et al. [10]. Significantly highest crop growth rate (30.00 g/m^2/day) was recorded in 'Hybrid DKC 9133' variety with the application of phosphorus 80 kg/ha might be due to increase in leaf area, photosynthesis improvement resulting in higher dry matter accumulation and increase in crop growth rate whereas, 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. These results are in conformity with Thakur et al. [11] and Alias et al. [8].

3.2 Yield Attributes

The data of yield attributes and yield (Table 2), had shown significantly and maximum number of cobs/plant (1.33) and number of grains/row (21.40) were recorded with application of Phosphorus 80 kg/ha along with Hybrid DKC 9133 variety. This might be due to physiological process occurred 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. [12]. The highest number of rows/cob (11.73) recorded in 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 application of phosphorus 80 kg/ha along with Hybrid DKC 9133 variety, might be due to more canopy of plant contributing higher photosynthetic activity to accumulate more biomass leads to bold grain. Further, significant and higher seed index was recorded with Phosphorus might be due to efficient absorption and utilization of other required plant nutrients which ultimately increased the grain. Similar results were also reported by Kripa et al. [13] and Reddy et al. [14]. Significant and higher grain yield (5.90 t/ha) was recorded with application of Phosphorus 80 kg/ha along with Hybrid DKC 9133. This might be due to more canopy of plant contributing higher photosynthetic activity to accumulate more biomass leads to bold grain and increases yield. Further, Phosphorus 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 results were also reported by Kripa et al. [13] and Khan et al. [15]. Significant and higher stover yield (9.91 t/ha) was recorded with application of phosphorus 80 kg/ha along with Hybrid 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. Further, 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 results were also reported by Kandel and Kumar, [7] and Kumari et al. [10]. Significant and higher harvest index (37.12 %) was recorded with application of Phosphorus 80 kg/ha along with Hybrid 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 seed index whereas adequate supply of phosphorus enhanced carbohydrate synthesis, cell division and elongation which leads to increase in biological yield. Similar results were reported by Kripa et al. [13] and Kumari et al. [10].

3.3 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 80 kg/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).

4. 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 characters *viz.,* plant height, dry weight and crop growth rate, yield and yield attributing characters No. of cob/plant, No. of grains/row, seed index, grain yield and stover yield. It also recorded the maximum gross return, net return and benefit cost ratio.

ACKNOWLEDGEMENT

I am grateful to my advisor as well as all of the faculty members of Department of Agronomy for their unwavering support and advice throughout the entire experimental research study.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Dragana IM, Jelena V, Dejana T, Zoran D, Marija K, Sofija B. Grain nutrient composition of Maize (*Zea mays* L.) drought tolerant populations. Journal of Agricultural and Food Chemistry. 2015; 63(4): 1251-1260.
2. Agricultural Statistics at a Glance. Government of India, Ministry of Agriculture & Farmers Welfare, Department of Ministry of Agriculture, Cooperation & Farmers Welfare, Directorate Statistics; 2021.
3. AICRP on Maize. In the national symposium on quality protein maize for human nutritional security and development of poultry sector in India. Held at NASC Complex and organized by Directorate of Maize Research (DMR). 2008;5.
4. Rashid M, Iqbal M. Effect of phosphorus fertilizer on the yield and quality of maize (*Zea mays* L.) fodder on clay loam soil. The Journal of Animal and Plant Sciences. 2012;22:199-203.
5. Anonymous. Performance of private sector maize hybrids (*Zea mays* L.) under different agroclimatic zones of U.P. Uttar Pradesh Council of Agricultural Research; 2015.
6. Gomez, KA, Gomez, AA. Three or more factor expects. In statistical Procedure for Agricultural Research. 1984;2:139-141.
7. Kandel BP, Kumar S. Performance evaluation of maize hybrids in inner-plains of Nepal. Heliyon.2020;6(1):05542.
8. Alias A, Usman M, Ullah E, Warraich AE. Effects of different phosphorus levels on the growth and yield of two cultivars of maize (*Zea mays* L.). International Journal of Agriculture & Biology. 2003;5 (4):632-634.
9. Mege D, Tara B, Devadas SV, Monlai S, Sharma A. Response of different maize (*Zea mays* L.) varieties to planting densities. Int. J. Curr. Microbiol. App. Sci. 2021;10 (02):1278-1284.
10. Kumari AH, Luther MM, Chandrasekhar K, Babu RP, Rani AY. Effect of sources and levels of phosphorus on growth and yield of no-till sorghum in rice-sorghum sequence. Int. J. Curr. Microbiol. App. Sci. 2018;7(11):65-76.
11. Thakur PM, Dawson J, Thakur T. Effect of Phosphorus, Zinc and Iron Levels on Growth and Yield of Kharif Maize (*Zea mays* L.). Int. J. Current Micro biology App. Sci. 2022;9(12):2312-2323.
12. Sharma A, Wadhwa M, Singh G, Hundal JS. Adaptability, yield and in vitro evaluation of some promising silage maize (*Zea mays* L.) hybrids under tropical climate. India Joumal of Animal Sciences. 2018;80(6):671-675.
13. Kripa A, Bhandar S, Aryal K, Mahato M, Shrestha J. Effect of different levels of nitrogen on growth and yield of hybrid maize (*Zea mays* L.) varieties. Journal of Agriculture and Natural Resources. 2021;4(2):48-62.
14. Reddy BVU, Reddy PG, Reddy SM, Kavitha P. Effect of Different Nitrogen and Phosphorus Levels on Growth and Yield of Maize during Kharif Season. Int. J. Curr. Microbiol. App. Sci. 2018;7(1):3548-355.
15. Khan AM, Abid M, Hussain N, Masood UM. Effect of phosphorous levels on growth and yield of maize (*Zea mays* L.) cultivars under saline conditions. International Journal of Agriculture & Biology. 2005; 7(3):512-514.

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The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/105507