International Journal of Agricultural Sciences
Volume 13 | Issue 2 | June, 2017 | 266-270 ■ e ISSN-0976-5670
DOI:10.15740/HAS/IJAS/13.2/266-270
Visit us : *www.researchjournal.co.in*

RESEARCH PAPER

Effect of different levels of phosphorus on the yield and yield components of maize under agro-climatic zone- II of Bihar

AJEET KUMAR* AND MUKUL KUMAR[1]
Regional Research Station, Madhopur, WEST CHAMPARAN (BIHAR) INDIA

Abstract : An explorative experimental trial was conducted to study the effect of different levels of phosphorus on the yield and yield components of maize in North-East Alluvial plains of Bihar, was conducted at Regional Research Station, Agwanpur, Saharsa (India). The experiment was laid out in Randomized Complete Block Design with three replications having a plot size of 5.40 m x 6.7 m with row to row distance of 0.75 m and plant to plant distance of 0.25 m. The levels of phosphorus were 0 (control), 50, 100, 150 and 200 kg ha^{-1}. Results indicated that the different levels of phosphorus significantly affected maize plant height, number of cobs plant^{-1}, number of grains cob^{-1} and grain yield, however, the effect was non-significant on number of plants m^{-2}, thousand grain weight and biological yield of maize. Application of phosphorus at the rate of 100 kg ha^{-1} resulted in maximum plant height (161 cm), number of cobs plant^{-1} (1.25), number of grain cob^{-1} (343), thousand grain weight (253 g), grain yield (2535 kg ha^{-1}) and biological yield (8398 kg ha^{-1}) as compared to the minimum values in control plots *i.e.* 148cm, 0.88, 290, 197 g, 1370 kg ha^{-1} and 6041 kg ha^{-1}, respectively. It is concluded that phosphorus should be applied at the rate of 100 kg ha^{-1} for best grain yield in the agro-climatic conditions of Bihar.

Key Words : Phosphorus, *Zea mays* L., Plant height, Grain yield

View Point Article : Kumar, Ajeet and Kumar, Mukul (2017). Effect of different levels of phosphorus on the yield and yield components of maize under agro-climatic zone- II of Bihar. *Internat. J. agric. Sci.*, **13** (2) : 266-270, **DOI:10.15740/HAS/IJAS/13.2/266-270.**

Article History : Received : 20.02.2017; **Revised :** 15.04.2017; **Accepted :** 29.04.2017

INTRODUCTION

Maize (*Zea mays* L.); family Poaceae. is an important *Rabi* crop widely grown in Koshi zone-II, of North-East Alluvial plains of Bihar. Maize is also known as queen of cereals because of its high production and productivity potentials. It is the third most important cereal crop after wheat and rice in Bihar and mostly consumed as human food and animal feed and provides raw material for food industry. It is widely grown through out the year, while it is luxuriantly grown in *Rabi*, where insect pest attack is minimal. Its grain is valuable source of protein, fats, starch, vitamins, and minerals. According to estimation, about 50 to 55 per cent of the total maize production is consumed as food by the farming community, 30 to 35 per cent goes for poultry, piggery and fish meal, in starch manufacturing industry and 10 to 12 per cent to wet milling industry. The green roasted ears of maize are consumed directly as food in and around cities. About 64 per cent of maize is grown under irrigated condition.

Maize is a C_4 plant which has high photosynthetic

*** Author for correspondence:**
[1]Department of Botany and Plant Physiology, Mandan Bharti Agriculture College, AGWANPUR SAHARSA (BIHAR) INDIA

