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MORPHOLOGICAL AND AGRONOMIC CHARACTERIZATION OF EXISTING MANDARIN (*Cirtrus reticulata blanco*) GERMPLASM

M. A. H. Talukder[1], M. M. Rahman[2], M. M. Hossain[2], M. A. K. Mian[3] and Q. A. Khaliq[4]

Abstract

An investigation was carried out in Sylhet, Moulvibazar, Panchagarh and Bandarban districts from September 2009 to December 2011 with a view to characterize and evaluate the existing mandarin germplasm. Twenty nine mandarin genotypes were studied of which twenty one were Khasi and eight were Nagpuri type. Wavy type of leaf lamina margin was observed in three genotypes of Khasi type (CR-Pan 017, CR-Pan 018 and CR-Pan 020) collected from Panchagarh. The number of fruits per plant ranged from 322 to 1270 in Khasi type and 415 to 960 in Nagpuri type. The highest fruit weight was 181.64 g in Khasi and 168.80 g in Nagpuri type. The genotype CR-Mou 002 of Khasi type and CR-Mou 003 of Nagpuri type produced the largest fruit. The number of segments varied from eight to eleven. Three years average yield per plant ranged from 25.15 kg in CR-Pan 023 to 184.42 kg in CR-Pan 023. BARI Komala-1(Khasi type) yielded 76.27 kg fruits per plant. Total Soluble Solids close to or more than BARI Komala-1 (8.66%) in Khasi genotypes were CR-Mou 004, CR-Mou 008, CR-Syl 010, CR-Mou 012, CR-Pan 017 and CR-Pan 018 and Nagpuri genotypes were CR-Mou 003, CR-Ban 027 and CR-Ban 030. The genotypes CR-Pan 017 and CR-Pan 018 of Panchagarh were assuming Darjeeling cultivars. Among the 29 genotypes, CR-Mou 008, CR-Syl 012, CR-Pan 017 and CR-Pan 018 of Khasi type and CR-Ban 027 and CR-Ban 030 of Nagpuri type were tasted well.

Key words: Genotype, characterization, variability, Khasi mandarin, Nagpuri mandarin.

Introduction

For commercial cultivation of a crop, there need to have several varieties that are high yielding and possess other desirable traits. At present, there is only one mandarin variety released by BARI. For the improvement of mandarin, it is necessary to find out more new germplasm that are superior to the existing one. Selection is one of the methods to obtain new improved variety(ies) from the existing germplasm pool. A successful progress in breeding depends upon the genetic variability present in the population (Singh *et al.,* 1980). Therefore, it is necessary to identify and collect all the existing germplasm from throughout the country to enrich the germplasm pool and from that pool new variety(ies) may be obtained by screening. Fortunately, there are some collections of mandarin germplasm at the Regional Agricultural Research Station (RARS), BARI, Akbarpur, Moulvibazar;

[1]Pomology Division, Horticulture Research Center, Bangladesh Agricultural Research Institute, Gazipur-1701, [2]Department of Horticulture, [3]Department of Genetics and Plant Breeding and [4]Department of Agronomy, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur-1706, Bangladesh

Citrus Research Station, Jaintiapur, Sylhet and Hill Agricultural Research Station, Khagrachari. These germplasm were collected time to time from different parts of Bangladesh. So, there lies a scope of selecting better clone(s) from them, which are superior to our existing varieties. But, before initiating a selection or other breeding program, there is immense need to characterize the germplasm. Many workers have tried to build up and characterize the genetic resources of various tropical and subtropical fruits (Gupta *et al.,* 1993; Rai *et al.,* 1995; Rana *et al.,* 1993; Singh and Chandha, 1993). The evaluation of germplasm in different location would provide more usefull information on relative magnitude of different genetic parameters (Johanson *et al.,* 1955). Therefore, an effort has been made to characterize and evaluate the mandarin germplasm with a view to develop improved variety(ies)

Materials and Methods

Place of study: Mandarin germplasm were evaluated in Juri, Moulvibazar; Jaintiapur, Sylhet; Panchagarh sadar, Panchagarh and Bandarban sadar, Bandarban from September 2009 to December 2011. Twenty nine mandarin germplasm were studied, of which twenty one were Khasi and the rest eight were Nagpuri type (Table 1). Among these germplasm, eight were collected from Moulvibazar and seven from each of Sylhet, Panchagarh and Bandarban district.

