

Grain Yield and Phenology of Maize Cultivars Influenced by Various Phosphorus Sources

IMRAN[1*] ASAD ALI KHAN[2]
1, 2 Department of Agronomy, The University of agriculture Peshawar, Pakistan
1*District field Agronomist IAO Project and Incharge Agriculture Officer, Matta Swat
*Corresponding author: imranagrarian@aup.edu.pk

Abstract
Field experiment was conducted to investigated the impact of P sources {DAP (Diammonium phosphate), NP (Nitrophos), TSP (Triple super phosphate) and SSP (Single super phosphate)} on maize penology, yield and yield component at two maize varieties (Pahari and Baber) at Swat during summer 2014. The experiment was laid out in randomized complete block design having three replications. Phenological parameters yield and yield components were significantly affected by P sources and varieties. DAP sources was significantly delayed days to maturity while TSP sources was increased plant height (cm), grains ear^{-1}, thousand grains weight, biological yield (kg ha^{-1}) and grain yield (kg ha^{-1}). Plant height and thousand grains weight was significantly increase by Pahari variety while delayed maturity and increase of grains ear^{-1}, biological yield (kg ha^{-1}) and grain yield (kg ha^{-1}) was observed in Baber variety. This study suggested that application of TSP and sowing of Baber variety performed better as compared to other sources and Pahari variety.
Keywords: Phosphorus sources, Varieties, Grain yield, phenology, yield and yield components.

Introduction

Maize (*Zea mays* L.) is the second most important crop after the wheat in the Khyber Pakhtunkhwa (KP) of the Pakistan but yield per unit area is very low (Amanullah *et al.,* 2009 a). Maize is important cereal crop all over the world. Maize ranks third in world's cereals after wheat and rice (Imran, 2015). 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 (Imran, 2015). Its grain is valuable source of protein, fats, starch, vitamins, and minerals (Muhammad, 1997). Among all the crop plants, maize is the most versatile one as it has great nutritive value 72% starch, 10% protein, 4.8% oil, 8.5% fiber, 3% sugar and 17% ash (Chaudhary, 1983). It is estimated that 70% of maize production is used directly or indirectly as food and rest of it finds its way to starch manufacturing and poultry industry. In the last decade (1993-94 to 2003-04) the maize area has expanded from 2,834 to 50,202 hectares occupying the third position among cereals (BBS, 2006). 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. (Bakht *et al.,* 2006). Varieties have a significant effect on maize. Maize varieties observed that with other yield and yield components, days to tasseling and silking was also positively affected by maize varieties (Nisar, 2000). The seed of improved variety and fertilizer are the main factors in enhancing the output of maize (Dowswell *et al.,* 1996). A good variety having a high yield potential is a key towards improving maize yield (Saleem *et al.,* 2003). Our soils are deficient in phosphorous and alkaline in nature so that fertilizer should be applied which is acidic in nature. Phosphorous stimulated seed formation. Appropriate type of fertilizer can increase the yield by 50%. (Onasanya *et al*. 2009). Phosphorus can significantly increase vegetative growth and grain yield. (Reghurum *et al*. 2000). The soils of KP are generally low in organic matter (Shah *et al.,* 2003) and low to medium in available phosphorus (Bhatti *et al.,* 1998). 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 (Hussain and Haq, 2000). 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 (Ibrikci *et al.,* 2005). Phosphorus plays an important role in many physiological processes that occur within a developing and maturing 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 (Imran, 2015) . It also affects the quality of the grains and it may increase the plant resistance to diseases. (Bundy and Carter, 1988). Phosphorus are essential for good vegetative growth and grain development in maize production. (Amanullah *et al.,* 2009 a) Phosphorus sources have significant effect on production of wheat and maize crops. The early maturity was observed with the application of single super phosphate (SSP) as compare to DAP and NP sources while higher grain yield and vegetative growth was obtain with the application of diammonium phosphate (DAP) as compared to SSP and nitrophos (NP). DAP performs is much batter in productivity of wheat-maize cropping system then SSP and NP. (Camargo *et al.,* 2000) concluded that the phosphorus deficiency is one of major limiting factors for wheat production under acid soil conditions. The application of phosphorus fertilizer can increase genetic variability of the crop. Genetic manipulation of segregation population to obtain high cultivars adapted to medium or low soil phosphorus content and better phosphorus uptake efficiency. (Uttarapong *et al.,* 2002) concluded that the applications of 100 kg ha^{-1} phosphorus fertilizer application increase yield in wheat crop in phosphorus deficient paddy soil. (Hussain and Haq 2000) 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 to reduce the phosphorus availability. Soils with high fixation capacity have higher demand for Phosphorus fertilizer requirement. (Amanullah *et al.,* 2009 b). reported that application of different phosphorus sources can increased leaf area, grains per ear and grains weight in maize crop. (Reghurum *et al.,* 2000) 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.,* 2009 a) 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.

