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Effect of mulching and irrigation interval on fruit quality and yield of litchi cv. Dehradun

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ABSTRACT

A study was conducted at the Research Farm, Division of Fruit Science, FOA Udheywalla, SKUAST, Jammu on 20-year-old trees of litchi cv. Dehradun. Trees were subjected to mulching with different types of materials (black polythene and paddy straw) and supplied with controlled irrigations @ 200 l/ tree at 3, 6 and 9 day intervals. Results revealed that the trees supplied with irrigation at 6 day interval and mulched with black polythene (T_8) showed least fruit cracking (10.15%) and maximum fruit yield (59.33 kg/tree). Fruit weight (18.27 g), fruit length (3.28 cm), fruit diameter (2.92 cm), pulp weight (10.45 g) and fruit firmness (2.51 kg/cm^2) were also found to be maximum in trees mulched with black polythene and irrigated at 6 day interval with highest benefit: cost ratio (2.77:1).

Key words: Litchi, mulching, irrigation, fruit cracking, yield.

INTRODUCTION

Litchi (*Litchi chinensis* Sonn.) is one of the important sub-tropical evergreen fruit tree and belongs to family Sapindaceae. Litchi is highly sensitive to water deficit, which aggravates the fruit cracking and shortens the post-harvest life. Further complexities in optimizing irrigation emerge due to different cultivars, plant sizes, and fruit developmental stages (Khurshid *et al*., 6). 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. Dehradun is an early variety of litchi, which matures in the 2nd week of June. Despite of its good qualities the litchi is severely affected by cracking, which drastically reduces the yield. General practice adopted by litchi growers is to avoid fruit cracking is by over irrigation. Due to climate change and dwindling water resources Indian Agriculture is suffering from water scarcity, thus the practice of over and excessive irrigation must be discouraged and irrigation requirements of individual fruit crops need to be optimized specially for the water sensitive crops like litchi. Thus, the present investigation was undertaken to study the effect of controlled irrigation at fixed intervals combined with an established practice of water conservation, *i.e.* mulching on yield and fruit quality of litchi.

MATERIALS AND METHODS

An experiment 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 2014-15 were selected for the study. The experimental site is situated at 32.73°N latitude and 74.87°E longitude at an elevation of 327 m from msl. Annual precipitation is about 1200 mm and about 70 percent of the rains are received during July to October. The annual mean maximum and minimum temperatures were 29.6° and 16.7°C, respectively. Summer months are hot with temperature and relative humidity ranging from 23.5° to 35.5°C and 53.0 to 73.5 per cent, respectively. The winter months experience mild to severe cold with average temperature ranging from 6.5° to 21.7°C. December is the coldest month, when minimum temperature reaches to 4.0°C. The highest temperature is recorded in the month of June (45.0°C). The daily maximum and minimum temperature and evaporation rate rise from March onwards. The soil type was sandy clay loam with pH 6.7, electrical conductivity 0.20 (dS m^{-1}) and 0.51% organic carbon. The soil had available nitrogen 225.5 (kg ha^{-1}), phosphorus 13.84 (kg ha^{-1}) and potassium 138 (kg ha^{-1}).

The treatment imposed were, T_1 = Irrigation at 3 day interval (control), T_2 = Irrigation at 6 day interval, T_3 = Irrigation at 9 day interval, T_4 = Paddy straw mulch + irrigation at 3 day interval , T_5 = Paddy straw mulch + irrigation at 6 day interval, T_6 = Paddy straw mulch + irrigation at 9 day interval , T_7 = Black polythene mulch + irrigation at 3 day interval, T_8 = Black polythene mulch + irrigation at 6 day interval, T_9 = Black polythene mulch + irrigation at 9 day

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interval. Irrigation at 3 day interval was taken as control because it is the farmers practice in the region and is recommended by SKUAST-J. Total number of treatments taken was 9 and each treatment was replicated thrice. Selected trees were subjected to mulching with two types of materials (black polythene and paddy straw) and controlled irrigation @ 200 l/ tree at 3, 6 and 9 intervals. Regulated irrigations were applied from the fruit set till harvesting by applying measured water @ 200 l/ tree/ irrigation in the basin (rainfall was not taken into account).

