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Short communication

Effect of regulated irrigation and calcium sprays on fruit yield and quality of Dehradun litchi

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ABSTRACT

An experiment was conducted to study the effect of calcium sprays on yield and quality of litchi cv. Dehradun under regulated irrigation. Trees were subjected to regulated irrigations at 3, 6, 9 and 12 days intervals and were sprayed with $CaCl_2$ @ 1, 1.5 and 2% concentration and compared with irrigation at 3 days interval without any $CaCl_2$ spray. Fruit set (38.67%), fruit volume (18.71 cm^3), fruit firmness (3.29 kg/ cm^2) and fruit yield (13.27 qts/acre) were found to be maximum in trees irrigated at 6 days intervals and sprayed with 2% $CaCl_2$ (T_4) with highest benefit: cost ratio (1.55).

Key words: *Litchi chinensis*, Calcium chloride, Fruit set, Fruit volume, fruit firmness.

Litchi (*Litchi chinensis* Sonn.) occupies prime place of importance amongst the fruit crops. It is a popular fruit of family Sapindaceae (Haq *et al.,* 3). It is an arillate fruit with sweet, translucent and juicy flesh. It is highly specific to climatic requirement and probably its cultivation is restricted to a few countries. It is highly sensitive to water deficit, which aggravates the fruit cracking and shortens the post-harvest life. Litchi requires optimum soil moisture for its optimum growth, development and fruit production. An average litchi plant requires 600-800 mm water, but the water requirement may vary with plant age or size as well as seasons (Spohrer *et al*., 8). The vegetative and reproductive growth can be manipulated by irrigation and nutrient management. Several attempts have been made to standardize nutrient and water requirement of litchi tree in India. Irrigation intervals affect physico-chemical quality attributes and fruit cracking in litchi. At early stage of litchi growth there is initiation of cracking of pericarp. Fruit cracking is enhanced by hot dry winds, low relative humidity, high temperature, lack or excessive irrigation. Calcium is structural component of cell wall. In litchi fruit calcium participates in cracking resistance because trees having higher calcium levels shows lower cracking incidence while low exchangeable calcium in plants results in high cracking incidence (Li *et al.,* 5). Thus, calcium related physiological disorders can be decreased by the foliar application of calcium on the fruit. Present investigation was undertaken to find out best combination of irrigation interval and calcium concentration to optimize fruit yield and quality of litchi with less irrigation.

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Study was conducted on 20-year old litchi trees of cv. Dehradun. Trees of uniform vigour and size, maintained under uniform cultural practices growing at the Research Farm, Division of Fruit Science, FoA Udheywalla, SKUAST-Jammu during 2013 were selected for the study. . The experiment was laid out in Randomised Block Design with ten treatments each replicated thrice with single tree as unit per treatment with following combinations: T_1 = Irrigation at 3 day interval (control), T_2 = Irrigation at 6 days interval +1 % $CaCl_2$, T_3 =Irrigation at 6 days interval +1.5 % $CaCl_2$, T_4 = Irrigation at 6 days interval +2 % $CaCl_2$, T_5 = Irrigation at 9 days interval +1 % $CaCl_2$, T_6 = Irrigation at 9 days interval +1.5 % $CaCl_2$, T_7 = Irrigation at 9 days interval +2 % $CaCl_2$, T_8 = Irrigation at 12 days interval +1 % $CaCl_2$, T_9 =Irrigation at 12 days interval +1.5 % $CaCl_2$, T_{10} = Irrigation at 12 days interval +2 % $CaCl_2$. Pre-harvest sprays of calcium chloride salt at 1, 1.5 and 2 per cent. $Cacl_2$ was given at fruit set stage and at 21 days intervals thereafter till harvest and with spray volume of 7 litres $plant^{-1}$. The control plants were sprayed with water alone. Mature fruits under various treatments were harvested at the same time and were analyzed for physiological and yield parameters and economics of various treatment was calculated. Data was analyzed by the method given by Panse and Sukhatme (7) by using two factor randomized block design.

There were significant differences among the treatments of calcium chloride application along with irrigation intervals on fruit yield of litchi cv. Dehradun. The data on effect of various treatments on fruit retention and fruit yield of litchi are presented

Table 1. Effect of irrigation intervals and calcium sprays on fruit set (%), fruit yield (q/ac), fruit volume (cm^3) and fruit Firmness (kg/cm^2) of Dehradun Litchi.