Characterization

Mandarin plants were planted sporadically in the homestead as well as in the mandarin garden by the growers. Age of the plants varied from eight to ten years. The germplasm were characterized following the descriptor for citrus (International Board for Plant Genetic Resources) (Anon., 1999).

Data recorded

Data on shape of leaf lamina, leaf lamina margin, shape of fruit base and apex, average fruits per plant and fruit weight, fruit yield per plant, average fruit yield per plant of three consecutive years, rind colour, fruit length and diameter, rind thickness and weight, fruit axis type and diameter, segments per fruit and adherence of segments to each other, juice content, edible portion, total soluble solids and organoleptic test were recorded during the investigation period. Leaf lamina shape, leaf lamina margin were assessed by visual observation of ten randomly selected leaves from the same plant. The stalk end and the stylar end of a fruit are considered as fruit base and fruit apex, respectively. Shapes of fruit base and fruit apex of randomly selected ten fruits per plant were keenly observed and were recorded following the descriptor of IBPGR for citrus. When the fruit colour changes from green to yellow or light orange and attains maximum size, then it is supposed to be matured and ready for harvest. Then all the fruits per plant were counted and recorded. The weight of ten fruits selected randomly from the same plant was determined by an electric balance in gram and the average fruit weight was calculated. Fruit yield per plant was calculated from the individual fruit weight multiplied by number of fruits per plant. Average number of fruits per plant, fruit weight and average fruit yield per plant were estimated from three consecutive years. Rind (skin) colour of a fruit was keenly observed

Table 1. Genotype, location and type of mandarin.

Sl. No.	Genotype	Location	Type
1.	CR-Mou 001	Moulvibazar	Khasi
2.	CR-Mou 002	Moulvibazar	Khasi
3.	CR-Mou 003	Moulvibazar	Nagpuri
4.	CR-Mou 004	Moulvibazar	Khasi
5.	CR-Mou 005	Moulvibazar	Khasi
6.	CR-Mou 006	Moulvibazar	Khasi
7.	CR-Mou 007	Moulvibazar	Nagpuri
8.	CR-Mou 008	Moulvibazar	Khasi
9.	BARI Komala-1	Sylhet	Khasi
10.	CR-Syl 010	Sylhet	Khasi
11.	CR-Syl 011	Sylhet	Khasi
12.	CR-Syl 012	Sylhet	Khasi
13.	CR-Syl 014	Sylhet	Khasi
14.	CR-Syl 015	Sylhet	Khasi
15.	CR-Syl 016	Sylhet	Nagpuri
16.	CR-Pan 017	Panchagarh	Khasi
17.	CR-Pan 018	Panchagarh	Khasi
18.	CR-Pan 019	Panchagarh	Khasi
19.	CR-Pan 020	Panchagarh	Khasi
20.	CR-Pan 021	Panchagarh	Nagpuri
21.	CR-Pan 022	Panchagarh	Khasi
22.	CR-Pan 023	Panchagarh	Khasi
23.	CR-Ban 024	Bandarban	Nagpuri
24.	CR-Ban 025	Bandarban	Khasi
25.	CR-Ban 026	Bandarban	Khasi
26.	CR-Ban 027	Bandarban	Nagpuri
27.	CR-Ban 028	Bandarban	Nagpuri
28.	CR-Ban 029	Bandarban	Khasi
29.	CR-Ban 030	Bandarban	Nagpuri

