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Characterization of pummelo germplasm in new alluvial zone of West Bengal

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Abstract

Pummelo (*Citrus grandis* Osbeck.), the giant among the citrus, is one of the major monoembryonic species and is well known as the ancestor of grapefruit. The present investigation was carried out with twelve genotypes of pummelo with three replications in each during 2016-17 considering nineteen characters like leaf characters, flowering and fruit morphological, physical and chemical characters from 'citrus descriptor' (cited by IPGRI, Rome, Italy). Among different morphological characters of leaf, fruit, pulp and seed the pattern of variation was more in characters like leaf lamina margin, leaf apex, fruit shape, fruit base, fruit skin colour, pulp colour and seed shape. The above-mentioned morphological characters are generally highly heritable characters and identity of individual types which may lead to chance of getting desirable types. Early flowering and maximum yield obtained in Type-1. The wide variation of fruit yield showed due to number of fruits per plant and other yield attributing characters. Less number of seeds in a fruit was obtained in Type-9. Significant variation in ascorbic acid (34.98 – 62.61 mg/100 ml juice) was obtained among different pummelo germplasm. From the present investigation, it can be concluded that there is a wide range of variation among different pummelo germplasm. Few types can be exploited for commercial cultivation in new alluvial zone of West Bengal like-Type-1, Type-2, Type-3, Type-5, Type-9 and Type-10 and Type-11.

Keywords: Pummelo, Citrus descriptor, variation, yield, TSS/acid ratio, characters.

Introduction

Citrus is a very ancient crop known to occur over 4000 years. There are more than 100 countries producing citrus in the world. In India citrus fruit ranks second in area after mango and third in production after banana and mango. Pummelo is one of the major monoembryonic species of citrus. It is considered as the giant among the citrus fruits and is well known as the ancestor of grapefruit. Pummelo is considered as an easily recognized species due to a number of notable morphological characteristics, such as huge leaves borne on broadly winged petioles, very large and fragrance flowers and big fruits (pyriform to sub-globose) with a single embryo, while most of other citrus species are polyembryonic [25]. It is botanically *Citrus grandis* Osbeck. syn. *Citrus maxima* Merrill., belongs to the family Rutaceae. It is supposed to be originated in the island east of Malaya (Malaysia) archipelago, including Fuji and Friendly Island [7] or in China [6]. Though it is most commonly known as pummelo, it is also called 'Pampanas' (Maharashtra), 'Bambalimas', 'Pamparapamasa' 'Chakotra' (South India), 'Mahtabi' (North India), Batabi (in Bengal), pompelmoes, pomelo, Bali lemon, limau basar and shaddock [2]. It is considered as an excellent tree for waste land development in arid and semi-arid region. Pummelo fruit is a fat, sodium and cholesterol free. This makes pummelo a very good source for dieters. It is a good source of vitamin C and calories. The nutritional value of 100 g edible portion consists of 25 – 58 calories, 84.82 – 94.1 g moisture, 0.5 – 0.74 g protein, 0.2 – 1.56 g fat, 6.3 – 12.4 g carbohydrates, 0.3 – 0.82 g fiber, 0.5 – 0.86 g ash, 21 – 30 mg calcium, 20 – 27 mg phosphorus, 0.3 – 0.5 mg iron, 20 IU vitamin A, 0.04 – 0.07 mg thiamine, 0.02 mg riboflavin, 0.3 mg niacin and 30 – 43 mg ascorbic acid [18]. Besides eating the juicy pulp, the skinned segments can be broken apart and used in salads and desserts or made into preserves. The extracted juice is an excellent beverage. The peel can be candied. The flowers are highly aromatic and often used in Asia for making perfumes.

