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## Morphological characterization for quantitative characters in Rose apple genotypes (*Syzygium* spp.)

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### Abstract

Characterization of germplasm is basis for crop improvement. The investigation was carried out with four rose apple genotypes viz. *Syzygium samarangense* (white), *Syzygium samarangense* (red), *Syzygium malaccense* and *Syzygium Jambos*. Commercial cultivation of rose apple is not traditional in Konkan region even though conditions are favourable for growth and development. The wide variability exists in relation to various qualitative as well as quantitative characters, which needs to characterize and evaluate to generate valuable information required for the development of descriptors. The genotype *Syzygium malaccense* found to be superior in terms of vigour viz. tree height, canopy spread and leaf area respectively. The genotype *Syzygium samarangense* (red) was promising for characters namely yield tree<sup>-1</sup>, pulp to seed ratio, number of seeds, total sugars and sensory score and hence it found to be superior for yield and quality parameters. The genotype *Syzygium Jambos* had the maximum TSS and total sugars.

**Keywords:** Characterization, rose apple, Variability, quantitative characters

### Introduction

Characterization is the basis for crop improvement. Majority of the variability of populations is due to the seedling origin, they are variable in fruit colour, pulp thickness, number of seeds, other morphological and quality characters are also reported from different regions. Hence, there is a great potential for the application of characterization and evaluation in fruit crops. It would further help in identification of potential parent genotypes for effective utilization in future breeding programme. Studies focus on characterization of wild species and local cultivars is still lacking in Indian breeding programme which plays a significant role for further crop improvement.

The Rose apple, Wax apple or Jambu air is non-climacteric tropical fruit and botanically identified as *Syzygium samarangense* and belongs to family Myrtaceae (Morton, 1987) [11]. It is also called as Malabar plum, Water apple, Java apple, Jambu, Jam, Bell fruit, Bodhi tree and Chambakka with different vernacular names. It is originated in Malaysia. It is also grown throughout the Southeast Asian countries, namely Thailand, Indonesia and Taiwan as well as other tropical countries. Rose apple is widely cultivated throughout the Malaysia mainly in small holdings ranging from 1 to 5 ha with a total hectare estimated at 1500ha in 2005 (Zenhong *et al.*, 2006) [17].

The Rose apple is extra tropical, growing only at lower altitudes up to 4000ft. (1,220m). It does best in parts of the Philippines that have a long dry season. In Malaysia, there are 3 species which bear edible fruits namely the Water apple (*Syzygium Aqueum*), Malay apple (*Syzygium malaccense*) and Rose apple or jambu (*Syzygium samarangense*). All three species are used interchangeably where they occur together (Whistler and Craig, 2006) [16]. *Syzygium samarangense* is the most popular of the three in Southeast Asia (Chang *et al.*, 2003) [1] and the trees are cultivated in home gardens, often planted along drive ways and paths. Now, the tree is cultivated throughout the tropics.

Recently, rose apple had become a popular exotic fruit in western countries because of the combination of apple-like crispness, watery sweet, low-acid taste and the aroma of roses (FAO, 2005) [2]. Fruit production is non-seasonal and the peak periods are February to April and October to December. Fruits can fetch a good price and had the potential to bring great benefit to local farmers. Trees grow best in areas with a fairly long dry season. Trees require a reliable water supply and is often planted along streams or ponds. Current distribution ranges from India through South-East Asia to the Pacific Islands (Huang *et al.*, 2015) [4]. The fruits are

rich source of phenolics, flavonoids and several antioxidant compounds and as a result it is believed to have great potential benefits for human health (Gurib, 2006) [3]. In addition, the plants extracts have potent free radical scavenging, antioxidation, antimutation and anticancer activities (Neerghen *et al.*, 2006) [12].

