Research Article

Efficacy of Different Phosphorus Levels on Growth and Yield of Phalsa (*Grewia asiatica* L.)

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Abstract | A field study was conducted to assess the potential role of phosphorus (P) on growth and yield of Phalsa (*Grewia asiatica* L.). Healthy phalsa plants were fertilized with P_2O_5 @ 50g, 100g and 150g plant^{-1}. Data were recorded on number of fruit bush^{-1}, yield bush^{-1} (kg), single fruit weight (g), fruit diameter (cm), number of fruiting nodes, length of new shoot (cm), number of sprouted shoots cane^{-1} and leaf area (cm^2). Treatments were applied under Randomized Complete Block Design (RCBD) in triplicates and means were compared by Tukey's HSD test. Association of the biological traits of phalsa with phosphorus was further estimated by correlation analysis. Results indicated that phosphorus application @ 150g plant^{-1} has improved various traits *i.e.* number of fruit bush^{-1} (4866.7), yield bush^{-1} (2.19 kg), single fruit weight (0.656 g), number of fruiting nodes (12.18) and number of sprouted shoots cane^{-1} (13.89). However, vegetative characters particularly leaf area showed negative correlation (-0.264) with the increased amount of phosphorus. Fruit diameter (p=0.993) and length of new shoot (p=0.122) did not exhibited any correlation with applied phosphorus. Overall it is concluded that phosphorus is not only helpful but necessarily required for fruit quality and optimum yield of phalsa.

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Introduction

Phalsa (*Grewia asiatica* L.) is an exclusive bushy plant, considered as small fruit crop of horticulture and a remedy for the consumers. It is consumed as ripe fruit, sometimes in truffles or processed fruit and drinks as well. It is highly consumed as drink in the scorching summer seasons in tropics (Salunkhe and Desai, 1984). Phalsa fruit contain higher medicinal and nutritional benefits. Ripe fruit alleviates irritation and it is suggested during respiratory and cardiac disorders. It can also be used for fever reduction and blood ailments. Its bark is given for the cure of diarrhea and rheumatism. The leaves pulp is applied on skin eruptions and they're identified to have antibiotic action (Morton, 1987).

In modern agriculture, maximizing and sustaining crop yields are the main objectives. One of the major problems constraining the development of an economically successful agriculture is nutrient deficiency (Fageria and Baligar, 2005). After nitrogen,

phosphorus (P) has more widespread influence on both natural and agricultural ecosystems than any other essential plant element (Brady and Weil, 2002). Phosphorus is an essential nutrient for both plants and animals. It is estimated that some 30 to 50% of the increase in world food production since the 1950s is attributable to fertilizer use, including P use (Higgs et al., 2000). Worldwide applications of phosphate fertilizers now exceed over 30 million metric tons annually (Epstein and Bloom, 2005). The P fertilizer requirement is the quantity of phosphate required to attain near maximum (95% of the attainable maximum) crop yield. Fertilizer requirement may differ tremendously because it is product of plant requirement, soil quantity and capacity factors (Fox and Kamprath, 1970).

Nutrient management particularly P has been a fundamental agricultural constraint yet to be resolved in Pakistan. Pakistani soils are seriously deficient in Phosphorus. Thousands of simple fertilizer trials have been conducted since 1958 under the auspices of Rapid Soil Fertility Survey Scheme. Earlier results based over millions of soil samples of Punjab province soil from 1981 to 1984 have revealed that about 93% of the samples contained less than 10 mg P kg^{-1} of soil. Thus, these soils required supplementary P application to improve their productivity and raise the crop yield (Malik et al., 1973). Similar results have also been reported from other provinces (Anwar and Sattar, 1975). Hence present investigations on phalsa have been designed to highlight the necessity of phosphorus management in orchards and emerging crops in the country as well.

Materials and Methods

The research was conducted in experimental orchard of Department of Horticulture, Ghazi University, Punjab, Pakistan (30.06 °N latitude, 70.63 °E longitude 129 m above sea level). The experiment was laid out in triplicate under (RCBD) with three levels of phosphorus (P) (T1=50 g, T2=100 g and T3= 150) and a control= T0. Half of the P was applied in the second week of February and the remaining half dose of P was applied in mid-April. Irrigation was applied after every dressing of fertilizers. Amongst all the cultural practices in phalsa cultivation, pruning is one of the needful cultural practices for increasing the production and productivity. In this experiment pruning was done in December with the help of secateurs by manual labor. Other agronomic practices were kept uniform. The data were recorded from 5 guarded plants on growth parameters i.e. leaf area (cm^2), number of sprouted shoot $cane^{-1}$, number of fruiting nodes $shoot^{-1}$ and length of new shoot (cm) and yield related parameters i.e. number of fruits $bush^{-1}$, fruit yield $bush^{-1}$ (Kg), single fruit weight (g) and fruit diameter (cm).

