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Effect of Foliar Spray of Micro Nutrients on Plant Growth, Yield and Fruit Quality of Phalsa (*Grewia asiatica* L.)

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Abstract Phalsa plant requires adequate nutrition for proper growth and development. Fulfiling tree nutrition requirements is important for economically profitable fruit production. The optimized standards of fertilizer application are of great importance to get good yield. The present investigation entitled effect of foliar spray of micro nutrients on plant growth, yield and fruit quality of Phalsa (*Grewia asiatica* L.) was carried out in randomized block design with 15 treatments and each treatment replicated thrice during December 2015—June 2016. The results of the present study, regarding the effect of micro nutrients zinc ($ZnSO_4$), boron (Bo) and Fe ($FeSo_4$) at 0.2% and 0.4% foliar spray on Phalsa have been discussed and interpreted in the light of previous research work done in India and abroad. The study showed significant finding and concluded that the treatment T_{14} (0.4% boron 0.4% ferrous sulfate 0.4% zinc sulfate) resulted with maximum number of canes per bush (15.00), days to sprouting of shoots (38.33), number of sprouted shoots per cane (24.86), number of leaves per shoots (27.73), length of shoots per cane (78.82 cm), number of fruiting nodes per shoots (24.85), number of fruits/ bush (2511.88), fruit yield/bush (kg) (4.43) and fruit yield (q/ha) (68.40) of Phalsa.

Keywords Phalsa, Foliar, Boron, Iron, Zinc.

Introduction

Phalsa (*Grewia asiatica* L.) also known as star apple, it is a sub-tropical fruit native to India, belongs to the family Tiliaceae . This family has about 41 genera and 400 species, which are mostly distributed in the tropical and sub-tropical region of the world. It is commercially grown in Punjab, Haryana, Gujarat, Maharashtra and Bihar. Its cultivation is favored around big cities where fruits find a read and quick sale. Regarding keeping quality, it is highly perishable in nature. Because of short shelf life, its fruits are suitable for local market or need to be processed immediately after harvesting [1]. It may be grown as an intercrop with mango, aonla, bael and ber. Phalsa is a bushy plant and can be grown in kitchen garden also. Ripe fruits are sub acidic and good source of vitamin A, vitamin C, phosphorus and iron. Fruits contain 50-60% juice, 10-11% sugar and 20.5% acid.

The fertilizer deficiency restricts the vegetative growth. A balanced fertilization comparing both of macro and micro nutrients can well enhance yield potential of Phalsa bushes. Considering the importance of Phalsa there is needed to initiate the nutrient

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management to increase vegetative growth, fruit size, uniform ripening, fruit yield and quality of Phalsa. Phalsa is generally grown on poor lands where nutrient availability is limited. Under these circumstances, it would be better with foliar feeding of vital nutrient for sustaining the plant against any nutrient deficiency. The foliar application of nutrient is considered beneficial when growing soil fail to support plant growth and yield. In addition to nutrient intensity has also been reported to manage plant canopy and enhance the flowering, fruiting, yield and quality of many fruit crops [2, 3].

Materials and Methods

An experiment entitled effect of foliar spray of micro nutrients on plant growth, yield and fruit quality of Phalsa (*Grewia asiatica* L) was carried out under Allahabad agro climatic conditions at the research farm. Department of Horticulture, Allahabad School of Agriculture, Sam Higginbottom Institute of Agriculture, Technology and Sciences, (Deemed To-Be University) Allahabad (UP) India. The pruning was done in January on 6 year old plants, with the help of lopper by manual labor. Prior to start the pruning, only 8-12 canes were selected from each bush for the observation. All the pruned canes were almost similar in diameter; the average diameter per cane was 2.5 cm. First spray of nutrients was done at time of vegetative growth period (pre bloom stage) and second at eight days after fruit set. The experiment was conducted with randomized block design with 15 treatments and each treatment replicated thrice, thus making a total number of 45 plants. The observations regarding number of canes per bush, days of sprouting of shoots, number of sprouted shoots per cane, total number of canes per plant, length of shoots per cane (cm), number of fruiting nodes per shoots and number of leaves per shoots were recorded at full growth stage, yield attributes such as number of fruits per bush, fresh fruit weight (g) and fruit yield were recorded at the time of fruit picking and quality parameters such as TSS, total sugar and titratable acidity were recorded at post harvest stage [4, 5]. Statistical analyses of the data obtained in the different sets of experiments were calculated as suggested by Panse and Sukhatme [6] and results were evaluated at 5% significance