and recorded. Length and diameter of fruits were measured by a digital slide calipers and recorded in centimeter from ten harvested fruits and mean value was calculated. The fruit was cut into halves and thickness of rind was measured in centimeter by a digital slide calipers at three points of the rind and mean was calculated. The weight of rind of ten fresh fruits was recorded with an electric balance and mean value was calculated. The axis of ten fruits per plant was keenly observed and the type was recorded as solid, semi-hollow and hollow. The diameter of fruit axis from ten fresh fruits was recorded with digital slide calipers and mean value was calculated. The number of segments in cut halves of ten fruits from the same plant was count and mean value was calculated. Adherence of segments is the degree of attachment of segment with each other during separation of segments and was recorded as weak, medium and strong. The separated pulp was blended with a blender and strained with fine cloth and the weight of juice was measured in grams by an electric balance and recorded. After separation of entire pulp from the segments, it was weighed by an electric balance in grams taken from ten fruits per plant and mean value was calculated. Percentage of edible portion was calculated using the average weight of pulp of randomly selected ten fruits with the following formula- Total soluble solids (TSS) content of mandarin pulp was estimated by using a hand refractometer. A drop of mandarin juice was squeezed from the fruit pulp on the prism of the refractometer (Model No. ATAGONI- Brix 0-32)

and per cent total soluble solid was obtained from the direct reading. The fruit was tested organoleptically by the members of the panel accordingly results were recorded.

Data analysis

Standard deviation (SD) and coefficient of variation (CV) were estimated according to Gomez and Gomez (1984).

Results and Discussion

A. Leaf and fruit shape: In all the genotypes, leaf form was observed as brevipetiolate i.e., length of petiole in all the genotypes was shorter than the length of leaf lamina. Leaf and fruit shape of different mandarin genotypes are presented in Table 2. Small variation was observed in leaf lamina shape and leaf lamina margin. Elliptic shape of leaf lamina was found in all the genotypes except CR-Mou 008 (Khasi type) and CR-Ban 028 (Nagpuri type) in which leaf lamina was ovate type. Wavy type of leaf lamina margin was observed only in three genotypes (CR-Pan 017, CR-Pan 018 and CR-Pan 020) which were of Khasi type. These three Khasi genotypes were different from other Khasi genotypes of Greater Sylhet and which are specific to Panchagarh. These genotypes may be of Darjeeling types. Rest of the genotypes showed slight wavy leaf lamina margin irrespective of genotypes. Fruit shape for all the genotypes was obloid type. Mazhar (1959) described the shape of fruits of Kinnow and Feutrell's Early as obloid and that of Nagpuri as ovate. The convex, truncate, concave and collared with neck shapes of fruit bases were observed in Khasi and collared with neck types are in Nagpuri (Table 2). Mazhar (1959) described that the base of the fruit of Kinnow, Wilking and Feutrell's Early is flat and that of Nagpuri is uneven. Both truncate and depressed type of fruits apex were found in Khasi and Nagpuri mandarin (Table 2).

B. Fruit characteristics

Data on fruits per plant, fruit weight and fruit yield per plant in different genotypes of mandarin are presented in Table 3. There was large variation in fruits per plant, fruit weight and fruit yield per plant in different genotypes of mandarin. Fruits of mandarin were harvested from 06 November to 22 November and different fruit characteristics were recorded. The number of fruits per plant is very important for mandarin farmer as they sell 8-10 Taka of each fruit whether it is sweet or not (Gafor and Choudhury, 2011). It ranged from 322 (CR-Pan 023) to 1270 (CR-Ban 025) per plant in Khasi type and it was 415 (CR-Syl 016) to 960 (CR-Ban 028) in Nagpuri type. Fifteen genotypes showed higher number of fruits than BARI Komala-1. The fruit weight ranged from 81.24 (CR-Pan 023) to 181.64 g (CR-Mou 002) in Khasi type. In Nagpuri type, it was from 81.40 g (CR-Syl 016) to 168.80 g (CR-Mou 003). Altaf *et al.* (2008) obtained 101 to 287 g fruit weight in Kinnow mandarin.

In Khasi type, three years average fruit yield per plant ranged from 25.15 kg in CR-Pan 023 to 184.42 kg in CR-Pan 023 per plant (Table 3). While in Nagpuri type, this range was from 35.37 kg in CR-Syl 016 to 132.09 kg in CR-Mou 003 per plant. BARI Komala-1 (Khasi type) yielded 76.27 kg per plant. In general, fruit yield per plant was higher in Khasi type than in Nagpuri type mandarin genotypes. This is due to the genetic potentiality of each genotype.

