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Studies of litchi cultivation and evaluation of different varieties and hybrids in Tripura

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ABSTRACT : Litchi (*Litchi chinensis* Sonn.) is one of the most relished evergreen tree with spreading branches and dense shining foliage and subtropical fruit with excellent quality, pleasant flavour and attractive colour. A study was conducted during 2009-11 in the college of Agriculture, Govt. orchards and farmers fields. The main varieties evaluated were Shahi, Swarna Roopa, China, Elachi, Bombai, Late Bedana, Dehradoon, Mazaffarpur, Early Bedana and Rose scented. Out of all the varieties studies in climatic condition of Tripura in respect of bearing habit, number of fruits per plants, time of maturity and quality parameters, the varieties Shahi, Mazaffarpur, Swarna Roopa, Bombai and Late Bedana were found in good performance. But Shahi variety showing excellence performance in all aspects like taste, flavour, aroma and other quality parameters with good market demand in Tripura conditions. Litchi provides food, nutrition, generate income, livelihood opportunity, improve the socio-economical status and poverty alleviation in rural and interior areas of the state.

KEY WORDS : Litchi, Evaluation, Varieties, Tripura

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The litchi (*Litchi chinensis* Sonn) an important subtropical evergreen fruit crop belonging to family Sapindaceae. It is highly specific to climatic requirements and probably due to this reason its cultivation is restricted to few states in the country. Litchi is the livelihood for thousand of people as it provides both on-farm and off-farm employment. Small and marginal farmers get additional income from litchi plants in their homesteads. Thus, litchi cultivation is the livelihood security for a large population, especially in the state of Tripura. Litchi is a delicious subtropical fruit of commercial importance and demarketed as a crop having high export potential. It is having attractive skin colour, excellent taste with flavour and treated as one of the finest fruits with high nutritional value. Shahi, Mazaffarpur, Swarna Roopa, Bombai and Late Bedana are grown commercially in Tripura. The economy of the state is basically agrarian and more than 70 per cent of the population depends on horticulture for their livelihood. The soil varies in reaction, very strong to strong acidic with medium organic matter content and low availability of phosphorus and potash contents. Considering the importance of this fruit crop in

the region, efforts are made to provide technological support through research and promoting production, post-harvest management and marketing, including export, through development programmes.

RESEARCH METHODS

The studies were conducted at College of Agriculture, Govt. orchards as well as farmers fields in the years 2009-2011 to know the adaptability and acceptability of some varieties of litchi under climatic condition of Tripura. Data were recorded and analysed statistically under standard procedure.

Production of planting materials:

Litchi is generally multiplied by vegetative methods of propagation. The most commonly practiced method of vegetative propagation is air-layering.

Air-layering:

Air-layering, known as 'goottee', is commercially practiced for large scale multiplication both in public sector

and private sector nurseries. Air-layer practiced now uses growth hormone and nutrient mixed media of peat moss or coir pith, which is covered with polythene. For preparation of the air-layer a healthy terminal branch receiving good sunshine with a thickness of about 1.2-1.5 cm is selected and a 2.5 cm ring is made by removal of bark about 45-50 cm below the apical growth. The cambium layer is rubbed off and the woody portion is exposed. Rooting hormone (1000 ppm IBA) is used as paste or powder. A layer of moist sphagnum moss or coir pith is placed and wrapped with a piece (20 x 25 cm) of 400 gauge polythene sheet and tied properly at both ends to ensure supply of proper moisture which facilitates the development of roots. After about 50-60 days, the adequate root system develops from the upper end of the ring, which is visible through the polythene film. The layer is removed by making a sharp cut about 5 cm below the lower end of the ring, preferably in 2-3 stages. The detached layers are planted in partial shade. Success in rooting of the layer is determined by temperature and humidity. When night-time temperature falls to less than 20°C the root becomes brittle. Thus, June-July is considered to be best time for air-layering. In order to enhance the success of the detached layer, defoliation of leaves up to 50 per cent is advocated. At the time of planting excess vegetative growth may be removed to maintain balance between the top and newly developed root system. Litchi layers become ready for field planting in 4-5 months. Growing of layers in the greenhouse has been found to enhance success.