Sl. No	Treatment symbol	Treatment combination (micro nutrients)
1	T_0	Control
2	T_1	0.2% Boron (B)
3	T_2	0.2% Zinc sulfate ($ZnSO_4$)
4	T_3	0.2% Ferrous sulfate ($FeSO_4$)
5	T_4	0.4% Boron (B)
6	T_5	0.4% Zinc sulfate ($ZnSO_4$)
7	T_6	0.4% Ferrous sulfate ($FeSO_4$)
8	T_7	0.2% Boron (B) + 0.2% Ferrous sulfate ($FeSO_4$)
9	T_8	0.2% Boron (B) + 0.4% Ferrous sulfate ($FeSO_4$)
10	T_9	0.2% Boron (B) + 0.2% Zinc sulfate ($ZnSO_4$)
11	T_{10}	0.2% Boron (B)+0.4% Zinc sulfate ($ZnSO_4$)
12	T_{11}	0.2% Boron (B) +0 2% Ferrous sulfate ($FeSO_4$) + 0.2% Zinc sulfate ($ZnSO_4$)
13	T_{12}	0.2% Boron (B) + 0.4% Ferrous sulfate ($FeSO_4$) + 0.4% Zinc sulfate ($ZnSO_4$)
14	T_{13}	0.4% Boron (B) + 0.2% Ferrous sulfate ($FeSO_4$) ($FeSO_4$) + 0.2% Zinc sulfate ($ZnSO_4$)
15	T_{14}	0.4% Boron (B) + 0.4% Ferrous sulfate ($FeSO_4$) + 0.4% Zinc sulfate ($ZnSO_4$)

Results and Discussion

The findings of the present study as well as relevant discussion have been presented under following heads.

Plant growth

Vegetative growth of Phalsa plants was greatly influenced with the application of fertilizers. The data revealed that the different fertilizers significantly increased the length of shoots per canes, number of leaves per shoots, no. of canes per bush and number of fruiting nodes per shoots (Table 1). Maximum length of shoots per canes (78.82 cm) and number of leaves per shoots of Phalsa (27.73 at 120 DAP) was recorded in plants applied with Bo + $FeSO_4$ + $ZnSO_4$ at 0.4% per plant. This effect on increased growth may be due to the fact that use of Zn accelerated the protein synthesis and chlorophyll synthesis, whereas boron and iron promotes the growth of plants [7]. The maximum no. of canes per bush (15.00) and fruiting nodes per shoots of Phalsa (24.85) was recorded in plants applied with treatment combination T_{14} (0.4%) boron + 0.4% ferrous sulfate + 0.4% zinc sulfate) while the

Table 1. Effect of foliar spray of micronutrients on vegetative growth of Phalsa (*Grewia asiatica* L.).

