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Performance of pummelo germplasm in new alluvial zone of West Bengal

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Pummelo (*Citrus maxima* Merill.) is one of the major monoembryonic species of citrus. It is easily grown in inferior, marginal and backyard orchard. Pummelo is considered as an excellent tree for waste land development in arid and semi-arid region. The fruit is a fat, sodium and cholesterol free and this makes a very good source for dieters. It is also 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 kg 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 (Morton, 1987). In spite of tremendous potentiality for commercial exploitation, pummelo plants are yet to be given due importance in India. The cultivation and improvement of pummelo did not receive any attention so far. It is mostly grown in homestead gardens in many parts of India. No standard variety of pummelo is found except Nagpur Chakotra (Rajput and Haribabu, 2004). 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 pummelo. West Bengal is also endowed with extremely diverse populations of pummelo in her diverse agro- ecological zones and altitudes.

Very little works have been done in India and particularly in West Bengal (Murthy *et al.*, 1989; Maiti *et al.*, 2001). Keeping this in view, twelve germplasm of pummelo were selected from different parts of West Bengal and conserved clonally at Horticultural Research Station, BCKV, West Bengal. The performance of these was studied with an objective to screen the superior germplasm for the new alluvial zone of West Bengal.

The experimental site is situated between 22.43 ^{0}N latitude and 88.34 ^{0}E longitudes with an altitude of 9.75 m above the mean sea level. The experiment was carried out during 2012-13 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 the course of investigation. Ten characters from 'citrus descriptor' (cited by IPGRI, Rome, Italy) were considered for characterization and evaluation of these pummelo germplasm. Three fully mature, healthy and disease free fruits from each replication were collected randomly from different direction for recording different observations. The physical and chemical characters of fruits were recorded after thorough washing with tap water to remove adhering impurities. Fruit and seed weight was measured by using electronic (digital) balance whereas fruit rind thickness was measured by slide calliperse. 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 (AOAC, 1984). The data obtained were analysed statistically by the analysis of variance method as suggested by Goon *et al.* (2001) 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. The phenotypic and genotypic coefficient of variability were computed.

The results presented in table 1, clearly revealed that the variation was wide and significant for number of fruits per plant (82.02 – 150.03) and fruit yield (68.07 – 164.08 kg plant^{-1}). Number of fruits per plant was less as compared with the earlier findings of Samarasinghe (2005) and Mitra *et al*. (2011). All the germplasm produced fruits with more than 1 kg (1.10 – 1.35 kg) except Type-7 (0.78 kg) and Type-10 (0.82 kg). The variation of fruit weight was more or less similar as studied by Ara *et al.* (2008) and Samarasinghe (2005). In contrast Mitra *et al*. (2011) obtained more wide range of fruit weight (570 – 2010 g), although number of seeds per fruit is almost similar to that of present findings. Present finding showed significant variation of number of seeds per fruit (50 – 164) with less number of seeds was obtained in Type-9 (50.0) and Type-12. But Hazarika (2013) obtained less number of seeds (12.67 – 37.50) among all the twelve collections of pummelo at Mizoram. Less number of

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seeds in a fruit was obtained in Type-9 (50.0) and Type-12 (52.0). Seed weight (20 numbers) in the present experiment varied widely (1.83 – 8.33 g) with less weight was found 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. Rind thickness ranged from 0.89 to 2.10 cm and it was thin in Type-5, Type-7, Type-11 and Type-12 (0.89 – 1.12 cm). So, fruit rind of few types are much lesser than the cv. 'Chandler' (Chen and Wu, 1994) growing in China and the cv. 'Shatianyou 2' (Shen *et al.,* 1999).

Table 1: Yield and physico-chemical characters of fruits of different pummelo germplasm

Germplasm	Fruit weight (kg)	Fruit rind thickness (cm)	No. of seeds fruit^{-1}	20 seed weight (g)	No. of fruits plant^{-1}	Yield plant^{-1} (kg)	TSS (°Brix)	Acidity (%)	Total sugar (%)	Ascorbic acid (mg. 100 ml$_{-1}$ juice)	TSS: acid ratio
Type-1	1.09	1.54	116.03	5.17	150.03	164.08	10.00	0.58	8.11	42.24	17.24
Type-2	1.33	1.49	82.02	2.67	115.50	151.94	9.40	0.54	7.27	45.54	17.41
Type-3	1.31	1.53	164.00	4.33	110.31	143.95	9.40	0.48	6.90	50.57	19.58
Type-4	1.35	2.10	132.06	7.83	100.36	135.54	9.00	0.42	7.69	62.61	21.43
Type-5	1.16	1.12	162.03	6.83	108.43	125.28	9.40	0.43	8.04	58.42	21.86
Type-6	1.18	1.63	88.06	7.67	82.02	97.05	8.97	0.43	6.83	56.10	20.86
Type-7	0.78	0.89	140.03	4.67	87.01	68.07	9.37	0.60	6.70	46.20	15.62
Type-8	1.29	1.81	76.03	2.60	91.03	117.78	9.80	0.54	7.09	39.60	18.15
Type-9	1.17	1.49	50.00	1.83	109.76	126.80	9.87	0.39	6.95	34.98	25.31
Type-10	0.82	1.40	75.06	4.50	105.06	86.07	9.45	0.34	8.20	48.58	27.79
Type-11	1.23	0.91	64.00	8.33	120.81	147.97	8.63	0.66	5.56	47.33	13.08
Type-12	1.24	1.07	52.05	6.60	101.63	125.37	8.83	0.64	6.07	54.54	13.80
SEm(±)	**0.10**	**0.14**	**9.06**	**0.40**	**1.70**	**10.75**	**0.21**	**0.05**	**0.28**	**2.90**	**—**
LSD (0.05)	**0.28**	**0.40**	**26.57**	**1.18**	**4.98**	**31.54**	**0.62**	**0.14**	**0.83**	**8.50**	**—**

