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Effect of foliar application of micronutrients on growth and yield of phalsa (*Grewia subinaequalis* D.C.)

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Abstract
The present investigation entitled "Effect of foliar application of micronutrients on growth and yield of phalsa (*Grewia subinaequalis* D.C.) Fruits" was carried out at Main Experimental Station, Department of Fruit Science, Acharya Narendra Deva University of Agriculture and Technology Kumarganj Ayodhya (U.P) during year 2017-18 to evaluate the effect of foliar feeding of micronutrients on growth and yield attributes of phalsa and its economic feasibility. The experiment comprised of eight effective treatments of zinc shulphate 0.4% Borax 0.2% and Iron 0.4% as individual and in combination with three replication. The data recorded and analysed by using Randomised block design (R.B.D). Under the experiment the phalsa plants were studied for shoot length, number of shoots per plant, number of leaves per shoot, inter-nodal length, Number of fruiting nodes, number of fruits per node, days to first picking of fruits, fruiting duration and fruit yield. The study showed significant findings in all parameters and concluded that treatment T_8 (0.4% zinc shulphate + 0.2% Borax + 0.4% Ferrous sulphate) resulted with maximum number of shoots per plant (56.33), shoot length (249.33 cm), number of leaves per shoot (86.00), inter-nodal length (6.77cm), number of fruiting nodes (11.93), number of fruits per node (8.85), days to first picking of fruits (40.67 days), duration of fruit picking (24 days)and fruit yield (53.07 q/ha or 3.54 kg/ha) of phalsa.

Keywords: Phalsa, micronutrients, borax, zinc sulphate, ferrous sulphate

Introduction
Phalsa one of most important Indigenous minor fruit belongs to family Tiliaceae, mostly grown in Punjab, Haryana, Uttar Pradesh, Madhya Pradesh, Maharashtra, Gujarat, Andhra Pradesh, Bihar and West Bengal. But no exact area and production of this fruit are available. Phalsa is a small shrub having long drooping branches the young branchlets are densely coated with hairs bear very small, red to purple fleshy fibrous drupe in clusters in the axils of leaves on young shoot which is ripened from April to May. The fruit contains 69-93% edible part and used for excellent quality of juice and squash. Ripe phalsa fruits have pleasant acidic flavour and good source of Vitamin A and E. It contains 80.80% moisture, 1.30% protein, 0.90% fat, 14.7% Carbohydrate, Iron 3.1mg/100g pulp and Ascorbic acid 22.0mg/100g pulp. Phalsa has great utility and medicinal and aphrodisiac properties but its popularity and cultivation is very much segregated. The major problem in phalsa cultivar is uneven ripening led to multiple picking and it is highly perishable in nature even start to spoil with in a day. Foliar application of micronutrients *viz.* Zinc, boron and Iron can improve the ripening as well as shelf life of phalsa fruit.
Zinc is one eight essential element responsible for the production of RNA polymerase and synthesis of IAA and water, nutrient uptake. Its availability reduced in Alkali soiltherefore foliar application of Zinc can be useful under this condition. Boron is essential micronutrient required for translocation of sugar which improves growth and development of fruits. Iron acts mainly in the synthesis of chlorophyll which is pre-requisite for photosynthesis and healthy plant and better quality of fruit. Maximum number of canes per bush (15.46), number of fruit increases per bush and significant increase in fresh weight of fruits in treatment of 0.2% Boron + 0.1% zinc sulphate 0.2% copper sulphate in phalsa plant (Kumar *et al.* 2017) [3].

Material and Methods
The present investigation was carried out at Main Experiment Station, Department of Horticulture, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya (U.P.) during year 2017-2018 on 20 year phalsa plants which were pruned in January.

The experimental site is located at the Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya. Geographically, It is situated at 26.47º North latitude, 82.12º East longitude and altitude of 113 meter from sea level. The site is located in typical saline alkaline belt of indo-gangetic plains of eastern Uttar Pradesh.

The experiment was laid out in Randomized Block Design with three replication in the month of January, 2018, with the allocation of eight treatment of micronutrients (Zn, Boron, Iron) as T_1 (Control), T_2 ($ZnSO_4$ 0.4%), T_3 Borax 0.2%, T_4 ($FeSO_4$ 0.4%), T_5 ($ZnSO_4$ 0.4% + Borax 0.2%), T_6 ZnSO4 (0.4%) + FeSO4 (0.4%), T_7 (Borax 0.2% + $FeSO_4$ 0.4%), T_8 ($ZnSO_4$ 0.4% + Borax 0.2% + $FeSO_4$ 0.4%). One plant was taken as a unit. The observations were recorded for length of shoot, number of shoot, number of leaves per shoot, Inter-nodal length, number of fruiting nodes per shoot, Days to first picking of fruits, duration of picking of fruits, fruit yield per plant as well as per hectare, Benefit cost ratio of different treatments.

