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Performance of Promising Litchi Cultivars in Red and Lateritic Zone of Birbhum

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ABSTRACT

A field investigation was conducted to study the characteristics and performance of some promising litchi cultivars (10 years old) grown under the semi-arid, subtropical, red and lateritic zone of Sriniketan region in Birbhum district of West Bengal during 2016-17. The cultivars were evaluated for various plant morphology, yield and physico-chemical characteristics of fruits. The pooled results of the two year experimentation revealed that 'Bombai' exhibited maximum tree height (5.18m), tree volume (79.11m), fruit yield (51.55kg/ tree), fruit size (length: 3.61cm; breadth: 3.34cm), fruit weight (19.86g), fruit volume (18.05cm^3) and minimum fruit cracking percent (2.15%). Whereas, the cultivar 'Bedana' exhibited maximum aril weight (15.40g), small seed size (1.55g), maximum aril/seed ratio (9.92), maximum TSS (19.28^{o}B), minimum acidity (0.28%), maximum sugar/acid ratio (70.54), maximum ascorbic acid (51.49mg/ 100g) and maximum sugars content. Based on the plant morphology, yield and physico-chemical characteristics of fruits the cultivars Bombai and Bedana are superior in growth, yield and fruit quality and stand promising for the small family farming orchard in the red and lateritic zone of Birbhum district in West Bengal.

Key words: Family farming, *Litchi chinensis*, Performance, Red and Lateritic zone.

INTRODUCTION

Litchi (*Litchi chinensis* Sonn.), belongs to the family Sapindaceae, is an evergreen, tropical to subtropical fruit tree, native to Southern China and Northern Vietnam (Menzel, 2001). The fruit has a good source of nutrition and medicinal properties (Wall, 2006; Hu *et al.,* 2010). It is an important commercial fruit crop of India which has a tremendous export potential (Jiang *et al.,* 2006). India is the second largest producer of litchi in the world after China with an area and production of 92,000 hectares and 686 million tonnes, respectively in 2017-18 (Anonymous, 2018). The leading litchi producing states in India is Bihar followed by West Bengal with an area and production of 33,270 ha and 2,82,270 tonnes respectively in 2017-18 (Anonymous, 2019). In West Bengal, litchi has been cultivated in districts of Malda, Murshidabad, 24 Parganas (North and South), Uttar Dinajpore, Cooch Behar, etc. and it is the livelihood for thousands of peoples in the state as it provides both on farm and off-farm employment. Presently litchi cultivars like Bombai, Deshi, Muzaffarpur and China are cultivated in West Bengal (Singh and Saxena, 2008). Other than fruit borer (*Conopomorpha cramerella*), fruit cracking, sun burning, fruit drop and quality deterioration are the major problems in semi-arid subtropical red lateritic zone of eastern India. Earlier many researchers have evaluated and analysed litchi cultivars in different part of India (Khurshid *et al.,* 2004; Chauhan *et al.,* 2008; Singh *et al.,* 2010; Dixit *et al.,* 2015; Kumar *et al.,* 2015; Rahman *et al.,* 2015; Mandal and Mitra, 2016). Although litchi originates in tropical to subtropical areas, however its performance in adverse agro-climatic region is directly and indirectly related to many intrinsic (genetic diversity and cultivar type) and extrinsic (soil type, temperature, precipitation and relative humidity) factors that affect all stages of growth and development. Since limited information is available on identification and characterization of the cultivars in the semi-arid, subtropical, red and lateritic zone of Birbhum region, precise information on nature and magnitude of performance among the existing litchi cultivars is a pre-requisite for its improvement in this region. Therefore, the present investigation was carried out to study the performance of some important litchi cultivars available in this region and to recommend them to the farmers for small family farming orchard.

