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Present status of Khasi Mandarin in Tripura state of North East India

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Abstract

Khasi Mandarin (*Citrus reticulata* Blanco.) is one of the most widely cultivated and important commercial fruit crop of North East India. During 2018, a survey was conducted in Mandarin orchards of Tripura to study the present status of Khasi Mandarin in relation to growth, yield, quality, soil, insect pest and disease tolerance. The study revealed that the present condition of Mandarin orchards from Tripura is not properly maintained by the farmers due to heavy infestation of insect, pest and diseases and lower nutrient status of soil. Though the two district viz., Sipahijala and Gomati district of Tripura was found to have Khasi mandarin fruits in the orchards but the production is gradually going to be decline. The Mandarin fruits were evaluated morphologically and biochemically for different parameters. Most of the orchards of two districts of Tripura recorded superior quality fruits in respect of juice content (%), acidity (%), TSS (°Brix), TSS: Acidity and Ascorbic acid (mg/100 ml) content. Among the growth, yield and yield attributing parameters, the orchards of Tripura showed significant difference for all the characters studied. Incidence of various diseases, occurrence of major insect pest, lower nutrient concentration and lack of disease free quality planting materials are the bottlenecks accounting for overall low average productivity of 4.09 MT/ha. Though at present Tripura have limited area under Khasi mandarin production, but their quality was found superior.

Keywords: Khasi mandarin, quality, insect pest, diseases, yield

Introduction

Mandarins of north eastern region is generally known as 'Khasi Mandarin', 'Sohniampra' in Khasi, 'Humthira' or 'Komola' in Assamese, 'Komla' in Bengali and Manipuri languages. North eastern region of India is known for commercial production of Khasi Mandarin (*Citrus reticulata* Blanco.) and considered as one of the most important centers of origin of Citrus species. It is the most popular and a commercially widely cultivated variety of North Eastern States. In Tripura, Khasi Mandarin has got less attention by the farmers. Due to serious problem with viruses infection and very limited information is available for the incidence and spread of diseases. Because of the problem of citrus decline, production of Khasi Mandarin in North East India is gradually declined. The decline of productivity has been attributed to various factors like lack of quality planting materials, inadequate application of nutrients and incidence of insect-pest and diseases. Citrus decline involves the defoliation of young shoots and dying back of twigs from the tip downwards, resulting in loss of vigour, general health and decreased fruit production. This ultimately leads to decline of productivity to a greater extent (Yadav *et al.*, 2003) [6].

In India, citrus is cultivated over an area of about 1,055 thousand hectares with a production of 12,746 thousand metric tons and the productivity of 12.08 MT/ha. Out of this, Khasi Mandarin alone occupies an area of 429 thousand hectares with a production of 4754 thousand metric tons and the productivity of 11.08 MT/ha. However, Tripura cultivated Khasi Mandarin in an area of about 7.60 thousand hectares with production of 31.09 thousand metric tons and the productivity of 4.09 MT/ha (Horticultural Statistics at a Glance, 2016-17). This low production and productivity of Tripura needs a thorough survey of Khasi mandarin orchards to assess the present status of Khasi mandarin in relation to growth, yield, quality, soil, insect pest and disease tolerance.

Methods and materials

The study was conducted in the district of Tripura viz., Sipahijala and Gomati during 2017. The geographical coordinates of two districts are: Sipahijala (latitude 23 °41' 11" N and