activity. It is nutrient exhaustive crop having higher production potential than other cereals and absorbs large quantity of nutrients from the soil during their different growth stages. Among the essential nutrients, phosphorus is one of the most important nutrients for higher yield in larger quantity (Chen *et al.*, 1994) and controls mainly the reproductive growth of plant (Wojnowska *et al.*, 1995). Generally, phosphorus is the second most crop-limiting nutrient in soils of this agro-climatic zone. It is second only to nitrogen in fertilizer use. Plant growth behaviour is influenced by the application of phosphorus. It is needed for growth, utilization of sugar and starch, photosynthesis, nucleus formation and cell division, fat and albumen formation. Energy from photosynthesis and the metabolism of carbohydrates is stored in phosphate compounds for later use in growth and reproduction (Ayub *et al.*, 2002). It is readily translocated within the plants, moving from older to younger tissues as the plant forms cells and develops roots, stems and leaves (Ali *et al.*, 2002). Adequate P results in rapid growth and earlier maturity and improves the quality of vegetative growth. Phosphorus deficiency is responsible for crooked and missing rows as kernel twist and produce small ears nubbies in maize and ultimately it will reduce overall plant growth (Rashid and Memon, 2001). Its deficiency is widespread in soils due to heavy fixation of phosphorus in soil in the insoluble forms *viz.*, iron phosphate and aluminium phosphate, since the soils of this region is highly dominated by iron. Thus, the application of phosphatic fertilizers is considered essential for crop production. Ali *et al.* (2002) reported significant effect of phosphorus application on grain yield; whereas Ayub *et al.* (2002) observed significant effect of phosphorus application on dry matter yield and individual plant characteristics like height, number of leaves and leaf area. Thus, the present study was aimed at evaluating the effect of various levels of phosphorus on the yield and yield components of maize under the agro-climatic conditions of Bihar.

MATERIAL AND METHODS

Experimental site and crop husbandry :

An explorative field trial was aimed for evaluating the "effect of different level of phosphorus on the performance of maize" at Regional Research Station, Agwanpur (86.34^0 longitudes and 25.55^0 N latitude), Saharsa, Bihar. The experiment was conducted in winter 2013-2014, at the Regional Research Station, Agwanpur, to investigate the effect of different phosphorus levels on the yield and yield components of maize. The experiment was laid out in Randomized Complete Block Design with three replications having a plot size of 5.40 m x 6.7 m with row to row distance of 0.75 m and plant to plant distance of 0.25 m. Among fertilizers nitrogen was applied in splits as it is scheduled like this- at the time of sowing the basal dose of nitrogen @ 60 kg ha^{-1}, was used. Again the nitrogen was applied at the rate of 50 kg ha^{-1} after 50- 60 days after sowing; again it was applied at the rate of 40 kg ha^{-1} at the time of silking. Since the soil of this region is sandy in nature, therefore, the the dose of potassium application was also split in two, basal dose was applied @ 30 kg ha^{-1}, rest 30 kg ha^{-1} at 45 days after sowing in order to make better utilization of potassium. The $ZnSO_4$ was applied @ 25 kg ha^{-1} evenly in the experimental field. Phosphorus was applied at the rate of 0, 50, 100, 150 and 200 kg ha^{-1}. Before sowing and after harvesting, a composite soil sample was taken for the estimation of phosphorus (Table A). Similarly, after harvesting, the plant samples were also analyzed for phosphorus. All recommended agronomic practices were carried out throughout the growing season. The parameters studied during the course of the experiment were number of cobs plant^{-1}, number of grains cob^{-1}, plant height (cm), thousand grain weight (g), grain yield (kg ha^{-1}) and biological yield (kg ha^{-1}). Data recorded for each trait were individually subjected to the ANOVA technique using MSTATC computer software. Means were separated using LSD test to signify the treatment differences at 5 per cent level of probability (Steel and Torrie, 1980).

Table A: Per cent P concentration in soil and plant

Phosphorus levels (kg ha^{-1})	P in soil before sowing (%)	P in leaf (%)	P in soil after harvest (%)
0	0.006	2.9	0.005
50	0.006	3.1	0.004
100	0.006	3.5	0.004
150	0.007	3.2	0.006
200	0.007	3.2	0.006

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Number of plants m^{-2} :

The effect of different levels of phosphorus was not significant on number of plants m^{-2} at harvest (Table 1). However, mean value of the data showed that higher number of plants m^{-2} (6) were recorded in plots where P was applied at the rate of 150 and 200 kg ha^{-1}, whereas lower number of plants m^{-2} (4) were recorded in control plots.

