International Journal of Environmental Sciences & Natural Resources
ISSN: 2572-1119

Research Article
Volume 11 Issue 4 - May 2018
DOI: 10.19080/IJESNR.2018.11.555820

Int J Environ Sci Nat Res

Foliar Application of Phosphorous on Maize Seedling Growth and P Concentrations

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Submission: May 11, 2018; **Published:** May 29, 2018

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Abstract

A pot experiment was carried out to evaluate the effect of foliar application of P on the growth as well as shoot P concentrations of 35 d old maize plants. The soil P in the form of KH2PO4 solution was applied to respective pots during sowing while the foliar P was applied 20 days after the germination of the crop. The maize shoot height, weight and P concentrations showed increasing trends with foliar application as compared to control. 4.14 And 3.89% increase in shoot heights over control were recorded by application of 1 and 2 % foliar applied P. The combined application of half P as soil (22.5 mg P2O5 kg^{-1}) plus foliar spray (1 % solution) produced the highest fresh weight of 127.47 g pot^{-1} which was up by 11.03 % over control, suggesting that the foliar application of P could reduce the soil applied P dose. The post-harvest soil AB-DTPA extractable P was also significantly higher in soil + foliar treatments with the value of 16.45 mg p kg^{-1} which was double of control. Such type of studies should be conducted on variety of crops under various soils for confirmation and widespread foliar P application.

Keywords: Foliar Spray; Maize; KH_2PO_4

Introduction

Maize (*Zea mays*) is third most important cereal after wheat and rice in Pakistan. By proper nutrients management its production could be improved. Phosphorus, a dominant macronutrient plays a significant role in various physiological functions of the crop [1]. Both organic and in organic forms of Phosphorous is applicable to crops [2]. Phosphorous is mostly applied to crops as inorganic fertilizers because it is the available forms of P soluble in water, however sometimes P fertilization strategies lost its usefulness by reacting with metals and converts into unavailable forms [3]. Plants also utilized phosphorus when it is sprayed on the leaves [4]. Yes this is fact that the practice is not so common but still there are many good reasons in supporting of foliar application of Phosphorous. It is oblivious and cleared that plants recovered only a small percentage (averaging about 20 % for the first year) of phosphorus fertilizers in most of the soil, on other hand all the P is absorbed by the leaves when P is applied as foliar spray. Keeping in view the low availability of P in highly calcareous soils of the country, this research was conducted to supplement the P through foliar application at earlier growth stages of maize crop gown in mixture of pure sand and soil (3:2). This research was conducted to provide basis for such type of studies at field level.

Materials and Methods

A pot experiment was conducted to investigate the effect of foliar phosphorus application on growth and P concentrations of maize seedlings during Kharif 2014 at Institute of Biotechnology and Genetic Engineering, The University of Agriculture, Peshawar. The following five treatments were included in the experiment.

i. T1. Control (No applied phosphorus)

ii. T2. 45 mg P2O5 kg^{-1}equals to 90 kg P2O5 ha^{-1} (Recommended level)

iii. T3.1% P as foliar spray

iv. T4. 2 % P as foliar spray

v. T5.22.5 mg P2O5 kg^{-1}plus 1 % P as foliar spray

The treatments were arranged in completely randomized design (CRD) with three replications. The pot contained 5kg soil plus pure sand mixture in such a way that the 3kg pure sand was on the top overlying the 2 kg soil collected from the Newly Developmental Farm (NDF) (Peshawar series). The 50ml N were applied to all pots in form of urea solution obtained by dissolving

13.04g urea L^{-1} water. Whereas 50ml K were applied to treatment T1, T3 and T4and 25ml to T5 in form of KCL solution obtained by dissolving its 4.72g L^{-1} water. For phosphorus application 8.6g KH_2PO_4 was dissolved in one L water which contained 4.5mg P2O5, 3mg K2O ml^{-1}. Fifty (50)mL of this solution were applied to treatments T2 only 25ml to T5 as such the T2 received 45mg P2O5 kg^{-1} whereas T5 received 22.5 kg P2O5 kg^{-1}. Similarly, a solution of 1% and 2% P prepared by dissolving 4.38 and 9.76g H_2PO_4 L^{-1} water was sprayed on maize crop after 20 days of germination. The spray could hardly utilize 10ml of solution per pot as such about in case of 1 and 2 % spray, the P was supplied at 4.6 and 9.2mg P_2O_5 kg^{-1} soil, respectively. Each pot was sown with 10 seeds that were then thinned to 5. The crop was irrigated as per crop requirement. It was grown up to silking stage and then was harvested on 21-Nov.2014 i.e 35 days after sowing. The pots were initially kept under glass shade during germination and then brought to open air for the rest of growth period.