Table 2. Shape of leaf lamina, leaf lamina margin, fruit base and fruit apex in different mandarin genotypes.

Genotype	Leaf lamina shape	Leaf lamina margin	Fruit base shape	Fruit apex shape
		Khasi		
CR-Mou 001	Elliptic	Slight wavy	Truncate	Truncate
CR-Mou 002	Elliptic	Slight wavy	Truncate	Truncate
CR-Mou 004	Elliptic	Slight wavy	Concave	Truncate
CR-Mou 005	Elliptic	Slight wavy	Collared with neck	Truncate
CR-Mou 006	Elliptic	Slight wavy	Convex	Truncate
CR-Mou 008	Ovate	Slight wavy	Truncate	Truncate
BARI Komala-1	Elliptic	Slight wavy	Truncate	Truncate
CR-Syl 010	Elliptic	Slight wavy	Collared with neck	Truncate
CR-Syl 011	Elliptic	Slight wavy	Collared with neck	Truncate
CR-Syl 012	Elliptic	Slight wavy	Concave	Depressed
CR-Syl 014	Elliptic	Slight wavy	Concave	Truncate
CR-Syl 015	Elliptic	Slight wavy	Collared with neck	Depressed
CR-Pan 017	Elliptic	Wavy	Convex	Truncate
CR-Pan 018	Elliptic	Wavy	Concave	Truncate
CR-Pan 019	Elliptic	Slight wavy	Truncate	Depressed
CR-Pan 020	Elliptic	Wavy	Truncate	Truncate
CR-Pan 022	Elliptic	Slight wavy	Truncate	Truncate
CR-Pan 023	Elliptic	Slight wavy	Truncate	Truncate
CR-Ban 025	Elliptic	Slight wavy	Convex	Truncate
CR-Ban 026	Elliptic	Slight wavy	Convex	Depressed
CR-Ban 029	Elliptic	Slight wavy	Truncate	Truncate
		Nagpuri		
CR-Mou 003	Elliptic	Slight wavy	Collared with neck	Truncate
CR-Mou 007	Elliptic	Slight wavy	Collared with neck	Depressed
CR-Syl 016	Elliptic	Slight wavy	Collared with neck	Truncate
CR-Pan 021	Elliptic	Slight wavy	Collared with neck	Depressed
CR-Ban 024	Elliptic	Slight wavy	Collared with neck	Truncate
CR-Ban 027	Elliptic	Slight wavy	Collared with neck	Depressed
CR-Ban 028	Ovate	Slight wavy	Collared with neck	Truncate
CR-Ban 030	Elliptic	Slight wavy	Collared with neck	Truncate

Table 3. Average fruits per plant, fruit weight and fruit yield per plant in different mandarin genotypes during 2009-2011.

Genotype	Average fruits/ plant (no.)	Average fruit weight (g)	Fruit Yield/ plant (kg)			Average fruit yield/plant (kg)
			2009	2010	2011	
			Khasi			
CR-Mou 001	462	179.21	82.80	70.00	89.30	80.70
CR-Mou 002	631	181.64	114.61	122.62	110.90	116.04
CR-Mou 004	423	177.77	75.20	68.40	71.00	71.53
CR-Mou 005	583	175.44	102.28	115.00	108.65	108.64
CR-Mou 006	412	144.65	59.60	55.25	52.80	55.88
CR-Mou 008	510	139.39	71.09	81.00	68.27	73.45

Table 3. Continued.