Planting:

To improve the fertility of the soil organic matter was added. A green manure crop was grown and incorporated into the soil, which improved its fertility, moisture holding capacity and physical condition. Pits 90 x 90 x 90 cm in dimension were dug at the spacing decided for the orchard. Pit opening is normally recommended in April-May to have a sterilization effect for about 3 days. Before the onset of monsoon pits were filled with topsoil mixed with about 40 kg decomposed compost, 2 kg neem cake, 1 kg bone meal/single super phosphate and 200-300 g muriate of potash. Incorporation of about 2 baskets of soil from the root zone of old litchi trees encourages the mycorrhiza growth. Then the soil was allowed to settle with the first few rains and leveled properly. Planting was done during June to July. At the time of planting a hole the size of ball of earth was made in the centre of the pit at the marked point where the plant was fixed and the soil was pressed to remove air.

Spacing and planting system:

Litchi is an evergreen spreading tree, which attains the height of about 10-12 m at its full growth and development. Light penetration of its canopy is also desirable for proper fruiting, hence, planting in square system at a distance of 5-

6 m within and between the rows has been practiced. Planting of litchi in a double hedgerow system at a distance of 4.5 x 4.5 x 9 m accommodating 329 plants/ha has been found to be the best and gave higher yield of equally good quality fruits up to 16 years of plantation. High density planting adopting a double row system has also been found to be superior at other locations in terms of yield and quantity of fruits.

RESEARCH FINDINGS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarised under following heads:

Present status of litchi cultivation (Table 1, 2, 3 and 4):

The world litchi production was about 2, 00, 000 tonnes during 2004-05 from an area of 7, 23,000 ha, most of litchis are produced in China, India and Thailand. India is the second largest producer of litchi in the world next to China. In India, commercial cultivation of litchi is restricted in the northern part and north-eastern part of India. The major litchi – growing states are Bihar, West Bengal, Uttarakhand, Jharkhand, Assam, Tripura and Orissa. Litchi accounts for around 1 per cent of the total area under fruits in the country, having definite economic significance in its growing areas. The present level of area, production and productivity in India have been given in Table 2. The exacting climatic requirements restrict its cultivation only to certain regions in the country, with an area of 74, 400 ha, production of 4, 83, 300 m.t and productivity of 6.5 tones per hectars (Table 2) (Anonymous, 2010). Bihar accounts for major share of more than 50 per cent of the country's total production. The area, production and productivity of litchi in 2007-08, 2008-09 and 2009-10 have been given in Table 3 (Anonymous, 2010). There has been a substantial increase in area and production of litchi in last few years. It has increased from 6,9100 ha in 2007-08 to 7,4400 ha in 2009-10 (Table 3) (Anonymous, 2010). In Tripura litchi is the six most important fruit crop next to jack fruit, banana, pineapple,

Table 1 : Area, production and productivity of litchi in Tripura

Year	Litchi		
	Area	Production	Productivity
2000-01	1478	8869	6.0
2001-02	1628	8900	5.5
2002-03	1738	8950	5.2
2003-04	2167	12528	5.8
2004-05	2212	12449	5.6
2005-06	2346	14255	6.1
2006-07	2476	14400	5.8
2007-08	2722	10032	5.89
2008-09	2762	16165	5.85
2009-2010	2762	16972	6.14

mango and citrus, is cultivated in about 2,762 ha and production is 16,972 m. t and productivity 6.14 t ha⁻¹ (Table 1) (Anonymous, 2010), which is far below the national productivity. There has been a substantial increase in area, production and productivity of litchi in Tripura in last 10 years. It has increased from 1,478 ha in 2000 to 2,762 ha in 2009-10. There has been a faster increase in area, production

and productivity of litchi in the state.

Evaluation of some varieties under climatic condition of Tripura:

Shahi:

It is one of the important and choice cultivars of Tripura, West Bengal and adjacent states. Besides having high

Table 2: All India area (000 ha), production (000mt) and productivity (ha/mt) of litchi

Year	Area	% of total frt. area	Production	% of total frt. area	Productivity
1991-92	49.3	1.7	243.8	0.9	4.9
2001-02	58.1	1.4	355.9	0.8	6.1
2002-03	54.1	1.4	476.4	1.1	8.8
2003-04	53.7	1.1	478.5	1.0	8.9
2004-05	60.0	1.2	368.6	0.7	6.1
2005-06	63.2	1.2	392.1	0.7	6.2
2006-07	65.0	1.2	403.0	0.7	6.2
2007-08	69.0	1.2	418.0	0.6	6.1
2008-09	72.0	1.2	423.0	0.6	5.9
2009-10	74.4	1.2	483.3	0.7	6.5

Source: Horticulture database 2010

Table 3 : State wise area (000 ha), production (000mt) and productivity (ha/mt) of litchi