Statistical Analysis

The data collected were analyzed statistically according to the procedure given by Jandel Scientific (1991) using Statistic, 2000 package and Least Significant Difference (LSD) test was used for any significant difference among the treatments as suggested by steel and torri [5].

Results and Discussion

Plant Height

The maize plant height showed increasing trend over control with P application either through soil or as foliar spray (Table 1). However the effect was statistically not significant that might be due to less time as the plant was harvested just 35 d after germination (Table 1). However, soil application of 45mg P_2O_5 $kg^{-1}$and foliar application at both concentrations (1 and 2%) produced the taller maize plants than control. The foliar application of 1% or 2% P solution sprayed 20 days after germination of crop yielded the taller plants of 63.37 and 63.19%, which were higher by 4.14 and 3.89% over control, respectively. This suggested that like soil application of P, the foliar application could also increase the plant height and could supplement the soil applied P. The non-significant difference between the 1 and 2 % solution of P suggested that any of them could be used for the purpose of foliar spray. And as such possibly, the combination of half of soil P (22.5mg P_2O_5) plus foliar spray (1% solution) plus could produce a valuable results in field conditions and may reduce the dose of soil applied P. However, the lower response of P in enhancing the plant height in the present study could be due to the optimum soil P as showed in Table 2.

Shoot Weight

The maize shoot weight showed a significant response ($p < 0.01$) whereby the application of applied P either as soil or foliar spray alone or in combination significantly enhanced the maize shoot weight over control (Table 1). The application of half P as soil (22.5 mg P2O5 kg^{-1}) plus foliar spray (1% solution) produced the highest fresh weight of 127.47 g pot^{-1} which was more than 11.03 % over control suggesting that the foliar application of P could reduce the soil applied P dose. Similarly, the higher fresh shoot weight in treatments receiving 2% foliar spray solution over 1 % suggested that this higher concentration could be safely used in field conditions for the said purpose. Such type of studies should be conducted at field conditions for confirmation of results (Figures 1 & 2).

Table 1: Maize shoot height and fresh weight of 35d old plants as influenced by soil and foliar application of phosphorus.

Soil P	Foliar P	Plant Length	Fresh Weight
-- mg P_2O_5 ha^{-1}--	% P solution	--------- cm --------	--- g pot^{-1}-----
0	0	60.85	114.8 c
45	0	64.28	122.33 ab
0	1	63.37	116.06 bc
0	2	63.19	125.63 a
22.5	1	63.16	127.47 a
LSD ≤ 0.05		NS	6.63
St. Error		1.03	2.10

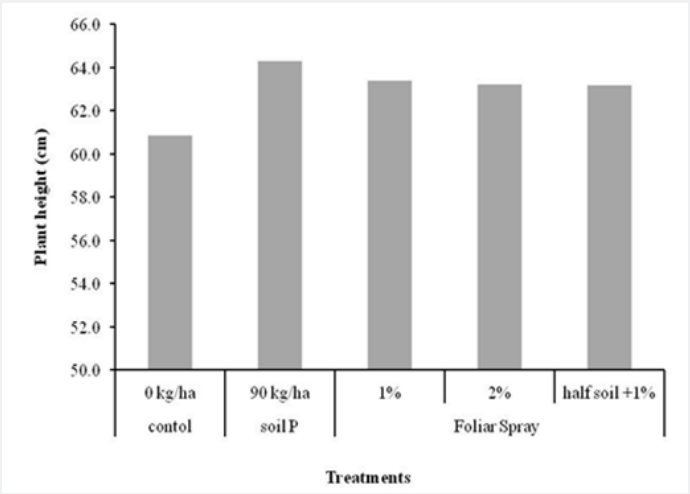

Figure 1: Maize shoot height of 35d old plants as influenced by soil or foliar applied P level.