Statistical analysis

Data were analyzed using the analysis of variance (ANOVA) and treatment means were compared using Tukey's HSD ($P < 0.05$). Relationship between parameters and applied phosphorus was studied by Pearson's correlation.

Results and Discussion

Effect of phosphorus on yield and quality of phalsa has been studied and summarized in Table 1. In the present study, effect of phosphorus on various parameters of Phalsa (*Grewia asiatica* L.) was studied. Application of phosphorus significantly affected the no. of fruit per bush. It was noticed that phosphorus induced more fruiting in phalsa when applied @150g and 100g $plant^{-1}$. Correlation analysis also indicates significant (0.838) effect of phosphorus on number of fruits in phalsa (Figure 1a). P application has enhanced the phalsa yield to a minor significance. However, maximum yield was recorded from @ 150g P_2O_5 $plant^{-1}$. Minor association (0.211) of P with yield indicates the role of this nutrient as yield contributing factors in phalsa (Figure 1b). Phosphorus enhanced the weight of phalsa fruit when applied @ 150g $plant^{-1}$. Although, effect of zero phosphorus (T0= control) also indicated the devastating effect on fruit weight of phalsa. Correlation analysis indicates little (0.365) but considerable effect of phosphorus application on optimum yield of phalsa (Figure 1c). However, phosphorus did not exhibit significant effects on fruit diameter of phalsa, concluding that fruit diameter is independent of phosphorus application in phalsa. Correlation constant (0.018) also indicates no association of P to the fruit diameter of phalsa (Figure 1d). Leaf area showed negative correlation (-0.264) with applied phosphorus (Figure 1e). Phosphorus dose was significantly correlated with number of sprouted shoots in phalsa. Higher was the dose of phosphorus, more was the number of sprouted shoots. Maximum Number of sprouted shoots $cane^{-1}$ were recorded in the T3= 150g followed by T2. This factor elaborates the significance of P-fertilizer for optimum growth of phalsa. Correlation coefficient (0.881) also demonstrate the strength of P association with higher

sprouting in phalsa at significant level (Figure 1f). Fruiting nodes were also associated with applied P in phalsa. This significance indicates the considerable effect of P on general plant vigor. However, this significance was independent of the dose applied. All treatments were effective for the improvement of this character in the plants as compared to untreated control. Correlation constant (0.293) indicates that number of sprouted shoots per cane was positively correlated to the dose of phosphorus up to a marginal extent (Figure 1g). The length of new shoot was found independent of the phosphorus application in phalsa almost in all cases. Hence, no correlation (0.089) was found for the length of new shoots to the applied P (Figure 1h).

Table 1: *Efficacy of phosphorus on yield and quality of phalsa (Grewia asiatica L.).*

	Phosphorus rates (grams)				
	150g	100g	50g	Control	p-value
No of fruit per bush	4866.7a	4266.7b	3811.7c	3293.3d	0.000
Yield per bush (Kg)	2.19a	1.80bc	1.85b	1.49c	0.013
Fruit weight (g)	0.656a	0.645ab	0.582bc	0.432c	0.000
Fruit diameter (cm)	1.49ab	1.41c	1.45bc	1.56a	0.993
Leaf area (cm^2)	5.46b	5.63a	5.60ab	5.66a	0.000
Number of sprouted shoots per cane	13.89a	13.69a	11.97b	8.96c	0.000
Number of fruiting nodes	11.30a	11.74a	12.18a	9.85b	0.000
Length of new shoot (cm)	61.83a	61.72a	60.78a	60.58a	0.122

