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Studies on genetic variability, heritability and genetic advance in custard apple (*Annona squamosa* L.) genotypes

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Abstract
In the present study, an attempt has been made to generate information on genetic variability using twelve custard apple genotypes. The variability, heritability and genetic advance as percent over mean were performed for 20 selected parameters among selected custard apple genotypes at Horticultural Research and Extension station, Tidagundi (Vijayapur). Higher phenotypic coefficient of variation is observed over genotypic coefficient of variation for all traits studied, indicating the performance of environment over genetic parameter. Higher GCV and PCV were observed for fruit weight, number of fruits per plant, yield per plant, total sugar and pulp weight. High heritability for stem girth, number of fruits per plant, pulp weight, fruit length, pulp/peel ratio and fruit width. High GAM was observed for yield per fruit, number of seeds per fruit and peel weight. So, these traits imply the potential for crop improvement through selection and hybridization.

Keywords: Genetic variability, heritability, genetic advance as over mean, custard apple

Introduction

Custard apple (*Annona squamosa* L.) is one of the commercially grown fruit crop in India. It belongs to Annonaceae family and native of tropical region of West Indies (Porwal *et al*., 2011) [9]. Custard apple is popularly called with numerous vernacular names such as sugar apple, sitaphal, sweetsop and Sharifa in Indian subcontinents (Ghawade *et al.*, 2018) [5]. It is a crop of high nutritional value which harbours many important nutritional traits such as high amount of essential minerals (calcium, potassium and phosphorous), calories, vitamin C, and carbohydrate contents (Bharad *et al.*, 2009) [2]. Because of its unique nutritional properties it is widely cultivated throughout the dry arid, semi-arid and tropical regions of the world. In India it is commercially grown on degraded lands having marginal soils mainly by subsistence farmers. Maximum diversity can be noticed among different cultivars available in India and outside with respect to shape, size, yield, quality and other traits. Identification of a variety better suited for a particular region and its improvement is of immediate task to exploit its potential. The successful selection depends on the amount of genetic variation present in a population. The improvement can be brought out after confirming the variability in different characters among different genotypes. The potential for improvement in any crop is proportional to the magnitude of genetic variability present in the germplasm. A wide range of variability is available in custard apple due to its ability to cross pollinate, which provides possibilities to improve fruit yield through a breeding programme. Hence, an experiment was conducted at Horticulture Research and Extension Station (HRES), Tidagundi, Vijayapur with the aim of estimating genetic variability, heritability and genetic advancement in custard apple (*Annona squamosa* L.) genotypes.

Material and methods

Twelve genotypes of custard apple (*Annona squamosa* L.) were evaluated at Horticultural Research and Extension Station, Tidagundi during 2018-2019 using Randomized Complete Block Design with three replications and observations recorded on different growth, yield and quality parameters. Analysis of variance in respect of various characters was studied and the genetic variability for the different characters was estimated as suggested by Heritability (broad sense) and genetic advance as percentage of mean were calculated as per Hanson *et al.* (1956) and Johnson *et al.* (1955) [6, 8].

Result and discussion

Analysis of variance was worked out for growth, yield and quality related traits. Analysis of variance revealed highly significant difference among the genotypes for all the traits studied.

Existence of genetic variability among the genotypes for the characters to be improved is the most basic requirement for successful selection. In the present investigation, variance within the genotypes was significant (at p=0.05) for all the characters viz., growth, yield and quality parameters (Table1) indicating the sufficient amount of variability existed for all the characters and considerable improvement could be achieved in most of these characters by selection.

The extent of variability with respect to 20 characters in different genotypes measured in terms of mean, range, genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV) along with the amount of heritability (h^2) and genetic advance as per cent over mean (GAM) are presented in Table 2. High estimates of GCV and PCV were observed for fruit weight, number of fruits per plant, yield per plant, pulp weight, peel weight, pulp/peel ratio and total sugar. These characters having higher range of variation in the germplasm and have better scope of improvement through selection. These results are in confirmation with George *et al*. (1999), Yadava *et al. (*2017) and Chandel *et al*., 2018 [4, 12, 3]. Moderate GCV and PCV were observed for plant height, canopy spread N-S and E-W, leaf length, fruit length, TSS and titrable acidity and reaming parameters showed moderate GCV and PCV except stem girth recorded low GCV and PCV. This suggests the need for generation of variability either by introduction, exploration or by hybridization to get substantial gain in their improvement. Similar results were also reported by Wang *et al*. (2001) and Arivazhagan *et al*. (2019) [11, 1].