Table 2: Variability of fruit characters of different pummelo germplasm

Characters	General mean	Range	GCV	PCV	Heritability (%) (Broad sense)	Genetic advance	Genetic advance (%of mean)
Fruit weight	1.16	0.78 – 1.35	13.61	19.82	47.10	0.22	18.97
Fruit rind thickness	1.41	0.89 – 2.10	23.78	29.05	67.00	0.57	40.43
No. of seeds fruits^{-1}	100.08	50.0 – 164.0	40.06	43.02	86.7	76.92	76.86
Seed weight	5.25	1.83 – 8.33	41.27	43.35	90.6	4.25	80.95
No. of fruits plant^{-1}	106.5	82.00 – 150.00	16.58	16.81	97.30	35.89	33.70
Yield plant^{-1}	124.16	68.07 – 164.08	21.12	35.90	66.50	44.04	35.47
TSS	9.34	8.63 – 10.00	3.91	5.53	50.00	0.53	5.67
Titratable acid	0.50	0.34 – 0.66	18.37	24.32	57.00	0.14	28.00
Total sugar	7.12	5.56 – 8.20	10.65	12.69	70.40	1.31	18.40
Ascorbic acid (mg 100 ml^{-1} juice)	48.89	34.98 – 62.61	15.34	18.45	69.10	12.84	26.26

Significant variation in fruit quality like TSS (8.63 – 10.00 °Brix), total sugar (5.56 – 8.20 %), ascorbic acid (34.98 – 62.61 mg/100 ml juice) and titratable acidity (0.34 – 0.66 %) was obtained among different pummelo germplasm (Table 1). The wide variation in physico-chemical composition of fruits offers wide scope for breeding to develop desirable hybrids. The variations of chemical composition of fruits are more or less similar to the earlier findings (Ara *et al.,* 2008 and Mitra *et al.,* 2011) with the exception of the findings of Hazarika *et al.* (2013) where they obtained higher fruit acidity (0.81 – 1.80 %). TSS/acid ratio in the present experiment was calculated and ranged between 13.08 and 27.79. Ketsa and Leelawatana (1992) 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. Wills *et al.* (1981) also found that the taste of fruits was usually a blend of balance of sweet and sour and opined that TSS/acid ratio was often better related to palatability of the fruit than with TSS or acid alone. In the present experiment, in spite of having maximum TSS content of fruits in 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 of fruits in 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.

In the variability studies, a wide range of variability was observed for almost all variables or characters (Table 2). The co-efficient of variation (both genotypic and phenotypic) was higher (>20) for characters like yield per plant, fruit rind thickness, seed weight and number of fruits per plant. Phenotypic co-efficient of variation was also high for titratable acidity. Similarly, Sudrik *et al.* (2014) also obtained higher genotypic and phenotypic co-efficient of variation for seed yield per plant (>50) and 100-seed weight (>25) considering thirteen characters among one hundred and ten accession of sunflower germplasm. The phenotypic variation present in a population is due to genotypic and environment effects. The phenotypic co-efficient of variation is the observable variation present in a character in a population. As a result, its magnitude differs under different environmental condition. Therefore, phenotypic co-efficient of variation (PCV) was higher than their corresponding genotypic co-efficient of variation. High heritability (>60) was found in number of fruits per plant, yield per plant, seed weight, number of seeds per fruit, total sugar and ascorbic acid. But the maximum heritability (97.30) was observed in number of fruits per plant. GCV associated with high heritability indicated that selection would be effective for the improvement of these characters but for a character with low heritability, selection may be comparatively difficult due to masking effect of the environment on the genotypic effects. This indicated that selection for yield per plant, fruit rind thickness, seed weight, number of seeds per fruit would be effective. Genetic advance (as percentage of mean) was higher (>30) for the number of fruits per plant, yield per plant and number of seeds per fruit. Panse (1957) suggested that if heritability is mainly due to additive gene effects, a high genetic advance with high heritability may be expected. In the present study, high genetic advance with high heritability was found in number of fruits per plant, yield per plant, number of seeds per fruit, fruit rind thickness and seed weight. So, selection of these characters would be highly effective.

From the result of present investigation, it can be concluded that there was a wide range of variation among the twelve pummelo germplasm and few germplasm may be exploited as high yielder (Type-1, Type-2, Type-3 and Type-11) and quality fruit producer (Type-9 and Type-10) for commercial cultivation in the new alluvial zone of West Bengal.

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