Plant height (cm) :

Data concerning to plant height (Table 1) indicated that the different levels of phosphorus had a significant effect on maize plant height. Application of phosphorus at the rate of 100 kg ha^{-1} resulted in long stature plants (161 cm), as expected, followed by phosphorus applied at the rate of 150 kg ha^{-1} (156 cm), it may be due to prolonged vegetative growth which increased the plant height. This may be due to increased root growth, which strengthened the stem against lodging during prolonged vegetative growth which increased the plants height. These results are in agreements with those of Maqsood *et al.* (2001) and Bakht *et al.* (2006), who reported that maize plant height increased with increase in phosphorus rates. This meant that phosphorus at the rate of 100 kg ha^{-1} might be the optimum rate to trigger an increase in production per unit area with per unit increase in phosphorus content as can be deduced from the control plots. Therefore, further increase in phosphorus above 100 kg ha^{-1} did not have a directly proportional effect on the plant height of maize, which is obvious from the plots with phosphorus application at the rate of 150 kg ha^{-1}. The short stature plants (148 cm) were observed in control plots. Phosphorus improves the root growth and their proliferation which has a great effect on the overall plant growth performance; therefore the regimes of phosphorus at the rate of 0 kg ha^{-1} resulted in the shortest stature plants. Promotion effect of high phosphorus level on plant height was probably due to better development of root system and nutrient absorption (Hussain *et al.*, 2006). Arain *et al.* (1989) reported that plant height of maize increased with increase in phosphorus application. A significant effect of NP application was observed on plant height by Maqsood *et al.* (2001) and Ayub *et al.* (2002). However, the results are in contrary to the findings of Amin *et al.* (1989), who reported that plant height of maize plants increased with increasing phosphorus levels.

Number of cobs $plant^{-1}$:

Data regarding number of cobs $plant^{-1}$ were significantly affected ($P \leq 0.05$) by the different levels of phosphorus (Table 1). Mean values of the data indicated that maximum number of cobs $plant^{-1}$ (1.25) was recorded in plots with P applied at the rate of 100 kg ha^{-1} followed by P applied at the rate of 150 kg ha^{-1} (1.04). The application of phosphorus at the rate of 100 kg ha^{-1} might be an optimum rate for best results in number of cobs $plant^{-1}$. Thus, increasing phosphorus level upto 100 kg ha^{-1} had a directly proportional effect on the number of cobs $plant^{-1}$ of maize. This effect can be clearly understood from the control plots where phosphorus was not applied. This can be the reason for the minimum number of cobs $plant^{-1}$ (0.88) recorded in the control plots. It may also be due to the fact that optimum availability of P has been associated with increased rapid growth and development, thus those plots which received optimum P produced more cob $plant^{-1}$ as compared to control plots. Arain *et al.* (1989) reported that number of cobs $plant^{-1}$ of maize increased with

Table 1: Effect of different levels of phosphorus on plant height (cm), number of cobs $plant^{-1}$, number of grains cob^{-1}, thousand grain weight, biological yield and grain yield of maize

P level (kg ha^{-1})	Number of plants m^{-2}	Plant height (cm)	Number of cobs $plant^{-1}$	Number of grains cob^{-1}	Thousand grain weight (g)	Biological yield (kg ha^{-1})	Grain yield (kg ha^{-1})
0	4	148 b	0.88 c	290 b	197	6041	1370c
50	5	154 ab	0.98 b	331 a	221	6232	1907 bc
100	6	161 a	1. 25 a	343 a	253	8398	2535 a
150	6	156 ab	1.04 b	336 a	231	6778	2128 ab
200	5	149 b	0.97 b	327 a	229	7486	2026 ab
LSD (0.05)	NS	7. 30	0.105	16.61	NS	NS	594.3

Means not sharing a letter differ significantly by LSD at 5 per cent probability level NS= Non-significant increase in P application. They argued that less number of cobs $plant^{-1}$ in the control plots resulted in less number of grains $plant^{-1}$ that finally resulted in minimum grain yield.