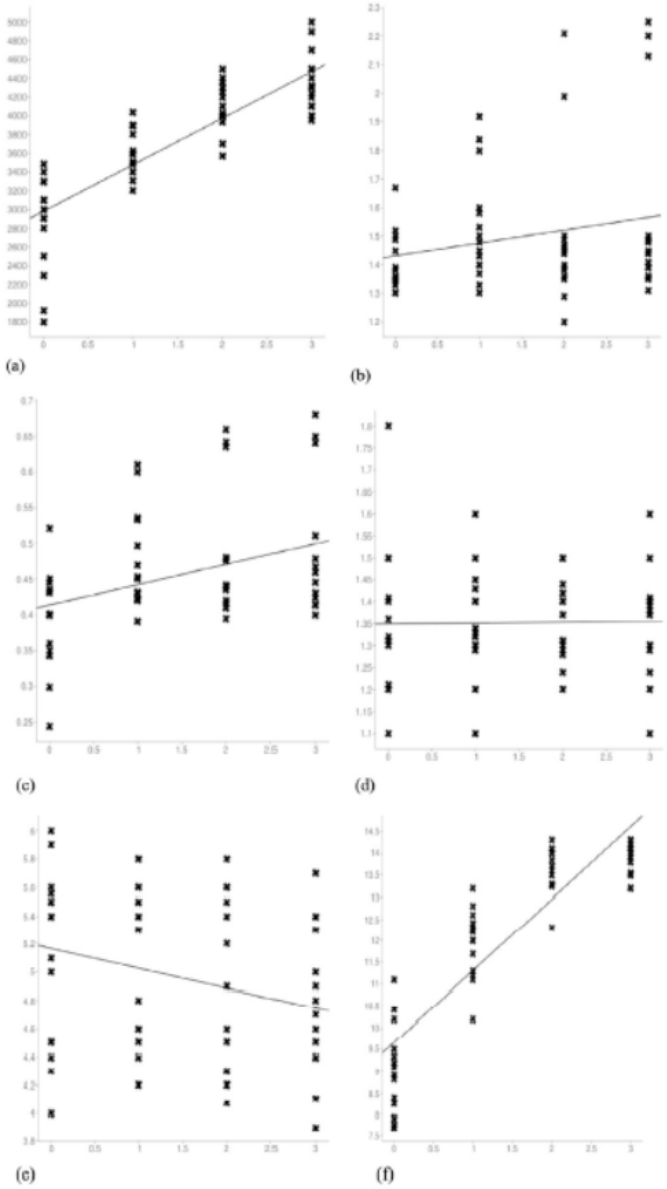

Figure 1: *: Correlation analysis of phosphorus for (a) No of fruit per bush (b) Yield per bush (c) Fruit weight (d) Fruit diameter (e) Leaf area (f) Number of sprouted shoots per cane*

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In the present study effect of soil application of P on various vegetative and yield related characters of phalsa were estimated. This research revealed some important results about the P-application in this plant. Generally, it was observed that phosphorus had arbitrarily influenced over various vegetative and yield related characteristics. In this research, number of fruits per bush were significantly higher in T3 where phosphorus was applied @ 150g. While minimum number of fruits were recorded in the control where P-application was zero. In case of yield, we found a moderate correlation with phosphorus. Although it was maximum in the T3 @ 150g.

There was a significant correlation between fruit weight and P-application. As the dose of phosphorus was increased, the fruit weight also enhanced continuously. Similarly, phosphorus was also found to induce higher number of sprouted shoots and fruiting nodes per cane. This ability of plant was reduced under the deficiency of phosphorus. Earlier studies about the application of phosphorus on phalsa have shown that it had been a key element for higher output in phalsa (Saravanan et al., 2013) and helps in the cell division and enhance the process of photosynthesis in phalsa. These results have revealed that number of sprouted shoots per cane, average number of fruits/bush, maximum number of canes/bush, number of fruiting nodes per shoot and fruit yield/bush were recorded in T7=100g N+50g P_2O_5+100g K_2O/bush. Moreover, the highest length of new shoot was recorded in the higher dose of NPK @ 150N+100g P2O5+150g K2O/bush. It was noted that application of inorganic fertilizers (NPK) are effective to enhance the growth and yield related characteristics in phalsa. Similar

results in phalsa crop were reported previously (Nijjar and Chand, 1989). It might be due to the fact that N is essential for various metabolic reactions in plants and affect vegetative growth that enhanced the number of flowers (Nijjar and Rehalia, 1977). Increment in the shoot length may be due to increased nutrients availability and production of promoters that might have caused cell elongation and multiplication, number of leaves be attributed to the solubilization effect of nutrients due to NPK addition. Similar results were also documented by other researchers (Shinde et al., 1976; Khan et al., 2017). Another study was carried out on nutrient management of phalsa to ascertain the effect of various doses of NPK on vegetative and yield contributing factors. Maximum plant growth and fruit yield was recorded in T6= FYM +75 per cent NPK+ Azotobacter+ PSB+ ZnSO4(0.4%) during both the year of study. The physical character of fruits viz., fruit diameter, pulp/stone ratio, fruit weight, juice per cent were also recorded significantly higher under optimum dose of NPK combined with FYM under field conditions (Yadav et al., 2008; Verma et al., 2014).

