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Collection and evaluation of custard apple (Annona squamosa L.) genotypes in Chhattisgarh plains

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Abstract
The present investigstion entitled "Collection and Evaluation of Custard apple (*Annona squamosa* L.) genotypes in Chhattisgarh plains" was carried out in the Department of Fruit science, College of Agriculture, IGKV, Raipur through the survey conducted in the different villages of district Bilaspur and Mahasamund, during the year 2016-17. All 18 genotypes were evaluated for yield parameters and physical aspects. The results revealed a great variability for yield and quality traits. The fruit physical characters *viz.*, fruit length (7.53 to 11.76 cm), fruit breadth (7.14 to 10.98 cm), fruit weight (155.86 to 365.78 g), pericarp weight (75.85 to 162.58 g), pulp weight (60.44 to 180.56 g), number of seeds per fruit (48.33 to 20.00) and seed weight (15.00 to 23.00 g) showed significant variation.

Keywords: Custard apple, collection, evaluation, physical characters, Chhattisgarh

1. Introduction
Annona squamosa is native to tropical America but its exact native range is unknown due to extensive cultivation but is thought to be in the Caribbean. The species was described from Jamaica. However, the origin of different species of *Annona* is reported to be at different regions. *Annona squamosa* is considered to be originated in Central America and it was distributed to Mexico and tropical America (Popenoe, 1974) [19]. It is widely distributed in Asia and the America and is most widely known as sugar apple, sweetsop and custard apple. Among Annonaceous fruits, custard apple is most favorite in India. In India, it is also known as Shariffa, sitaphal (Thakur and Singh, 1967) [24]. In India, custard apple is grown in an area of 29.87 thousand hectare with an annual production of 228.37 million tonnes. Chhattisgarh is one of the states in which custard apple is produced in 7.99 thousand hectare having annual production 39,730 metric tonnes (Anon., 2014) [1]. In India, the custard apples are very popular in Deccan Plateau and are grown commercially on smaller scale in Andhra Pradesh, Gujarat, Bihar, Maharashtra, Uttar Pradesh, Tamil Nadu, Assam, Karnataka and Odisha. In Chhattisagrh, it is mostly cultivated on wasteland, rice bund and most of the forest areas of Kanker, Bastar, Bilaspur, Mahasamund and Raipur. Custard apple is a nutritive fruit due to the fact that its 100 gram edible portion contains 1.5 per cent of protein, 23.5 per cent carbohydrates, 17 mg calcium, 47 mg phosphorus, 1.5 mg iron, 0.07 per cent thiamine, 0.17 mg riboflavin, 1.3 mg niacin and 37 mg ascorbic acid (Shrivastava and Kumar, 1998) [23].
Custard apple being a cross-pollinated crop has wide variation in form and size of fruit as well as colour of pulp. This natural variability available within the species is often exploited to identify superior genotypes. Chhattisgarh plains has availability of lines of custard apple and exists in the form of land races, hence there exists a lot of scope to identify best one amongst wild strains available in plenty. Till date no systematic collection and evaluation of custard apple cultivars has been carried out in Chhattisgarh. Thus, there is an urgent need for identification, characterization and evaluation of high-yielding genotypes which can be successfully grown on commercial scale in Chhattisgarh. Hence in the light of above context, the present study was under taken with the main objective to study the physico-chemical properties of collected custard apple genotypes.

2. Materials and Methods
The experiment was carried out in the Department of Fruit science, College of Agriculture, IGKV, Raipur through the survey conducted in the different villages of district Bilaspur and

Mahasamund, during the year 2016-17. For present investigation, nine genotypes collected from Bilaspur district viz., BSPCA-1, BSPCA-2, BSPCA-3, BSPCA-4, BSPCA-5, BSPCA-6, BSPCA-7, BSPCA-8 and BSPCA-9 as well as nine genotypes collected from Mahasamund district viz., MSCA-1, MSCA-2, MSCA-3, MSCA-4, MSCA-5, MSCA-6, MSCA-7, MSCA-8 and MSCA-9 were evaluated. Observations on yield characters viz., number of fruits per tree, yield of fruits per tree, fruit weight, pericrp weight, pulp weight, seed weight, number of seeds per fruit and qualitative traits viz., TSS, titrable acidity, ascorbic acid, total sugar, reducing sugar and non-reducing sugar were recorded.