Fruit set (%) and fruit cracking (%) were recorded on the selected tagged branches. Eight branches in each tree were randomly selected and tagged for recording data. Observations were recorded on fruit weight (g), fruit length (cm), fruit diameter (cm), pulp weight (g) and fruit firmness (kg/ cm^2). Fruit weight was measured by electronic balance and expressed in g. Fruit length (cm) and fruit diameter (cm) were measured using Vernier calipers. Pulp weight was obtained by subtracting the seed weight + peel weight from the total fruit weight and was expressed in g. The fruit firmness (kg/ cm^2) was determined by a pressure tester (penetrometer). Yield was recorded as yield per tree and expressed in kg/ tree. The economics of using different mulching materials and irrigation intervals in litchi orchard of cv. Dehradun have been worked out by calculating net returns for each treatment. Data was analysed by the method given by Panse and Sukhatme (7) by using two factor randomized block design.

RESULTS AND DISCUSSION

A significant response of application of mulch along with irrigation at 6 day interval on fruit cracking was observed over other treatments. Results revealed that on overall basis trees irrigated at 6 day interval and mulched with black polythene mulch (T_8) showed least fruit cracking (10.15%) and had the highest yield (59.33 kg /plant) compared to control. Whereas, T_9 (black polythene mulch + irrigation at 9 day interval) showed highest fruit cracking (22.53%), and lowest yield (42.60 kg /plant). Increased fruit yield in T_8 (6 day irrigation interval + black polythene mulching) could be attributed to induction of mild water stress due to increase in irrigation interval from 3 to 6 day and further significant decrease in fruit yield when irrigation interval was further increased to 9 day must be because of severe water stress. On mean value basis, irrigation at 3 day interval showed the minimum fruit cracking (13.26%) and was at par with irrigation at 6 day interval and black polythene mulch in terms of fruit yield (54.89%) (Table 1). On mean value basis, black polythene mulch was significantly effective in controlling fruit cracking (14.35%) and gave the maximum yield (53.48 kg/ plant). All the interactions were also found to be significant. These findings are supported by the work of Southwick (13) who stated the relationship between stress severity and the flowering response, however, when water stress is severe, flower disorders induce a heavy drop. Alaoui *et al*. (1) studied the impact assessment of deficit irrigation on yield and fruit quality in peach reported that higher yield and good quality can be obtained with less irrigation water and adequate frequency. A significant reduction of fruit cracking was recorded, as mulching and mild water stress are significantly effective in reducing fruit cracking in litchi. These results are in conformity with the findings of Joshi *et al*. (5) who reported that mulching helps to reduce the fluctuation in soil moisture in the cv. Rose Scented. Sandhu and Bal (12) worked on the effect of mulching and irrigation treatments on fruit cracking in Baramasi lemon and reported that use of black polythene mulch and irrigation intervals change the microclimate of the trees. Bal and Singh (4) working on the effect of

Table 1. Effect of mulching and irrigation interval on fruit cracking and yield in litchi cv. Dehradun.

Irrigation interval	Fruit cracking (%)				Fruit yield (kg/ tree)			
	No mulch	Paddy straw	Black polythene	Mean	No mulch	Paddy straw	Black polythene	Mean
3 day (control)	15.05	14.38	10.36	13.26	52.34	53.82	58.51	54.89
6 day	18.29	13.29	10.15	13.91	50.91	54.34	59.33	54.86
9 day	21.30	19.05	22.53	20.96	44.64	49.67	42.60	45.57
Mean	18.21	15.57	14.35		49.29	52.61	53.48	
CD at 5%								
Factor (A)		0.25				0.44		
Factor (B)		0.25				0.44		
Factor (A × B)		0.44				0.76		

mulching material on yield of *ber* reported that plants under black polythene mulch gave the maximum yield because of increased availability of soil moisture and control of weed growth. Similarly, Bakshi *et al*. (3) evaluated the effect of mulching material on yield of strawberry and reported that maximum yield per plant was under black polythene because of larger fruit owing to better hydrothermal regime of soil and complete weed-free environment. Various physical characteristics, *viz.*, fruit weight, fruit length, fruit diameter, pulp weight and fruit firmness significantly decreased when irrigation interval was increased without mulching. Reza *et al.* (11) while studying the effect of irrigation on fruit weight of litchi also reported that among the three irrigation treatments, *viz.*, No irrigation (I_0), one irrigation (I_1) and two irrigations (I_2), the maximum fruit weight was observed in I_2 followed by I_1 and I_0 days. However, when irrigation intervals were coupled with mulching all the physical characteristics recorded increase up to 6 day irrigation interval.

