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EFFECT OF SOIL AND FOLIAR APPLICATION OF ZINC ON FRUIT SET, FRUIT RETENTION, FRUIT DROP, FRUIT CRACKING, QUALITY AND YIELD OF LITCHI CV. DEHRADUN

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ABSTRACT

A field experiment was conducted during 2005 and 2006 at Regional Horticultural Research Station, Jachh, Kangra and in Department of Pomology, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan (H.P.). Fruit nutrition plays an important role in overall productivity of plants and determination of nutritional needs of fruit crops. In order to meet out the nutritional requirements of the fruit trees, soil and foliar application were tried in litchi cv. Dehradun. Fruit trees sprayed with 1.0 per cent zinc sulphate in mid February and first week of May at pit hardening stage showed highest fruit set (109.20), fruit retention (21.96%), fruit yield (25.28 kg/tree), lowest fruit drop (78.04%) and minimum fruit cracking (13.91).

Key words : *Zinc, fruit set, retention, cracking, Dehradun, litchi*

The Litchi (*Litchi chinensis* Sonn) is an important sub-tropical evergreen fruit crop grown in the foothills of Himachal Pradesh. It is highly specific to climatic requirements and due to this reason its cultivation is restricted to few countries in the world. Despite the fact that the litchi is one of the finest fruit and has a strong growing demand in national and international markets, productivity continues to be low.

Fruit nutrition plays an important role in overall productivity of plants and determination of nutritional needs of fruit crops. In various biotic and abiotic factors, nutritional deficiencies especially of zinc has been reported as one of the reason for poor fruit set, high percentage of fruit cracking and fruit drop by (1). Moreover, widespread deficiencies of zinc were pointed by (2) in the litchi growing areas of Himachal Pradesh.

The key to the mineral nutrition of any orchard is the judicious application of fertilizers on the basis of leaf and soil analysis. The determination of nutritional need of crop is an important aspect of nutrient management for the orchardist and leaf analysis has been widely used as an analytical tool in understanding the nutritional requirements (3). In order to meet out the nutritional requirements of the fruit trees, soil and foliar application plays an important role, but their efficacy differ significantly, through their mobility in soil and plants. No doubt many workers have reported that foliar and soil application of nutrient elements improve fruit set, retention, yield and reduce the extent of fruit cracking, but the results are inconsistent. Hence, the present study was made to evolve the optimum dose of zinc on improving fruit set, retention, yield, quality and reducing cracking of litchi cv. Dehradun.

MATERIALS AND METHODS

The present investigations were undertaken in the experimental orchard of the Regional Horticulture Research Station, Jachh, Kangra, Himachal Pradesh, during 2005 and 2006. The experimental area is located at an elevation of 428 m amsl and lies at 32o18' N latitude and 75o55' E longitude, experiencing an average annual rainfall of about 1500 mm. The orchard soil was sandy loam to clay and pH varied from 6.5 to 7.5.

For nutrient application Zinc Sulphate was applied as foliar application at the rate of 0.6, 0.8 and 1.0 percent in Mid February (Pre bloom application) and secondly, in first week of May at pit hardening stage. However soil applications of zinc sulphate were made at the rate of 100 g, 150 g and 200 g/tree in mid February. Another treatment of grass mulch along with untreated control was also incorporated to observe the effect of soil moisture conservation on fruit set, retention, fruit drop, fruit cracking and yield of litchi cv. Dehradun. The leaf and soil samples were collected in last week of March and again in 2nd week of June (at the time of fruit harvesting). The experiment was conducted in randomized block design with three replications under rainfed conditions.

Number of fruits per panicle was counted on the tagged branches in second week of April and average

Table-1: Effect of soil and foliar application of zinc on fruit set, fruit retention, fruit drop, fruit cracking and yield of litchi cv. Dehradun.