The wood is heavy, hard, tough, fine grained and suitable for making tool handles. Regarding medicinal uses, decoctions of the leaves, flowers and rind are given for their sedative effect in cases of epilepsy, cholera and convulsive coughing. Gum that exudes from declining trees is collected and taken as a cough remedy in Brazil [18]. Now its several therapeutic properties have also been established particularly for its pectins and flavonoids. Hesperidins, naringin, tangeretin and nobiletin have anti-inflammatory and anti-allergic activities. These flavonoids also improve circulatory system. Its therapeutic and nutritive values along with its taste and flavour have placed it in the regular dietary list of the people living in advanced countries [19]. The cultivation and improvement of pummelo did not receive any attention so far. However the scientist [4], who described 9 different forms of pummelo from Assam and said none of the forms of pummelo, has any importance as horticultural variety. However, the diverse eco-geographical distribution in India and the occurrence of spontaneous mutation and natural hybridization have given rise to a wide range of variability in citrus. West Bengal is also endowed with extremely diverse populations of pummelo in her diverse agro-ecological zones and altitudes. Characterization of citrus genetic resources was first attempted by [5], who described the citrus germplasm available in India. Citrus gene pool has been evaluated for Agri-Horticultural characteristics [8, 24]. Few attempts on genetic diversity of pummelo have been done earlier [10, 21, and 15]. Very little works have been done in India and particularly in West Bengal [20, 16]. Thus, considering the above facts it has been decided to undertake this research programme entitled "Characterization of pummelo germplasm in new alluvial zone of West Bengal".

Materials and Method

The experiment was carried out on the pummelo orchard at Horticultural Research Station, Mondouri of Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal. The experimental site is situated between 22.43 °N latitude and 88.34 °E longitudes with an altitude of 9.75 m above the mean sea level. The experiment was carried out during 2016-17 in Randomized Block Design with three replication and the plants are spaced at a distance of 7 × 7 m. Plants were uniform in age (15 years) and received same cultural practices during investigation. Twelve germplasm with three replications were considered for obtaining data. Nineteen characters like leaf characters, flowering and fruit morphological, physical and chemical characters from 'citrus descriptor' (cited by IPGRI, Rome, Italy) were considered for characterization and evaluation of these pummelo germplasm. Five fully opened and matured green leaves free from any pest-disease attack were collected randomly for each type from different directions for recording observations on leaf characters. All the morphological characters of leaves and fruits of different germplasm were recorded by visual observation and were categorized as mention in descriptor. Three fully mature, healthy and disease-free fruits from each replication were collected randomly from different direction for recording different observations. Fifteen inflorescences from different direction in each plant were tagged for recording number of flower bud and fruit set per inflorescence. Number of fruits per plant was counted and yield per tree was calculated by multiplying the number of fruits with the mean fruit weight. The physical and chemical characters of fruits were recorded after thorough washing with tap water to remove adhering impurities. Fruit and seed

weight were measured by using electronic (digital) balance whereas fruit rind thickness was measured by slide calliper. Ten vesicles for each replication were taken for vesicle length and thickness. Vesicles were taken for recording observation from centre of segment of fruit. Total soluble solids content of fruits was determined with the help of a hand refractometer. The sugars, acidity and ascorbic acid content of fruit were estimated by following the standard methods [1]. The data obtained were analysed statistically by the analysis of variance method [11] and the significance of different source of variation was tested by error mean square by Fisher's 'F' test of probability level of 0.05 percent.

Results and discussion

The results obtained from the present studies indicated that there was wide variation in the leaf, flowering, fruit set, yield and physico-chemical characters of fruit.

Among different morphological characters of leaf, fruit, pulp and seed the pattern of variation was more in characters like leaf lamina margin (crenate, dentate, sinuate, entire), leaf apex (rounded, obtuse, acute, acuminate), fruit shape (spheroid, ovate, pyriform, obloid), fruit base (convex, truncate, necked, concave), fruit skin colour (yellowish green, yellow, dark yellow, greenish yellow), pulp colour (white, whitish pink, pinkish white, light pink, pink) and seed shape (fusiform, ovoid, clavate, spheroid) presented in Table 1 and Table 2. Flowering time ranged from first week of January to last week of February. The above-mentioned morphological characters are generally highly heritable characters and identity of individual types. So, the wide pattern of variation among different germplasm may lead to chance of getting desirable types. More pattern of variation in respect of fruit shape and pulp colour among 15 clones also obtained [17] in West Bengal but one scientist [22] noted less variation among 82 pummelo trees. In present studies, flowering was early in Type-1 and late in Type-4, Type-7 and Type-8 as stated in Table 2.

Different germplasm of pummelo showed significant variation in number of flowers per inflorescence although the variation was insignificant for number of fruits set per inflorescence. The variation was wide and significant for fruit yield (68.07–164.08 kg/plant). The wide variation of fruit yield showed in Table 3 was not due to number of fruits set per inflorescence. It was due to number of fruits per plant and other yield attributing characters like fruit weight (0.78 – 1.35 kg), fruit length (10.50–15.50 cm), fruit diameter (12.07 – 15.35 cm), vesicle length (1.57 – 2.31 cm), vesicle diameter (0.20 – 0.45 cm), seed number (52.00 – 164.00) and 20 seed weight (1.83 – 8.33 g).