On overall basis, maximum fruit weight (18.27 g), fruit length (3.28 cm), fruit diameter (2.92 cm), pulp weight (10.45 g) and fruit firmness (2.51 kg/ cm^2) were observed in trees mulched with black polythene and irrigated at 6 day interval as compared to control. Whereas, minimum fruit weight (13.88 g), fruit length (2.60 cm), fruit diameter (2.38 cm), pulp weight (8.58 g) and fruit firmness (1.07 kg/cm^2) was found to be in treatment T_9 (black polythene mulch + irrigation at 9 day interval) (Tables 2 & 3). On mean value basis, irrigation at 3 and 6 day intervals were at *par* with each other in terms of fruit weight (17.33 and 17.44 g, respectively), fruit length (3.12 and 3.10 cm, respectively), fruit diameter (2.80 and 2.78 cm, respectively), pulp weight (9.91 and 9.96 g, respectively), fruit firmness (2.31 and 2.35 kg/cm^2, respectively) and specific gravity (1.060 and 1.064, respectively). On mean basis, all the mulching treatments were at par with each other in respect of fruit weight, fruit length, fruit diameter, pulp weight and specific gravity. The increase in

Table 2. Effect of mulching and irrigation interval on fruit characteristics of litchi cv. Dehradun.

Irrigation interval	Fruit wt. (g)				Fruit length (cm)				Fruit dia. (cm)			
	No mulch	Paddy straw	Black polythene	Mean	No mulch	Paddy straw	Black polythene	Mean	No mulch	Paddy straw	Black polythene	Mean
3 day (control)	16.78	17.33	17.88	17.33	3.40	3.08	3.20	3.12	2.72	2.81	2.87	2.80
6 day	16.42	17.63	18.27	17.44	2.92	3.12	3.28	3.10	2.61	2.83	2.92	2.78
9 day	15.51	14.53	13.88	14.64	2.85	2.72	2.60	2.72	2.54	2.42	2.38	2.44
Mean	16.24	16.49	16.67		3.05	2.97	3.02		2.61	2.68	2.70	
CD at 5%												
Factor (A)			0.19				0.15				0.12	
Factor (B)			0.19				0.16				0.15	
Factor (A × B)			0.34				0.25				0.20	

Table 3. Effect of mulching and irrigation intervals on pulp weight (g), fruit firmness (kg/ cm^2) and specific gravity of litchi cv. Dehradun.

Irrigation interval	Pulp wt. (g)				Fruit firmness (kg/ cm^2)				Specific gravity			
	No mulch	Paddy straw	Black polythene	Mean	No mulch	Paddy straw	Black polythene	Mean	No mulch	Paddy straw	Black polythene	Mean
3 day (control)	9.71	9.89	10.15	9.91	2.32	2.25	2.38	2.31	1.064	1.064	1.053	1.060
6 day	9.39	10.04	10.45	9.96	2.20	2.33	2.51	2.35	1.065	1.063	1.062	1.064
9 day	9.28	8.56	8.58	8.80	2.17	1.13	1.07	1.46	1.066	1.071	1.073	1.070
Mean	9.46	9.49	9.72		2.23	1.90	1.99		1.065	1.06	1.06	
CD at 5%												
Factor (A)			0.12				0.11				0.002	
Factor (B)			0.28				0.11				0.002	
Factor (A × B)			0.49				0.20				0.005	