Materials and Methods

The experiment entitled " phenology and yield of maize cultivars influenced by various phosphorus sources" the experiment was conducted at Agriculture Officer Circle Matta, (Sambat Cham) during Kharif season 2014. The experiment was laid out in randomize complete block design having three replications. Plot size was $15m^2$ (5m x 3m). Sample was taken randomly from the field. Distance from plant to plant was 10-15cm while row to row distance was kept as 75cm. Row length was 5 m and each plot was contain five rows was kept plant population 60,000 was two time weeding and give four times irrigation and planted on 10 June 2014 and harvested on 12 October 2014.The experiment was consists of two varieties (Pahari and Baber) and recommended Phosphorus (90 kg ha^{-1}) application from various sources (DAP, Nitrophous, TSP and SSP).

Statistical Analysis

The data were statistically analyzed using analysis of variance appropriate for randomized complete block design. Combine analysis was performed to detect the variation between the years. Means were separated using LSD test at 0.05 level of probability (Steel and Torrie, 1984).

Results and Discussion

Plant height (cm)

Plant height as affected by varieties and phosphorus sources are reported in Table 1. Varieties and phosphorus sources significantly affected plant height while interaction between varieties and phosphorus sources were also significant. A long stature plant (230 cm) was observed in Pahari variety while a short stature plant was observed in Baber (222 cm). It might be due to difference in the genetic potential of these varieties. The Higher plant height (246 cm) was recorded in the TSP source while lower was recorded in SSP sources (215 cm). In case of interaction taller plants (271 cm) were recorded in Pahari 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. The findings of the results were supported by Imran, 2015. In case of interaction this might be due difference in their genetic make-up of varieties to utilizes phosphorus nutrients. Our results are also similar with (Sahoo & Panda 2001) who reported that P application was significant increase in maize heights.

Days to maturity

Data concerning days to maturity are reported in Table 2. Varieties and phosphorus sources significantly affected days to maturity. Interaction between varieties and phosphorus sources was not significant. Comparing varieties Baber delayed maturity (73.9 days) as compare to Pahari (72.6 days). It might be due to the genetic potential of these varieties. In case phosphorus sources DAP sources delayed maturity (74.5 days) while early maturity was observed in TSP (72.3 days). 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. The findings of the results were supported by Imran, 2015. These results agree with the finding of (Amanullah *et al.,* 2009 a) in the plots applied with DAP or SSP may be the possible cause of higher days to maturity.

Grains ear^{-1}

Data regarding grains ear^{-1} are reported in Table 3. Analysis of data reveled that varieties, phosphorus sources and its interaction were significant on grains ear^{-1}. Highest grains (443) were produced by Baber variety as compare with Pahari (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. The findings of the results were supported by Imran, 2015. In case of interaction Baber produced highest grains (465) with application of DAP while lowest grain were produced in Pahari (375) 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. The findings of the results were supported by Imran, 2015. 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.,* 2009 b) with increase in P level probably may be due to the increase number of grains ear^{-1} and also (Okalebo and Probert, 1992). 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.,* 2000) has reported that DAP is better P fertilizer than other sources of P for maize crop the increase grains ear^{-1}. (Amanullah *et al.,* 2009 a) reported that application of different phosphorus sources can increase grains ear^{-1} and grains weight in maize crop.