State	2007-08			2008-09			2009-10		
	Area	Pron.	Pdy.	Area	Pron.	Pdy.	Area	Pron.	Pdy.
Bihar	29.8	223.2	7.5	30.5	216.9	7.1	30.6	215.1	7.0
West Bengal	8.1	77.8	9.6	8.4	81.2	9.7	8.4	82.4	9.8
Jharkhand	3.3	16.5	5.0	4.3	20.3	4.8	4.3	51.1	12.0
Assam	4.8	34.0	7.1	4.8	34.9	7.2	5.1	39.2	7.7
Punjab	1.5	19.3	12.9	1.5	21.3	13.9	1.6	22.4	14.1
Chhatisgarh							3.0	17.8	6.0
Orrisa	4.0	12.8	3.2	4.2	13.0	3.1	4.3	17.1	4.0
Tripura	2.6	14.4	5.5	2.8	14.4	5.1	2.8	17.1	6.1
Uttrakhand	8.8	15.1	1.7	8.8	15.3	1.7	9.1	15.7	1.7
Others	6.2	5.3	0.9	6.6	6.2	0.9	5.2	5.5	1.1
Total	69.1	418.4	6.1	71.9	423.4	5.9	74.4	483.3	6.5

Source: Horticulture database 2010

Table 4 : Evaluation of different varieties of litchi under climatic condition of Tripura

Varieties and Hybrids	Fruit wt. (g)	Pulp wt.(g)	Seed wt.(g)	TSS (%)	Acidity (%)	Vit. 'C'(mg/ 100 g pulp)	Creaking %	Yield (kg/Tree)
Shahi	22.42	17.02	3.57	22.62	0.29	53.27	10.18	61.57
Swarna Roopa	18.47	14.95	3.17	18.88	0.39	46.57	0.0	48.27
China	20.50	13.53	3.92	20.72	0.47	46.57	0.0	47.73
Elachi	16.07	11.60	2.18	18.45	0.46	46.83	14.10	43.30
Bombai	19.43	14.48	3.67	20.28	0.33	60.40	0.0	60.67
Early Bedana	19.45	14.88	1.93	19.67	0.29	51.13	4.33	43.17
Late Bedana	19.65	15.07	2.07	21.03	0.31	62.17	8.07	54.60
Dehradon	17.05	12.10	2.53	17.75	0.78	42.70	10.00	56.33
Mazaffarpur	18.45	13.67	2.82	18.05	0.79	40.50	8.16	56.25
Rose Scented	19.75	13.70	3.47	21.47	0.35	41.07	8.68	54.82
S.E. ±	0.53	0.47	0.18	0.36	0.02	02.51	1.48	3.58
C.D. (P=0.05)	1.57	1.41	0.53	1.06	0.06	07.43	4.41	10.65

quality fruit, it has a distinct rose aroma and hence is called 'Rose Scented'. This is regular bearing and high yielding (60-70kg/tree) under climatic condition of Tripura, which start flowering in first week of February and ripening start in first week of May. The fruits are large in size (3.8 cm long and 3.3 cm in diameter), heavier in weight (22.42 g/ fruit), pulp weight (17.02 g), seed weight (3.57g), oval to oblong-conical in shape having crimson red tubercles on uranium-green skin background at full ripening (Table 4). Fragrant aril is greyish white, soft, moderately juicy (65%) sweet containing 22.62 °brix TSS, acidity (0.29 %), and ascorbic acid (53.27mg/100 g pulp). It has large seed (2.5 cm long and 1.6 cm diameter) with smooth, shining and dark chocolate seed coat. The cracking percentage is 10-11 %. This cultivar is suitable for canning.

Bombai:

It is important cultivar of Tripura, West Bengal possesses vigorous canopy attaining a height of 6-7m and spread 7-8 m and bears fruits in large bunches (Table 4). The tree starts flowering at first week of February and fruit matures last week of April to first week of May and yield about 60-65 kg per tree. Fruits are large in size (3.6 cm long and 3.3 cm diameter) obliquely heart shape and each fruit has another tiny underdeveloped fruit attached to the fruit stalk. The ripe fruit is attractive carmine red with uranium green skin colour. The average fruit weight is 19.43 g per fruit, pulp is creamy white, pulp weight is 13.67g, seed weight (2.82 g), pulp soft, juicy (55-60 %), good flavour, aroma, test, sweet containing 18.050 brix TSS, ascorbic acid (60.40 mg/100 g pulp) and 0.33 % acidity. Seed is big (3.67 g), elongated, smooth and shining light chocolate colour is 2.4 cm long with 1.7cm diameter.