fruit weight under black polythene mulch could be due to better soil moisture conservation and better soil temperature. According to Baba *et al*. (2), fruit weight was found significantly higher from plants mulched with black polythene. Further decrease in all these physical characteristics when irrigation interval was increased to 9 day can be explained in the light of fact that even mulching cannot overcome the negative effect of severe water stress induced by irrigation at 9 day interval. Earlier Rab and Haq (9) have also reported that specific gravity increased with increasing irrigation intervals. Benefit: cost ratio was found maximum in the treatment comprising of black polythene mulch and irrigation at 6 day interval (2.77:1) and minimum (1.01:1) in irrigation at 3 day interval. This may be attributed to higher yields and superior quality of fruits with different mulching treatments. These results are in confirmation with the results obtained by Prakash *et al*. (8) on litchi (Tables 4 & 5). With regard to increase in irrigation interval from 3 to 6 day resulted into high B:C ratio but when irrigation interval was further increased to 9 day a significant decrease in B:C was recorded. Reddy *et al*. (10) studied the effect of different types of irrigation and growing methods on growth, yield and water-use efficiency of tomato and recorded highest net returns (1,02,708 Rs./ha) and benefit cost ratio (2.41:1) recorded with furrow + black polythene mulch + trellising.

It was concluded that to get more income and better quality fruits in a litchi orchard, water management conditions must be improved by applying irrigations at 6 day interval and mulching trees with black polythene. This practice will result into increased on-farm crop water utilization and better fruit quality with less irrigation thereby conserving water.

Table 4. Average cost of cultivation (Rs.) of litchi cv. Dehradun using different mulching materials and irrigation intervals.

S. No.	Item	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9
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
b)	Cost of Urea (₹)	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
d)	Cost of MOP (₹)	17.07	17.07	17.07	17.07	17.07	17.07	17.07	17.07	17.07
e)	Cost of mulching material (₹)	-	-	-	220.00	220.00	220.00	300.00	300.00	300.00
	Total cost of inputs (A)	199.74	199.74	199.74	419.74	419.74	419.74	499.74	499.74	499.74
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
b)	Cost of irrigation (₹)	2472.40	1236.20	741.72	2472.40	1236.40	741.72	2472.40	1236.20	741.72
c)	Tagging	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	164.82	164.82	164.82	-	-	-
e)	Fertilizer application	41.47	41.47	41.47	41.47	41.47	41.47	41.47	41.47	41.47
f)	Mulch application	-	-	-	41.47	41.47	41.47	41.47	41.47	41.47
g)	Harvesting	123.62	123.62	123.62	123.62	123.62	123.62	123.62	123.62	123.62
	Total operational cost (B)	3079.55	1843.35	1348.87	2956.19	1720.19	1225.51	2791.37	1555.17	1060.69
C.	Total cost (₹) C = (A + B)	3279.29	2043.09	1548.61	3375.93	2139.73	1645.25	3291.11	2054.91	1560.43
D.	Total cost/plant (₹)	1093.09	681.03	516.20	1125.31	713.24	548.41	1097.03	708.99	520.14
E.	Total cost/ha (₹)	109309.67	68103.00	51620.33	112531.00	71324.33	54841.67	109703.67	70899.00	52014.33

Table 5. Effect of mulching and irrigation interval on B: C ratio of litchi cv. Dehradun.

Treatment	Av. yield (kg/ tree)	Rate/ kg fruit (₹)	Gross return (₹)	Gross return/ ha (₹)	Cost of cultivation (B) (₹)	Net return C = (A-B) (₹)	Benefit: cost ratio
T_1 : Irrigation at 3 day interval (control)	52.34	42.00	2198.8	219828.00	109309.67	110518.33	1.01:1
T_2 : Irrigation at 6 day interval	50.91	43.00	2189.13	218913.00	68103.00	150810.00	2.21:1
T_3 : Irrigation at 9 day interval	44.64	35.00	1562.40	156240.00	51620.33	104619.67	2.03:1
T_4 : Paddy straw + Irrigation at 3 day interval	53.82	45.00	2421.90	242190.00	112531.00	129659.00	1.15:1
T_5 : Paddy straw + Irrigation at 6 day interval	54.34	43.00	2336.62	233662.00	71324.33	162337.67	2.28:1
T_6 : Paddy straw + Irrigation at 9 day interval	49.67	35.00	1738.45	173845.00	54841.67	119003.33	2.17:1
T_7 : Black Polythene + Irrigation at 3 day interval	58.51	45.00	2632.95	263295.00	109703.67	153591.33	1.40:1
T_8 : Black Polythene + Irrigation at 6 day interval	59.33	45.00	2669.85	266985.00	70899.00	196086.00	2.77:1
T_9 : Black Polythene + Irrigation at 9 day interval	42.60	35.00	1491.00	149100.00	52014.33	97085.67	1.87:1

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