In the present experiment, number of fruits per plant was less as compared with the findings of few scientists [17, 22]. The variation of fruit weight among different germplasm was more or less similar as reported according to scientists [3, 22]. In contrast with [17] obtained more wide range of fruit weight (570 – 2010 g), although number of seeds per fruit is almost similar to that of present findings. But some researcher [12] obtained less number of seeds (12.67 – 37.50) among 12 collections of pummelo at Mizoram.

The present experiment revealed that all the germplasm produces fruits with more than 1 kg (1.10 – 1.35 kg) except Type-7 (0.78 kg) and Type-10 (0.82 kg). Fruit rind was thin in Type-5, Type-7, Type-11 and Type-12 (0.89 – 1.12 cm) stated in Table 2. So, fruit rind of few types are much lesser than the cv. 'Chandler' [9] growing in China and the cv. 'Shatianyou 2' [23]. Less number of seeds in a fruit was obtained in Type-9 (50.0) and Type-12 (52.0). Seed weight (20 numbers) was low

in Type-9 (1.83), Type-8 (2.60) and Type-2 (2.67). In spite of lesser number of seeds in a fruit, the seed weight (20 numbers) was found higher in Type-12. This was simply due to larger seed size.

Significant variation in ascorbic acid (34.98 – 62.61 mg/100 ml juice) was obtained among different pummelo germplasm revealed in Table 3 which more or less similar to the earlier findings (Ara *et al.*, 2008; Samarasinghe, 2005; Mitra *et al.*, 2011) TSS/acid ratio in the present experiment was calculated and ranged between 13.08 and 27.79. Scientist [13], who noted that the consumer acceptance had a direct correlation with TSS/acid ratio, an inverse correlation with titratable acidity and bitterness and no relationship with TSS and total sugars. A group of researcher [26], also found that the

taste of fruits is usually a blend of balance of sweet and sour and opined that TSS/acid ratio is often better related to palatability of the fruit than with TSS or acid alone. Beside this sugar/ acid ratio also calculated and ranged between 8.42 and 24.12. In accordance with [14], who reported that the sugar/acid ratio is one of the important maturity indices of citrus. In the present experiment, in spite of having maximum TSS content in fruits of Type-1, the TSS/acid ratio was less in it. This was due to higher titratable acidity in fruits. However, the higher TSS/acid ratio in fruits of Type-9 and Type-10 was due to higher TSS and lesser titratable acidity content. So, these two types might have better consumer acceptance than others.

Table 1: Leaf morphological characters and leaf size of different germplasm of pummel

Germplasm	Leaf lamina shape	Leaf lamina margin	Leaf apex	Petiole wing shape	Leaf size	
					Leaf lamina lengthm (cm)	Leaf lamina width (cm)
Type-1	Ovate	Crenate	Obtuse	Obcordate	12.59	6.25
Type-2	Elliptic	Crenate	Rounded	Obdeltate	12.51	6.98
Type-3	Obovate	Dentate	Acute	Obdeltate	11.88	4.81
Type-4	Elliptic	Dentate	Acute	Obcordate	12.59	5.29
Type-5	Ovate	Dentate	Acute	Obcordate	12.90	5.48
Type-6	Elliptic	Crenate	Obtuse	Obdeltate	11.51	6.14
Type-7	Elliptic	Sinuate	Acuminate	Obcordate	13.24	5.74
Type-8	Obovate	Dentate	Acuminate	Obdeltate	12.59	5.25
Type-9	Ovate	Crenate	Rounded	Obcordate	15.00	7.83
Type-10	Ovate	Dentate	Acuminate	Obcordate	13.16	5.39
Type-11	Elliptic	Dentate	Acute	Obcordate	12.70	4.78
Type-12	Elliptic	Entire	Obtuse	Obovate	13.92	6.51
SEM _±	-	-	-	-	0.40	0.12
LSD (0.05)	-	-	-	-	1.17	0.34

Table 2: Flowering and fruit morphological characters of different pummelo germplasm

