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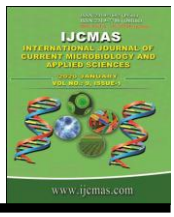

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Effect of Pruning Intensity and Foliar Feeding of Nutrients on Growth and Quality of Phalsa (*Grewia subinaeqalis* D.C)

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A B S T R A C T

A field experiment was conducted at Main Experiment Station, Department of Horticulture, NDUAT, Kumarganj, Faizabad (U.P.). Pruning of Phalsa at 50 cm above ground level combined with $ZnSO_4$ 0.4% increased number of shoot and fruiting nodes closely followed by Urea 2% and K_2 SO_4 0.2% with pruning at 50 cm above ground level. Better response was obtained with fruit yield attributing attributes also. The fruit quality in terms of TSS, acidity, ascorbic acid content, juice percent and sugar content were better with $ZnSO_4$ 0.4% combined with pruning at 50 cm above ground level closely followed by K_2SO_4 0.2% with pruning at 50 cm above

Introduction

Phalsa is also known as star apple, a subtropical fruit which is cultivated commercially in various states of India like Punjab, Haryana, Uttar Pradesh and Madhya Pradesh. Phalsa is also cultivated in limited scale in the states of Maharashtra, Gujrat, Andhra Pradesh, Bihar and West Bengal. The fruits of phalsa are eaten fresh. The juice of phalsa is used for making squash and syrup. Since vedic times phalsa is known for its good medicinal properties. The woody part of phalsa is used for fuel by rural people and is also used for basket making which is an income generating entrepreneurship to the rural farmers and poor people. It is quick growing, very hardly shrub which thrives well in wide range of soils even on salt affected wastelands. Phalsa can also be grown as intercrop in mango, aonla, bael and ber orchards. In India, the phalsa grows well up to an elevation of 3,000 ft (914 m). It can stand light frosts which cause only shedding of leaves. The phalsa grows in most any soil-sandy, clay or limestone but rich loam improves fruit production, along with irrigation during the fruiting season and in dry

periods, even though the tree is drought-tolerant. Generally, it is grown in marginal land close to city markets. Seeds are the usual means of propagation and they germinate in 15 days. Ground-layers, treated with hormones, have been 50% successful; air-layers, 85%. Cuttings are difficult to root. Only 20% of semi-hardwood cuttings from spring flush, treated with 1,000 ppm NAA, and planted in July (in India) rooted and grew normally. The flower contains grewinol, a long chain keto alcohol (Laxmi and Chauhan, 1976). The seed of phalsa contains 5% oil, which is bright yellow in colour and contains 65 % linoleic acid, 13.5% oleic acid and 11% stearic acid (Morton, 1987).

Little or meager information is available on effect of pruning combined with foliar feeding for better plant growth and higher production of quality fruits of this crop.

Materials and Methods

Field experiment was conducted at Main Experiment Station, Department of Horticulture, NDUAT, Kumarganj, Faizabad (U.P.). Forty five plants of eighteen years old phalsa cv. Sharbati, uniform in size and vigour were planted at distance at 3x2 m were selected. The experiment was laid out in Factorial RBD with three replications having 15 treatment combination including 3 levels of pruning viz. pruned at 25 cm, 50 cm and 75 cm above ground level and 5 chemical treatment viz. control (water), $ZnSO_4$ 0.4%, $CuSO_4$ 0.4%, K_2SO_4 0.2% and urea 2% solution.

Pruning of phalsa bushes was done in first week of February and spray of nutrient solution was done on second fortnight of March (pre 100 m stage) while second spray was done after fruit setting. Observations were recorded on number of shoots/fruiting nodes, fruits/node, fruit yield/plant, weight of 50 fruits, juice percent and quality of juice in terms of TSS, acidity ascorbic acid and sugar content as per methods given in A.O.A.C (1996).

Foliar treatments: C_0- Control (water); C_1-$ZnSO_4$ 0.4%; C_2-$CuSO_4$ 0.4%; C_3- K_2SO_4 0.4%; C_4-Urea 2.0%.

Pruning intensity: P_1- 25 cm; P_2- 50 cm and P_3- 75 cm.

Results and Discussion

A perusal of data presented in Table 1 (a and b) reveals that shoot per plant, fruiting node per shoot, fruits/node and fruit yield was influenced significantly. Pruning intensity and foliar feeding of nutrients influenced all yield characters significantly. The highest number of shoots (300), nodes/shoot (18.08), fruit number per were recorded with pruning 50 cm above ground level. Same level of pruning and foliar feeding of $ZnSO_4$ 0.4% for followed by urea 2.0%. The increase in growth parameters might be due to the fact that Potash, Zinc and Copper activate many enzymes required for photosynthesis and also plays a vital role in metabolism and same time spray of and Urea is constituent of protein essential for formation of protoplasm, influence cell division, elongation and causes better plant growth. The findings are in line with the findings of (Kumar *et al*., 2004) in litchi and (Kumar *et al*., 2008 and Rathore, 2010) in phalsa.