3. Result and discussion

3.1 Yield parameter

3.1.1Number of fruits per plant

Data regarding number of fruits per plant given in Table 1 showed the variation in total number of fruits per tree in different genotypes. The number of fruits per plant ranged from 26 to 41 with population mean of 32.83.The maximum number of fruits per plant was observed in the genotype BSPCA-1 (41) followed by MSCA-7 (40) and BSPCA-8 (37), whereas minimum number of fruits per plant found in the genotype MSCA-2 (26) followed by MSCA-8 (27) and MSCA-5 (28). The variation in number of fruits per tree might be due to genetic diversity amongst number of shoot, shoot length and number of flowers per shoot of different genotypes as well as due to climatic conditions. The maximum number of fruits per tree obtained in genotypes BSPCA-1, MSCA-7, BSPCA-8 might be due to more vegetative growth which results in more number of fruits per tree. Some genotypes produced fewer yields even after more number of fruits per plant, this might be due to lesser accumulation of photosynthetic products in custard apple fruit, as also reported by Dubey (2000) [4] in sweet orange. These findings are in accordance with the earlier reports of Kaur *et al.* (2014) [11] in mango.

3.1.2Fruit yield per plant

Data related to fruit yield presented in Table 1 showed significant variation in fruit yield among different genotypes. The fruit yield ranged from 4.05 to 14.99 kg per plant with population mean of 8.39 kg. The highest yield per plant was observed in the genotype BSPCA-1 (14.99 kg) followed by BSPCA-8 (13.04 kg) and BSPCA-4 (10.48 kg) whereas, lowest yield per plant was found in the genotype MSCA-2 (4.05 kg) followed by MSCA-8 (4.55 kg) and MSCA-6 (5.09 kg). The significant variation in yield per tree might be due to number of fruits retained per shoot, fruit retention percentage and average fruit weight. Higher plant height and high canopy spread might also contribute for the maximum fruit yield in genotypes BSPCA-1, BSPCA-8 and BSPCA-2. The finding implies that the selection for more number of fruits will automatically lead to higher yield. Yield being the polygenic and complex character is determined by various vegetative and reproductive characters as also reported by Shete *et al*., (1991) [22] in custard apple. These results are in line with the reports of Selvarajan *et al.*, (2008) [21], Dikshit *et al*., (2008) [3] in custard apple and Kamatyanatti *et al.* (2016) [10] in acid lime.

3.1.3 Fruit length

The observation regarding fruit length in different genotypes of custard apple (Table 1) indicated that the fruit length ranged from 7.53 to 11.76 cm and maximum fruit length was recorded in genotype BSPCA-1 (11.76 cm), which was at par with BSPCA-8 (11.52 cm), BSPCA-4 (11.32 cm), MSAC-5 (11.21 cm) and MSCA-1 (10.98 cm) followed by BSPCA-9 (10.31 cm) and MSCA-9 (10.23 cm), whereas minimum fruit length was recorded in MSCA-2 (7.53 cm), which was at par with MSCA-8 (7.53cm), BSPCA-2 (7.84 cm), MSCA-6 (8.21 cm), BSPCA-6 (8.42 cm) followed by BSPCA-5 (9.11 cm) and MSCA-3(9.45 cm), respectively. The variation in fruit size was influenced by several factors viz., number of fruits on the tree, production of optimum photosynthates, soil moisture status and fertility of the soil. These factors might play important role in production of optimum size of fruit and maintenance of its quality. Gibberellins produced in the seeds might also influence the size of the fruit. These findings are in agreement with the work of Mathakar (2005) [13], Bakane *et al.* (2015) [2] in custard apple and Githai *et al.* (2016) [6] in mango.

3.1.4 Fruit width

The data regarding fruit width in different genotypes of custard apple are presented in Table 1. The fruit width ranged from 7.14 cm to 10.98 cm and maximum fruit width was observed in BSPCA-1 (10.98 cm) which was at par with BSPCA-8 (10.78 cm) and BSPCA-5 (10.64 cm) and MSCA-5 (10.54 cm) followed by MSCA-1 (9.91cm),whereas minimum fruit width was recorded in MSCA-8 (7.14 cm) which was at par with BSPCA-1 (7.21 cm), MSCA-2 (7.25 cm), MSCA-6 (7.68 cm) and followed by BSPCA-5 (8.51 cm), respectively. The climatic as well as edaphic condition influenced the fruit size and its quality. Maximum fruit width might also be due to accumulation of maximum seeds in horizontal plain of the fruit. Production of gibberellins in the seeds might also contribute in the growth, which also influences the size of the fruit. Similar results were also reported by Thakur and Singh (1967) [24] and Mathakar (2005) [13] in custard apple and Jadhao (2012) [7] in sweet orange.