The present study was undertaken in College of agriculture, Dapoli, Maharashtra during 2017-2019. This Konkan region has warm and humid climate suitable for growing tropical fruit crops. In north as well as south Konkan, it had proved better performance in terms of growth and yield. Under changing climatic conditions, it shows better performance in terms of fruit set and yield. It had more demand in town and cities market as an edible fruit. However, rose apple had not received so much attention for its cultivation and improvement. In the reason, Department of Horticulture, College of Agriculture, Dapoli had collected and planted genotypes of rose apple in germplasm block. By considering future importance of rose apple in Konkan as an edible fruit, it was felt necessary to undertake the work on characterization and evaluation of four rose apple genotypes for different parameters with the objectives (i) to characterize the various rose apple genotypes and (ii) To evaluate the various rose apple genotypes.

#### Materials and methods:

The experiment was conducted at Department of Horticulture, College of Agriculture, Dr. Balasaheb Sawant Konkan Krishi Vidyaapeeth, Dapoli, Dist. Ratnagiri (M.S.) India. Characterization and evaluation carried for four rose apple genotypes (*Syzygium samarangense* (white), *Syzygium samarangense* (red), *Syzygium malaccense* and *Syzygium jambos*) which were of eight years old and no special cultural practices have been followed.

Growth characters were recorded on the basis of descriptor prescribed for Jamun by the National Bureau of Plant Genetic Resources (Mahajan *et al.*, 2002) [7] in the natural state immediately after harvest. Flower characters were recorded from ten flowers or inflorescences per tree at full flowering. Fruits were recorded on ten mature fruits were randomly collected from each tree recording the following observations of individual fruit from each genotype. The data analysis was statistically analysed by the methods suggested by Panse and Sukhatme (1995) [14].

#### Results and discussion

The results for different quantitative characters of four rose apple genotypes are presented in Table (1, 2, 3 and 4). While analysing all the quantitative and qualitative tree characters of rose apple under study it was revealed that large scale variation in tree characters was observed.

Data related to growth characters studied presented in Table 1. Genotype *Syzygium malaccense* had the highest (6.74m) tree height, while the lowest height was recorded in *Syzygium jambos* (3.35m). The genotype *Syzygium samarangense* (white) had the highest stem girth (138 cm), while the lowest was observed in *Syzygium malaccense* (31.48cm). *Syzygium Samarangense* (white) recorded the highest canopy spread (7.32m) whereas the lowest was in *Syzygium malaccense* (3.27m). These results are in conformity with the work of Morton (1987) [11], Whistler and Craig *et al.*, (2006) [16], Orwa *et al.*, (2009) [13] and Khandekar *et al.*, (2016) [6] in rose apple genotypes. The leaf lamina length ranged from 17.27cm

(*Syzygium samarangense* (red)) to 34.45 cm (*Syzygium malaccense*). The genotype *Syzygium malaccense* had the highest leaf lamina width (9.38cm), while the lowest was observed in *Syzygium jambos* genotype (3.09cm). The area of individual leaf was the highest (320.35cm<sup>2</sup>) in *Syzygium malaccense* genotype, while it was lowest (62.09cm<sup>2</sup>) in *Syzygium jambos*.

The data regarding quantitative flower characters are presented in Table 2. The number of buds per inflorescence in Table 2, showed wide variation. The lowest number of buds was reported in *Syzygium jambos* (5.30), while the highest number of buds was recorded in *Syzygium samarangense* (white) (14.40). The number of stamens were ranged from 224 (*Syzygium jambos*) to 397.5 (*Syzygium samarangense* (white)) with mean of 305.63. The highest stamen length was (3.80 cm) was observed in *Syzygium jambos*, while the lowest (2.70 cm) was in *Syzygium malaccense*. The mean style length of 3.59cm was exceeded by *Syzygium samarangense* (white) (3.95cm), while *Syzygium samarangense* (red) showed 3.40cm. There was no much variation in days to flowering. Days to flowering was 23 days in genotypes *Syzygium samarangense* (white) and *Syzygium malaccense*, while 20 days taken for flowering in *Syzygium samarangense* (red) and 22 days in *Syzygium jambos* genotype. Similar results were obtained by scientists (Morton, 1987 [11]; Moneruzzaman *et al.*, 2012a) [8] in Rose apple.