Treat-ments	Treatments combination	Number of canes per bush	Days of sprouting shoots	Number of sprouted shoots per canes	Length of shoots (cm)	Number of fruiting nodes/ shoots	Number of leaves per shoots
T_0	Control	7.33	48.00	10.14	66.32	12.20	19.23
T_1	0.2% Boron (B)	12.23	47.76	13.20	70.68	18.33	20.41
T_2	0.2% Zinc sulfate ($ZnSO_4$)	11.80	45.66	14.25	67.65	17.24	21.63
T_3	0.2% Ferrous sulfate ($FeSO_4$)	13.00	46.33	14.35	74.86	18.80	23.42
T_4	0.4% Boron (B)	12.86	45.10	15.19	73.99	20.66	24.08
T_5	0.4% Zinc sulfate ($ZnSO_4$)	12.12	43.93	17.32	71.95	19.22	22.55
T_6	0.4% Ferrous sulfate ($FeSO_4$)	13.56	44.78	19.35	75.47	21.33	25.18
T_7	0.2% Boron (B) + 0.2% Ferrous sulfate ($FeSO_4$)	13.33	47.13	18.64	75.22	20.36	24.83
T_8	0.2% Boron (B) + 0.4% Ferrous sulfate ($FeSO_4$)	13.66	43.66	19.74	75.90	21.86	25.79
T_9	0.2% Boron (B) + 0.2% Zinc sulfate ($ZnSO_4$)	11.83	43.57	18.65	72.47	19.03	21.80
T_{10}	0.2% Boron (B) + 0.4% Zinc sulfate ($ZnSO_4$)	12.00	42.80	18.47	73.06	19.64	23.14
T_{11}	0.2% Boron (B) + 0.2% Ferrous sulfate ($FeSO_4$) + 0.2% Zinc sulfate ($ZnSO_4$)	13.96	41.25	20.56	76.12	22.76	26.04
T_{12}	0.2% Boron (B) + 0.4% Ferrous sulfate ($FeSO_4$) + 0.4% Zinc sulfate ($ZnSO_4$)	14.60	41.00	24.22	77.90	24.08	27.28
T_{13}	0.4% Boron (B) + 0.2% Ferrous sulfate ($FeSO_4$) + 0.2% Zinc sulfate ($ZnSO_4$)	14.10	39.81	23.30	76.83	23.20	26.94
T_{14}	0.4% Boron (B) + 0.4% Ferrous sulfate ($FeSO_4$) + 0.4% Zinc sulfate ($ZnSO_4$)	15.00	38.33	24.86	78.82	24.85	27.73
	F-test	S	S	S	S	S	S
	CD at 0.5%	1.71	5.32	2.47	3.73	2.70	3.19
	SEd	0.83	2.60	1.21	1.82	1.32	1.56

minimum was noticed in T_0 (control). The treatment T_{14} (0.4% boron + 0.4% ferrous sulfate + 0.4% zinc sulfate) took significant less days to sprouting (38.33) and also recorded significantly maximum number of sprouted shoots per canes (24.86 at 120 DAP) Singh et al. [8] also associated with foliar feeding of nutrients increased growth, yield and quality of Phalsa fruit.

Yield traits

Significant effect of nutrients foliar application was also found helpful in increasing the yield of Phalsa plant. The maximum fresh weight of 10 fruits (8.91g) and maximum number of fruits per bush (2511.88) was recorded with treatment T_{14} (0.4% boron + 0.4% ferrous sulfate + 0.4% zinc sulfate) which contributed positively to give maximum yield per bush and per ha.

The treatment T_{14} (0.4% boron + 0.4% ferrous sulfate + 0.4% zinc sulfate) gave maximum fruit yield per bush (4.43 kg) and maximum fruit yield (q/ha) (68.40) whereas the minimum fruit yield per bush (1.02 kg) and minimum fruit yield (q/ha) (19.44) was noticed with T_0 (control). Yadav et al. [9] reported similar results and observed that spraying of $ZnSO_4$,$FeSO_4$ and boric acid were most effective to increase yield and quantity of grape cv Perlette.