Thousand grains weight (g)

Data concerning thousand grains weight (g) are reported in Table 4. Varieties and phosphorus sources significantly affected thousand grains weight. Interaction between phosphorus sources and varieties was not significant. Maximum thousand grains weight (260.8 g) was recorded in Pahari variety as compare to Baber (240.7 g). In case of varieties it might be due to the difference in genetic potential of these varieties. In case of phosphorus sources higher thousand grains weight (276.8 g) was recorded with application of TSP source and the lower thousand grains weight (224.6 g) was recorded with application SSP source. 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 findings of the results were supported by Imran, 2015. 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 (Sahoo and Panda, 2001). The highest grain weight of maize with higher phosphorus uptake and (Amanullah *et al.,* 2009 b) reported that application of different phosphorus sources can be increase grains weight in maize crop.

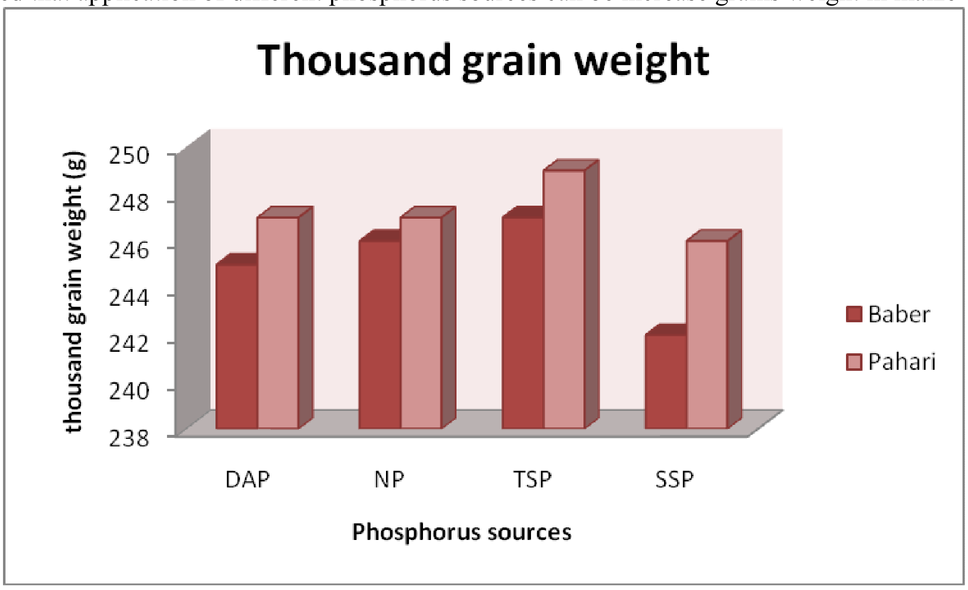

Fig1: Thousand grain weight (g) influenced by P sources of the two Maize cultivars

Biological Yield (kg ha^{-1})

Biological yields (kg ha^{-1}) as affected by varieties and phosphorus sources are reported in Table 6. Perusal of data indicated that varieties, phosphorus sources and interaction between varieties and phosphorus sources significantly affected biological yield. Maximum biological yield (13092 kg ha^{-1}) was produced in Baber variety as compare to Pahari (11824 kg ha^{-1}). It might be due to the difference in genetic potential of these varieties. The higher biological yield (13296 kg ha^{-1}) was produced at TSP source while lower biological yield (11092 kg ha^{-1}) was recorded at DAP source. In case of interaction higher biological yield were produced at (14037 kg ha^{-1}) with application of TSP while lower were produces in Pahari (9629 kg 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. The findings of the results were supported by Imran, 2015.These results were similar with finding of (Okalebo and Probert, 1992) reported that higher uptake of phosphorus can increase the biological yield. The findings of the results were supported by Imran, 2015.