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MATERIALS AND METHODS

The present investigation was carried out in Horticulture Research Farm of Department of Horticulture and Postharvest Technology, Institute of Agriculture, Visva-Bharati, Sriniketan, West Bengal, India during 2016-17. The experimental orchard is located at an elevation of 40m above mean sea level at 23°42′ N latitude and 87° 47′ 30′′ E longitudes, representing the humid, semi-arid, subtropical region under 'Red and lateritic' zone of Birbhum region. The experiment was carried out in 10 years old litchi trees of

four popular cultivars, *viz.* Bedana, Bombai, Elaichi and Muzaffarpur, which were planted at a distance of 8 x 8m in square system. Uniform cultural operations were followed during the course of investigation.

Tree height and spread were measured by measuring pole (SI scale marking on it), to assess the canopy expansion of the tree. Tree volume was calculated according to the methods of Westwood (1978) from tree height and tree spread.

Digital calliper's was used for measuring fruit length and diameter and expressed in 'millimetre.' The fruit was weighed individually in semi-analytical balance and expressed in g/fruit. Fruit volume was measured by water displacement method and expressed in cm^3. Aril and seed weight were individually obtained by weighing each party in semi-analytical balance and expressed in grams. Aril/seed ratio was also calculated.

Analysis of the titratable acidity followed the procedures described by Adolfo Lutz Institute (2008); evaluation of total soluble solids (TSS) was carried out from direct reading in the digital refractometer with results expressed in °Brix. The sugar: acid ratio was also calculated. Ascorbic acid, total sugar and reducing sugars were estimated by the method described by AOAC (2010). Non-reducing sugars was obtained by subtracting reducing sugars from total sugar.

The data were analyzed using randomized block design (RBD) considering each cultivar as treatment. Each treatment was replicated five times and each tree represents a single replication. Analyses of variance were carried out using PROC GLM procedure of SAS software (SAS/STAT, 2009).

RESULTS AND DISCUSSION

Tree growth parameters

The critical examination of the data on tree growth parameters clearly shows that significant variation was observed among different cultivars. The data presented in Table 1 revealed that the maximum tree height (5.07m in 2016, 5.28m in 2017 and 5.18m in the pooled mean) and tree volume (78.32m^3 in 2016, 79.90m^3 in 2017 and 79.11m^3 in the pooled mean) were recorded in Bombai followed by Elaichi and Bedana whereas the minimum tree height and tree volume were observed in Muzaffarpur. The differences in the morphological characteristics of different litchi cultivar are probably due to their genetic makeup as well as due to the influence of climatic factors (Khurshid *et al*., 2004). The results are in agreement with Singh *et al.* (2012) which categorised Bombai as vigorous cultivar (height: 6 to 7m and spread 7 to 8m), Elaichi as moderately vigorous cultivar (height: 5 to 6m and spread: 6 to 7 m) and Bedana and Muzaffarpur as medium growth cultivars (height: 5m and spread: 6m). Earlier Mandal and Thokchom (2018) also observed variation in tree growth parameters of different mango cultivars under these stress conditions of Birbhum district of West Bengal.

Fruit cracking

The data of fruit cracking per cent given in Table 1 shows significant differences among the cultivars. Minimum fruit cracking percent was recorded in the Bombai (2.30% in 2016, 2.00% in 2017 and 2.15% in the pooled mean) followed by Elaichi, Bedana and Muzaffarpur. These finding are in accordance with Singh *et al.* (2012) which reported Bombai and Elaichi to have less prone to cracking. Finding of Mandal and Mitra (2016) also supported the present result which stated that litchi cv. Bombai, Bedana and Elaichi to have minimum fruit cracking percent (2.6 to 4.98%) compared to Muzaffarpur (17.33%).