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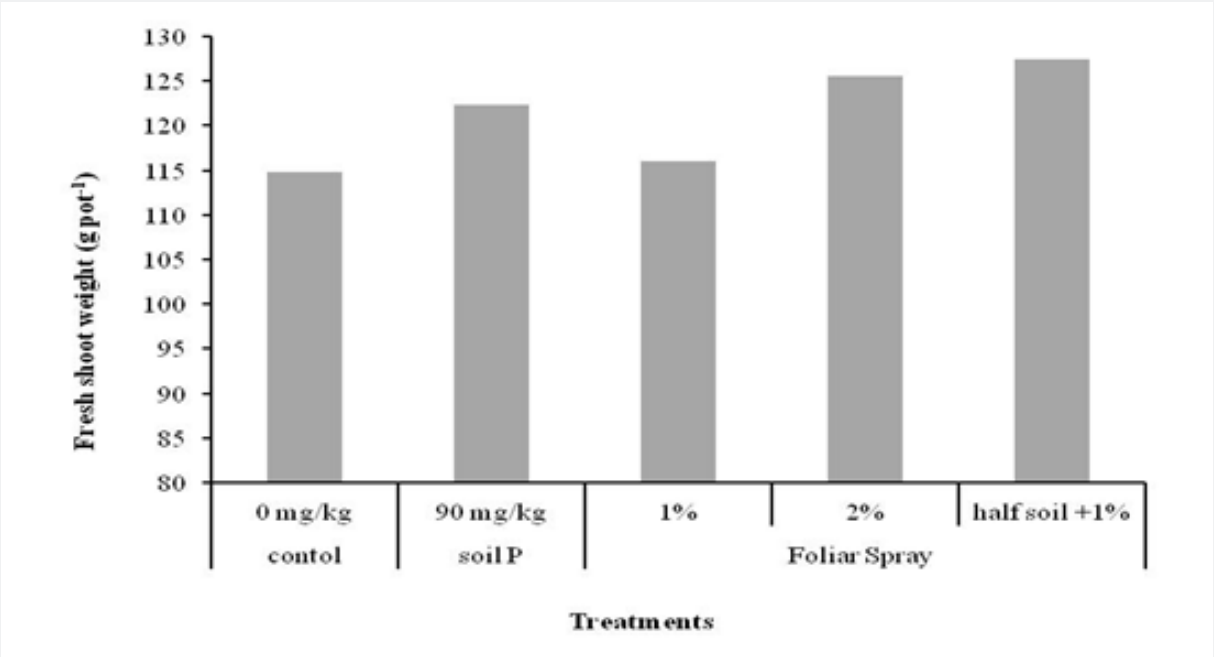

Figure 2: Fresh shoot weight (g pot^{-1}) of 35 d old maize plants as influenced by soil and foliar applied phosphorus.

Post-Harvest Soil P

The data on post-harvest soil P showed a significant repose ($p < 0.01$) to applied P levels. The application of 22.5 mg P_2O_5 kg^{-1} plus 1 % P solution had the highest post-harvest P with value of 16.45 mg kg^{-1} whereas the control and the treatment receiving alone 1 % P solution as foliar spray had post-harvest P of 8.76 and 7.39 mg P kg^{-1}, respectively. The lower P in 1 % solution spray than control could be due to the higher P uptake associated with comparatively higher biomass in this treatment. The combine application of P as 22.5 mg P_2O_5 kg^{-1} though soil and 1 % solution producing the highest post-harvest P among as compared to sole application of either soil or foliar suggested that this combination could be the optimum choice in field conditions. The post-harvest soil P ranging from 7.39 to 16.45 mg kg^{-1} showed that almost all the soils were adequate in soil P when compared with the standard values (Rashid, 1996).

Shoot P Concentrations

The shoot P determined at 35th day after germination varied from 0.83 to 1.06g kg^{-1} showing increases over control with application of P. However, the effect was not significant at 0.05 % probability but was significant at $p < 0.13$ %. The application of 2 % P solution as foliar spray produced even higher shoot P concentration of 1.03 g kg^{-1} than soil applied P (0.94g kg^{-1}) indicating that plant P could be absorbed though leaves stomata. Combine application of soil and foliar spray of P while producing the highest shoot P of 1.06 % among the treatments suggested that it could be the most optimum level at field conditions. The non-significant differences among the treatments could be associated to sufficient P level as indicated by the post-harvest soil P.

Uptake of P

The values of P uptake by maize shoot varied from 0.1 to 0.14 g pot^{-1} showing increases with increase in applied P over control (Table 2). It followed almost the same pattern as shoot P where the combination of soil and foliar applied P exhibited the higher P uptake of 0.14g pot^{-1} as compared to 0.12g pot^{-1} observed in treatments receiving the soil application of 45mg P_2O_5 kg^{-1} alone. This revealed that soil plus foliar application not only complement the effect of other but would also reduce the dose of applied P (Figures 3 & 4).

Table 2: Post harvest soil AB-DTPA extractable P, shoot P concentrations and P uptake by maize plants as influenced by soil and foliar application of phosphorus.

