ISAH-INDIAN JOURNAL OF ARID HORTICULTURE
2020, Vol. 2 (1&2):62-66

Studies on sun burn and fruit cracking in litchi cultivars under Bihar condition

Narayan Lal[1*] and Vishal Nath
[1]ICAR-Indian Institute of Soil Science, Bhopal, MP
ICAR-National Research Centre on Litchi, Muzaffarpur, Bihar
[*]Corresponding author's email: narayanlal.lal7@gmail.com
(Received: 26.01.2021; Accepted: 27.03.2021)

Abstract

An experiment was conducted at ICAR-National Research Centre on Litchi, Muzaffarpur, Bihar during 2017 and 2018 to assess the response of twenty cultivars of litchi to sun burn and fruit cracking. Result revealed that sun burn and fruit cracking varied from 0 to 13.61% and 0 to 14.57%, respectively. CSL-16 exhibited maximum sun burning (13.61%) and fruit cracking (14.57 %) whereas ten cultivars *viz*., CHL-4, CHL-5, CSL-1, CSL-2, CSL-4, CSL-5, CSL-10, CSL-11, CSL-12 and CSL-18 were found free from sun burn and fruit cracking. Sun burn and fruit cracking started in all susceptible cultivars during 51-56 days after fruit set. Sun burn and fruit cracking in different cultivars were found maximum in last ten to fifteen days of fruit growth and development. Sun burn and fruit cracking were not significantly influenced by orientation of fruits on the tree. All the early ripening cultivars were susceptible to sun burn and fruit cracking while late ripening cultivars exhibited tolerance. Tolerant cultivars can be used in breeding programme for further improvement.

Key words: Litchi, cultivars, sun burn, fruit cracking, susceptible, tolerance

Introduction

Litchi (*Litchi chinensis* Sonn.) is an evergreen subtropical fruit tree and important member of family Sapindaceae which has strong mycorrhizal association (Lal and Nath, 2020a). Litchi has high nutritive and medicinal values. It is good source of vitamin-C and phenolics (Lal *et al*., 2018a). Litchi is highly specific to its climatic requirements particularly low temperature for bumper flowering and fruiting and this is the reason of its restricted cultivation in few countries and limited states in India. Total by-product in litchi is found to the tune of 19.85 to 59.54 per cent in different genotypes fractioning with 6.96 to 22.58 per cent seed and 12.89 to 36.96 per cent pericarp. Litchi pericarp and seed are good source of total phenol with 7.5-62.2 mg GAE/g and 23.01-85.57 mg GAE/g, respectively (Lal *et al*., 2018b). It produces inflorescence called panicle which is the fruiting body for ensuring the final yield of litchi and emergence and size of panicle is also influenced by phenol content in the tree (Lal *et al*., 2019a). Many genotypes bear loose or compact panicle which also depends on climatic condition. However, any cultivar of litchi does not follow regular pattern of flowering during young stages (Lal *et al*., 2019b). There are three types of flower on the inflorescence in litchi: male (M_1), pseudo-hermaphrodite male (M_2) and pseudo-hermaphrodite female (F) flowers. Male flowers bloom first followed by an overlapping successions of female flowers with pseudo-hermaphrodite male and flowers bloom for 7-10 days and the number of flowers on a single inflorescence vary from hundreds to several thousand (Lal, 2018). Pollen grains of M_2 flowers are more viable and fruit set depends on the sources of pollen grains (Lal *et al*., 2019c and 2019d). However, fluctuation in temperature significantly affects fruit retention (Lal *et al*., 2017a). Litchi suffers from many problems *viz*., fruit drop (Lal *et al*., 2017b, c), seed and fruit borer, sun burn and fruit cracking (Lal *et al*., 2018c), pericarp browning (Purbey *et al*., 2019) but sun burn and fruit cracking is very important which directly heat to economic parts (fruits). Aberrant weather also influences the productivity and quality of litchi (Lal and Nath, 2020b). Fruit set vary with cultivars grown in the same condition and nutritional condition of plants as highest fruit set (23.96%) and lowest fruit drop (13.06%) was recorded in trees fertilized with calcium nitrate+urea (Jeet *et al*., 2016). The availability of limited number of litchi cultivars restricts the choices of cultivars, therefore, the assessment of genotypes of litchi become very much essential. Thus, present investigation was conducted to assess the response of genotypes to sun burn and fruit cracking in litchi.