Treatments	Fruit set (Number of fruits/panicle)			Fruit retention (%)			Fruit drop (%)			Fruit cracking (%)			Yield (kg/plant)		
	2005	2006	Pooled	2005	2006	Pooled	2005	2006	Pooled	2005	2006	Pooled	2005	2006	Pooled
T_1 = Control	67.67	35.67	51.67	19.43 (4.41)	28.75 (5.36)	24.09 (4.91)	22.30	5.29	13.79	9.29 (3.05)	7.05 (2.66)	8.17 (2.86)	90.71 (72.26)	92.95 (74.60)	91.83 (73.39)
T_2 = 0.6% $ZnSO_4$	98.00	64.33	81.17	12.36 (3.52)	23.14 (4.81)	17.75 (4.21)	23.80	8.26	16.03	17.49 (4.18)	13.67 (3.70)	15.58 (3.95)	82.51 (65.29)	86.33 (68.32)	84.42 (66.76)
T_3 = 0.8% $ZnSO_4$	106.70	79.00	92.83	11.34 (3.37)	19.73 (4.44)	15.54 (3.94)	28.60	10.27	19.43	19.82 (4.45)	14.38 (3.79)	17.10 (4.14)	80.18 (63.57)	85.62 (67.72)	82.90 (65.58)
T_4 = 1.0% $ZnSO_4$	125.00	93.33	109.20	9.96 (3.15)	17.86 (4.22)	13.91 (3.73)	36.70	13.86	25.28	25.40 (5.04)	18.52 (4.30)	21.96 (4.69)	74.60 (59.38)	81.48 (64.53)	78.04 (63.06)
T_5 = 100 g/tree $ZnSO_4$	91.33	67.33	79.33	17.33 (4.16)	24.73 (4.97)	21.03 (4.58)	24.80	8.11	16.45	16.09 (4.01)	11.27 (3.35)	13.68 (3.70)	83.91 (66.36)	88.73 (70.42)	86.32 (68.30)
T_6 = 150 g/tree $ZnSO_4$	78.00	48.67	63.34	13.70 (3.70)	23.78 (4.88)	18.74 (4.33)	22.40	7.23	14.81	14.06 (3.75)	10.31 (3.21)	12.19 (3.49)	85.94 (68.00)	89.69 (71.29)	87.82 (69.59)
T_7 = 200 g/tree $ZnSO_4$	85.00	58.00	71.50	16.31 (4.04)	24.10 (4.90)	20.21 (4.49)	24.20	8.15	16.17	11.43 (3.38)	11.40 (3.37)	11.42 (3.38)	88.57 (70.25)	88.60 (70.28)	88.59 (70.26)
T_8 = Grass Mulch	75.00	51.67	63.34	10.59 (3.25)	18.25 (4.27)	14.42 (3.80)	26.40	7.51	16.95	13.62 (3.69)	12.62 (3.55)	13.12 (3.62)	86.38 (68.35)	87.38 (69.19)	86.88 (68.77)
CD = 0.05	17.99	11.03	12.70	0.21	0.40	0.23	3.15	0.79	1.63	0.24	0.27	0.12	1.51	1.67	0.77

* Figures in the parentheses are square root and arc sine transformed values

fruit set were worked out per replicate. Subsequently average fruit set (number) per panicle for treatment was calculated. The total number of fruits retained on the tagged branches was counted at the time of harvest and the percentage of fruit retained was calculated on the basis of total number of fruits at the time of fruit set. Fruit retention (%) = Number of fruits at harvest x 100/ Number of fruit set. Percent fruit drop was worked out by subtracting, percent fruit retention from 100 and average was worked out. At maturity, the total numbers of cracked and uncracked fruits in ten selected branches per tree were counted and data were expressed in percent. Fruit cracking was worked out as per the formula given below Fruit Cracking (%) = Number of cracked fruits on tagged branches x 100/ Total number of fruits on tagged branches. At the time of harvest, all the fruits from each replication were weighed on top pan balance and production was expressed kg/tree. Five fruits from each replication were weighed on electronic balance. Subsequently, average fruit weight was calculated and expressed in g. Aril % was calculated on the basis of fruit weight and aril weight. Aril (%) = Aril weight x 100/ fruit weight

RESULTS AND DISCUSSION

Fruit set : Foliar application of 1.0 per cent zinc sulphate (T_4) recorded highest fruit set (109.20) as compared to other treatments (Table-1). Similar results were reported by (4). Increase in the fruit set with zinc sulphate has also been observed by (5). Higher fruit set by zinc application might be due to its effect on processes of fertilization and hormonal metabolism. Zinc is known to be essential for auxin synthesis (IAA), as it is an activator of enzyme Tryptophan Synthetase.