Treatments	Fruit retention	Fruit yield	Fruit volume	Fruit firmness
T_1 (Irrigation at 3 days interval [control])	24.29	10.67	14.76	2.66
T_2 (Irrigation at 6 days interval +1 % $CaCl_2$)	32.36	12.31	16.31	2.82
T_3 (Irrigation at 6 days interval +1.5 % $CaCl_2$)	33.09	12.59	17.12	2.87
T_4 (Irrigation at 6 days interval +2 % $CaCl_2$)	38.67	13.27	18.71	3.29
T_5 (Irrigation at 9 days interval +1 % $CaCl_2$)	30.28	10.70	14.12	2.65
T_6 (Irrigation at 9 days interval +1.5 % $CaCl_2$)	31.48	10.82	14.17	2.72
T_7 (Irrigation at 9 days interval +2 % $CaCl_2$)	32.27	11.13	14.47	2.78
T_8 (Irrigation at 12 days interval +1 % $CaCl_2$)	20.63	9.36	11.87	2.44
T_9 (Irrigation at 12 days interval +1.5 %$CaCl_2$)	21.53	9.58	12.57	2.52
T_{10} (Irrigation at 12 days interval +2 % $CaCl_2$)	22.35	9.81	13.36	2.55
C.D at 5%	1.60	0.53	0.96	0.018

Total no. of irrigations: At 3 days interval-25; At 6 days interval-14; At 9 days interval- 11; At 12 days interval-8
Total no. of sprays of $cacl_2$: 4 no's

in Table 1. It is indicated that all the treatments exerted a significant influence on fruit retention and fruit yield. Maximum fruit retention (38.67 %) and fruit yield (13.27 quintal/acre) were observed in tress irrigated at 6 days interval and sprayed with 2% $CaCl_2$ (T_4) followed by T_3 (irrigation at 6 days interval + 1.5 % $CaCl_2$) i.e 33.09 % and 12.59 q/ac while minimum fruit retention (20.63%) and fruit yield (9.36 quintal/acre) was found in T_8 (irrigation at 12 days interval +1% $CaCl_2$ which was significantly lower than control i.e. 24.29 % and 10.67 quintal/acre of fruit retention and fruit yield, respectively. These results are in agreement with the findings of Batten *et al.* (1) who also reported that water deficits experienced by the unirrigated trees significantly reduced fruit drop in litchi. This may have been due to suppression of vegetative growth due to irrigation which ultimately increases fruit retention and yield in trees irrigated at 6 days interval and spray with 2% $CaCl_2$.

The maximum fruit volume of 18.71 cm^3 was recorded in irrigation at 6 days interval and spray with $CaCl_2$ 2% followed by irrigation at 6 days interval and spray with $CaCl_2$ 1.5% i.e., 17.12 cm^3. Minimum value was recorded in irrigation at 12 days interval and spray with $CaCl_2$ 1% i.e., 11.87 which was even lower than control (14.76 cm^3). With the increase in irrigation interval from 3 to 6 days fruit volume of litchi fruit also increased. The present study also inconsonance with the findings of Miller *et al.* (6). Maximum fruit firmness of 3.29 kg/cm^2 was observed in irrigation at 6 days interval and spray with 2 % $CaCl_2$ followed by irrigation at 6 days interval and spray with 1.5% $CaCl_2$ i.e., 2.87 kg/cm^2 which was significantly higher than control (2.66 kg/cm^2). Irrigation at 12 days interval and spray with 1% $CaCl_2$ showed least firmness i.e 2.44 kg/cm^2. The beneficial effect of calcium on firmness of fruits is due to thickening of middle lamella of fruit cell wall owing to increased formation and deposition of calcium pectate (Gupta *et al*., 2).

Average cost of cultivation of litchi using calcium chloride and irrigation under different treatments are given in Table 2. The lowest cost of cultivation (Rs 61,334.00) was recorded with treatment having irrigation at 12 days interval and application of 1% $CaCl_2$, while the highest cost of cultivation was in control (Rs 103533.66), followed by treatment comprising application of 1% $CaCl_2$ and irrigation at 12 days interval (Rs 82,975.66). Although there was higher cost of production associated with the application of 1% $CaCl_2$ and irrigation at 12 days interval but the price realisation in terms of per kg fruit was higher resulting in the highest gross returns per plant and per ha basis.

Benefit: cost ratio was found maximum in the treatment comprising of 2 % $Cacl_2$ and irrigation at 6 day interval (1.55) and minimum (0.64) in irrigation at 3 day interval (Table 3). This may be attributed to higher yields and superior quality of fruits with different calcium spray and irrigation treatments. These results are in confirmation with the results obtained by Kharwade *et al*. (4).

In conclusion, the present study showed that if litchi is sprayed with 2% $CaCl_2$ better fruit yield and quality can be obtained even with less irrigation thereby, optimizing the use of precious input and this treatment gave highest cost benefit ratio (1.55)

Table 2. Average cost of cultivation of litchi using calcium chloride and irrigations.