Fruit yield

The careful scrutiny of the data in Table 1 clearly indicates that different cultivars differ significantly with respect to fruit yield. During the year 2016, maximum fruit yield (58.39 kg/ tree) was recorded in Bombai followed by Muzaffarpur, Elaichi and Bedana. But, during 2017, the yield trend has been changed and maximum yield was observed in Elaichi (49.66 kg/tree) followed by Bedana. Drastic decrease in yield of Bombai and Muzzafarpur has been observed. According to Ghosh *et al*. (2001) adverse climatic and environmental condition as well as the alternate bearing tendency can change the yield trend of Bombai and Muzaffarpur cultivars. In pooled mean, similar trend of the yield has been observed as that of the 2016 data. These findings are in agreement with that of Bose *et al.* (2001); Ghosh *et al.* (2001) who reported Bombai to be superior in production in West Bengal condition. Bose *et al.* (2001) also reported Bedana to be low yielding litchi cultivars of West Bengal.

Fruit physical characteristics

The data in Table 2 shows that Bombai had maximum fruit size in 2016 (length 3.58cm and diameter 3.32cm), 2017 (length 3.63cm and diameter 3.37cm) and in the pooled mean (length 3.61cm and diameter 3.34cm). Similarly, Bombai also exhibited maximum fruit weight (19.80g in 2016, 19.92g in 2017 and 19.86g in the pooled mean) and fruit volume (18.00 cm^3 in 2016, 18.10 cm^3 in 2016-17 and 18.05 cm^3 in the pooled mean) and are statistically higher than other cultivars. These results are in conformity with that of Singh *et al.,* (2012), which categorised cultivar, Bombai (15 to 20g) and Muzaffarpur (average weight of 18.2g) in large size fruit, whereas, cultivar, Bedana (15 to 18g) and Elaichi (12 to 15g) in medium size fruit. Farther, variation in fruit's physical quality attributes of different litchi cultivars has been earlier reported by Mandal and Mitra (2016) in West Bengal condition and Dixit *et al*. (2015) in Chhattisgarh condition. In other fruits Mandal and Thokchom (2018) also reported variation in physical quality attributes among different mango cultivars in red and lateritic zone of Birbhum region.

The data regarding aril weight, seed weight and aril/ seed ratio represented in Table 3 shows significant differences among the cultivars. Bedana shows maximum aril weight in 2016 (15.37g), 2017 (15.43g) and in the pooled mean (15.40g). Bedana also exhibited minimum seed weight

Table 1: Physical characteristics of tree (height and volume), fruit cracking percentage and yield of different litchi cultivars.

Cultivars	Tree height (m)			Tree volume (m^3)			Fruit cracking %			Yield (kg/tree)		
	2016	2017	Pooled mean	2016	2017	Pooled mean	2016	2017	Pooled mean	2016	2017	Pooled mean
Bombai	5.07	5.28	5.18 (87.69)*	78.32	79.90	79.11	2.30	2.00	2.15	58.39	44.72	51.55 (115.20)*
Muzaffarpur	4.32	4.47	4.39 (74.36)*	49.80	51.13	50.47	13.80	13.84	13.82	54.12	41.59	47.86 (107.03)*
Bedana	4.47	4.73	4.60 (78.13)*	53.11	54.64	53.88	4.17	4.34	4.26	42.32	46.73	44.53 (108.98)*
Elaichi	4.63	4.81	4.72 (79.94)*	61.24	62.61	61.92	2.76	2.86	2.81	45.56	49.66	47.61 (116.17)*
SEm±	0.04	0.02	0.45**	0.28	0.17	0.23	0.14	0.17	0.15	0.37	0.13	0.45**
CD ($P \leq 0.05$)	0.12	0.06	1.34**	0.85	0.53	0.68	0.41	0.50	0.44	1.13	0.39	1.35**

'*'= mean (transformation).

'**'= CD at 5% and SEm ± (transformation).

Table 2: Physical characteristics of fruits (size, weight and volume) of different litchi cultivars.