Materials and Methods

The experiment was carried out at the farm of ICAR-National Research Centre on Litchi, Muzaffarpur, Bihar during 2017-18. The research farm is situated at 26°5'87"N latitude, 85°26'64" E longitude at an elevation of 210 m above msl to assess the response of litchi cultivars to sun burn and fruit cracking. The soil type of the site was alluvial with sandy loam texture having calcareous in nature with pH ranging from 7.5-8.0. The temperature varied from 30°C to 43 °C in summer and 5°C to 10°C in winter. The region was characterized by dry and hot summer and cold winter with

heavy rainfall during rainy season. The fifteen years old litchi plants of twenty cultivars viz. 'Bombai-II, CHL-4, CHL-5, CHL-8, CSL-1, CSL-2, CSL-3,CSL-4, CSL-5, CSL-6, CSL-7, CSL-9, CSL-10, CSL-11, CSL-12, CSL-13, CSL-15, CSL-16, CSL-18, CSL-19 were planted at 8 m × 8 m spacing in randomized blockdesign with three replications, were used for the experiment. The observations made for this experiment were percentage of sun burn and fruit cracking at harvest; relationship between panicle direction (east, west, north and south) and percentage of sun burning and fruit cracking at different stages of fruit growth and development. The data was subjected to statistical analysis by using analysis of variance (Burton, 1952). Critical difference values at $p<0.05$ were used to determine the significance of difference between treatment means.

Results and Discussion

The different cultivars showed significant variation in sun burning and fruit cracking at harvest (Tables 1 and 2). Sun burning varied from 0 to 13.61% and fruit cracking varied from 0 to 14.57% among the twenty studied cultivars. Cultivar CSL-16 exhibited maximum sun burning (13.61%) and fruit cracking (14.57 %) and ten cultivars namely CHL-4, CHL-5, CSL-1, CSL-2, CSL-4, CSL-5, CSL-10, CSL-11, CSL-12 and CSL-18 were found free from sun burn and fruit cracking. It seems that there is strong correlation between sun burn and fruit cracking. The cultivars which were free from sun burn were also free from fruit cracking. Similarly, cultivars affected with sun burn were also affected from fruit cracking. Sun burn is a predisposed to the fruit cracking in litchi. It has been also observed that all early ripening cultivars were susceptible to sun burn and fruit cracking while late ripening cultivars were free from sun burn and fruit cracking. Mitra *et al.* (2014) reported 10-25% crop loss due to fruit cracking and sun-burning in West Bengal condition. The variation in sun burn and fruit cracking among the cultivars were reported by earlier workers (Pereira *et al*., 2005 and Sanyal *et al*., 1990). It is clear from the Table 1 & 2 that sun burn and fruit cracking was recorded maximum on the southern side of the tree canopy. In southern direction of tree, sun burn varied from 0 to 19.86% and fruit cracking varied 0 to 20.88%.The maximum sun burn and fruit cracking on southern side were due to more light intensity, high temperature and longer duration of light exposure on this side. However, minimum sun burn and fruit cracking were observed either in north side followed by west side. Kumar *et al.* (2001) found higher sun burn and fruit cracking on south side of the tree canopy.

It is clear from the table 3 that sun burn started between 46 to 50 days after fruit set in CSL-1, CSL-6, CHL-8 and CSL-16 but it started in all susceptible cultivars during 51-56 days after fruit set. The cultivars CSL-3, CSL-6, CHL-8, CSL-9, CSL-13, CSL-15, CSL-16 and CSL-19 showed maximum sun burn between 61 to 65 days after fruit set, whereas, in CSL-1 and CSL-7, it was between 66 and 70 days after fruit set. Similarly, fruit cracking started between 51-56 days after fruit set in all susceptible cultivars (Table 4). The cultivars CSL-3, CSL-6, CHL-8, CSL-9, CSL-13, CSL-15 and CSL-19 exhibited maximum fruit cracking between 61 to 65 days after fruit set whereas CSL-1, CSL-7 and CSL-16 exhibited between 66 to 70 days after fruit set. Sun burn and fruit cracking were also influenced by orientation of fruits on the tree (Table 5) but not significantly (Fig. 1).