Germplasm	Flowering time	Number of flower bud / inflorescence	Number of fruit set / inflorescence	Fruit shape	Shape of fruit base	Shape of fruit apex	Fruit skin colour	Fruit surface texture	Fruit axis	Pulp colour	Pulp firmness	Seed shape
Type-1	First week of January	7.67	1.33	Spheroid	Convex	Truncate	Yellowish green	Rough	Semi hollow	White	Firm	Fusiform
Type-2	Third week of January	7.83	1.50	Spheroid	Convex	Truncate	Yellowish green	Smooth	Semi hollow	Pinkish White	Soft	Ovoid
Type-3	Last week of January	8.17	2.00	Spheroid	Convex	Truncate	Yellowish green	Rough	Solid	White	Firm	Clavate
Type-4	Last week of February	8.67	2.17	Spheroid	Convex	Truncate	Yellow	Rough	Solid	Whitish Pink	Soft	Fusiform
Type-5	Third week of January	6.00	1.83	Spheroid	Truncate	Truncate	Yellowish green	Rough	Hollow	Light Pink	Soft	Fusiform
Type-6	Second week of January	7.00	2.00	Ovate	Concave	Depressed	Dark yellow	Bumpy	Semi hollow	White	Firm	Ovoid
Type-7	Last week of February	6.67	2.00	Spheroid	Convex	Truncate	Yellowish green	Rough	Solid	Light Pink	Soft	Fusiform
Type-8	Last week of February	7.67	1.50	Ovate	Convex	Truncate	Greenish yellow	Rough	Hollow	Pink	Firm	Fusiform
Type-9	Second week of January	6.33	2.33	Pyriform	Necked	Depressed	Greenish yellow	Smooth	Hollow	Pinkish White	Soft	Spheroid
Type-10	First week of February	7.00	1.33	Obloid	Truncate	Depressed	Yellowish green	Smooth	Semi hollow	Pink	Soft	Spheroid
Type-11	Third week of	4.50	1.67	Obloid	Truncate	Truncate	Greenish yellow	Rough	Solid	Pink	Firm	Fusiform

	February											
Type-12	Second week of February	5.50	2.17	Spheroid	Convex	Truncate	Greenish yellow	Rough	Hollow	Whitish Pink	Intermediate	Spheroid
SEM+	--	0.74	0.31	-	-	-	-	-	-	-	-	-
LSD (0.05)	--	2.17	N.S	-	-	-	-	-	-	-	-	-

Table 3: Physical and chemical characters of fruits of different germplasm of pummel

Germplasm	Fruit weight (kg)	Fruit diameter (cm)	Fruit length (cm)	Vesicle length (cm)	Vesicle thickness (cm)	Number of seeds/fruits	Ascorbic acid (mg/100 ml juice)	TSS/acid ratio	Yield / plant (kg)	Sugar/acid ratio
Type-1	1.09	14.92	13.67	1.67	0.21	116.00	42.24	17.24	164.08	13.98
Type-2	1.33	13.88	14.13	1.57	0.27	82.00	45.54	17.41	151.94	13.46
Type-3	1.31	14.10	13.23	1.92	0.31	164.00	50.57	19.58	143.95	14.38
Type-4	1.35	15.35	14.67	2.31	0.20	132.00	62.61	21.43	135.54	18.31
Type-5	1.16	14.52	12.77	1.79	0.31	162.00	58.42	21.86	125.28	18.70
Type-6	1.18	15.28	14.33	2.04	0.28	88.00	56.10	20.86	97.05	15.88
Type-7	0.78	12.07	10.50	1.79	0.28	140.00	46.20	15.62	68.07	11.17
Type-8	1.29	15.07	15.17	1.90	0.33	76.00	39.60	18.15	117.78	13.13
Type-9	1.17	14.65	15.50	1.95	0.23	50.00	34.98	25.31	126.80	17.82
Type-10	0.82	12.62	11.00	1.72	0.22	75.00	48.58	27.79	86.07	24.12
Type-11	1.23	14.42	13.17	2.05	0.45	64.00	47.33	13.08	147.97	8.42
Type-12	1.24	14.50	12.70	2.19	0.29	52.00	54.54	13.80	125.37	9.48
SEM+	0.10	0.30	0.33	0.10	0.02	9.06	2.90	--	10.75	-
LSD (0.05)	0.28	0.89	0.96	0.29	0.05	26.57	8.50	--	31.54	-

Conclusion

From the result of present investigation, it can be concluded that there is a wide range of variation among different pummelo germplasm. Following types can be exploited for commercial cultivation in new alluvial zone of West Bengal.

- Type-1 (Early flowering)
- Type-1, Type-2, Type-3 and Type-11 (High yielder)
- Type-5, Type-9 and Type-10 (Good quality).

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