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longitude 91° 28' 49" E) and Gomati (latitude 23° 38' 14" N and longitude 91° 31' 48" E). Five mandarin grower's orchards from each of the two districts were selected randomly for investigation. Twenty plants from each of the five orchards from each district were selected to study the tree characters, yield and yield attributing characters and quality characters of the fruits. The morphological parameters were recorded in the orchards itself. The biochemical and soil parameters were carried out at Citrus Research Station, Assam Agricultural University, Tinsukia. Soil samples were collected according to the procedures of soil sample collection from different orchards. Symptomatic leaves with twigs using standard sampling technique were collected from 10 orchards for detection of Citrus greening disease. Per cent incidences of insect pest were recorded in the field itself. Data on growth and yield parameters viz., plant height (m), stem girth (cm), N-S plant spread (m), E-W plant spread (m), fruit length (cm), fruit diameter (cm), number of fruits per plant, fruit yield per plant (kg), fruit yield (t/ha) and fruit weight (g); quality parameters of the fruits viz., juice content (%), acidity (%), TSS (^oBrix), TSS: Acidity and ascorbic acid (mg/100 ml) and soil parameters viz., Fe, Mn, Cu and Zn content were recorded. The data was statistically analyzed by applying Fisher's analysis of variance (Panse and Sukhatme, 1989).

Results and discussion

Growth and yield parameters: The data presented in Table (1) reveals that the growth and yield parameters of Khasi Mandarin showed significant difference among different orchards from Sipahijala and Gomati district. The highest plant height of (7.63m) was recorded for Gomati district of orchard 2d which was at par with orchard 2e (7.30m), 2c (7.17m), 2a (6.80m) of Gomati district and 1e (7.03m) and 1a (6.77m) of Sipahijala district. The lowest plant height of (6.53m) was recorded for 1c and 1d of Sipahijala district. Hangsing *et al.* (2016) [2] reported plant height of 6.48m to 4.60m in Garo Hills of Meghalaya. Kakoti *et al.* (2019) reported 8.20m to 7.03m plant height of Khasi Mandarin in Manipur. In case of stem girth, the highest stem girth of 14.83cm was recorded for Gomati district of orchard 2c which was at par with all other orchards from Gomati district and orchard 1b, 1c and 1d of Sipahijala district. This highest result of plant height and stem girth of Gomati district was might be due to nutrients uptake by the plants. The lowest stem girth of 13.80cm was recorded for the orchard 1a and 1e of Sipahijala district. In regards to fruit length, Gomati district recorded highest (7.23cm) in orchard 2b which was at par with all other orchard viz., 2c (7.20cm), 2d (7.20cm), 2a (7.03cm) and 2e (6.93cm) from Gomati district. The lowest fruit length of 5.70cm was recorded for Sipahijala district. Similarly, fruit breadth showed highest for Gomati district in orchard 2c (7.90cm) which was again at par with the entire orchard from Gomati district viz., 2d (7.80cm), 2b (7.57cm), 2a (7.37cm) and 2e (7.03cm) respectively and also orchard 1b (6.60cm), 1c (6.57cm) and 1d (6.57cm) of Sipahijala district. The lowest fruit breadth of 6.17cm was recorded for orchard 1a of Sipahijala district. Maximum number of fruits per plant (119.67) was recorded for the district Gomati in orchard 2d which was at par with entire orchards from Gomati and Sipahijala district. In respect of fruit weight, the highest fruit weight of 210.17g was recorded for Gomati district which was statistically at par with entire orchard from Gomati and Sipahijala district except the orchard 1d (145.10g) from Sipahijala. Das *et al.* (2004) [1] reported fruit length of 5.28cm and fruit diameter of 5.22cm in case of Khasi Mandarin in