Table 1. Incidence of sun-burning of fruits in different directions

	Directional variation in sun burn (%)				
Cultivars	North	South	East	West	Sun burn (%)
Bombai-II	0.00	0.00	0.00	0.00	0.00
CHL-4	0.00	0.00	0.00	0.00	0.00
CHL-5	0.00	0.00	0.00	0.00	0.00
CSL-1	7.15	18.65	12.24	10.56	12.15
CSL-2	0.00	0.00	0.00	0.00	0.00
CSL-3	4.75	16.33	11.84	9.68	10.65
CSL-4	0.00	0.00	0.00	0.00	0.00
CSL-5	0.00	0.00	0.00	0.00	0.00
CSL-6	6.75	14.89	12.76	9.86	11.07
CSL-7	5.75	13.89	11.76	8.86	10.07
CHL-8	5.35	14.00	10.36	8.35	9.52
CSL-9	3.76	12.35	8.26	5.68	7.51
CSL-10	0.00	0.00	0.00	0.00	0.00
CSL-11	0.00	0.00	0.00	0.00	0.00
CSL-12	0.00	0.00	0.00	0.00	0.00
CSL-13	6.86	15.12	10.56	9.13	10.42
CSL-15	5.38	14.12	10.39	8.37	9.57
CSL-16	8.78	19.86	14.53	11.26	13.61
CSL-18	0.00	0.00	0.00	0.00	0.00
CSL-19	7.65	16.85	12.60	10.76	11.97
SE(d)	0.098	0.18	0.175	0.135	0.212
CD (0.05)	0.2	0.365	0.356	0.275	0.432

Thus, it may be concluded that the sun burn and fruit cracking in different cultivars started in last thirty days of fruit growth and were found maximum in last ten to fifteen days of fruit growth and development. During 15 to 31 May (last 15 days of fruit growth) atmospheric temperature was high (38 to 40°C) and relative humidity was low (50% to 60%) which triggered sun burn and fruit cracking.

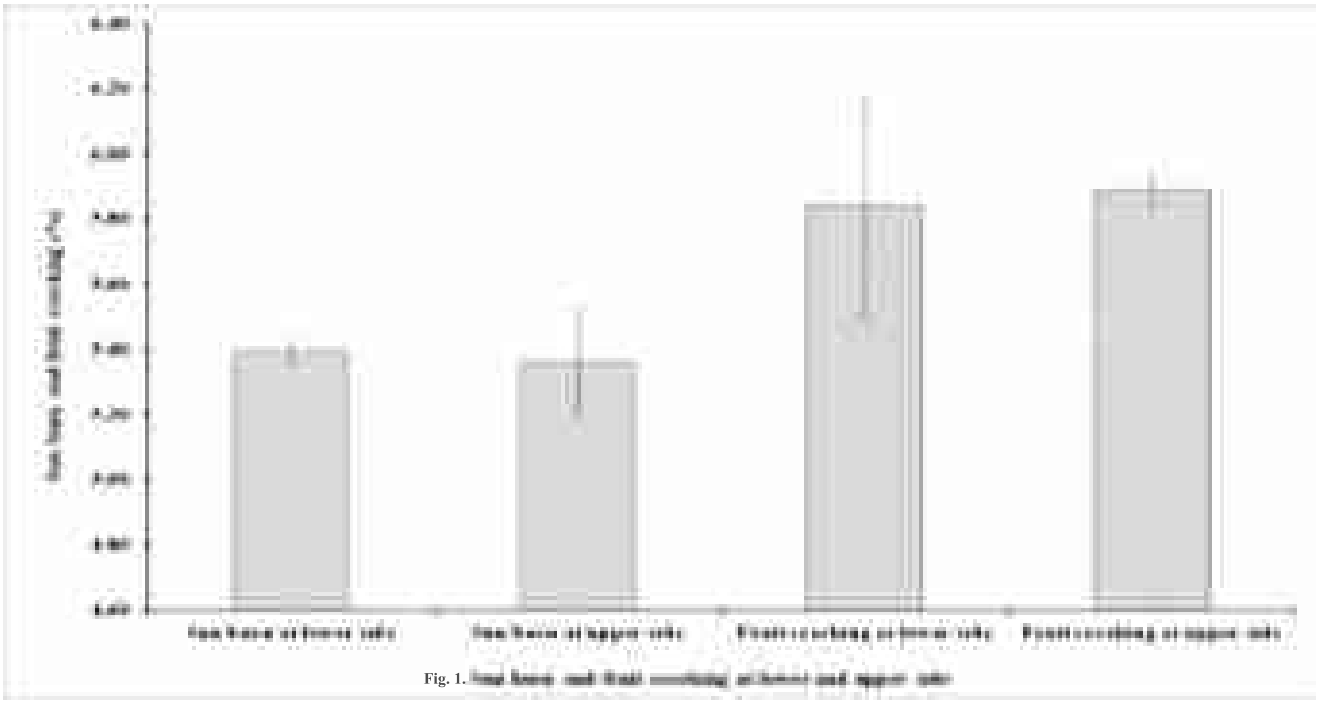

Fig. 1.