BARI Komala-1	562	142.26	79.95	70.60	78.25	76.27
CR-Syl 010	602	169.80	102.22	89.12	105.00	98.78
CR-Syl 011	715	175.65	125.59	116.08	113.70	118.46
CR-Syl 012	367	160.08	58.75	61.24	66.00	62.00
CR-Syl 014	535	152.73	81.71	82.00	89.13	84.28
CR-Syl 015	345	156.98	54.16	50.65	48.83	51.21
CR-Pan 017	650	157.76	102.54	86.57	101.50	96.87
CR-Pan 018	700	161.25	112.88	109.00	100.64	107.51
CR-Pan 019	411	139.10	57.17	51.25	56.40	54.94
CR-Pan 020	580	149.87	86.92	78.20	89.10	84.74
CR-Pan 022	450	141.98	63.89	50.00	62.57	58.82
CR-Pan 023	322	81.24	26.16	28.28	21.00	25.15
CR-Ban 025	1270	134.07	170.27	202.00	181.00	184.42
CR-Ban 026	650	99.45	64.64	69.10	51.02	61.59
CR-Ban 029	450	134.68	60.61	58.50	52.33	57.15
			Nagpuri			
CR-Mou 003	825	168.80	139.26	125.00	132.01	132.09
CR-Mou 007	655	96.10	62.95	56.55	68.10	62.53
CR-Syl 016	415	81.40	33.78	33.60	38.74	35.37
CR-Pan 021	612	96.71	59.19	66.27	52.00	59.15
CR-Ban 024	900	89.67	80.70	93.40	78.10	84.07
CR-Ban 027	730	87.93	64.19	58.17	69.20	63.85
CR-Ban 028	960	84.56	81.18	88.00	73.04	80.74
CR-Ban 030	460	106.76	49.11	52.10	40.00	47.07
Mean	592.66	136.79	80.12	78.89	78.23	79.08
SD	206.86	33.92	31.38	34.70	32.71	32.48
CV (%)	34.90	24.80	39.17	43.98	41.82	41.07

Data regarding rind colour, fruit length, fruit diameter, rind thickness and rind weight of fruit in different genotypes are presented in Table 4. Rind colour varied in the genotypes. In Khasi mandarin, seven genotypes produced orange colour rind, five orange green, five greenish orange, two yellowish green and two yellow coloured fruit harvested in mid November. In Nagpuri mandarin, one genotype produced orange colour, two orange green, two greenish yellow, one yellowish green, one greenish yellow and one green fruit. Chahidi *et al.* (2008) reported various rind colour in Clementine mandarin.

Length of fruit ranged from 5.11 cm (CR-Pan 019) to 6.16 cm (CR-Pan 017) and diameter of fruit ranged from 4.84 cm (CR-Pan 023) to 6.65 cm (CR-Mou 002) in Khasi type (Table 4). The genotype CR-Mou 002 produced the largest fruit (5.70 cm × 6.65 cm) and CR-Pan 019 produced the smallest fruit (5.11 cm × 5.41 cm). The genotype CR-Mou 003 produced the largest fruit and CR-Syl 016 produced the smallest fruit (5.24 cm × 4.85 cm) in Nagpuri type. Altaf *et al.* (2008) reported fruit length varied from 4.2 to 7.0 cm and diameter ranged from 5.2 to 8.5 cm. Rind thickness in Khasi mandarin varied from 5.27 (CR-Pan 019) to 6.94 mm (CR-Mou 008). Whereas in Nagpuri type, the highest rind thickness was observed in CR-Ban 024 (7.21 mm) and the lowest was in CR-Pan 021 (5.51 mm). Rind thickness was comparatively higher in Nagpuri than in Khasi mandarin. Rind weight varied from 18.60 to 43.64 g in Khasi type. Genotype CR-Mou

Table 4. Rind colour, fruit length, fruit diameter, rind thickness and rind weight in different mandarin genotypes.