Muzaffarpur (syn. Late Large Red):

It is important cultivar grown in Tripura and West Bengal. The fruits are deep orange to pink, start flowering at first week of February and fruit matures last week of April to first and second week of May and yield about 55-60 kg per tree (Table 4). Average fruit weight is 18.45 g per fruit, pulp is greyish creamy white, pulp weight (14.48 g), seed weight (2.82 g), pulp soft, juicy (50-60 %), good flavour, aroma, test, sweet containing 18.45 ° brix TSS, ascorbic acid (40.50 mg/100 g pulp) and 0.79 % acidity. Seed is medium (2.82 g).

Swarna Roopa:

It is a clonal selection from seedless group of litchi cultivar. Tree is medium tall to medium spread with dense foliage and leaf is dark green foliage where as new flush is pink in colour. Tree starts flowering at first week of February and fruit matures last week of April to first and second week of May and yield is about 55-60 kg per tree (Table 4). Average

fruit weight is 18.47 g per fruit, medium size (3.2 cm), length and 2.8 cm diameter and bears fruits in cluster, attractive red in colour, pulp is creamy white, pulp weight is 14.95 g, seed weight is 3.17 g, pulp soft, juicy (50-60 %), sweet, containing 18.88 ° brix TSS, ascorbic acid (46.57 mg/100 g pulp) and 0.39 per cent acidity.

Late Bedana (syn. Late Seedless) :

It is one of the cultivar is also known as Late Seedless. This is a late maturing cultivar, usually tree start flowering in first week of February, usually ripens in second week of May to last week of May. The trees are vigorous having an height of 5 to 6 m and spread of 6 to 7 m (Table 4). It is a high yielder with annual yield of 50-60 kg/ tree under Tripura condition. The fruit is medium size (3.3 cm length and 3 cm diameter) with average fruit weight (19.65g per fruit). The fruits are conical in shape with reddish pink in colour having dark blackish brown tubercles at maturity. The pulp weight (15.07 g), seed weight (2.06 g), pulp is creamy white, soft, juicy (60-65 %) , sweet having 21.030 brix TSS, ascorbic acid (62.17mg/ 100g pulp) and 0.31 per cent acidity. The seed are small (2.1 cm length and 1.1 cm in diameter) with chocolate in colour having fusiform shape. The cracking percentage is 8.07 per cent.

China:

It is one of the good cultivar of litchi. The trees are semi- dwarf with small leaves. This is mid season cultivar, tree start flowering in first week of February, usually ripens in second week of May to last week of May (Table 4). Height of the tree is 4-5 m and spread 5-6m with a yield 45-50 kg per tree. The fruits are medium in size (3.80 cm length and 3.20 cm diameter), medium in weight (20.50 g/fruit), oblong in shape and reddish in colour with dark tubercles at maturity. Pulp weight is (13.53 g), seed weight (3.92 g), pulp is creamy white, soft, juicy (55-60 %), sweet having 18.88 ° brix TSS, ascorbic acid (46.57mg/ 100g pulp) and 0.47 per cent acidity. Seed is big (3.92 g), dark chocolate colour oblong to concave in shape, size 3 cm long with 1.6 cm diameter.

Elachi:

This is important cultivars grown in Tripura and West Bengal. The trees are of medium height of 5-6 m and spread of 6-7 m (Table 4). It is a mid season cultivar which starts flowering in last week January to first week of February, usually ripens in second week of May to last week of May with a yield of 40-45 kg per tree. Fruits are conical, marigold-orange red in colour with an average weight (16.07 g per fruit), pulp weight (11.60g), seed weight (2.18g), pulp creamy white in colour, sweet, soft, juicy (55-60 %) with good flavour and taste. TSS is 18.45 ° brix, ascorbic acid (46.83mg/100g pulp) and 0.46 per cent acidity. Seeds are small and shining.

Early Bedana (syn. E. Bedana):

This fruits are also known a Early Seedless because of its early ripening and small seeds (1.93g). Tree has medium canopy attaining an average height of 4-5 m and spread of 5.5 to 6.5 m (Table 4). It is a regular bearing and medium yielder (40-45 kg per tree). The fruits are medium size (3.3 cm length and 3.1 cm diameter) and average weight (19.45 g) having oval or heart shape, rough surface with uranium green skin cover with carmine red tubercles at maturity. Pulp weight is 14.88g, pulp creamy white in colour, sweet, soft, juicy (65-70 %) with good flavour and taste, TSS 19.67 °Brix, ascorbic acid (51.13mg/100g pulp) and 0.29 per cent acidity. Seeds are small, shrunken, glabrous and dirty chocolate in colour. The over all fruit acceptability is good.