Table 2. Incidence of cracking of fruits in different directions

Cultivars	Directional variation in fruit cracking (%)				Fruit cracking (%)
	North	South	East	West	
Bombai-II	0.00	0.00	0.00	0.00	0.00
CHL-4	0.00	0.00	0.00	0.00	0.00
CHL-5	0.00	0.00	0.00	0.00	0.00
CSL-1	8.45	19.65	12.73	11.49	13.08
CSL-2	0.00	0.00	0.00	0.00	0.00
CSL-3	5.84	17.67	12.67	10.12	11.58
CSL-4	0.00	0.00	0.00	0.00	0.00
CSL-5	0.00	0.00	0.00	0.00	0.00
CSL-6	7.94	15.94	13.03	10.96	11.97
CSL-7	6.46	14.88	12.68	10.28	11.08
CHL-8	6.25	15.68	11.24	9.12	10.57
CSL-9	4.38	13.56	9.86	6.48	8.57
CSL-10	0.00	0.00	0.00	0.00	0.00
CSL-11	0.00	0.00	0.00	0.00	0.00
CSL-12	0.00	0.00	0.00	0.00	0.00
CSL-13	8.64	16.48	12.80	10.76	12.17
CSL-15	6.38	15.68	11.12	9.62	10.70
CSL-16	9.78	20.88	15.46	12.14	14.57
CSL-18	0.00	0.00	0.00	0.00	0.00
CSL-19	9.30	17.95	13.58	11.35	13.05
SE(d)	0.112	0.256	0.215	0.174	0.178
CD (0.05)	0.227	0.52	0.437	0.354	0.361

Table 3. Sun-burning of fruit (%) at different stages of fruit growth and development

Cultivars	Days after fruit set						Sun burn (%)
	Between 40-45	Between 46-50	Between 51-55	Between 56-60	Between 61-65	Between 66-70	
Bombai-II	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHL-4	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHL-5	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CSL-1	0.00	1.25	1.59	2.57	3.00	3.74	12.15
CSL-2	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CSL-3	0.00	0.00	1.56	2.75	5.35	1.00	10.66
CSL-4	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CSL-5	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CSL-6	0.15	0.86	2.68	2.75	4.24	0.39	11.07
CSL-7	0.00	0.00	0.52	1.75	3.75	4.05	10.07
CHL-8	0.00	0.56	0.00	0.45	5.68	2.83	9.52
CSL-9	0.00	0.00	0.24	0.46	3.45	3.36	7.51
CSL-10	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CSL-11	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CSL-12	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CSL-13	0.00	0.00	2.56	1.56	5.75	1.55	11.42
CSL-15	0.00	0.00	0.24	1.26	4.56	3.51	9.57
CSL-16	0.00	0.68	1.56	3.56	3.46	4.35	13.61
CSL-18	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CSL-19	0.00	0.00	1.53	2.68	6.48	1.28	11.97
SE(d)	-	0.004	0.021	0.019	0.088	0.034	0.212
CD (0.05)	-	0.009	0.042	0.038	0.179	0.069	0.432

Table 4. Percentage of fruit cracking at different stages of fruit growth and development

	Days after fruit set						
Cultivars	Between 40-45	Between 46-50	Between 51-55	Between 56-60	Between 61-65	Between 66-70	Fruit cracking (%)
Bombai-II	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHL-4	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHL-5	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CSL-1	0.00	1.28	1.63	2.63	3.14	4.40	13.08
CSL-2	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CSL-3	0.00	0.00	1.83	2.35	5.62	1.78	11.58
CSL-4	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CSL-5	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CSL-6	0.00	0.76	2.67	2.83	4.82	0.89	11.97
CSL-7	0.00	0.00	0.52	1.75	3.75	5.06	11.08
CHL-8	0.00	0.62	0.00	0.48	5.84	3.63	10.57
CSL-9	0.00	0.00	0.63	0.52	3.96	3.46	8.57
CSL-10	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CSL-11	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CSL-12	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CSL-13	0.00	0.00	2.35	1.45	5.86	2.51	12.17
CSL-15	0.00	0.00	0.18	2.54	5.60	2.38	10.70
CSL-16	0.00	0.68	2.14	3.28	3.86	4.61	14.57
CSL-18	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CSL-19	0.00	0.00	1.75	2.84	7.15	1.31	13.05
SE(d)	-	0.005	0.025	0.031	0.065	0.044	0.178
CD (0.05)	-	0.011	0.05	0.064	0.133	0.089	0.361

Table 5. Sun burn and fruit cracking influenced by orientation of fruit on the tree

Cultivars	Sun burn (%)		Fruit cracking (%)	
	Lower	Upper	Lower	Upper
Bombai-II	0.00	0.00	0.00	0.00
CHL-4	0.00	0.00	0.00	0.00
CHL-5	0.00	0.00	0.00	0.00
CSL-1	12.43	11.86	13.00	13.16
CSL-2	0.00	0.00	0.00	0.00
CSL-3	11.00	10.32	11.54	11.62

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