Genotype	Rind colour	Fruit length (cm)	Fruit diameter (cm)	Rind thickness (mm)	Rind wt. (g)
		Khasi			
CR-Mou 001	Greenish orange	5.78	6.42	5.37	43.31
CR-Mou 002	Orange green	5.70	6.65	5.49	43.64
CR-Mou 004	Orange green	5.66	6.47	5.62	41.32
CR-Mou 005	Orange green	5.35	6.52	6.20	42.18
CR-Mou 006	Orange	5.51	5.42	6.37	36.85
CR-Mou 008	Orange	5.68	6.12	6.94	31.54
BARI Komala-1	Orange	5.50	6.15	5.52	29.25
CR-Syl 010	Orange	5.64	6.14	5.50	33.15
CR-Syl 011	Orange green	5.61	6.43	5.84	41.00
CR-Syl 012	Orange	5.21	6.35	5.36	34.15
CR-Syl 014	Yellowish green	5.25	6.13	5.96	26.56
CR-Syl 015	Orange	5.33	6.33	6.72	35.40
CR-Pan 017	Yellow	6.16	5.96	6.24	24.08
CR-Pan 018	Greenish orange	5.87	6.20	6.61	25.58
CR-Pan 019	Orange	5.11	5.41	5.27	20.65
CR-Pan 020	Greenish orange	5.69	6.10	5.44	20.06
CR-Pan 022	Greenish orange	5.47	5.57	5.75	27.23
CR-Pan 023	Yellow	5.46	4.84	5.90	19.34
CR-Ban 025	Yellowish green	5.75	5.61	5.64	18.60
CR-Ban 026	Greenish orange	5.61	5.33	6.46	21.42
CR-Ban 029	Orange green	5.46	6.44	5.90	27.10
		Nagpuri			
CR-Mou 003	Greenish orange	5.89	6.14	6.91	39.94
CR-Mou 007	Green	5.42	4.82	6.89	25.35
CR-Syl 016	Orange green	5.24	4.85	6.59	18.50
CR-Pan 021	Orange	5.13	5.02	5.51	16.90
CR-Ban 024	Greenish orange	5.52	4.93	7.21	21.55
CR-Ban 027	Yellowish green	5.45	5.06	6.25	18.71
CR-Ban 028	Orange green	5.40	4.95	5.63	19.23
CR-Ban 030	Greenish yellow	5.57	5.41	6.74	18.35
Mean	-	5.53	5.79	6.06	28.31
SD	-	0.24	0.61	0.58	8.95
CV (%)	-	4.32	10.57	9.51	31.63

002 produced the heaviest fruit rind followed by CR-Mou 001, CR-Mou 004 and CR-Mou 005 and the lightest was in CR-Ban 025. In Nagpuri mandarin, CR-Mou 003 produced the heaviest rind weight and lightest fruit rind weight in CR-Pan 021. Rind weight was higher in Khasi than in Nagpuri mandarin. Altaf *et al.* (2008) observed 24 to 71 g peel weight in Kinnow mandarin. According to a description given by Mazhar (1959), Kinnow, Feutrell's Early, Coorg and Nagpuri varieties have less percentage of rind.

Data regarding type of fruit axis, axis diameter, number of segment and segment adherence to each other of different mandarin genotypes are presented in Table 5. Fruit axis in most of the genotypes was solid and the rest were hollow and semi-hollow irrespective of Khasi and Nagpuri types. Thirteen genotypes of Khasi and five of Nagpuri cultivars showed solid fruit axis. Four genotypes of Khasi and 2 of Nagpuri genotypes showed semi-hollow fruit

Table 5. Fruit axis type, axis diameter, segments per fruit and adherence of segments to each other in different mandarin genotypes.