Fruit retention : In litchi, there is a major problem of fruit drop after pollination. However, maximum (21.96%) fruit retention at harvest was observed with foliar sprays of 1.0 per cent zinc sulphate (Table-1). The present findings are in confirmed by (6), who reported that foliar application zinc sulphate results in higher fruit retention, when compared with control. These results also found support from (5), who also reported similar results in litchi plants, when sprayed with zinc sulphate. The probable reason for greater number of fruit retention probably be the production of natural growth substance in the plant itself, with

Table-2: Effect of soil and foliar application of zinc on fruit weight, percent aril, total soluble solids, acidity and sugars of litchi cv. Dehradun

Treatments	Fruit weight (g)			Percent aril (%)			TSS (°B)			Acidity (%)			Reducing sugars (%)			Non-reducing sugars (%)			Total sugars (%)		
	2005	2006	Pooled	2005	2006	Pooled	2005	2006	Pooled	2005	2006	Pooled	2005	2006	Pooled	2005	2006	Pooled	2005	2006	Pooled
T_1 = Control	15.47	15.27	15.37	0.61 (0.78)	0.68 (0.82)	0.64 (0.80)	8.77 (2.96)	8.12 (2.85)	8.44 (2.91)	4.75 (2.18)	4.61 (2.15)	4.68 (2.16)	13.77 (3.71)	12.97 (3.60)	13.37 (3.66)	56.81 (48.92)	57.39 (49.25)	57.10 (49.08)	16.40	15.80	16.10
T_2 = 0.6% ZnSO4	16.43	16.80	16.62	0.53 (0.73)	0.44 (0.67)	0.49 (0.70)	9.27 (3.05)	10.25 (3.20)	9.76 (3.12)	4.75 (2.18)	4.71 (2.17)	4.73 (2.18)	14.27 (3.78)	15.21 (3.90)	14.74 (3.84)	60.29 (50.94)	61.22 (51.48)	60.75 (51.21)	17.20	18.10	17.65
T_3 = 0.8% ZnSO4	14.87	15.40	15.13	0.49 (0.70)	0.43 (0.65)	0.46 (0.68)	9.31 (3.05)	10.50 (3.24)	9.91 (3.15)	4.86 (2.21)	4.63 (2.15)	4.75 (2.18)	14.43 (3.80)	15.37 (3.92)	14.90 (3.86)	56.23 (48.58)	57.75 (49.46)	56.99 (49.02)	17.60	18.30	17.95
T_4 = 1.0% ZnSO4	15.67	15.90	15.78	0.45 (0.67)	0.40 (0.63)	0.42 (0.65)	9.73 (3.12)	11.01 (3.31)	10.37 (3.22)	5.26 (2.29)	4.59 (2.14)	4.93 (2.22)	15.27 (3.91)	15.84 (3.98)	15.55 (3.94)	58.50 (49.90)	59.08 (50.23)	58.79 (50.06)	18.20	18.60	18.40
T_5 = 100 g/tree ZnSO4	15.50	15.00	15.25	0.62 (0.79)	0.54 (0.74)	0.58 (0.76)	8.61 (2.93)	9.27 (3.04)	8.94 (2.99)	4.71 (2.17)	4.62 (2.15)	4.68 (2.16)	13.57 (3.68)	14.13 (3.76)	13.85 (3.72)	58.04 (49.63)	56.67 (48.83)	57.35 (49.23)	16.40	17.10	16.75
T_6 = 150 g/tree ZnSO4	15.27	14.87	15.07	0.60 (0.77)	0.53 (0.73)	0.56 (0.75)	8.87 (2.98)	9.55 (3.09)	9.21 (3.04)	4.61 (2.15)	4.55 (2.13)	4.58 (2.14)	13.83 (3.72)	14.34 (3.79)	14.08 (3.75)	57.41 (49.27)	56.24 (48.59)	56.83 (48.93)	16.60	17.30	16.95
T_7 = 200 g/tree ZnSO4	15.80	15.50	15.65	0.58 (0.76)	0.52 (0.72)	0.55 (0.74)	8.73 (2.95)	9.41 (3.07)	9.07 (3.01)	4.71 (2.17)	4.71 (2.17)	4.71 (2.17)	13.79 (3.71)	14.37 (3.79)	14.08 (3.75)	58.86 (50.10)	58.04 (49.63)	58.45 (49.86)	16.60	17.40	17.00
T_8 = Grass Mulch	16.00	16.20	16.10	0.57 (0.76)	0.52 (0.72)	0.55 (0.74)	9.05 (3.01)	9.27 (3.05)	9.16 (3.03)	4.73 (2.18)	4.74 (2.18)	4.74 (2.18)	14.03 (3.75)	14.27 (3.78)	14.15 (3.76)	59.37 (50.40)	59.77 (50.63)	59.57 (50.52)	16.80	17.30	17.05
CD0.05	0.60	1.01	0.66	0.04	0.05	0.03	0.07	0.17	0.11	0.07	0.02	0.04	0.04	0.11	0.06	1.00	0.65	0.65	0.50	0.75	0.50

* Figures in the parentheses are square root and arc sine transformed values

application of zinc, which inhibits the formation of abscission layer.

