



Research Article

Volume 13 Issue 3 - January 2018
DOI: 10.19080/ARTOAJ.2018.13.555881

Agri Res & Tech: Open Access J

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The Impact of Different P Fertilizer Sources on Growth, Yield and Yield Component of Maize Varieties



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Submission: September 12, 2017; **Published:** January 09, 2018

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Abstract

Phosphorus (P) fertilizer source had considerable impact on growth yield and yield components of maize (*Zea mays* L.). Field experiment was conducted to investigate the impact of different P sources (DAP (Diammonium Phosphate), NP (Nitrophos), TSP (Triple Super Phosphate) and SSP (Single super phosphate)) on growth, yield and yield component at two maize varieties (Azam vs. Jalal) at Dargai Malakand during summer. The experiment was laid out in randomized complete block design having three replications. Application of DAP delayed than other P-sources, application of TSP increased plant height, number of grains ear-1, thousand grains weight, biological and grain yields. Azam had taller plants with higher thousand grains weight than Jalal, while Jalal with delayed maturity had more number of grains ear-1 and higher biological and grain yields. Application of TSP and use of variety Jalal could increase maize productivity in the study area.

Keywords: Maize; P-sources; Varieties; Growth; Yield and yield components

Introduction

Maize (*Zea mays* L.) is the second most important crop after wheat in the Khyber Pakhtunkhwa (KP) of the Pakistan but yield per unit area is very low [1]. Maize is important cereal crop all over the world. Maize ranks third in world's cereals after wheat and rice [2]. It is the short duration crop, capable of producing large quantity of food grain. It can be grown twice a year, both for grain and fodder. It is getting popularity among growers due to its multipurpose use, like human food, animal feed and raw materials for different industries. Its grain is valuable source of protein, fats, starch, vitamins, and minerals [3]. Maize has great nutritive value containing 72% starch, 10% protein, 4.8% oil, 8.5% fiber, 3% sugar and 17% ash [4]. Although, soil and climate condition of Pakistan are highly favorable and high yielding varieties are also available, yet the yield recovery of maize at farmer's field is very low when compared with other maize producing countries like USA, Canada, Egypt, etc. [5]. The seed of improved variety and fertilizer are the main factors in enhancing maize production [6]. A good variety having a high yield potential is a key towards improving maize yield [7].

Our soils are deficient in phosphorous and alkaline in nature so that fertilizer should be applied which is acidic in nature. Phosphorous stimulate seed formation. Appropriate type of fertilizer can increase the yield by 50% [8]. Phosphorous can significantly increase vegetative growth and grain yield [9]. The soils of KP are generally low in organic matter Shah et al. [10] and low to medium in available phosphorus [11]. These soils contain high calcium carbonate with pH ranging from 7 to 9. This high calcium activity coupled with high pH favors the formation of relatively insoluble dicalcium phosphate and tricalcium phosphates. Soils with high fixation capacity have higher demand for phosphatic fertilizer [12]. Phosphorus deficiency is invariably a common crop growth and yield-limiting factor in unfertilized soils, especially in soils high in calcium carbonate, which reduces P solubility [13]. Phosphorus plays an important role in many physiological processes that occur within a plant. It is involved in enzymatic reactions in the plant. Phosphorus is essential for cell division because it is a constituent element of nucleoproteins which are involved in the cell reproduction processes. It also

affects the quality of the grains and it may increase the plant resistance to diseases [14]. It is essential for good vegetative growth and grain development in maize production. Amanullah et al. [1] Phosphorus sources have significant effect on production of maize crops. Early maturity was observed with the application of single super phosphate (SSP) as compared to DAP and NP sources while higher grain yield and vegetative growth was obtained with the application of diammonium phosphate (DAP) as compared to SSP and nitrophos (NP). DAP performs better in productivity of wheat-maize cropping system than SSP and NP. Camargo et al. [14] concluded that the phosphorus deficiency is one of major limiting factors for wheat production under acid soil conditions. Uttarapong et al. [15] concluded that the applications of 100kg ha^{-1} phosphorus fertilizer increased yield of wheat in phosphorus deficient paddy soil. Hussain & Haq [12] demonstrated that the soil of KP have low organic matter and having low to medium availability of phosphorus contents due to high calcium carbonate with a pH of 7-9 which reduce the phosphorus availability Amanullah et al. [1]. Reported that application of different phosphorus sources can increased leaf area, grains per ear and grains weight in maize. Reghurum et al. [9] reported that diammonium phosphate (DAP) was the efficient source of phosphorus for increasing grain yield in maize as compared to single super phosphate (SSP) and triple super phosphate (TSP). Amanullah et al. [1] stated that phosphorus fertilizer affected plant growth, yield and also increased plant height, leaf area, grain weight, grains ear $^{-1}$, grain and stover yields, shelling percentage and harvest index of maize as compared with control. The present research was therefore designed to evaluate the effect of P fertilizer sources on yield and growth of maize varieties.