Conclusions and Recommendations

Results indicated that phosphorus application @ 150g plant^{-1} has improved various traits *i.e.* number of fruit bush^{-1} (4866.7), yield bush^{-1} (2.19 kg), single fruit weight (0.656 g), number of fruiting nodes (12.18) and number of sprouted shoots cane^{-1} (13.89). However, vegetative characters particularly leaf area showed negative correlation (-0.264) with the increased amount of phosphorus. Fruit diameter (p=0.993) and length of new shoot (p=0.122) did not exhibited any correlation with applied phosphorus. Overall it is concluded that phosphorus is not only helpful but necessarily required for optimum yield of phalsa.

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Novelty Statement

Optimum phosphorus is not only helpful to increase yield of phalsa but also necessary for better fruit quality.

Author's Contributions

Tanveer Ahmad Author of the article, Muhammad Mujtaba Rafiq co Author, Waqas Ahmed Dogar external member for research, Abid Mahmood Alvi external member for research, Qumer Iqbal Article reviewer, Muhammad Azam Article reviewer, and Arshad Ali Khan reviewer.

References

Anwar, M. and S.A. Sattar. 1975. Phosphorus and potassium status of soils and cotton crop of Therparkar district. Pak. Cottons, 19 (2): 127-134.

Brady, N.C. and R.R. Weil. 2002. Phosphorus and potassium. Nat. Prop. Soils. Prentice-hall of India, Delhi, 352.

Epstein, E. and A.J. Bloom. 2005. Mineral nutrition of plants: Principles and perspectives 2nd Ed. Sinauer Assoc. Inc Publ. Sunderland, Massachusetts.

Fageria, N.K. and V.C. Baligar. 2005. Nutrient availability. In: Encyclopedia of soils in the environment, D. Hillel, Ed., San Diego, CA: Elsevier. pp. 63–71. https://doi.org/10.1016/B0-12-348530-4/00236-8

Fox, R.L. and E.J. Kamprath. 1970. Phosphate sorption isotherm for evaluating the phosphate requirement of soils. Soil Sci. Soc. Am. Proc. 34: 902- 907. https://doi.org/10.2136/sssaj1970.03615995003400060025x

Higgs, B., A.E. Johnston, J.L. Salter and C.J. Dawson. 2000. Some aspects of achieving sustainable phosphorus use in agriculture. J. Environ. Qual. 29 (1): 80-87. https://doi.org/10.2134/jeq2000.00472425002900010010x

Khan, A.A., M. Sajid, A. Rab, N. Amin, A. Iqbal, F. Shah, B. Islam, F. Ali and W. Ali. 2017. Effect of mixture of nitrogen from poultry manure and urea on mineral profile of tomato grown in KPK-Pakistan. Comm. Soil Sci. Plant Anal. 48(12): 1486-1493. https://doi.org/10.1080/00103624.2017.1374395

Malik, D.M., A.G. Chaudhary and M.I. Salim. 1973. Available status of Punjab soils. In: Survey of soil fertility status and quality of ground water in Punjab.

Malik, D.M., B. Ahmad and M. Ahmad. 1984. Department of agriculture, Lahore, Pakistan. Digest. 1981-1984.

Morton, J. 1987. Phalsa. *In*: Fruits of Warm Climates. J.F. Morton Publisher. Miami, USA. pp. 352-358

Nijjar, G.S. and R. Chand. 1989. The effect of different doses of nitrogen and phosphorus on yield and quality of phalsa. Indian J. Hortic., 26(3-4): 110

Nijjar, G.S. and A.S. Rehalia. 1977. Effect of N, P and K on the growth and flowering of rose cv. Super star. Indian J. Hortic. 34(1): 75-79.

Salunkhe, D.K. and B.B. Desai. 1984. *Phalsa*. *In*: Salunkhe and Desai (eds.), Postharvest biotechnology of fruits. CRC Press, Boca Raton, FL. Vol. 2. pp. 129.

Saravanan, S., C. Parkesh, R. Kumar and J. Singh, 2013. Influence of different levels of NPK on growth, yield and quality of phalsa (*Grewia subinaequalis* L.). Asian J. Hortic. 8: 433-435.

Shinde, N.M., D.C. Warke and M.B. Sonakke. 1976. Effect of different levels of nitrogen on growth and yield of phalsa. Indian J. Hortic. 53(1): 32-33.

Verma R.S., H.K. Singh and S.S. Verma. 2014. Effect of integrated nutrient management on plant growth, fruit yield and quality of phalsa (*Grewia subinaequalis* DC). Asian J. Hortic. 9(1): 48-52.

Yadav, K., Dinesh, S. Pathak, and A.L. Yadav. 2008. Effect of integrated nutrient management on vegetative growth and yield of phalsa (*Grewia subinaequalis* DC). Plant Arch. 9(1): 461-463.