Genotype	Fruit axis types	Axis diameter (cm)	Segments/ fruit (no.)	Segments adherence to each other
		Khasi		
CR-Mou 001	Hollow	1.56	11	Strong
CR-Mou 002	Hollow	1.41	9	Strong
CR-Mou 004	Semi-hollow	1.33	10	Strong
CR-Mou 005	Hollow	1.55	10	Strong
CR-Mou 006	Solid	1.64	9	Strong
CR-Mou 008	Solid	1.41	8	Medium
BARI Komala-1	Solid	1.12	10	Strong
CR-Syl 010	Semi-hollow	1.10	10	Medium
CR-Syl 011	Hollow	1.60	10	Strong
CR-Syl 012	Semi-hollow	1.16	10	Weak
CR-Syl 014	Solid	1.36	10	Strong
CR-Syl 015	Solid	1.17	9	Strong
CR-Pan 017	Solid	1.06	9	Medium
CR-Pan 018	Solid	1.32	10	Strong
CR-Pan 019	Solid	1.14	9	Strong
CR-Pan 020	Solid	1.55	10	Strong
CR-Pan 022	Solid	1.43	10	Strong
CR-Pan 023	Solid	1.52	10	Strong
CR-Ban 025	Solid	1.38	10	Strong
CR-Ban 026	Solid	1.54	11	Strong
CR-Ban 029	Semi-hollow	1.32	9	Medium
		Nagpuri		
CR-Mou 003	Solid	1.54	10	Strong
CR-Mou 007	Hollow	1.41	10	Weak
CR-Syl 016	Solid	1.69	10	Strong
CR-Pan 021	Solid	0.96	9	Strong
CR-Ban 024	Semi-hollow	1.45	9	Weak
CR-Ban 027	Semi-hollow	1.20	10	Medium
CR-Ban 028	Solid	1.42	10	Strong
CR-Ban 030	Solid	1.31	10	Strong
Mean	-	1.37	9.72	-
SD	-	0.19	0.65	-
CV (%)	-	13.84	6.67	-

axis. Diameter of fruit axis in Khasi mandarin ranged from 1.06 cm (CR-Pan 017) to 1.64 cm (CR-Mou 006) and in Nagpuri mandarin this range was from 0.96 cm (CR-Pan 021) to 1.54 cm (CR-Mou 003). Fruit axis diameter of some genotypes in Khasi type (CR-Mou 001, CR-Mou 005, CR-Mou 006, CR-Syl 011 and CR-Pan 20) was recorded higher than in the genotype CR-Pan 021 which produced highest fruit axis diameter in Nagpuri types.

From the Table 5 it was revealed that number of segments varied in different genotypes. Most of the Khasi genotypes and all of Nagpuri produced nine to ten segments. The highest number of segments (11) in a fruit of Khasi type was recorded from CR-Mou 001 and CR-Ban 026. Whereas, minimum segments (8) was recorded in CR-Mou 008. Most of the Nagpuri mandarin produced ten segments and only CR-Pan 021 and CR-

Ban 024 produced nine segments. Altaf *et al.* (2008) found 8-12 segments per fruit in Kinnow mandarin. Whereas, Singh and Singh (2004) were noted that 11.5 segments exist per fruit in mandarin. The number of segment represents the number of carpels within the ovary. Segment adherence to each other was strong in most of the genotypes of Khasi and Nagpuri mandarins. Four genotypes of Khasi and one of Nagpuri showed weak adherence. On the other hand four of Khasi and one of Nagpuri genotypes showed medium adherence of segments.

Data on juice content, edible portion, total soluble solids (TSS) and taste of different genotypes of mandarin are presented in Table 6. Various amount of juice was obtained in the studied genotypes. The genotype CR-Mou 003 produced higher amount of juice (60.63 ml) in Khasi type followed by CR-Mou 002 (58.03 ml), CR-Mou 005 (60.63 ml), CR-Syl 010 (56.30 ml), CR-Syl 011 (59.64 ml) and CR-Syl 015 (56.51 ml), CR-Pan 017 (59.18 ml) and the lowest in CR-Syl 014 (43.46 ml). The highest amount of juice in Nagpuri mandarin was obtained in CR-Mou 003 (61.00 ml) and the lowest in CR-Pan 016 (23.72 ml). Percentage of edible portion also varied. Maximum edible portion (85.51%) in Khasi mandarin was found in the genotype CR-Pan 020 and minimum (72.98%) in the genotype CR-Mou 006. The genotypes in which more edible part was observed than in BARI Komala-1(77.82%) included CR-Syl 010 (79.16%), CR-Syl 014 (81.68%), CR-Pan 017 (83.36%), CR-Pan 018 (82.9%), CR-Pan 019 (83.51%), CR-Pan 020, CR-Pan 022 (79.62%), CR-Ban 025 (84.44) and CR-Ban 029 (78.30%). Whereas in Nagpuri type edible portion varied from 72.61% (CR-Mou 007) to 80.98% (CR-Ban 30). All the genotype produced more than 70% edible portion.