Cultivars	Fruit length (cm)			Fruit diameter (cm)			Fruit weight (g)			Fruit volume (cm^3)		
	2016	2017	Pooled mean	2016	2017	Pooled mean	2016	2017	Pooled mean	2016	2017	Pooled mean
Bombai	3.58	3.63	3.61	3.32	3.37	3.34	19.80	19.92	19.86	18.00	18.10	18.05
Muzaffarpur	3.42	3.48	3.45	3.21	3.28	3.25	19.00	19.10	19.05	17.28	17.37	17.33
Bedana	3.31	3.34	3.33	3.12	3.17	3.15	18.70	18.82	18.76	17.00	17.12	17.06
Elaichi	3.30	3.34	3.32	3.11	3.16	3.14	18.66	18.74	18.70	16.98	17.04	17.01
Sem±	0.02	0.03	0.03	0.03	0.02	0.03	0.17	0.10	0.14	0.16	0.10	0.14
CD ($P \leq 0.05$)	0.06	0.08	0.09	0.08	0.06	0.08	0.52	0.30	0.41	0.48	0.32	0.42

Table 3: Physical characteristics of fruits (aril weight, seed weight and aril/seed ratio) of different litchi cultivars.

Cultivars	Aril weight (g)			Seed weight (g)			Aril/seed ratio		
	2016	2017	Pooled mean	2016	2017	Pooled mean	2016	2017	Pooled mean
Bombai	14.67	14.71	14.69	3.03	3.10	3.07	4.84	4.74	4.79
Muzaffarpur	13.48	13.53	13.50	3.47	3.52	3.49	3.89	3.86	3.87
Bedana	15.37	15.43	15.40	1.53	1.58	1.55	10.06	9.78	9.92
Elaichi	14.70	14.77	14.73	2.06	2.12	2.09	7.12	6.97	7.05
Sem±	0.19	0.11	0.15	0.04	0.06	0.05	0.19	0.11	0.15
CD (P ≤ 0.05)	0.55	0.34	0.45	0.12	0.17	0.14	0.56	0.32	0.44

Table 4: Chemical characteristics of fruits (TSS, acidity and TSS/acidity ratio) of different litchi cultivars.

Cultivars	TSS (°Brix)			Acidity (%)			Sugar/acid ratio		
	2016	2017	Pooled mean	2016	2017	Pooled mean	2016	2017	Pooled mean
Bombai	18.26	18.52	18.39	0.35	0.37	0.36	52.86	50.78	51.82
Muzaffarpur	17.81	17.96	17.89	0.43	0.45	0.44	41.32	40.49	40.90
Bedana	19.06	19.50	19.28	0.28	0.28	0.28	69.71	71.37	70.54
Elaichi	17.94	18.20	18.07	0.37	0.38	0.37	49.26	48.83	49.04
Sem±	0.08	0.10	0.09	0.02	0.02	0.02	3.59	3.21	3.41
CD (P ≤ 0.05)	0.24	0.30	0.26	0.07	0.06	0.05	10.62	9.51	10.23

Table 5: Chemical characteristics of fruits (ascorbic acid, total sugar, reducing sugar and non-reducing sugar) of different litchi cultivars.

Cultivars	Ascorbic acid (mg/100g)			Total sugar (%)			Reducing sugar (%)			Non-reducing sugar (%)		
	2016	2017	Pooled mean	2016	2017	Pooled mean	2016	2017	Pooled mean	2016	2017	Pooled mean
Bombai	48.38	48.49	48.44	11.53	12.02	11.78	7.63	7.83	7.73	3.90	4.19	4.04
Muzaffarpur	46.62	46.73	46.68	11.00	11.56	11.28	7.57	7.79	7.68	3.42	3.77	3.60
Bedana	51.40	51.57	51.49	12.85	13.00	12.92	8.16	8.38	8.27	4.69	4.62	4.65
Elaichi	44.61	44.73	44.67	11.46	11.94	11.70	7.74	7.88	7.81	3.72	4.06	3.89
SEm±	0.18	0.12	0.15	0.05	0.04	0.04	0.06	0.08	0.07	0.09	0.05	0.07
CD (P ≤ 0.05)	0.55	0.38	0.44	0.14	0.13	0.12	0.18	0.25	0.20	0.26	0.15	0.20