Meghalaya. Medhi *et al.* (2007) [4] reported fruit weight of 113.3g to 159.6g of Khasi Mandarin in Assam. Hangsing *et al.* (2016) [2] reported highest Khasi Mandarin fruit weight of 130.69g for the Garo Hills of Meghalaya. Kakoti *et al.* (2019) reported fruit length ranging from 7.33cm to 5.23cm, fruit breadth ranged from 8.43cm to 6.67cm, fruits per plant ranged from 126.00 to 82.33 and fruit weight ranged from 243.55g to 133.31g in case of Khasi Mandarin in Manipur. Gomati district of Manipur again recorded highest fruit yield/plant (22.30kg) in orchard 2d which was at par with entire orchard from Gomati and also orchard 1b (19.00kg) of Sipahijala. Similarly, Gomati district also recorded highest fruit yield (9.14t/ha) in orchard 2d which was again at par with entire orchards from Gomati and orchard 1b (7.10t/ha) from Sipahijala. The lowest fruit yield of 4.06t/ha was exhibited by orchard 1e of Sipahijala district. Sarangthem and Sharma (2017) found fruit number ranged from 310 to 80 and fruit yield per plant ranged from 46.8 to 11.6 kg/plant in case of Khasi Mandarin in Tamenglong district of Manipur. Kakoti *et al.* (2019) reported fruit yield per plant ranged from 28.33kg to 11.08kg and fruit yield ranged from 11.32t/ha to 4.54t/ha of Khasi Mandarin in Manipur. The results of growth and yield parameters from present investigation indicated that, Gomati district was found to be the highest for most of the parameters as compared to Sipahijala. This lowest result of Sipahijala district was might be due to improper management of Khasi Mandarin orchards, lack of nutrients to the plants and also heavy infestation of insect pest and diseases. This gradually leads to a decline in Khasi Mandarin orchards.

Quality parameters: The results on quality parameters showed significant variations among the orchards of Sipahijala and Gomati district of Tripura (Table 2). Data revealed that the highest juice content (45.38%) was exhibited by orchard 2c of Gomati district which was at par with entire orchard from Gomati and Sipahijala district except the orchard 1b (41.07%) of Sipahijala. Similarly, the minimum acidity content of 0.62% in orchard 2d was exhibited by Gomati district which was at par with entire orchards of Gomati and orchard 1c and 1e of Sipahijala district. The maximum acidity content of 0.69% was exhibited by orchard 1d of Sipahijala. Further, Gomati district recorded highest TSS content (12.00 ^oBrix) in orchard 2b which was at par with orchard 2c (11.67 ^oBrix) and 2e (11.67 ^oBrix). The lowest TSS content (10.00 ^oBrix) was exhibited by orchard 1b of Sipahijala. In respect of TSS: acidity ratio, Gomati district recorded the highest 18.68 in orchard 2c which was at par with entire orchards of Gomati and Sipahijala district. Medhi *et al.* (2007) [4] reported acidity content ranging from 0.42 to 0.48% and TSS ranged from 9.28 to 10.80 ^oBrix in case of Khasi Mandarin in Assam. Kakoti *et al.* (2019) reported juice content ranged from 46.53 to 41.40%, acidity content ranged from 0.69 to 0.62% and TSS content ranged from 12.67 to 10 ^oBrix in case of Khasi Mandarin fruits in Manipur. In case of ascorbic acid content, the highest was exhibited by Gomati district of orchard 1d (49.74mg/100ml) which was at par with entire orchards of Gomati and Sipahijala district. The lowest ascorbic acid content of 43.50mg/100 ml was recorded for Sipahijala in orchard 1d. Das *et al.* (2004) [1] reported ascorbic acid content of 21mg/100 ml in Khasi mandarin. Yadav *et al.* (2003) [6] reported 28.40 to 35.50mg/100 ml of ascorbic acid content in Khasi mandarin. Medhi *et al.* (2007) [4] reported ascorbic acid content of 43.82 to 50.44mg/100ml in Khasi Mandarin fruits in Assam. Kakoti *et al.* (2019) [3] reported

ascorbic acid content ranged from 50.49 to 38.34 mg/100ml of Khasi Mandarin fruits in Manipur.

Detection of Citrus greening disease: The incidences of CGD of 10 orchards were found very high as 92% in Sipahijala district and 88% in Gomati district. The detection of CGD was done through iodine based technique and biological indexing.