Grain yield (kg ha^{-1})

Data pertaining grain yield (kg ha^{-1}) are presented in Table 5. Analysis of data show that varieties and phosphorus sources significantly affected grain yield. Interaction between varieties and phosphorus sources was not significant. Baber variety produced higher grain yield (3580 kg ha^{-1}) while Pahari produced lower grain yield (3096 kg ha^{-1}). It might be due to difference in the genetic potential of these varieties. The findings of the results were supported by Imran, 2015. In case of phosphorus sources maximum grain yield (3742 kg ha^{-1}) was recorded at TSP source while minimum grain yield was recorded on SSP (2713 kg 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}). The findings of the results were supported by Imran, 2015. These results were similar with finding of (Hussanin and Haq, 2000). The lower grain yield in the absence or lower P rate indicating higher demand for P fertilizer and (Amanullah *et al.,* 2009 a) 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.,* 2009 b) stated that phosphorus fertilizers affects plant growth, yield of maize and also increases grain yields and harvest index as compared with control. The findings of the results were supported by Imran, 2015.

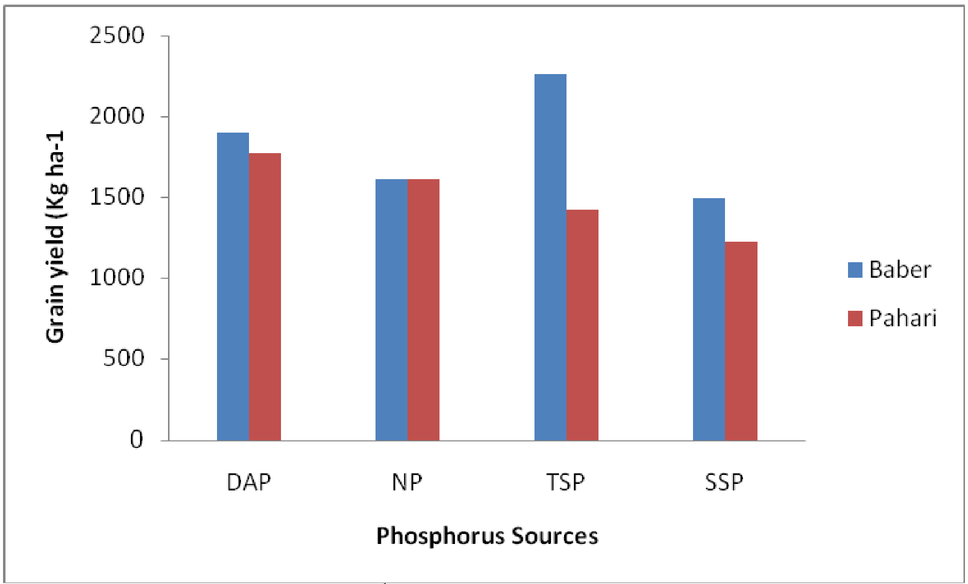

Fig 2: Grain yield (kg ha^{-1}) influenced by P sources of the two Maize cultivars.

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	220 b	74.5 a	420 ab	245 bc	11092 b	3670 ab
NP	224 b	73.3 ab	443 a	256 ab	12722 a	3227 b
TSP	246 a	72.3 b	430 a	276 a	13296 a	3742 a
SSP	215 b	73.0 b	403 b	224 c	12722 a	2713 c
LSD						
Varieties						
Pahari	230 a	72.6 b	405 b	260 a	11824 b	3096 b
Baber	222 b	73.9 a	443 a	240 b	13092 a	3580 a
LSD						
Interaction						
PS x V	*	ns	*	ns	*	ns

Conclusion and Recommendations

Among all P_2O_5 sources, diammonium phosphate (DAP) source was significantly delayed days to maturity while

TSP sources was increased plant height (cm), grains ear^{-1}, thousand grains weight, biological yield (kg ha^{-1}) and grain yield (kg ha^{-1}). Plant height and thousand grains weight was significantly increase by Pahari cultivar while delayed maturity and increase of grains ear^{-1}, biological yield (kg ha^{-1}) and grain yield (kg ha^{-1}) was observed in Baber variety. This study suggested that application of TSP and sowing of Baber variety in the study area performed better as compared to other sources of P and Pahari cultivar.

References

Amanullah, M. Asif, S.S. Malhi, and R.A. Khattak. 2009b. Effects of phosphorus fertilizer source and plant density on growth and yield of maize in northwestern Pakistan. J. Plant Nut. 32(12): 2080-2093.

Amanullah, R.A. Khattak, S.K. Khalil. 2009a. Effects of plant density and N on phenology and yield of maize. J. Plant Nutr. 32(3): 245-259.