Materials and Methods

Site description

The research study was carried out during the growing seasons of 2010. The site is located at the Dargai Malakand. The soil of the farm is clay loamy having pH values ranges between 6.5-7.8 (Figure 1).

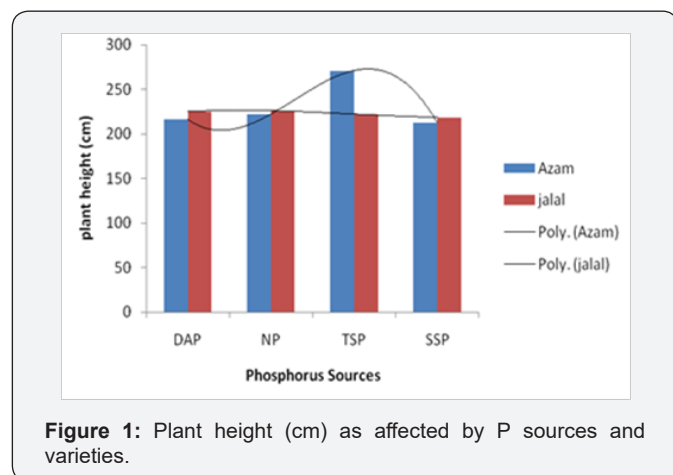


Figure 1: Plant height (cm) as affected by P sources and varieties.

Experimental description

Field experiment was conducted to investigated the impact of different P fertilizer sources (DAP (Diammonium phosphate), NP (Nitrophos), TSP (Triple super phosphate) and SSP (Single super phosphate)) on growth, yield and yield component at two maize varieties (Azam vs. Jalal) at, Dargai Malakand during kharif 2010. The experiment was laid out in 2-factorial randomized complete block design having three replications. A plot size of 15m 2 having four rows, five meter was used. Plant to plant was 25-30cm while row to row distance was kept as 75cm. All the agronomic practices were applied when needed. A basal dose of 150kg N ha^{-1} was applied. Thinning was done after 15 days of emergence and Maintained recommended population 60,000. Field planted on 16 June 2010 and harvested on 25 October 2010. Recommended Phosphorus (90kg ha^{-1}) application from various sources (DAP, Nitrophous, TSP and SSP) (Figure 2).

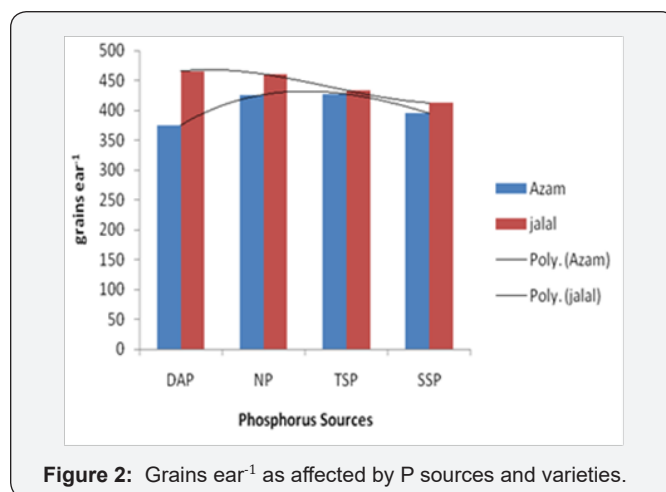


Figure 2: Grains ear $^{-1}$ as affected by P sources and varieties.

Statistical analysis

The data were statistically analyzed using analysis of variance appropriate for randomized complete block design. Means were separated using LSD test at 0.05 level of probability (Figure 2).

Results and Discussion

Plant height (cm)

Varieties (V) and phosphorus sources (PS) and VxPS significantly affected plant height (Table 1). Long statured plants (230cm) were observed in Azam variety while short statured plants (222cm) were observed in Jalal. It might be due to difference in the genetic potential of these varieties. Higher plant height (246cm) was recorded in the TSP source while lower plant height (215cm) was recorded in SSP. In case of interaction taller plants (271cm) were recorded in Azam with application of TSP as compared to others. It might be due to the phosphorus sources the probable reason could be that at high phosphorus uptake of triple super phosphate, favorable environment, optimum utilization of solar light, higher assimilates production and its conversion to starches resulted higher plant height. In

case of interaction this might be due difference in their genetic make-up of varieties to utilizes phosphorus nutrients. Our results agree with [16] who reported that P application was significant increase in maize heights.