Fruit drop : Under favorable climatic conditions in the litchi growing areas, litchi plants flower profusely, but only 2 to 4.5 per cent of the total fruit set in different varieties is carried to maturity. The rest drops during the period of fruit development, the peak being just after the fruit set. Apart from the competition among fruits for water and nutrients and other physiological causes, strong winds during the period of fruit development also contribute significantly to fruit drop.

The data recorded in Table-1 shows that minimum fruit drop (78.04%) was found in the treatments of 1.0 per cent in zinc sulphate applied at pre-bloom and 1st week of May at pit hardening stage, when compared over control (91.83%). These findings are in consonance with (7), who recorded minimum fruit drop in litchi with 1.0 per cent zinc sulphate as foliar application. Present finding are also in conformity with those of (8), who found lowest fruit drop in litchi fruit trees, when sprayed with zinc sulphate. Reduction in fruit drop by zinc sulphate sprays can be attributed to the role of zinc in auxin synthesis that delayed the formation of abscission layer during early stages of fruit development (9).

Fruit cracking : Fruit cracking is observed as main constraint of Dehradun cultivar of litchi, in our area, which makes the fruit unfit for marketing, causing great economic losses to orchardists. It is clear from the perusal of the data presented in Table-1 that fruit cracking percentage in all the treatments was significantly less as compared to control but the maximum reduction (13.91%) in fruit cracking was observed in plants treated with 1.0 per cent zinc sulphate and grass mulch (T8). These results are in harmony with those of (7) who reported from their findings that foliar application of zinc has significantly reduced the fruit cracking in litchi, which might be due to the fact that zinc in adequate amount is known to maintain auxin in active state (9), which result in rapid cell multiplication and maintain elasticity. However, litchi plants mulched with farm residue helped in conserving the soil moisture, which significantly reducing the fruit cracking. Reduced fruit cracking with grass mulching (T_8), attributed to adequate soil moisture during early period of fruit growth, as this made the skin of the fruit elastic and cope with the

internal pressure due to growth of aril during dry period (10).

Yield : Significantly higher fruit yield was observed (Table-1) with treatment of 1.0 per cent zinc sulphate as foliar application, when compared to control. These results are in consonance with those of (11), which might be due to higher fruit retention or increased uptake of nutrients and enhanced translocation of sugar and metabolites (12).

Fruit quality : Data related to fruit quality attributes presented in Table-2 shows that maximum fruit weight and per cent aril was obtained in the fruits treated with 0.6 per cent zinc sulphate. However, maximum total soluble solids (TSS), reducing sugar, non-reducing sugars, total sugars and minimum acidity was observed in the fruits treated with 1.0 per cent zinc sulphate as foliar application. The present findings are in line with those of (6, 7), who reported that different treatments of zinc sulphate are quite effective in improving the quality attributes in litchi fruits. The possible reason for increase in fruit weight and per cent aril might be due to faster loading and mobilization of sugars into fruits and increased value of intercellular spaces in the pulp. Increase in total soluble solids may be due to quick metabolic transformation of starch and pectin into soluble compounds and rapid translocation of sugars from leaves to the developing fruits. However, the increase in total and non-reducing sugars can be attributed to the accumulation of oligosaccharides and polysaccharides in higher amount. The reduced acid content under the influence of foliar application of zinc sulphate might be due to fastly conversion of acids into sugars and their derivatives by reactions involving reversal or glycolytic pathway (13).

CONCLUSION

On the basis of the result obtained in the present studies, it can be concluded that foliar application of zinc sulphate applied at the rate of 1.0 per cent in mid February and first week of May at pit hardening stage, found effective in improving fruit set, fruit retention, fruit quality, yield and minimizing fruit cracking in litchi cv. Dehradun.

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