Incidence of insect pest: The major insect pest found in Khasi Mandarin orchards during the survey of Tripura are Trunk Borer, Bark Eating Caterpillar, Leaf Miner, Lemon Butterfly and Citrus Psylla. Among them, Trunk Borer recorded the highest incidence (41.10%) in orchard 1d of Sipahijala district. The lowest incidence of Trunk Borer was recorded in orchard 2d of Gomati district (11.60%). Bark Eating Caterpillar also showed highest incidence (35.50%) in orchard 1d of Sipahijala district. However, the lowest incidence of Bark Eating Caterpillar was again recorded in orchard 1b of Sipahijala district (10.90%). Further, Sipahijala district also recorded highest incidence of Leaf Miner (49.27%) in orchard 1e. The least incidence of Leaf Miner (15.40%) was found in orchard 2a of Gomati district. Lemon Butterfly showed highest incidence in orchard 1e (27.89%) of Sipahijala district and the lowest infestation of Lemon Butterfly was recorded in orchard 2b (6.54%) of Gomati district. Citrus Psylla showed least incidence (3.66%) in orchard 2a of Gomati district. The highest infestation of

Citrus Psylla (7.88%) was observed in orchard 1d of Sipahijala district.

Soil parameters: The data presented in Table (5) reveals that the soil parameters of Khasi Mandarin showed significant difference among two districts of Tripura. In respect of Fe present in soil of Khasi Mandarin orchards, Gomati district recorded the highest (87.03 mg/kg) in orchard 2b which was at par with same district of orchards 2c (84.08mg/kg). Sipahijala district recorded the lowest Fe content (68.81mg/kg) in orchard 1d. Additionally, Mn content was recorded highest in Gomati district (22.59mg/kg) in orchard 2b which was at par with orchard 2d (21.07mg/kg). The lowest amount of Mn was found in Sipahijala district (17.11mg/kg) in orchard 1b. Similarly, Cu and Zn contents were also found highest in Gomati district (0.85mg/kg) in orchard 2e and (0.74mg/kg) in orchard 2a. Sipahijala district recorded the lowest amounts of Cu (0.59mg/kg) in orchard 1d and Zn (0.48mg/kg) in orchard 1b in soil. Except Fe content, the distribution of Mn, Cu and Zn content varied from optimum to low to deficient level. In Sipahijala district, Cu and Zn content were found to be deficient. From the result, it was observed that growth and yield parameters were found to be the maximum where micro- nutrient contents were also found optimum in the soil. Kakoti *et al.* (2019)^[3] reported Fe, Mn, Cu and Zn content ranged from 84.88 to 66.20mg/kg, 22.09 to 18.28mg/kg, 0.87 to 0.57mg/kg and 0.75 to 0.47mg/kg in soils of Khasi Mandarin in Manipur.





Fig 1: Khasi mandarin orchards from Tripura



Fruits from Sipahijala



Fruits from Gomati

Fig 2: Khasi mandarin fruits from Tripura

Table 1: Growth and yield parameters of Khasi mandarin in Sipahijala and Gomati districts of Tripura

Districts with orchards	Plant height (m)	Stem girth (cm)	Fruit length (cm)	Fruit breadth (cm)	Fruits /plant	Fruit weight (g)	Fruit yield /plant (kg)	Fruit yield (t/ha)
1. Sipahijala								
1a	6.77	13.80	5.70	6.17	94.67	179.73	16.50	5.70
1b	6.70	14.40	5.97	6.60	100.67	183.73	19.00	7.10
1c	6.53	14.23	5.93	6.57	99.33	173.35	15.13	5.40
1d	6.53	14.37	5.97	6.57	105.33	145.10	14.02	5.04
1e	7.03	13.80	5.73	6.23	104.33	168.16	11.70	4.06
2. Gomati								
2a	6.80	14.33	7.03	7.37	109.67	206.49	20.30	8.30
2b	6.70	14.33	7.23	7.57	116.67	201.45	21.97	8.76
2c	7.17	14.83	7.20	7.90	112.00	191.85	19.16	7.49
2d	7.63	14.73	7.20	7.80	119.67	210.17	22.30	9.14
2e	7.30	14.40	6.93	7.03	112.67	207.40	21.38	8.74
SEd (\pm)	0.45	0.44	0.46	0.75	12.69	22.95	2.74	1.20
CD at 5%	0.91	0.89	0.95	1.54	26.01	47.05	5.62	2.46