Table 1: Plant height (cm), days to maturity, grains ear-1, thousand grains weight, biological yield (kg ha⁻¹) and grain yield (kg ha⁻¹) as affected by phosphorus sources and varieties

Phosphorus Sources	Plant Height (cm)	Days to Maturity	Grains ear ⁻¹	Thousand Grains Weight (g)	Biological Yield (kg ha ⁻¹)	Grain Yield (kg ha ⁻¹)
DAP	220b	74.5a	420ab	245bc	11092b	3670ab
NP	224b	73.3ab	443 a	256ab	12722a	3227b
TSP	246a	72.3 b	430a	276a	13296a	3742a
SSP	215b	73.0 b	403b	224c	12722a	2713c
LSD	1.27	9.21	21.22	21.34	670.7	440.1
Varieties						
Azam	230a	72.6b	405b	260a	11824b	3096b
Jalal	222b	73.9a	443a	240b	13092a	3580a
LSD	1.03	7.52	17.33	17.42	547.6	359.4
Interaction						
PS x V	*	ns	*	ns	*	ns

Days to maturity

Varieties (V) and phosphorus sources (PS) significantly affected days to maturity while interaction between and VxPS were not significant (Table 1a). Comparing varieties Jalal delayed maturity (73.9 days) as compare to Azam (72.6 days). It might be due to the genetic potential of these varieties. Phosphorus sources DAP sources delayed maturity (74.5 days) while early

maturity (72.3 days) was observed in TSP. The probable reason could be that high phosphorus uptake of triple super phosphate, favorable environment, optimum utilization of solar light, higher assimilates production and its conversion to starches resulted increase of vegetative growth and delay maturity. These results agree with the finding of Amanullah et al. [1] in the plots applied with DAP or SSP may be the possible cause of higher days to maturity.

Table 1a: Analysis of variance Plant height (cm), days to maturity, grains ear-1, thousand grains weight, biological yield (kg ha⁻¹) and grain yield (kg ha⁻¹) as affected by phosphorus sources and varieties.

S.O.V	DF	Plant Height (cm)	Days to Maturity	Grains ear ⁻¹	Thousand Grains Weight (g)	Biological Yield (kg ha ⁻¹)	Grain Yield (kg ha ⁻¹)
Replication	2	155.1ns	1.79ns	50.3ns	273ns	171296ns	297770ns
Varieties	1	350.6*	9.38*	8240.3*	2420*	9654858*	1405846*
P sources	3	1125.0*	4.93*	1678.6*	2842*	5413427*	1351582*
V x Ps	3	1136.2*	3.15 ns	2086.1*	1068 ns	2270760*	174870ns
Error	14	73.9	1.41	391.9	396	391167	168495
Total	23						

Grains ear-1

Varieties (V), phosphorus sources (PS) and V x PS were significantly affected grains ear⁻¹ (Table 1). Highest grains (443) were produced by Jalal variety as compare with Azam (405). It might be due to the difference in genetic potential of these varieties. The maximum grains (443 and 430) were observed at NP and TSP source which are statically similar with each other while minimum grains (403) were observed at SSP. In case of interaction Jalal produced highest grains (465) with application of DAP while lowest grain (375) were produced in Azam with application of DAP also. The probable reason could be that at high utilization of nitrophos, favorable environment, optimum utilization of solar light, higher assimilates production and its

conversion to starches resulted higher grains number. In case of interaction might be due to the genetic potential of these varieties to utilize phosphorus sources nutrients to increase grain ear⁻¹. Our results are also similar with of Amanullah et al. [1] with increase in P level probably may be due to the increase number of grains ear-1 and also Okalebo & Probert [17]. Reported that the increase in P level might have partitioned greater amount of assimilates to ears which resulted in the highest number of rows and grains ear-1 of maize and also Reghurum et al. [9] has reported that DAP is better P fertilizer than other sources of P for maize crop the increase grains ear⁻¹. Amanullah et al. [1] reported that application of different phosphorus sources can increase grains ear⁻¹ and grains weight in maize crop.