S. No.	Items	(T_1)	(T_2)	(T_3)	(T_4)	(T_5)	(T_6)	(T_7)	(T_8)	(T_9)	(T_{10})
A.	Cost of inputs										
a)	Cost of FYM (₹)	90.00	90.00	90.00	90.00	90.00	90.00	90.00	90.00	90.00	90.00
b)	Cost of Urea (₹)	24.57	24.57	24.57	24.57	24.57	24.57	24.57	24.57	24.57	24.57
c)	Cost of DAP (₹)	68.10	68.10	68.10	68.10	68.10	68.10	68.10	68.10	68.10	68.10
d)	Cost of MOP (₹)	17.07	17.07	17.07	17.07	17.07	17.07	17.07	17.07	17.07	17.07
e)	Cost of calcium chloride (₹)	-	97.44	146.16	194.88	97.44	146.16	194.88	97.44	146.16	194.88
	Total cost of inputs (A)	199.74	297.18	345.90	394.62	297.18	345.90	394.62	297.18	345.90	394.62
B.	Operational cost										
a)	Cost of basin preparation	82.41	82.41	82.41	82.41	82.41	82.41	82.41	82.41	82.41	82.41
b)	Cost of irrigation (₹)	2299.12	1287.51	1287.51	1287.51	1011.61	1011.61	1011.61	735.72	735.72	735.72
c)	Tagging	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
d)	Weeding	329.65	329.65	329.65	329.65	329.65	329.65	329.65	329.65	329.65	329.65
e)	Fertilizer application	41.47	41.47	41.47	41.47	41.47	41.47	41.47	41.47	41.47	41.47
f)	Calcium chloride application	-	199.99	199.99	199.99	199.99	199.99	199.99	199.99	199.99	199.99
g)	Harvesting	123.62	123.62	123.62	123.62	123.62	123.62	123.62	123.62	123.62	123.62
	Total operational cost (B)	2906.27	2094.65	2094.65	2094.65	1818.75	1818.75	1818.75	1542.86	1542.86	1542.86
C.	Total cost (₹) C=(A+B)	3106.01	2391.83	2440.55	2489.27	2115.93	2164.65	2213.37	1840.04	1888.76	1937.48
D.	Total cost/plant (₹)	1035.33	797.27	813.51	829.75	705.31	721.55	737.79	613.34	629.58	645.82
E.	Total cost /ha (₹)	103533.66	79727.66	81351.66	82975.66	70531.00	72155.00	73779.00	61334.00	62958.00	64582.00

Table 3. Effect of calcium chloride and irrigation on Benefit cost ratio of litchi.

Treatments	Average yield of Litchi kg/tree	Rate/kg fruit (₹)	Gross return (₹)	Gross return/ha (₹)	Cost of cultivation (B) (₹)	Net return C=(A-B) (₹)	Benefit : cost ratio (C/B)
T_1 (Irrigation at 3 days interval [control])	42.70	40	1708.00	170800.00	103533.66	67266.34	0.649
T_2 (Irrigation at 6 days interval +1 % $CaCl_2$)	49.27	40	1970.80	197080.00	79727.66	117352.34	1.471
T_3 (Irrigation at 6 days interval +1.5 % $CaCl_2$)	50.36	40	2014.40	201440.00	81351.66	120088.34	1.476
T_4 (Irrigation at 6days interval +2 % $CaCl_2$)	53.09	40	2123.60	212360.00	82975.66	129384.34	1.559
T_5 (Irrigation at 9 days interval +1 % $CaCl_2$)	42.83	35	1499.05	149905.00	70531.00	79374.00	1.125
T_6 (Irrigation at 9 days interval +1.5 % $CaCl_2$)	43.31	35	1515.85	151585.00	72155.00	79430.00	1.100
T_7 (Irrigation at 9 days interval +2 % $CaCl_2$)	44.54	35	1558.9	155890.00	73779.00	82111.00	1.112
T_8 (Irrigation at 12 days interval +1 % $CaCl_2$)	37.45	30	1123.50	112350.00	61334.00	54761.00	0.892
T_9 (Irrigation at 12 days interval +1.5 %$CaCl_2$)	38.33	30	1149.90	114990.00	62958.00	55865.00	0.887
T_{10} (Irrigation at 12 days interval +2 % $CaCl_2$)	39.26	30	1177.80	117780.00	64582.00	57124.00	0.888

as compared to other treatments. This practice will result into increased on-farm crop water utilization and better fruit quality with less irrigation thereby conserving water and litchi can be produced with 4 sprays of 2% $CaCl_2$ with 14 irrigation i.e. 11 less irrigations than recommended.

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