For different fruit characters studied (Table 3), Genotype *Syzygium samarangense* (red) showed the highest fruit length (6.30cm), while the lowest was observed in *Syzygium jambos* (3.40cm). Average fruit diameter (4.20cm) was exceeded by *Syzygium samarangense* (white) (4.34cm) whereas *Syzygium samarangense* (red) genotype showed the less fruit diameter (3.66cm). These variation results are in accordance with the observations recorded by Moneruzzaman *et al.*, 2011 [9] & 2012b [10] and Khandekar *et al.*, 2016 [6]. They noticed that 4.7cm to 5.0 cm wide in bell shaped fruits whereas 4cm wide in elongated fruits in *Syzygium samarangense* genotypes. Genotype *Syzygium malaccense* had the highest (32.94 cm<sup>2</sup>) fruit size, while the lowest was observed in *Syzygium Jambos* (11.56 cm<sup>2</sup>). *Syzygium Jambos* recorded the lowest 16.37g fruit weight, whereas it was the highest (54.40g) in *Syzygium malaccense*. Shu *et al.*, (2001) [15] described that fruit weight ranged from 28g to 100g in rose apple genotypes. Pulp weight was in the range of 12.67 (*Syzygium Jambos*) to 49.0g (*Syzygium malaccense*). Days to harvest i.e. from flowering to harvest in rose apple genotypes under study also showed variation and it was in the range of 68 (*Syzygium samarangense* (red)) to 87 (*Syzygium Jambos*). These results are tally with the findings of Whistler and Craig *et al.*, (2006) [16] who noticed 60 days required for the harvesting of fruits after the anthesis. The fruit volume was the lowest in *Syzygium Jambos* (14.60cm<sup>3</sup>), while the highest in *Syzygium malaccense* (46.60cm<sup>3</sup>). Specific gravity of fruits in genotypes ranged from 0.99 in *Syzygium malaccense* to 1.34 in *Syzygium samarangense* (white) with the mean of 1.13. The lowest number of fruits was recorded in the genotype *Syzygium malaccense* (18.30kg<sup>-1</sup>), while the highest number of fruits recorded in *Syzygium jambos* (61.00 kg<sup>-1</sup>). The highest percentage of fruit set was observed in *Syzygium malaccense* (91.51%), while it was the lowest in *Syzygium jambos* (50.83%). Khandaker *et al.*, (2013) [5] noticed fruit set percentage in wax apple fruits was 29%.

Wide variation was observed in seed length and it ranged

from 1.50cm in *Syzygium jambos* to 3.80cm in *Syzygium malaccense*, while the genotype *Syzygium samarangense* (white) showed seed length (1.67cm) which was below the mean (2.32cm). In case of genotype *Syzygium samarangense* (red), rudimentary seeds were seen because of embryo abortion. The average seed width of fruit varied from 1.40cm in *Syzygium samarangense* (white) to 3.90cm in *Syzygium malaccense*. Greater variation was observed among the seed weight and it was in the range of 1.50 (*Syzygium samarangense* (white)) to 5.20g (*Syzygium jambos*). *Syzygium samarangense* (white) showed 3.2 seeds, while *Syzygium malaccense* showed 2.00 seeds and *Syzygium jambos* showed 1.00 seed per fruit. However no seed was observed in genotype *Syzygium samarangense* (red). These results are in line with the findings of Khandekar *et al.*, (2011) [9], while studying the seed characters.

As per the data in Table 4, Chemical analysis of fruit revealed that the moisture content of fruit varied from 82.54 (*Syzygium jambos*) to 91.81per cent in *Syzygium samarangense* (red). The TSS of the fruit varied from 6.12 to 10.9 °B in *Syzygium malaccense* and *Syzygium jambos* respectively. These results are in consonance with the work of Shu *et al.*, (2007) [15] and Khandaker *et al.*, (2012) [7] in rose apple genotypes. The average titrable acidity of fruits was 0.63 per cent. The highest per cent of acidity was reported in *Syzygium malaccense* with 1.41per cent, while the lowest (0.33%). The rose apple showed that average ascorbic acid content was

3.79mg/100g fruit. The average reducing, non-reducing and total sugars in fruits of different genotypes were 4.22, 1.02 and 5.21 per cent respectively.