It is also clear from the data (Table 2a) that response of pruning and nutrients also increased fruit yield being highest (4.10 kg per plant) with pruning 50 cm above ground level combined with $ZnSO_4$ 0.4% foliar feeding follow by same level of pruning follow by spray of Urea 2.0%. Similar findings were observed by Tiwari *et al.*, (2011) in aonla and Mishra and Pathak (1998) in guava.

A perusal of data presented in table 2 (a and b) that weight of 50 fruit and juice percent were influenced by pruning intensity and feeding of nutrients. The highest 50 fruits was recorded (47.67 g) pruning at 50 cm above ground level with $ZnSO_4$ 0.4% followed by same level of pruning sprayed with 2.0% urea foliar feeding followed by K_2SO_4 0.2% foliar feeding (49.67) and pruning at 50 cm above ground level. The present findings are in close agreement with Arora and Yamdagni (1985) in sweet lime, Singh and Singh (2008) in aonla cv. NA-7 and Singh *et al.*, (2001) in aonla cv. Francis where the juice content increased due to fact that nutrients (N, K, Zn and Cu) application. Uptake of nutrients in plant with minerals led to increase in turgor pressure which resulted in increased juice percent. The present findings are also in agreement with Kumar (2004) in litchi.

Table.1(a) Effect of pruning intensity and foliar feeding of nutrients on number of shoots per plant

Treatments	Pruning (Above ground level)			Mean
	25 cm (P_1)	50 cm (P_2)	75 (P_3)	
Control (water) (C_0)	22.67	26.67	21.00	23.44
$ZnSO_4$ 0.4% (C_1)	32.00	33.33	31.33	32.22
$CuSO_4$ 0.4% (C_2)	29.00	29.67	28.67	29.11
K_2SO_4 0.4% (C_3)	30.00	30.33	29.67	30.00
Urea 2.0% (C_4)	32.67	33.00	30.67	32.11
Mean	29.27	30.60	28.27	
	P	C	PxC	
SEm±	0.40	0.51	0.89	
CD at 5%	1.15	1.48	NS	

Table.1(b) Effect of pruning intensity and foliar feeding of nutrients number of fruiting nodes per shoot

Treatments	Pruning (Above ground level)			Mean
	25 cm (P_1)	50 cm (P_2)	75 (P_3)	
Control (water) (C_0)	15.67	16.40	14.67	15.58
$ZnSO_4$ 0.4% (C_1)	18.67	19.80	18.33	18.93
$CuSO_4$ 0.4% (C_2)	17.00	17.60	16.67	17.09
K_2SO_4 0.4% (C_3)	16.67	18.00	17.33	17.33
Urea 2.0% (C_4)	17.67	18.60	16.00	17.42
Mean	17.14	18.08	16.60	
	P	C	PxC	
SEm±	0.31	0.40	0.70	
CD at 5%	0.90	1.17	2.02	

Table.1(c) Effect of pruning intensity and foliar feeding of nutrients on number of fruits per node

Treatments	Pruning (Above ground level)			Mean
	25 cm (P_1)	50 cm (P_2)	75 (P_3)	
Control (water) (C_0)	14.00	14.70	14.33	14.34
$ZnSO_4$ 0.4% (C_1)	16.33	17.15	16.00	16.49
$CuSO_4$ 0.4% (C_2)	15.33	16.10	15.00	15.48
K_2SO_4 0.4% (C_3)	15.67	16.40	14.67	15.58
Urea 2.0% (C_4)	16.33	17.10	15.00	16.14
Mean	1553	16.29	15.00	
	P	C	PxC	
SEm±	0.28	0.37	0.63	
CD at 5%	0.82	1.06	1.84	

Table.1(d) Effect of pruning intensity and foliar feeding of nutrients on fruit yield per plant (kg/plant)

Treatments	Pruning (Above ground level)			Mean
	25 cm (P_1)	50 cm (P_2)	75 (P_3)	
Control (water) (C_0)	2.84	3.10	2.83	2.92
$ZnSO_4$ 0.4% (C_1)	3.70	4.10	3.67	3.82
$CuSO_4$ 0.4% (C_2)	3.60	3.95	3.63	3.73
K_2SO_4 0.4% (C_3)	3.56	3.90	3.79	3.81
Urea 2.0% (C_4)	3.68	4.05	3.71	
Mean	3.48	3.82	3.53	
	P	C	PxC	
SEm±	0.07	0.08	0.15	
CD at 5%	0.19	0.25	0.43	