It is revealed from the Table 6 that TSS (%) in the genotypes varied from 7.21 (CR-Ban 029) to 9.30 (CR 018). Altaf *et al.* (2008) obtained 8-12.5% TSS in mandarin. Babu and Yadav (2002) obtained that 10.48% TSS in mandarin. Khasi genotypes in which the TSS (%) was close or more than in the released variety BARI Komala-1 (8.66%) were CR-Mou 004 (8.75%), CR-Mou 008 (8.75%), CR-Syl 010 (8.65%), CR-Mou 0012 (9.20%), CR-

Table 6. Juice content, edible portion, TSS and taste in different mandarin genotypes.

Genotype	Juice content (%)	Edible portion (%)	TSS (%)	Taste
Khasi				
CR-Mou 001	42.06	74.86	8.11	Very poor
CR-Mou 002	46.54	74.92	7.70	Very Poor
CR-Mou 004	43.64	75.63	8.75	Poor
CR-Mou 005	50.35	74.62	7.22	Fair
CR-Mou 006	52.50	72.98	7.84	Poor
CR-Mou 008	41.44	75.70	8.75	Good
BARI Komala-1	51.77	77.82	8.66	Good
CR-Syl 010	45.59	79.16	8.65	Good
CR-Syl 011	49.02	75.32	8.13	Very poor
CR-Syl 012	44.83	77.78	9.20	Excellent
CR-Syl 014	38.12	81.68	7.87	Fair

Table 6. Continued.

Genotype	Juice content (%)	Edible portion (%)	TSS (%)	Taste
CR-Syl 015	51.44	76.37	7.26	Very poor
CR-Pan 017	48.99	83.36	8.61	Good
CR-Pan 018	45.26	82.90	9.30	Good
CR-Pan 019	41.87	83.51	7.25	Fair
CR-Pan 020	42.41	85.51	7.71	Very poor
CR-Pan 022	49.82	79.62	7.61	Very poor
CR-Pan 023	42.92	74.73	8.40	Very poor
CR-Ban 025	38.28	84.44	7.22	Poor
CR-Ban 026	52.80	76.56	7.98	Fair
CR-Ban 029	50.87	78.30	7.21	Very poor
Nagpuri				
CR-Mou 003	52.38	74.54	8.96	Good
CR-Mou 007	43.25	72.61	7.20	Very poor
CR-Syl 016	41.73	75.07	6.00	Very poor
CR-Pan 021	45.51	79.53	7.44	Very poor
CR-Ban 024	41.54	73.90	7.62	Poor
CR-Ban 027	51.40	76.87	8.85	Good
CR-Ban 028	46.50	74.91	6.62	Very poor
CR-Ban 030	47.29	80.98	8.78	Good
Mean	46.21	77.86	8.10	-
SD	4.43	78.64	0.69	-
CV (%)	9.58	9.29	8.49	-

Pan 017 (8.61%) and CR-Pan 018 (9.30%). In case of Nagpuri genotypes, CR-Mou 003 (8.96 %), CR-Ban 027 (8.85 %) and CR-Ban 030 (8.78 %) produced the higher TSS than the BARI Komala-1. Percentage of TSS is an important issue in selecting a variety for commercial cultivation. In the present study, the genotype that had equal or higher TSS (%) than the recommended variety might be selected for commercial cultivation if they possess other desired characters. Most of the identified genotypes were able to satisfy the panel of judge except CR-Mou 004. Genotype CR-Syl 012 was excellent in taste. Anand and Leisram (1963) found that among nine mandarin varieties Nagpuri was the most palatable and least bitter. Babu and Yadav (2002) observed the highest juice (58.80%) and TSS (10.48%) content in Khasi mandarin. Ladaniya (1996) reported, Nagpuri mandarins grown near Nagpur developed minimum 10% TSS after 270-280 days from fruit set.

From this study it can be concluded that genotypes CR-Mou 008, CR-Syl 012, CR-Pan 017, CR-Pan 018, CR-Pan 017, CR-Pan 018, CR-Ban 027 and CR-Ban 030 were performed better and these can be recommended for mandarin variety.

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