Quality traits

A significant increase in TSS content was observed in fruits of Phalsa with increase in fertilizer doses (Table 2). Significantly higher TSS (22.52^0Brix) was recorded in fruits of plants applied with Bo + $FeSO_4$ + $ZnSO_4$ at 0.4% per plant. The present results are in accordance with the findings of Wali et al. [10] in Phalsa. The improvement in TSS of fruits could easily be explained by the fact that zinc and iron is helpful in photosynthesis which ultimately led to the accumulation of carbohydrates and helped to increase the TSS of Phalsa. The fertilizers found to exert non-significant effect on acidity of Phalsa. Minimum tritratable acidity (as % malic acid (2.17) recorded in fruits of

Table 2. Effect of foliar spray of micro nutrients on yield and quality traits of Phalsa (*Grewia asiatica* L.).

Treatments	Treatments combination	Fresh weight of 10 fruits (g)	Number of fruits/ bush	Fruit yield/ bush (kg)	Fruit yield (q/ha)	Titrable acidity	TSS (^{0}Brix)	Total sugar per cent
T_0	Control	5.15	1408.33	1.02	19.44	2.94	16.82	8.32
T_1	0.2% Boron (B)	5.25	1532.21	1.55	27.90	2.85	17.85	8.55
T_2	0.2% Zinc sulfate ($ZnSO_4$)	5.01	1480.00	1.29	23.29	2.45	18.76	8.46
T_3	0.2% Fereous sulfate ($FeSO_4$)	5.52	1506.66	1.63	29.35	2.61	18.76	8.46
T_4	0.4% Boron (B)	5.88	1642.15	2.66	47.97	2.54	18.33	9.31
T_5	0.4% Ferrous sulfate ($ZnSO_4$)	5.37	1528.01	1.52	27.36	2.53	19.73	10.57
T_6	0.4% Ferrous sulfate ($FeSO_4$)	6.29	1596.50	3.20	54.65	2.41	18.42	8.83
T_7	0.2% Boron (B) + 0.2% Ferrous sulfate ($FeSO_4$)	6.38	1802.10	2.84	51.30	2.53	18.75	9.91
T 8	0.2% Boron (B) + 0.4% Ferrous sulfate ($FeSO_4$)	7.22	1953.33	3.01	52.18	2.56	17.56	9.09
T_9	0.2% Boron (B) + 0.2% Zinc sulfate ($ZnSO_4$)	5.41	1712.21	1.93	34.66	2.53	19.35	10.54
T_{10}	0.2% Boron (B) + 0.4% Zinc sulfate ($ZnSO_4$)	6.47	1781.66	2.35	42.33	2.80	19.82	10.36
T_{11}	0.2% Boron (B) + 0.2% Ferrous sulfate ($FeSO_4$) + 0.2% Zinc sulfate ($ZnSO_4$)	7.68	2178.70	3.15	56.61	2.40	20.51	10.83
T_{12}	0.2% Boron (B) + 0.4% Ferrous sulfate ($FeSO_4$) + 0.4% Zinc sulfate ($ZnSO_4$)	8.15	2215.04	3.87	65.03	2.46	21.97	11.88
T_{13}	0.4% Boron (B) + 0.2% Ferrous sulfate ($FeSO_4$) + 0.2% Zinc sulfate ($ZnSO_4$)	7.91	2460.00	3.50	62.00	2.18	20.69	11.25
T_{14}	0.4% Boron (B) + 0.4% Ferrous sulfate ($FeSO_4$) + 0.4% Zinc sulfate ($ZnSO_4$)	8.91	2511.88	4.43	68.40	2.17	22.52	11.93
	F-test	S	S	S	S	NS	S	S
	CD at 0.5%	0.79	97.11	0.35	6.08	0.45	2.60	1.33
	SEd	0.39	47.41	0.17	2.97	0.22	1.27	0.65

plants applied with B + $FeSO_4$ + $ZnSO_4$ at 0.4% per plant and minimum (2.18%) was recorded in fruits obtained from plants applied with B +Fe SO_4 + $ZnSO_4$ at 0.4% + 0.2% + 0.2% per plant. Maximum total sugars (11.93%) were recorded under treatment T_{14} (0.4% boron + 0.4% ferrous sulfate + 0.4% zinc sulfate) than control. Similar findings were also reported earlier [10, 11, 12].