Table 2: Quality parameters of Khasi mandarin in Sipahijala and Gomati districts of Tripura

Orchard No.	Juice content (%)	Acidity (%)	TSS (^o Brix)	TSS: Acidity	Ascorbic acid (mg/100 ml)
Sipahijala					
1a	42.09	0.68	10.33	15.38	45.15
1b	41.07	0.67	10.00	14.67	46.71
1c	43.13	0.64	10.33	15.62	47.96
1d	44.21	0.69	10.67	16.15	43.50
1e	43.13	0.64	11.00	17.27	45.16
Gomati					
2a	44.49	0.64	11.33	17.23	45.87
2b	45.30	0.64	12.00	18.56	44.34
2c	45.38	0.66	11.67	18.68	44.08
2d	44.21	0.62	11.00	17.02	49.74
2e	44.69	0.66	11.67	17.95	48.31
SEd (\pm)	2.06	0.02	0.75	3.00	3.07
CD at 5%	4.23	0.04	1.53	6.15	6.30

Table 3: Detection of Citrus greening disease in Sipahijala and Gomati districts of Tripura

Orchard No.	No. of sample	+ve to CGD	-ve to CGD
1. Sipahijala			
1a	5	4	1
1b	5	5	0
1c	5	4	1
1d	5	5	0
1e	5	5	0
2. Gomati			
2a	5	4	1
2b	5	5	0
2c	5	5	0
2d	5	4	1
2e	5	4	1

Table 4: Per cent incidence of major insect pests of Citrus in Sipahijala and Gomati districts of Tripura

Orchard No.	Trunk Borer	Bark Eating Caterpillar	Leaf Miner	Lemon Butterfly	Citrus Psylla
1. Sipahijala					
1a	26.60	19.20	28.13	19.57	6.60
1b	25.70	10.90	25.80	17.87	7.80
1c	32.08	30.22	17.54	12.46	5.68
1d	41.10	35.50	15.70	20.16	7.88
1e	28.10	31.21	49.27	27.89	7.18
2. Gomati					
2a	20.00	13.10	15.40	7.01	3.66
2b	13.90	22.80	19.90	6.54	4.90
2c	14.40	35.21	20.42	11.55	4.42
2d	11.60	31.90	19.86	19.32	4.50
2e	19.70	20.58	17.85	18.69	3.67

Table 5: Micronutrient status of Khasi mandarin in Sipahijala and Gomati districts of Tripura

Orchard No.	Fe (mg/kg)	Mn (mg/kg)	Cu (mg/kg)	Zn (mg/kg)
1. Sipahijala				
1a	71.75	19.76	0.64	0.52
1b	70.15	17.11	0.63	0.48
1c	74.86	17.99	0.77	0.65
1d	68.81	18.80	0.59	0.55
1e	73.66	18.51	0.78	0.64
2. Gomati				
2a	81.95	19.38	0.83	0.74
2b	87.03	22.59	0.80	0.67
2c	84.08	19.20	0.79	0.69
2d	76.59	21.07	0.76	0.67
2e	75.06	20.58	0.85	0.69
SEd (\pm)	2.63	1.32	0.03	0.03
CD at 5%	5.39	2.70	0.06	0.07

Conclusion

From the present investigation, it was concluded that Khasi mandarin orchards from Tripura produces mandarin in a limited quantity. However, results also indicated that the production is gradually going to be decline due to heavy infestation of insect, pest and diseases and lower nutrient status of soil. Farmers are also facing a problem on marketing of their produce. Therefore, certain strategy to be followed to increase the yield of mandarin by establishing new orchard with disease free planting material and also improved technology of integrated insect, pest, diseases and nutrient management will further help in improving the Khasi mandarin production in Tripura.

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