The results presented in the Table 5. Revealed that fruits of all the rose apple genotypes were acceptable and sensory score was in the range of 6.7 to 8.00 with mean of 7.37. Among the four rose apple genotypes; the highest sensory score for colour (8), flavour (8) and texture (8) was noticed by the genotype *Syzygium samarangense* (red). It is evident from the data that the highest average sensory score (8.00) was recorded by *Syzygium samarangense* (red) followed by *Syzygium samarangense* (white) (7.50) and *Syzygium jambos* with score of 7.3, whereas the lowest score (6.7) was recorded by genotype *Syzygium malaccense*.

The variability among the genotypes under study is due to the seedling origin. The genotypes showed greater amount of variation in growth flower, fruit and other morphological characters. The difference in amount of variation in genotypes could be the influence of its genotype environment also. Hence, there is a great potential for the application of characterization and evaluation of rose apple genotypes. It would further help in identification of potential parent genotypes for effective utilization in future breeding programme. Studies focus on characterization of wild species and local cultivars is still lacking in Indian breeding programme which plays a significant role for further crop improvement.

**Table 1:** Variation in growth characters of rose apple genotypes

Characters	Genotypes				Range	Mean	S.D.	Variance	C.V.	S.E.
	<i>Syzygium samarangense</i> (white)	<i>Syzygium samarangense</i> (red)	<i>Syzygium malaccense</i>	<i>Syzygium jambos</i>						
Tree height (m)	6.71	6.40	6.74	3.35	3.35-6.74	5.80	1.64	2.69	28.29	0.82
Canopy spread (m)	7.32	4.72	3.27	5.18	3.27-7.32	5.12	1.68	2.81	32.72	0.84
Trunk girth (cm)	138	77	31.48	88	31.48-138	83.62	43.74	1912.62	52.30	21.87
Leaf length (cm)	21.25	17.27	34.45	19.81	17.27-34.45	23.20	7.68	59.01	33.12	3.18
Leaf width (cm)	5.63	6.39	9.38	3.09	3.09-9.38	6.12	2.59	6.71	42.30	1.29
Leaf area (cm <sup>2</sup> )	173.45	111.30	320.35	62.09	62.09-320.35	166.80	112.05	12555.31	67.18	56.03

**Table 2:** Variation in flower characters of rose apple genotypes

Characters	Genotypes				Range	Mean	S.D.	Variance	C.V.	S.E.
	<i>Syzygium samarangense</i> (white)	<i>Syzygium samarangense</i> (red)	<i>Syzygium malaccense</i>	<i>Syzygium jambos</i>						
Number of buds/inflorescence	14.40	11.20	7.90	5.30	5.30-14.40	8.53	3.96	15.65	46.40	1.98
Number of stamens/flower	397.50	352.00	249.00	224.00	224-397.5	305.63	82.58	6820.23	27.02	49.21
Length of stamen (cm)	3.00	3.20	2.70	3.80	2.70-3.80	3.18	0.46	0.22	14.63	0.23
Length of pistil (cm)	3.95	3.40	2.80	4.20	2.8-4.2	3.59	0.62	0.39	17.35	0.31
Days to flowering	23.00	20.00	23.00	22.00	20-23	22.00	1.41	2.00	6.43	0.71