Bakht, J., S. Ahmad, M. Triq, H. Akber and M. Shafi. 2006. Response of maize to planting methods and fertilizer nitrogen. J. Biol. Sci. 1(3):4-18.

BBS. 2006. Statistical Yearbook of Bangladesh. Bangladesh Bureau of Statistics, Ministry of Planning, Bangladesh.

Bhatti, A.U. M. Khan, K.S. Khurshid, F. Ullah. 1998. Site specific determination of N rates for rainfed wheat using available soil moisture. Pakistan J. Arid Agri. 1: 11-18.

Bundy, G.L. and P.R. Carter. 1988. Corn hybrid response to nitrogen fertilization in northern Corn Belt. J. Prod. Agric., 1(2): 99-104.

Camargo, C. J.C. Felicio, J.G. Freitas and S. Paulo. 2000. Evaluation of wheat cultivars for phosphorus efficiency on acid soil and nutrient solution. Eco. Agric. Sustain. dev. 2: 289-297.

Chaudhary, A.R. 1983. Maize in Pakistan. Punjab Agriculture Research Coordination Board, University of Agriculture, Faisalabad.

Dowswell, C.R. R.L. Paliwal, and R.P. Cantrell. 1996. Maize in the third world. West view Press, Pp: 268.

Hussain, M.Z. I.U. Haq. 2000. Phosphorus absorption capacities of KPK soils. In: Proceedings of Symposium on integrated plant nutrient management held at Islamabad on 8-10 Nov., 1999. pp. 284-296.

Ibrikci, H. J. Ryan, A.C. Ulger, G. Buyuk, B. Cakir, K. Korkmaz, E. Karnez, G. Ozgenturk, O. Konuskan. 2005. Maintenance of P fertilizer and residual P effect on corn production. Nigerian J. Soil Sci. 2: 1279-286.

Imran, 2015. Effect of germination on proximate composition of two maize cultivars. J. Bio. Agri and H.Care.5: 3: 123-128

Morris, L.M. 1998. Maize seed industries in developing countries. Lynne Rienner. Publisher London. p. 14.

Muhammad, A. 1997. Effect of various herbicides on the growth and the yield of maize varieties. Abstracted in Weed Sci. Abst. Pp. 28:20.

Nisar, A. H.M. Bhatti. 1978. Relative efficiency of P sources and time of application to wheat crop. Paper presented in seminar on "Wheat Research and Production", held in August 1978 at Pakistan Agriculture Research Council, Islamabad.

Okalebo, J.R. M.E. Probert. 1992. Affects of phosphorus on the growth and development of maize. A search for strategies for sustainable dryland cropping in semi-arid eastern Kenya. Nairobi Agriculture J. 12: 8-20.

Onasanya, R.O., O.P. Aiyelari, A. Onasanya, S. Oikeh, F.E. Nwilene and O.O. Oyelakin. 2009. Growth and yield response of maize to different rates of nitrogen and phosphorus fertilizers in southern Nigeria. J.Agric. sci. 5(4):400-407.

Reghurum, K. T.A. Singh and N.K. Vasta. 2000. Effect of phosphate fertilizers of different water solubility on maize and residual effect on wheat in a mollisol. Pantnagar J. of Res., 29: 40-43.

Sahoo, S.C., Panda, M., 2001. Effect of phosphorus and detasseling on yield of babycorn. Indian J. Agri. Sci. 71: 21-22.

Saleem, A., H.I. Javed, Z. Ali, and I. Ullah. 2003. Response of maize cultivars to different NP levels under irrigated condition in Peshawar valley. Pak. J. Bio. Sci. 6(14): 1229-1231.

Shah, Z. S.H. Shah, M.B. Peoples, G.D. Schwenke, and D.F. Herriedge. 2003. Crop residue and fertilizer N effects on nitrogen fixation and yields of legume-cereal rotations and soil organic fertility. Field Crops Res. 83: 1-11.

Uttarapong, W. C. Phongphan and B. Samrith. 2002. Phosphorus and wheat in paddy field. J. Agron. Crop Sci. 4: 359-363.