Economics

The maximum benefit cost ratio of treatment T_{14} (0.4% boron + 0.4% ferrous sulfate + 0.4% zinc sulfate) i.e. (1:12.62) followed by treatment T_{12} (0.2% boron + 0.4% ferrous sulfate + 0.4% zinc sulfate) i.e. (1:12.46), were also found to be the best treatment combination in terms of economic returns.

Conclusion

The study reveals that the orchard nutrition management plays a very crucial role in plant growth and its productivity. Overall results suggest the definite role of micronutrients in plant health and fruit production of Phalsa. These results also provide information that plants should be applied nutrients at critical growth stages when plants really have a demand of nutrition. The information obtained from the trial is helpful to design nutrition program according to plant growth. From the above findings it is concluded that the treatment T_{14} (0.4% boron + 0.4% ferrous sulfate + 0.4% zinc sulfate) found to be best results in maximum in plant growth, fruit quality, fruit yield and benefit cost ratio of Phalsa followed by treatment T_{12} (0.2%) boron + 0.4% berrous sulfate + 0.4% zinc sulfate) and minimum with T_0 (Control) respectively.

References

1. Salunkhe DK, Desai BB (1984) Phalsa. In : Salunkhe and Desai (eds). Postharvest biotechnology of fruits. Vol. 2. CRC Press, Boca Raton, FL, pp 129.
2. Singh SK, Singh HK (2008) Pruning behavior in aonla (*Emblica officinalis* Gaertn.) cv Narendra aonla. Environ and Ecol 26 : 1039—1041.
3. Ali HS, Ghaffor A, Waseem K, Nadeem MA (2001)

Growth and yield response of Phalsa (*Grewia asiatica* L.) to various pruning intensities and dates. J Biol Sci 1 : 548—550.
4. AOAC (2000) Association of Official Agricultural Chemistry. Methods of analysis (15th edn). Washington, DC, USA.
5. Gould WA (1978) Food quality assurance. Westport Connecticut AVI Publ, pp178—180.
6. Panse VG, Sukhatme PV (1985) Statistical methods for agricultural workers. Ind Coun Agric Res,:New Delhi, pp 197.
7. Gill Singh B, Khehra S, Kaur G, Sing S (2015) Effect of inorganic fertilizers on the plant growth and fruit quality in phalsa (*Grewia asiatica* D.C.). Adv Res J Crop Improv 6 : 100—104.
8. Singh P, Singh HK, Vishwanath, Pratap B (2009) Response of foliar feeding of nutrients on growth, yield and quality of Phalsa (*Grewia subinaequalis* D.C.) fruits. Ann Hort 2 : 67—71.
9. Yadav M, Yadav AL, Singh HK (2007) Effect of foliar feeding of nutrients on growth and yield of Phalsa (*Grewia subinaequalis* D.C.). Pl Arch 7 : 199—200.
10. Wali VK, Kaul R, Kher R (2005) Effect of foliar spray of nitrogen, potassium and zinc on yield and physico-chemical composition of Phalsa (*Grewia subinaequalis* D.C.) cv Purple Round. Haryana J Hort Sci 34 : 56—57.
11. Kumar S, Yadav AL, Vishwakarma G, Yadav DK (2014) Effect of foliar feeding of nutrients and plant growth regulators on physico-chemical attributes of Phalsa (*Grewia subinaequalis* D.C.). Res Environ Life Sci 4 : 317—318.
12. Singh AK, Kumar A, Yadav AL (2015) Effect of pruning intensity, foliar feeding of PGR and micro nutrients on physico-chemical attributes of Phalsa (*Grewia subinaequalis*) fruits. Res Environ Life Sci 8 : 675—678.