3.1.5 Fruit weight

The data pertaining to fruit weight in different genotypes of custard apple are presented in Table 1. The maximum average fruit weight was recorded under genotype BSPCA-1 (365.78 g) which was at par with BSPCA-8 (348.56), BSPCA-4 (338.26 g) and followed by MSCA-5 (321.48 g) and MSCA-1 (316.65 g), whereas the minimum fruit weight was recorded in genotype MSCA-2 (155.86 g), which was at par with BSPCA-2 (165.89 g), MSCA-8 (168.65 g), MSCA-6 (175.86 g) followed by BSPCA-6 (198.75 g), BSPCA-5 (208.36 g), respectively. Maximum fruit weight in genotypes BSCPCA-1, BSPCA-8 and BSPCA-4 might be due the higher canopy spread which contributed to the accumulation of higher photosynthates in fruit to attain optimum fruit size. The variation in fruit weight is correlated with the length and breadth of the fruit which helps in attaining the good fruit size. Beside this, the age, vigour of plant and eco-physiological conditions may also influence the fruit weight. Similar results were also reported by Ghosh *et al*. (2001) [5], Dikshit *et al*. (2008) [3] in custard apple, Patil (2004) [18] and Mohar *et al.* (2011) [16] in sweet orange.

3.1.6 Pericarp weight

The observation recorded on pericarp weight in different genotypes of custard apple (Table 1) indicated that the pericarp weight was minimum in genotype MSCA-6 (75.85 g) and at par with the genotype BSPCA-2 (78.26 g) and followed by MSCA-8 (80.21 g), MSCA-2 (80.42 g), whereas

the maximum pericarp weight was recorded under genotype BSPCA-1 (162.58 g), which was at par with BSPCA-8 (158.08 g) and followed by MSCA-5 (144.36 g) and MSCA-1 (141.65 g), respectively. As the pericarp is the outer layer of the fruit which is not an edible part in custard apple, hence the minimum pericarp weight is of an utmost importance for selecting the superior genotype, so as to have more pulp weight in the fruit. The minimum pericarp weight was recorded in genotypes MSCA-6 and BSPCA-2, but these two genotypes had lesser pulp weight in comparison to their pericarp weight, therefore one can inferred that it was not of solely importance that minimum pericarp weight was alone a deciding criterion for selecting superior genotypes but the composition of minimum pericarp weight as well as maximum pulp weight might be taken as the deciding criterion for selecting the superior genotypes. In this condition genotypes BSPCA-1, BSPCA-8 and MSCA-5 can be considered as superior genotypes as their pericarp weight was lesser than their pulp weight. This result is in agreement with the reports of Mathakar (2005) [13] and Dikshit *et al.* (2008) [3] in custard apple.

3.1.7 Pulp weight

The data pertaining to pulp weight in different genotypes of custard apple (Table 1) showed that the maximum pulp weight was recorded under genotype BSPCA-1 (180.56 g), which was at par with BSPCA-8 (167.82 g) and followed by BSPCA-4 (165.63 g), whereas the minimum pulp weight was observed in genotype MSCA-2 (60.44 g), which was at par with BSPCA-2 (70.61 g), MSCA-8 (73.44 g) followed by MSCA-6 (84.26 g) and BSPCA-6 (86.42 g), respectively. There is significant variation in the pulp weight of different genotypes. Higher pulp weight is essential character for fruit to fetch higher market price. There are many factors which attributes to higher pulp weight viz., fruit weight, fruit size and less number of seeds. These results are in accordance with the findings of Mathakar (2005) [13], Dikshit *et al.* (2008) [3] in custard apple and Meena *et al.* (2013) [15] in guava.

3.1.8 Seed weight

The observation recorded on seed weight in different genotypes of custard apple is given in Table 1. The minimum seed weight was observed in genotype MSCA-2 (15.00 g), which was at par with MSCA-8 (15.67 g) and BSPCA-2 (16.00 g) followed by MSCA-6 (17.33 g) and MSCA-3 (18.00 g), whereas the maximum seed weight was observed under BSPCA-4 (23.00 g) which was at par with MSCA-1 (22.66 g), MSCA-4 (22.33 g), BSPCA-1 (21.66 g), BSPCA-3 (21.00 g) and followed by BSPCA-9 (20.66 g) and BSPCA-7 (20.33 g), respectively. The composition of minimum seed weight, minimum pericarp weight and maximum pulp weight was good criterion for selecting the superior genotypes. The minimum seed weight noticed in the genotypes MSCA-2, MSCA-8 and BPSCA-2 might be due to the accumulation of lesser photosynthates into the seeds. The data indicated that the seed weight increases as the fruit size increases, but this was not always true. These findings are in accordance with the work of Mathakar (2005) [13], Dikshit *et al.* (2008) [3] and Rao and Subramanyam (2010) [20] in custard apple.