Table.1(e) Effect of pruning intensity and foliar feeding of nutrients on number of fruiting nodes per shoot

Treatments	Pruning (Above ground level)			Mean
	25 cm (P_1)	50 cm (P_2)	75 (P_3)	
Control (water) (C_0)	15.67	16.40	14.67	15.58
$ZnSO_4$ 0.4% (C_1)	18.67	19.80	18.33	18.93
$CuSO_4$ 0.4% (C_2)	17.00	17.60	16.67	17.09
K_2SO_4 0.4% (C_3)	16.67	18.00	17.33	17.33
Urea 2.0% (C_4)	17.67	18.60	16.00	17.42
Mean	17.14	18.08	16.60	
	P	C	PxC	
SEm±	0.31	0.40	0.70	
CD at 5%	0.90	1.17	2.02	

Table.2(a) Effect of pruning intensity and foliar feeding of nutrients on weight of 50 fruits (gm)

Treatments	Pruning (Above ground level)			Mean
	25 cm (P_1)	50 cm (P_2)	75 (P_3)	
Control (water) (C_0)	42.67	43.00	42.33	42.67
$ZnSO_4$ 0.4% (C_1)	47.00	47.67	42.00	45.56
$CuSO_4$ 0.4% (C_2)	40.33	42.00	41.00	41.11
K_2SO_4 0.4% (C_3)	43.00	44.33	41.33	42.89
Urea 2.0% (C_4)	43.33	44.00	43.00	43.44
Mean	43.27	44.20	41.93	
	P	C	PxC	
SEm±	0.27	0.35	0.61	
CD at 5%	0.79	1.01	1.76	

Table.2(b) Effect of pruning intensity and foliar feeding of nutrients on juice percent (%)

Treatments	Pruning (Above ground level)			Mean
	25 cm (P_1)	50 cm (P_2)	75 (P_3)	
Control (water) (C_0)	37.00	37.00	36.33	36.78
$ZnSO_4$ 0.4% (C_1)	47.67	48.67	44.67	47.00
$CuSO_4$ 0.4% (C_2)	46.67	50.33	43.33	46.78
K_2SO_4 0.4% (C_3)	50.00	51.00	48.00	49.67
Urea 2.0% (C_4)	49.33	52.00	49.00	50.11
Mean	46.13	47.80	44.27	
	P	C	PxC	
SEm±	0.47	0.61	1.05	
CD at 5%	1.36	1.76	3.04	

Table.3(a) Effect of pruning intensity and foliar feeding of nutrients on fruit quality (TSS)

Treatments	Pruning (Above ground level)			Mean
	25 cm (P_1)	50 cm (P_2)	75 (P_3)	
Control (water) (C_0)	19.22	21.23	18.38	19.61
$ZnSO_4$ 0.4% (C_1)	27.65	28.40	26.76	27.87
$CuSO_4$ 0.4% (C_2)	26.12	26.34	25.16	25.87
K_2SO_4 0.4% (C_3)	26.91	27.62	25.82	26.78
Urea 2.0% (C_4)	26.13	27.13	25.87	26.38
Mean	25.20	26.15	24.40	
	P	C	PxC	
SEm±	0.19	0.25	0.43	
CD at 5%	0.56	0.72	1.25	

Table.3(b) Effect of pruning intensity and foliar feeding of nutrients on acidity (%)

Treatments	Pruning (Above ground level)			Mean
	25 cm (P_1)	50 cm (P_2)	75 (P_3)	
Control (water) (C_0)	2.35	2.20	2.30	2.28
$ZnSO_4$ 0.4% (C_1)	1.83	1.80	1.88	1.84
$CuSO_4$ 0.4% (C_2)	2.25	2.32	2.27	2.28
K_2SO_4 0.4% (C_3)	1.96	2.02	2.05	2.01
Urea 2.0% (C_4)	2.22	2.13	2.35	2.23
Mean	2.12	2.09	2.17	
	P	C	PxC	
SEm±	0.03	0.04	0.06	
CD at 5%	NS	0.10	NS	

Table.3(c) Effect of pruning intensity and foliar feeding of nutrients on ascorbic acid content (mg/100g pulp)

Treatments	Pruning (Above ground level)			Mean
	25 cm (P_1)	50 cm (P_2)	75 (P_3)	
Control (water) (C_0)	27.03	27.81	26.65	27.16
$ZnSO_4$ 0.4% (C_1)	36.50	37.28	35.98	36.59
$CuSO_4$ 0.4% (C_2)	34.86	35.58	33.97	34.80
K_2SO_4 0.4% (C_3)	35.90	36.63	35.05	35.86
Urea 2.0% (C_4)	35.21	35.91	34.86	35.32
Mean	33.90	34.64	33.30	
	P	C	PxC	
SEm±	0.22	0.29	0.49	
CD at 5%	0.64	0.83	NS	