(1.53g in 2016, 1.58g in 2017 and 1.55g in pooled mean) and maximum aril/seed ratio (10.06 in 2016, 9.78 in 2017 and 9.92 in pooled mean). Maximum aril weight and minimum seed weight in Bedana was earlier reported by Singh *et al.* (2010); Singh *et al.* (2012); Chandola and Mishra (2015). Farther maximum aril weight, small seed size and high aril/seed ratio in Bedana and Elaichi was earlier reported by Mandal and Mitra (2016) in West Bengal condition. The possible scientific reason might be due to the correlation of weight of the aril and the whole fruit with the pericarp weight, irrespective of the fruit having normal or aborted seed (Huang and Qiu, 1987).

Fruit chemical characteristics

The scrutiny of the data in Table 4 clearly indicated that different cultivars of litchi significantly vary in chemical quality attributes of the fruits. Among different cultivars, Bedana exhibited highest TSS content in 2016 (19.06°Brix), 2017 (19.50°Brix) and in the pooled mean (19.28°Brix) followed by Bombai, Elaichi and Muzaffarpur. These findings are in accordance with Mandal and Mitra (2016); Menzel *et al.,* (2005) which reported Bedana and Bombai to have high TSS content (>18°B) followed by Elaichi and Muzaffarpur (17.90°Brix). These variations in TSS content might be due to maximum conversion of starch into sugar which might be related to inherent varietal character (Singh *et al*., 2010).

Among the different cultivars Bedana shows lowest acidity content and highest sugar/acid ratio in all the years and in the pooled mean followed by Bombai, Elaichi and Muzaffarpur respectively (Table 4). These results are in conformity with Singh *et al.* (2012); Bose *et al*. (2001) who reported lowest acidity content in Bedana followed by Bombai, Elaichi and Muzaffarpur. Again variation in acidity content and sugar/acid ratio was also reported in different litchi cultivars by Singh and Mishra (2013); Chandola and Mishra (2015); Rahman *et al.* (2015); Mandal and Mitra (2016). According to Singh *et al*. (2010) the possible explanation for variation in acidity content and sugar/acid ratio might be due to inherent varietal character in which the role of pyruvic acid in the process of respiration might be manifested and expressed in the form of titratable acidity.

Maximum ascorbic acid content (51.40mg/100g in 2016, 51.57mg/100g in 2017 and 51.49mg/100g in the pooled mean) was recorded in Bedana (Table 5). The results are in accordance with Singh *et al.* (2012) who reported higher ascorbic acid content in Bedana (50.40 mg/100g) and

Bombai (49.40 mg/100g). Variation in ascorbic acid content among various cultivars of litchi has also been earlier reported by Chandola and Mishra (2015); Mandal and Mitra (2016).

A perusal of the data presented in Table 5 revealed that the highest sugars (total, reducing and non-reducing sugars) content has been observed in 'Bedana', whereas the lowest was observed in 'Muzaffarpur' in all the years and in the pooled mean. The results are in agreement with Mandal and Mitra (2016) which reported highest sugars content in Bedana compare to cultivar Bombai, Elaichi, Muzaffarpur in West Bengal conditions.

CONCLUSION

Based on the present investigation, litchi cv. Bombai has superior plant characteristics, lowest cracking percent, high yielding and best physical characteristics of fruits, whereas, the cultivar Bedana has superior bio-chemical quality with high flesh recovery and shrivelled seeds. It can be concluded that litchi cultivars Bombai and Bedana can perform well for the small family farming orchard in the semi-arid, sub-tropical, red and lateritic zone of Birbhum district in West Bengal. But prior to recommend to farmer for large scale orchard establishment the investigation need to be further carried out with more cultivars and local genotypes.

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