Result and Discussion

Data recorded on shoot length, number of shoots per plants, number of leaves per shoots and internodal length are presented in Table -1. The maximum shoot length and (249.33cm) and number of shoot per plant (56.33) were recorded with foliar spray of Zinc sulphate (0.4%) + Borax (0.2%) + Ferrous sulphate (0.4%) whereas, minimum shoot length and number of shoots per plant were found in control. Highest number of leaves per shoot (86.00) and inter nodal length (6.77cm) were recorded in T_8 Zinc sulphate (0.4%) + Borax (0.2%) + Ferrous sulphate (0.4%) which was in close conformity with the findings of Yadav *et al.* (2008) [16], Yadav *et al.* (2004) [14, 15], Singh and Singh (2017) [8]. Data recorded on yield attributing parameters *viz.* number of fruiting nodes per shoots, number of fruits per node, fruit yield have been enhanced significantly with the foliar application of micronutrients presented in (Table-2) The maximum number of fruits per node (8.85) was obtained with the foliar spray of Zinc sulphate (0.4%) + Borax (0.2%) + Ferrous sulphate (0.4%) similar results were also recorded by Bhoyar *et al.* (2016) [2], Neware *et al.* (2017) [6], Singh *et al.* (2017) [8] and Yadav *et al.* (2004) [14, 15]. The reason for higher number of fruits per node might be due to the fact that zinc and iron play significant role in photosynthetic activity and better translocation of metabolites. Boron helps in improving fruiting, pollen germination and cell division with results in developing fruit lets. The maximum number of fruiting node per shoot (11.93) was counted with foliar application of Zinc sulphate (0.4%) + Borax (0.2%) + Ferrous sulphate (0.4%) earlier researcher *viz.* Singh *et al.* (2009) [9] and Singh *et al.* (2015) [7] It might be possible as zinc seems to activate the enzymes that involved in bio-chemical reactions and boron also involves in the metabolism of amino acids, proteins and carbohydrates which leads to reproductive developments of plants. The maximum number of days to first picking (40.67 days) was recorded with foliar application of Zinc sulphate (0.4%) + Borax (0.2%) + Ferrous sulphate (0.4%) similar results were also observed by Singh *et al.* (2001) and Chhonkar *et al.* (1983) [10]. It might be due to fact that energy and nutrients are distributed more in heavy yield plants than low yield plants. significantly maximum duration of picking (24.00 days) was noted with the foliar application of Zinc sulphate (0.4%) + Borax (0.2%) + Ferrous sulphate (0.4%).This increase in duration of picking of phalsa fruits may be associated with fact more number of pickings were needed in high yielded plants which ultimately increases duration of picking in phalsa. Wali *et al.* (2005) [13], Mishra *et al.* (2017) [5], Verma *et al.* (2009) [12] and Singh *et al.* (2007) [11] also reported similar results in aonla and phalsa respectively. The variation in cost of cultivation was due to different combination of micro-nutrient. Yield was major factor which cause difference in net income and net return per rupees invested (C: B ratio) Maximum net income (Rs ha^{-1}) and net return per rupee (C: B ratio) (1:2.22) were recorded with the foliar application micronutrients of Zinc sulphate (0.4%) + Borax (0.2%) + Ferrous sulphate (0.4%). (Table 3). Similar findings also reported by Meena *et al.* (2013) [4] noted maximum Cost:benefit ratio with application of 100 ppm NAA and 0.4% ferrous sulphate in ber and Abhijith *et al.* (2018) [1] also reported highest cost benefit ratio with foliar application of $ZnSO_4$ (0.5%), $FeSO_4$ (0.5%) and Borax (0.25%) in aonla cv. NA-7.