Soil P	Foliar P	Soil P	Shoot P	P uptake
-- mg P_2O_5 ha^{-1}--	% P solution	---- $mgkg^{-1}$----	---- g kg^{-1} ------	---- g pot^{-1}---
0	0	8.760 c	0.83	0.10
45	0	13.21ab	0.94	0.12
0	1	7.39c	0.91	0.11
0	2	10.00bc	1.03	0.13
22.5	1	16.45a	1.07	0.14
LSD ≤ 0.05		1.89	NS	-
St. Error		1.33	0.03	-

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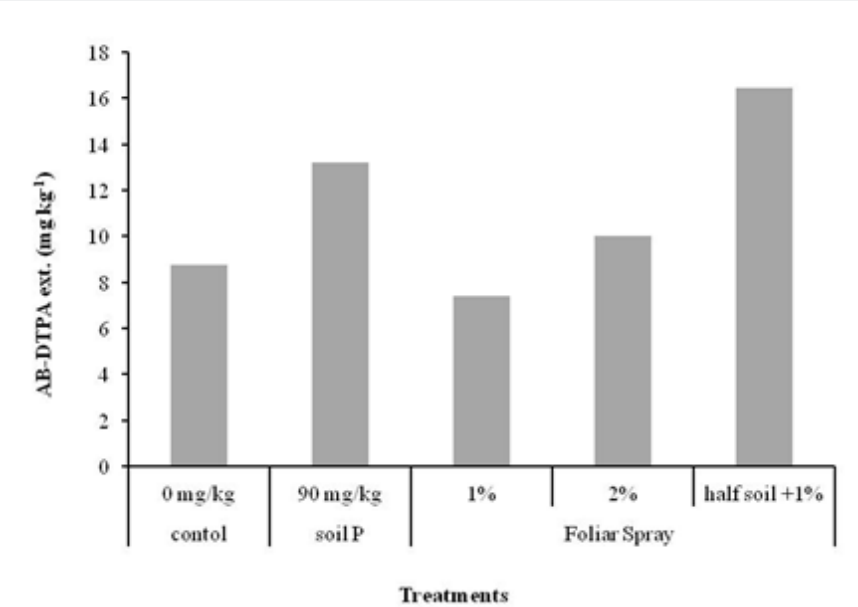

Figure 3: Post harvest AB-DTPA extractable P as influenced by soil and foliar applied Phosphorus.

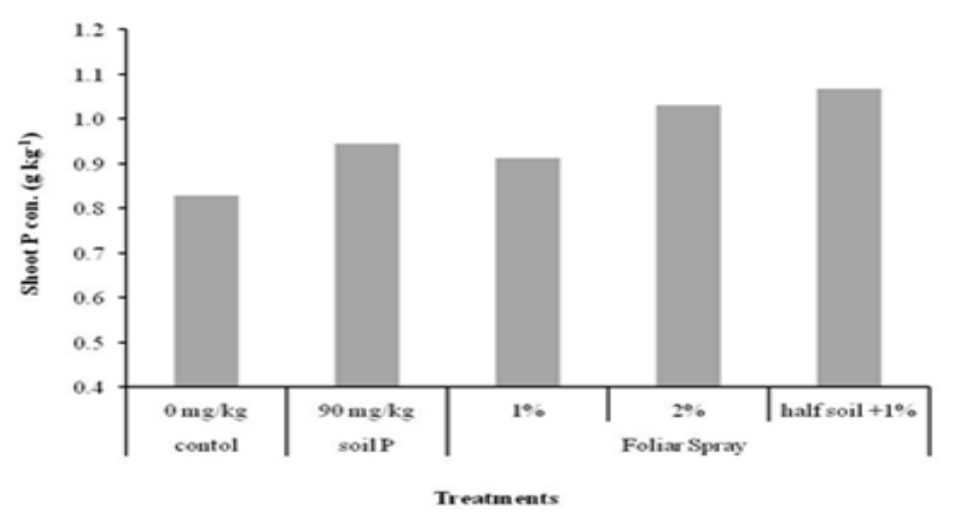

Figure 4: Shoot P concentration of 35 d old maize plants as influenced by soil and applied phosphorus.

Conclusions and Recommendations

The increase in 35 d old maize shoot height, shoot weight and shoot P concentrations with foliar application of 1 and 2 % foliar P spray suggested that foliar P may complement the soil P solution. The higher plant P in case of foliar spray suggested that P could be absorbed though leaves stomata. The parallel or even higher maize growth and plant P concentration at 2% solution indicated that this level of P could be safely used for foliar spray of P in the form of KH2PO4 solution. The higher plant growth and plant P concentrations in treatments receiving 22.5mg P2O5 kg^{-1} (half P dose) plus 1 % P solution spray indicated that soil P requirement could be reduced with foliar application of P. However such type of studies should be conducted at field level before widespread recommendations.

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