Table.4(a) Effect of pruning intensity and foliar feeding of nutrients on reducing sugar (%)

Treatments	Pruning (Above ground level)			Mean
	25 cm (P_1)	50 cm (P_2)	75 (P_3)	
Control (water) (C_0)	11.52	11.93	10.57	
$ZnSO_4$ 0.4% (C_1)	13.29	13.76	13.25	
$CuSO_4$ 0.4% (C_2)	12.88	13.07	12.48	
K_2SO_4 0.4% (C_3)	12.92	13.13	12.73	
Urea 2.0% (C_4)	12.80	12.87	12.86	
Mean	12.68	12.95	12.37	
	P	C	PxC	
SEm±	0.15	0.19	0.33	
CD at 5%	0.43	0.56	NS	

Table.4(b) Effect of pruning intensity and foliar feeding of nutrients on non-reducing sugar (%)

Treatments	Pruning (Above ground level)			Mean
	25 cm (P_1)	50 cm (P_2)	75 (P_3)	
Control (water) (C_0)	3.16	3.27	2.90	3.11
$ZnSO_4$ 0.4% (C_1)	3.65	3.77	3.63	3.69
$CuSO_4$ 0.4% (C_2)	3.53	3.58	3.42	3.51
K_2SO_4 0.4% (C_3)	3.54	3.60	3.49	3.55
Urea 2.0% (C_4)	3.51	3.53	3.53	3.52
Mean	3.48	3.55	3.40	
	P	C	PxC	
SEm±	0.04	0.05	0.09	
CD at 5%	0.12	0.15	NS	

Table.4(c) Effect of pruning intensity and foliar feeding of nutrients total sugars (%)

Treatments	Pruning (Above ground level)			Mean
	25 cm (P_1)	50 cm (P_2)	75 (P_3)	
Control (water) (C_0)	14.68	15.20	13.47	14.45
$ZnSO_4$ 0.4% (C_1)	16.94	17.53	16.88	17.12
$CuSO_4$ 0.4% (C_2)	16.42	16.65	15.90	16.32
K_2SO_4 0.4% (C_3)	16.46	16.73	16.22	16.47
Urea 2.0% (C_4)	16.32	16.40	16.38	16.37
Mean	16.16	16.50	15.77	
	P	C	PxC	
SEm±	0.19	0.25	0.43	
CD at 5%	0.56	0.71	1.25	

Pruning intensity and foliar feeding of nutrients influenced the TSS, acidity and ascorbic acid content in juice Table 1 (a and b). The interaction effect between pruning levels and chemicals on TSS was found significant and noted highest (28.40) with combined effect of $ZnSO_4$ 0.4% along with pruning at 50 cm above ground level and effect was significant than rest of the combination. The increase in TSS content may be explained by the fact that applied nutrients are helpful to photosynthesis which ultimately led to the accumulation of carbohydrate which helps to increase TSS content of juice. The acid content in juice decreased significantly with foliar feeding, while non-significant effect was observed with pruning levels. The reason for decreased acidity due to nutrients (N, K, Zn and Cu) might be due to increase in translocation of carbohydrates due to conversion of acid to sugar. These findings are in agreement to Joon *et al.*, (1984). The highest ascorbic acid content (37.28 mg/100g juice) was recorded with combined effect of $ZnSO_4$ 0.4% closely followed by spray of K_2SO_4 0.2% (36.63 mg/100 g juice) along with pruning at 50 cm above ground level. Similar response has also been reported by Singh *et al.*, (2009) in aonla and Singh *et al.*, (1995) in ber. The increase in ascorbic acid content may be attributed to quality improving properties of N, K, Zn and Cu. The increase in ascorbic acid content in potassium treated fruits might be due to the

stimulated function of enzymes which participate in the synthesis of ascorbic acid. The reducing sugar, non-reducing sugar and total sugars in fruits juice of phalsa have also been increased as influenced by pruning levels and spray of nutrients Table 4 (a and b).

The highest level of reducing sugars (13.76), non-reducing sugar (3.77%) and total sugar (17.53) were found with foliar spray of $ZnSO_4$ 0.4% followed by $K_2 SO_4$ 0.2% along with pruning at 50 cm above ground level. The significant increase in sugar content might be due to accumulation of carbohydrates in fruits as a result of N, K, Zn and Cu application and also the role played by regular pruning of phalsa, as phalsa needs regular pruning of previous season shoots. Similar findings were also reported by Singh *et al*., (1979) in grapes and Bhatia and Yadav (2005) in ber.

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