Number of grains cob^{-1} :

Perusal of the data revealed that different levels of phosphorus had a significant effect ($P \leq 0.05$) on number of grains cob^{-1} of maize. The application of P_2O_5 at the rate of 100 kg ha^{-1} resulted in highest number of grains cob^{-1} (343), which was at par with all the other treatments of phosphorus application except the control (290). This indicates that phosphorus at the rate of 100 kg ha^{-1} might be the optimum rate for enhancing the number of grains cob^{-1}, which ultimately had a direct effect on grain yield. Therefore, further increase in phosphorus above 100 kg ha^{-1} did not have a linear effect on the number of grains cob^{-1} of maize which is obvious from the plots with phosphorus application at the rate of 150 kg ha^{-1} that had less number of grains cob^{-1} even though both treatments were statistically at par. The application of phosphorus @150 kg ha^{-1} or more has may be antagonistic effect due to alteration of ideal fertilizer ratio inside the soil. Off course phosphorus is responsible for good root growth and their proliferation which directly affects the overall plant performance but nutrient should be in ideal proportion. The results are in accordance with those of Sharma and Sharma (1989) who reported that phosphorus fertilizer applications significantly affected the grains per cob. The results are similar with that of Maqsood *et al.* (2001) and Leon (1999) who reported that number of grains cob^{-1} were influenced significantly with NP application. Arain *et al.* (1989) reported that number of grains cob^{-1} of maize increased with increase in phosphorus application.

Thousand grain weight (g) :

The effect of different levels of phosphorus on thousand grain weight was not significant. However, a highest thousand grain weight of 253 g was recorded in plots with P_2O_5 applied at the rate of 100 kg ha^{-1}. The thousand grain weight is an important yield component that helps a lot in the grain yield estimation. The application of phosphorus @100 kg ha^{-1} seems to be the most economical and yield enhancing in case of maize crop because none of the rest of the phosphorus levels positively affected the thousand grain weight even though all the treatments were statistically at par except control. It also indicated that increasing phosphorus above 100 kg ha^{-1} had nothing to do with the improvement of crop performance in any parameter of the data (Table 1). The lowest thousand grain weight (197 g) was observed in the control plots. Hussain *et al.* (2006) observed an increase in 1000 grain weight with increase in NP application. Phosphorus being responsible for good root growth directly affected the thousand grain weight because phosphorus at the rate of 0 kg ha^{-1} (control plots) resulted in the least thousand grain weight.

Grain yield (kg ha^{-1}) :

The statistical data revealed that different phosphorus levels had significantly affected grain yield. The grain yield as affected by phosphorus levels is reported in Table 1. Mean values of the data showed that maximum grain yield (2535 kg ha^{-1}) was produced by the treatments of 100 kg P_2O_5 ha^{-1}, followed by 150 kg P_2O_5 ha^{-1} (2128 kg ha^{-1}). The control plot resulted in minimum grain yield (1370 kg ha^{-1}). Phosphorus application at rate of 100 kg P_2O_5 ha^{-1} resulted in long stature plants, more number of cobs m^{-1} and number of grains cob^{-1}, which resulted in greater grain yield as compared to other phosphorus levels. This disclosed that phosphorus at the rate of 100 kg ha^{-1} might be the optimum rate for obtaining a desirable increase in production per unit area with per unit increase in phosphorus content because the grain yield in the control plot was the lowest whereas it was highest in the plot with phosphorus applied at 100 kg ha^{-1}. Increasing phosphorus above 100 kg ha^{-1} might be excessive that had decreased the grain yield of maize which indicated that applying P in maize above 100 kg ha^{-1} is uneconomical and just wastage of currency. The effect of phosphorus levels showed that maximum grains weight recorded in plots treated with (100) as compared to lower doses as well as higher doses. It may be due to greater contribution of N and P by producing healthy grains by well filled grains and bigger grains while minimum grains weight was obtained at lower levels (0) P kg ha^{-1}. Maximum grain yield at optimum level of phosphorus may be due to proper nutrient availability during seed filling duration and resulted in the development of reproductive part especially in seed formation when large quantity of phosphorus is found. These results are in line with those of Onasanya *et al.* (2009) who reported that nitrogen and phosphorus alone or in combination significantly increased grain yield. The increase in grain yield due to NP application was also reported by Maqsood *et al.* (2001). Similar results were also reported by Hussain *et al.* (2006) who found that grain yield increased with phosphorus application and plots receiving 90 kg P_2O_5 ha^{-1} gave maximum grain yield as compared to lower dose grain yield.