3.1.9 Number of seeds per fruit

The data regarding number of seeds per fruit in different genotype of custard apple (Table 1) indicated that the minimum number of seeds was observed in the genotype MSCA-2 (20.00) and at par with BSPCA-2 (20.33) and MSCA-8 (20.66), followed by MSCA-6 (24.00), BSPCA-6 (26.33), whereas maximum number of seeds per fruit was noted in the genotype MSCA-1 (48.33) which was significantly maximum from all genotypes followed by BSPCA-4 (44.33) and was found at par with MSCA-4 (44.00), BSPCA-1(43.66), MSCA-4 (43.00), BSPCA-3 (41.33), BSPCA-8 (41.00), BSPCA-9 (40.67), MSCA-5 (40.66) followed by MSCA-9 (36.66) and MSCA-3 (33.66), respectively. In custard apple, the fruits having higher number of seeds would not fetch higher price in market as it likely to be failed to attract the consumer, therefore lesser of number of seeds per fruit preferred for table and processing purposes. Data indicated that the number of seeds per fruits increases as the fruit size increases but it was not likely be always true. Minimum number of seeds per fruit in genotypes MSCA-2, BSPCA-2 and MSCA-8 might be due to higher pulp per cent in the genotypes. Results obtained in the present investigation are in conformity with Shete *et al.* (1991) [22], Jalikop and Kumar (2000) [8], Mathakar (2005) [13] and Kumar (2015) [12] in custard apple.

Table 1: yield parameters of custard apple genotypes

S.No.	Genotypes	Number of fruits per tree	Fruit yield per plant (kg)	Fruit length (cm)	Fruit width (cm)	Fruit weight (g)	Pericarp weight (g)	Pulp weight (g)	Seed weight (g)	Number of seeds per fruit
1.	BSPCA-1	41	14.99	11.76	10.98	365.78	162.58	180.56	21.66	43.66
2.	BSPCA-2	34	5.64	7.84	7.21	165.89	78.26	70.61	16.00	20.33
3.	BSPCA-3	36	8.84	9.89	8.98	245.69	103.31	120.34	21.00	41.33
4.	BSPCA-4	31	10.48	11.32	10.65	338.26	148.54	165.63	23.00	44.33
5.	BSPCA-5	30	6.25	9.11	8.51	208.36	99.65	88.65	19.00	32.33
6.	BSPCA-6	32	6.36	8.42	7.79	198.75	92.46	86.42	18.66	26.33
7.	BSPCA-7	36	10.64	10.42	9.84	295.74	128.75	145.87	20.33	32.33
8.	BSPCA-8	37	13.04	11.52	10.78	348.56	158.08	167.82	22.00	41.00
9.	BSPCA-9	30	7.97	10.31	9.84	265.68	108.74	135.21	20.66	40.67
10.	MSCA-1	33	10.44	10.98	9.91	316.65	141.65	151.42	22.66	48.33
11.	MSCA-2	26	4.05	7.53	7.25	155.86	80.42	60.44	15.00	20.00
12.	MSCA-3	35	7.36	9.45	8.54	210.32	100.86	91.26	18.00	33.66
13	MSCA-4	30	6.95	9.76	8.73	231.96	109.41	100.89	22.33	43.00
14.	MSCA-5	28	9.00	11.21	10.54	321.48	144.36	156.79	20.33	40.66
15.	MSCA-6	29	5.09	8.21	7.68	175.86	75.85	84.26	17.33	24.00
16.	MSCA-7	40	9.82	9.75	8.81	245.66	107.84	114.86	21.33	44.00
17.	MSCA-8	27	4.55	7.54	7.14	168.65	80.21	73.44	15.66	20.66
	MSCA-9	35	9.65	10.23	9.68	275.95	116.98	138.71	20.00	36.66
	Sem±	1.15	0.33	0.35	0.32	9.65	12.42	4.60	0.80	1.34
	CD%	3.36	0.92	1.03	0.92	27.86	4.30	13.28	2.31	3.87

Conclusions

Significant variability was observed in custard apple genotypes which can be exploited for making selection of superior types. The different genotypes varied in growth and yield characters of fruits. The genotypes superior in fruit characters were found low yielder, however adoption of modified agronomical and horticultural practices can overcome the barrier of low yield. Based on overall performance, considering all characters together genotypes BSPCA-1, BSPCA- 4, BSPCA-8, MSCA-1 and MSCA-5 were found superior and genotypes MSCA-2 and BSPCA-2 were inferior in maximum traits. All these five genotypes were superior in quality traits and could be commercially viable cultivars.

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