Dehradoon (syn. Dehra Rose):

This is an important cultivar and also known with the name of Dehra Rose. The tree start flowering in first week of February, usually ripens in last week of May with a yield of 55-60 kg per tree (Table 4). Tree medium size (4-5m height and 6-7 m spread). The fruits are medium size with 3.5 cm length and 3.3 cm diameter, 17.08 g weight having oblique-heart to roundish shape. At ripening stage it has attractive bright rose pink coloured fruits. Pulp weight is 12.10 g, pulp is greyish-white, soft, juicy (60-93 %), sweet 17.75 °Brix, ascorbic acid (42.70mg/100g pulp) and 0.78 per cent acidity. Seeds are medium (2.5 cm length and 1.5 cm diameter), light in weight (2.53g), shrunken, oblong in shape and dark chocolate in colour. The creaking percentage is 10 per cent.

Rose Scented:

This is a popular cultivar, having distinct rose aroma and hence called as Rose Scented. The tree start flowering in first week of February usually ripens in last week of May with a yield of 50-55 kg per tree (Table 4). Tree vigorous size (7-8 m height and 8-9 m spread). Fruits are medium size (3.1 cm length and 3 cm diameter) with average weight (19.75 g) having globosely heart shape having rose madder and fuchsia purple background with red tubercles at maturity. Pulp weight is 13.70 g, pulp is greyish -white, soft, moderately juicy (50-55 %), sweet 21.47 °brix, ascorbic acid (41.07mg/100g pulp) and 0.35 per cent acidity. Seeds are medium (2 cm length and 1.40 cm diameter), light in weight (2.47g), smooth, shining, round-ovate in shape and blackish chocolate in colour. The creaking percentage is 1.48 per cent.

Among the varieties studied (Table 4) the highest fruit weight was recorded in variety Shahi (22.42 g) followed by China (20.50) and lowest fruit weight was found in variety Elachi (16.07g). The highest fruit pulp was recorded in variety Shahi (17.02 g) followed by Late Bedana (15.07 g) and lowest pulp weight was recorded in variety Elachi (11.60g).

The lowest seed weight was recorded in the variety Early Bedana (1.93 g) and highest seed weight was recorded variety China (3.92 g). The variety Shahi recorded highest TSS (22.62°Brix) followed by Late Bedana (21.47°Brix). The lowest acidity recorded in the varieties Shahi (0.29 %) and Early Bedana (0.29 %). The variety Late Bedana recorded highest ascorbic acid (62.17 mg per 100 g pulp) followed by variety Bombai (60.40 mg per 100 g pulp). The highest creaking per cent was recorded variety Elachi (14.10 %) followed by variety Shahi (10.18 %) and the varieties Swarna Roopa, China, Bombai was recorded in no cracking. The highest yield recorded variety Shahi (61.57 kg per tree) followed by variety Bombai (60.67 kg per tree). Similar kind of observations were also reported with respect of average yield per tree, average fruit weight, pulp content, TSS and acidity by Kanwar and Nijjar (1975); Jawanda and Singh (1977); Batten (1984) and Menzel and Simpson (1986) and also the physico-chemical characteristics like fruit weight, peel percentage, TSS and acidity of some important cultivars as described by Ghosh *et al.* (1987); Menzel *et al.* (1986) and Sharma and Ray (1991). Among the varieties evaluated under Tripura condition, the varieties Shahi, Mazaffarpur, Swarna Roopa, Bombai, Rose scented and Late Bedana were found for good performance, demand, adoptability, acceptability, colour, size, shape, pulp content, taste, aroma and yield.

Conclusion :

Among the varieties evaluated under Tripura condition, the varieties Shahi, Mazaffarpur, Swarna Roopa, Bombai, Rose scented and Late Bedana were found for good performance, demand, adoptability, acceptability, colour, size, shape, pulp content, taste, aroma and yield. The Shahi is choice cultivar with high TSS (22.62 °Brix), low acidity(0.29 %), heavier in fruit weight (22.42 g/ fruit), pulp weight (17.02 g), high yield (60-70kg/tree) and also for its attractive colour, taste, aroma, sweetness and local demand. Litchi, a climate specific, evergreen fruit plant, has adapted well to the climate in North- Eastern India including Tripura. Due to its increasing demand day-by-day, the area under cultivation has increased manifold. However, there is need for improving productivity and also widening the genetic base. Concerted research efforts and effective linkages are essential. Suitable cultivars are needed for this climatic conditions. It is also essential to develop promising lines/hybrids, which have larger fruit size, small/chicken-tongued seeds, tolerance to pericarp splitting, fruit borers and having various time interval for maturity groupings.

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