Biological yield (kg ha^{-1}) :

Data pertaining to biological yield revealed that different levels of phosphorus had a non significant effect on biological yield of maize (Table 1). Highest biological yield (8398 kg ha^{-1}) was obtained in plots with phosphorous applied at the rate of 100 kg ha^{-1} as compared to the control plots where the biological yield was lowest (6041 kg ha^{-1}). The root growth of maize plants was best at 100 kg ha^{-1} phosphorus level which resulted in best biological yield due to efficient photosynthesis and other physiological functions of the maize at this phosphorus level. That's why the biological yield was the lowest in the control plots.

Conclusion and recommendation :

It is concluded that the application of phosphorus at the rate of 100 kg ha^{-1} has the highest impact on the performance for obtaining maximum grain yield of maize. Therefore, the application of phosphorus at the rate of 100 kg ha^{-1} is highly recommended for gaining optimum grain yield of maize particularly in the agro-climatic zone II, of Bihar. Further these results may test under varying soil and climatic conditions in future studies.

Acknowledgement :

The authors express profound gratitude to Dr. R.C. Yadav, Associate Director Research, Regional Research Station, Agwanpur, Saharsa, for providing all kind of support required for the completion of this study.

REFERENCES

Ali, J., Bakht, J., Shafi, M., Khan, S. and Shah, W.A. (2002). Uptake of nitrogen as affected by various combinations of nitrogen and phosphorus. *Asian J. Pl. Sci.,* **1**: 367-369.

Amin, R., Zia, M.S., Berger, K.C. and Aqil, K. (1989). Effect of fertilizer rateand phosphorus placement methods on corn production. *Sarhad J. Agric*, **5**: 221–227.

Arain, A.S., Aslam, S.M. and Tunio, A.K.G. (1989). Performance of maize hybrids under varying NP fertilizer environments. *Sarhad J. Agric*., **5** (6) : 623-626.

Ayub, M., Nadeem, M.A., Sharar, M.S. and Mahmood, N. (2002). Response of maize (*Zea mays* L.) fodder to different levels of nitrogen and phosphorus. *Asian J. Pl. Sci*., **1**: 352-354.

Bakht, J., Ahmad, S., Tariq, M., Akber, H. and Shafi, M. (2006). Response of maize to planting methods and fertilizer N. *J. Agric. & Biological Sci.,* **1**: 8-14.

Chen, M.L., Jiang, X.L., Zoov, B.Y. and Zheri, Z.Y. (1994). Mathematical models and best combination of high yield cultivation technique for rapeseed variety Zhenyouyoum. *Acta. Agric. Zhejiiangenesis*, **6** : 22-26.

Hussain, N., Khan, A.Z., Akbar, H. and Akhtar, S. (2006). Growth factors and yield of maize as influenced by phosphorus and potash fertilization. *Sarhad J. Agric.,* **22**(4): 579-583.

Leon, L.A. (1999). Phosphorus and potassium interactions in acid soils of the eastern plains of Colombia. *Better Crops Int'1*., **13**(2): 8-10.

Maqsood, M., Abid, A.M., Iqbal, A. and Hussain, M.I. (2001). Effect of various rates of nitrogen and phosphorus on growth and yield of maize. *Pak. J. Biol. Sci*., **1**: 19-20.

Onasanya, R.O., Aiyelari, O.P., Onasanya, A., Oikeh, S., Nwilene, F.E. and Oyelakin, O.O. (2009). Growth and yield response of maize (*Zea mays* L.) to different rates of nitrogen and phosphorus fertilizers in southern Nigeria. *World J. Agric. Sci.,* **5**: 400-407.

Rashid, A. and Memon, K.S. (2001). Soil and fertilizer phosphorus. Soil Sci. B. Elenaand R. Bantel (Eds). National Book Foundation, Islamabad, Pakistan. pp. 300-302.

Sharma, J.P. and Sharma, U.C. (1989). Effect of nitrogen and phosphorus on the yield and severity of turcicum blight in maize Nagaland. *Indian Phytopath.,* **44**: 383-385.

Steel, R.G.D. and Torrie, J.H. (1980). *Principles and procedures of statistics.* McGraw Hill Book Co. Inc. NEW YORK, U.S.A.

Wojnowska, T., Panak, H. and Seikiewiez, S. (1995). Reaction of winter oilseed rape to increasing levels of nitrogen fertilizer application under condition of Ketizyn Chernozem. *Rosling Oleiste.,* **16**:173-180.