**Table 3:** Variation in fruit characters of rose apple genotypes

Characters	Genotypes				Range	Mean	S.D.	Variance	C.V.	S.E.
	<i>Syzygium samarangense</i> (white)	<i>Syzygium samarangense</i> (red)	<i>Syzygium malaccense</i>	<i>Syzygium jambos</i>						
Fruit length (cm)	4.57	6.30	6.10	3.40	3.4-6.3	5.09	1.37	1.87	26.85	0.68
Fruit breadth (cm)	4.34	3.66	5.40	3.40	3.4-5.4	4.20	0.89	0.80	21.26	0.45
Fruit size (cm <sup>2</sup> )	19.83	23.06	32.94	11.56	11.56-32.94	21.85	8.84	78.13	40.46	4.42
Fruit weight (g)	26.61	34.22	54.40	16.37	16.37-54.4	32.90	16.09	258.93	48.91	8.05
Pulp weight (g)	25.04	34.22	49	12.67	12.67-49	30.23	15.31	234.51	50.65	7.66
Fruit volume (cm <sup>3</sup> )	29.50	34.70	46.60	14.60	14.60-46.60	31.35	13.26	175.92	42.31	6.63
Specific gravity	1.34	1.03	0.99	1.16	0.99-1.34	1.13	0.16	0.03	14.12	0.08
Fruit set (%)	66.50	70.75	75.00	50.83	50.83-75.00	65.77	10.55	111.24	16.04	5.27
Days to harvest	75	68	83	87	68-87	78.25	8.46	71.58	10.81	4.23
Number of fruits kg <sup>-1</sup>	37.57	29.20	18.30	61	18.30-61	36.52	18.13	328.64	49.64	9.06
Yield tree <sup>-1</sup> (kg)	52	56	34	16.2	16.2-56	39.50	18.36	337	46.67	9.18

Seed length (cm)	1.67	-	1.74	1.50	0-3.8	1.74	1.56	2.14	89.73	0.78
Seed width (cm)	1.40	-	1.78	1.80	0-3.9	1.78	1.61	2.60	90.89	0.81
Seed weight (g)	1.57	Negligible	2.62	3.70	0-5.2	2.62	2.29	5.26	87.65	1.15
Number of seeds per fruit	3.20	-	1.55	1.00	0-3.2	1.55	1.37	1.88	88.38	0.68
Pulp to seed ratio	15.95	34.22	7.20	3.42	3.42-34.22	7.20	7.01	49.21	97.46	3.51

**Table 4:** Variation in chemical composition of rose apple genotypes

Genotypes	Parameters						
	Moisture (%)	TSS (°B)	Acidity (%)	Ascorbic acid (mg/100g)	Reducing sugars (%)	Total sugars (%)	Non reducing sugars (%)
<i>Syzygium samarangense</i> (white)	91.74	8.70	0.47	1.83	3.61	3.97	0.50
<i>Syzygium samarangense</i> (red)	91.81	7.27	0.33	6.02	3.67	4.73	1.06
<i>Syzygium malaccense</i>	85.26	6.12	1.41	3.88	2.25	4.20	1.95
<i>Syzygium jambos</i>	82.54	10.90	0.33	3.45	6.13	8.25	2.12
Range	82.54-91.81	6.12-10.9	0.33-1.41	1.83-6.02	2.25-6.13	3.97-8.25	0.50 – 2.12
Mean	87.84	8.25	0.63	3.79	3.91	5.29	1.41
S.D.	4.68	2.06	0.52	1.73	1.61	2.00	0.76
Variance	21.90	4.24	0.27	2.99	2.61	4.01	0.58
C.V.	5.33	24.97	82.31	45.54	41.25	37.87	54.32
S.E.	2.34	1.03	0.26	0.86	0.81	1.00	0.38

**Table 5:** Sensory evaluation of rose apple genotypes

Genotypes	Sensory score			Total score	Average score
	Colour	Flavour	Texture		
<i>Syzygium samarangense</i> (white)	7.5	7.5	7.5	22.5	7.50
<i>Syzygium samarangense</i> (red)	8	8	8	24	8.00
<i>Syzygium Malaccense</i>	6.5	6.5	7.00	20	6.7
<i>Syzygium Jambos</i>	7	8	7	22	7.3

## Conclusion

On the basis of foregoing results, it could be concluded that the rose apple genotypes under study showed wide variation in most of the growth, leaf, flower, fruit and seed characters. The genotypes *Syzygium samarangense* (red) and *Syzygium samarangense* (white) had better yield. However, fruit weight found to be superior in the genotypes *Syzygium malaccense* and *Syzygium samarangense* (red). The genotype *Syzygium samarangense* (red) secured the sensory score of 8 i.e. like extremely. The genotypes *Syzygium jambos* and *Syzygium samarangense* (white), *Syzygium samarangense* (red) had the maximum TSS, while *Syzygium jambos* and *Syzygium samarangense* (red) had maximum total sugars.

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