Thousand grains weight (g)

Varieties (V) and phosphorus sources (PS) significantly affected thousand grains weight while V x PS was not significant (Table 1). Maximum thousand grains weight (260.8g) was recorded in Azam variety as compare to Jalal (240.7g). In case of varieties it might be due to the difference in genetic potential of these varieties. Phosphorus sources higher thousand grains weight (276.8g) was recorded with application of TSP source and the lower thousand grains weight (224.6g) was recorded with application SSP. The probable reason may be that high utilization of triple super phosphate, optimum utilization of solar light, higher assimilates production and its conversion to starches resulted to increase grain size to produces higher thousand grain weight. The interaction between varieties and phosphorus sources had not significant affect thousand grain weights. This might be due to the genetic potential of these varieties and less utilization of nutrients had not increase size and weight. These results are similar to the findings of [16]. The highest grain weight of maize with higher phosphorus uptake and Amanullah et al. [1] reported that application of different phosphorus sources can be increase grains weight in maize crop.

Biological yield (kg ha-1)

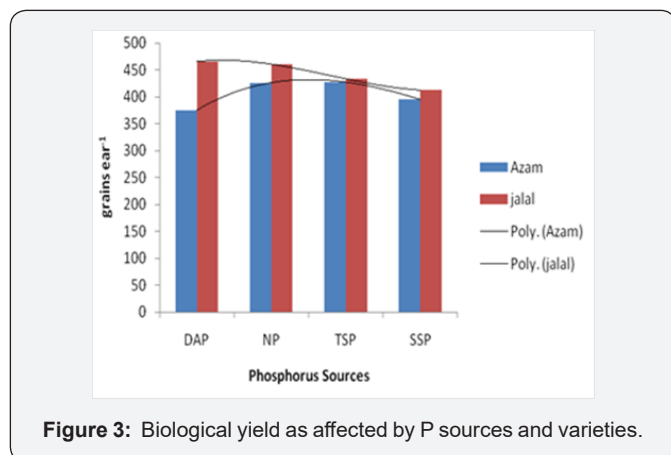


Figure 3: Biological yield as affected by P sources and varieties.

Perusal of data indicated that varieties (V), phosphorus sources (PS) and V x PS significantly affected biological yield (Table 1). Maximum biological yield (13092kg^{ha}⁻¹) was produced in Jalal variety as compare to Azam (11824kg ^{ha}⁻¹). It might be due to the difference in genetic potential of these varieties. The higher biological yield (13296kg^{ha}⁻¹) was produced at TSP source while lower biological yield (11092kg^{ha}⁻¹) was recorded at DAP source. In case of interaction higher biological yield were produced at (14037kg^{ha}⁻¹) with application of TSP while lower were produces in Azam (9629kg ^{ha}⁻¹) with application of DAP source. It might be due the phosphorus sources probable reason could be that high utilization of triple super phosphate, favorable environment, optimum utilization of solar light, higher assimilates production and its conversion to starches resulted higher biological yield. These results were similar with

finding of Okalebo & Probert [17] reported that higher uptake of phosphorus can increase the biological yield.

Grain yield (kg^{ha}⁻¹)

Varieties (V) and phosphorus sources (PS) significantly affected grain yield while V x PS was not significant (Table 1). Jalal variety produced higher grain yield (3580kg^{ha}⁻¹) while Azam produced lower grain yield (3096kg ^{ha}⁻¹). It might be due to difference in the genetic potential of these varieties. In case of phosphorus sources maximum grain yield (3742kg ^{ha}⁻¹) was recorded at TSP source while minimum grain yield was recorded on SSP (2713kg^{ha}⁻¹). The increase in grain yield application of triple super phosphate may attribute to enhanced crop growth rate, net assimilation rate which ultimately increased grain yield (kg^{ha}⁻¹). These results were similar with finding of Hussain & Haq [12]. The lower grain yield in the absence or lower P rate indicating higher demand for P fertilizer and Amanullah et al. [1] reported that in the plots applied with DAP or SSP may be the possible cause of higher DM accumulation and grain yield in maize and also Amanullah et al. [1] stated that phosphorus fertilizers affects plant growth, yield of maize and also increases grain yields and harvest index as compared with control [18,19].

Conclusion

It is concluded from the results that application of phosphorus from TSP (triple super phosphate) increased the yield and yield components of maize. Maize variety Jalal performed better in terms of yield and yield components as compared to Azam. Application of TSP and Jalal variety is recommended for higher growth and yield.

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DOI:10.19080/ARTOAJ.2018.13.555881

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