Table 1: Effect of foliar application of micronutrients on vegetative growth of phalsa

Treatment	Shoot Length (Cm)	Number of Shoots Per Plant	Number of Leaves Per Shoot	Inter Nodal Length (Cm)	Number of Fruits Per Node	Number of Fruiting Node Per Shoot
T_1 Control	205.00	37.00	71.33	6.17	5.24	7.80
T_2 ZnSO4 0.4%	231.00	41.33	79.67	6.47	5.52	8.80
T_3 Borax 0.2%	211.83	45.67	79.67	6.37	6.50	9.40
T_4 $FeSO_4$ 0.4%	245.67	48.00	81.33	6.72	5.40	8.50
T_5 $ZnSO_4$ 0.4% + Borax 0.2%	243.00	43.67	78.67	6.32	6.82	9.06
T_6 $ZnSO_4$ 0.4% + $FeSO_4$ 0.4%	234.33	53.67	80.33	6.50	6.99	9.13
T_7 Borax 0.2% + $FeSO_4$ 0.4%	233.33	46.67	78.67	6.22	5.71	8.87
T_8 $ZnSO_4$ 0.4% + Borax 0.2% + $FeSO_4$ 0.4%	249.33	56.33	86.00	6.77	8.85	11.93
S.Em±	5.42	1.85	1.41	0.07	0.68	0.47
C. D. (P=0.05)	16.43	5.61	4.28	0.23	2.07	1.43

Table 2: Effect of foliar application of micronutrients on fruiting attributes of phalsa

Treatment	Fruit Yield Per Plant (Kg)	Fruit Yield (Q/Ha)	Days To First Picking (Days)	Duration of Picking (Days)
T_1 Control	2.27	34.03	31.00	16.00
T_2 ZnSO4 0.4%	2.57	38.58	35.67	16.67
T_3 Borax 0.2%	2.45	36.68	36.00	18.67
T_4 $FeSO_4$ 0.4%	2.59	38.78	36.67	19.33

T_5 $ZnSO_4$ 0.4% + Borax 0.2%	2.73	40.98	37.67	20.00
T_6 $ZnSO_4$ 0.4% + $FeSO_4$ 0.4%	2.89	43.37	38.33	21.33
T_7 Borax 0.2% + $FeSO_4$ 0.4%	2.96	44.33	40.00	22.67
T_8 $ZnSO_4$ 0.4% + Borax 0.2% + $FeSO_4$ 0.4%	3.54	53.07	40.67	24.00
S.Em±	0.15	2.18	0.38	0.52
C. D. (P=0.05)	0.44	6.61	1.15	1.57

Table 3: Effect of foliar application of micronutrients on cost-benefit ratio of phalsa

Treatment	YIELD (q/ha)	Cost of cultivation (Rs/ha)	Gross income (Rs/ha)	Losses (10%)	Net return (Rs)	Cost-benefit ratio
T_1 Control	34.03	138964	340300	34030	167306	1:1.20
T_2 ZnSO4 0.4%	38.58	142361	385800	38580	204859	1:1.43
T_3 Borax 0.2%	36.68	142267	366800	36680	187853	1:1.32
T_4 $FeSO_4$ 0.4%	38.78	141362	387800	38780	207658	1:1.46
T_5 $ZnSO_4$ 0.4% + Borax 0.2%	40.98	145664	409800	40980	223156	1:1.53
T_6 $ZnSO_4$ 0.4% + $FeSO_4$ 0.4%	43.37	144758	433700	43370	245572	1:1.69
T_7 Borax 0.2% + $FeSO_4$ 0.4%	44.33	144665	443300	44330	254305	1:1.75
T_8 $ZnSO_4$ 0.4% + Borax 0.2% + $FeSO_4$ 0.4%	53.07	148062	530700	53070	329568	1:2.22
S.Em±	2.18	57.91	53.45	22.04	19877.20	0.08
C. D. (P=0.05)	6.61	175.61	162.11	66.84	60282.4	0.24

Conclusion

Based on the results, it can be concluded that two times foliar application of micronutrients at pre bloom stage and just after fruit set showed significantly positive response in phalsa. The application of Zinc sulphate 0.4% + Borax 0.2% + Ferrous sulphate 0.4% increased shoot length, number of shoot, number of leaves per plant, inter-nodal length significantly. The fruiting node per shoot, number of fruits per node, days to first picking, duration of picking and fruit yield was also found maximum with foliar spray of Zinc sulphate 0.4% + Borax 0.2% + Ferrous sulphate 0.4% The same treatment produced quality fruits in terms of increased TSS, ascorbic acid, sugars and decreased acid content of phalsa fruit. This treatment also gave maximum net return per hectare

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