Table 1: Analysis of variance (mean sum of squares) for growth, yield and quality parameters in custard apple genotypes

Sl. No.	Characters	Replication	Treatments	Error	S.E m ±	CD (5%)	CD (1%)
	Degrees of freedom	2	11	22			
A.	Growth parameters						
1	Plant height (m)	0.147	0.305**	0.060	0.14	0.41	0.56
2	Stem girth (cm)	0.267	0.915**	0.151	0.71	2.09	2.84
3	Canopy spread N-S (m)	0.198	1.202**	0.126	0.20	0.60	0.81
4	Canopy spread E-W (m)	0.071	0.566**	0.091	0.17	0.51	0.69
5	Leaf length (cm)	2.171	3.837*	1.479	0.70	2.15	2.79
6	Leaf width (cm)	0.027	2.604**	0.622	0.45	1.33	1.81
B.	Yield parameters						
7	Fruit length (cm)	0.173	3.191**	0.221	0.27	0.79	1.08
8	Fruit width (cm)	0.026	5.736**	0.168	0.23	0.69	0.94
9	Fruit weight (g)	62.861	6582.270**	122.255	6.38	18.72	25.44
10	Number of fruits per plant	13.08	116.608**	5.598	1.36	4.00	5.44
11	Yield per plant (kg)	1.418	10.173**	23.201	0.38	1.12	1.52
12	Number of seeds per fruit	30.083	76.250**	12.446	2.03	5.97	8.11
C.	Quality parameters						
13	Pulp weight (g)	1.750	2822.007**	26.23	2.95	8.67	11.78
14	Peel weight (g)	6.861	1410.815**	14.012	2.16	6.33	8.61
15	Pulp/peel ratio	0.0190	0.778**	0.022	0.08	0.25	0.34
16	TSS (°Brix)	5.591	26.650**	3.343	1.05	3.09	4.20
17	Titrable acidity (%)	0.001	0.006**	0.001	0.02	0.06	0.09
18	Total sugar (%)	3.962	46.329**	2.842	0.97	2.85	3.88
19	Reducing sugar (%)	1.300	48.454**	3.204	1.03	3.03	4.12
20	Non reducing sugar (%)	0.210	0.785*	0.279	0.30	0.89	1.21

**Significant @ 5 % * Significant @ 1 %

Table 2: Estimation of mean, range, components of variance, heritability and genetic advance for growth, yield and quality parameters of custard apple

Sl. No	Characters	Mean	Range		GV	PV	GCV (%)	PCV (%)	h^2 (%) (BS)	GA	GA% mean
			Min.	Max.							
A.	Growth parameters										
1	Plant height (m)	2.72	2.04	3.08	0.08	0.14	10.49	13.83	57.73	0.44	16.39
2	Stem girth (cm)	22.68	19.13	25.48	0.25	0.40	6.98	8.82	62.74	0.82	11.40
3	Canopy spread N-S (m)	3.44	2.61	4.47	0.35	0.48	17.39	20.22	73.94	1.06	30.80
4	Canopy Spread E-W (m)	2.64	2.00	3.47	0.15	0.24	15.07	18.93	63.74	0.65	24.73
5	Leaf length (cm)	7.97	6.17	10.13	0.78	2.26	11.12	18.87	34.70	1.07	13.49
6	Leaf width (cm)	5.07	3.82	6.93	0.66	1.28	16.02	22.33	51.48	1.20	23.68
B	Yield parameters										
7	Fruit length (cm)	6.71	4.90	8.27	0.99	1.21	14.81	16.39	81.71	1.85	27.59
8	Fruit width (cm)	6.90	5.67	10.57	1.85	2.02	19.73	20.61	91.66	2.68	38.92
9	Fruit weight (g)	170.63	107.33	240	2153.59	2275.59	27.19	27.95	94.63	92.98	54.49
10	Number of fruits per plant	21.33	14.33	35.00	37.00	42.60	28.51	30.59	86.66	11.67	54.74
11	Yield per plant (kg)	3.69	1.610	6.683	3.24	3.68	48.69	51.88	88.10	3.48	94.15
12	Number of seeds per fruit	25.25	18.00	34.66	21.26	33.71	38.34	42.82	80.63	2.77	70.71
C.	Quality parameters										
13	Pulp weight (g)	94.08	65.00	155.00	931.92	958.15	32.44	32.90	97.26	62.01	65.91
14	Peel weight (g)	64.52	29.33	93.66	465.60	479.61	33.43	33.93	97.05	43.79	67.87
15	Pulp/peel ratio	1.56	0.97	2.25	0.25	0.27	32.0	33.42	91.69	0.99	63.13
16	TSS (⁰Brix)	22.81	18.72	27.73	7.76	11.11	12.21	14.60	69.91	4.80	21.03

17	Titrable acidity (%)	0.30	0.24	0.41	0.01	0.03	13.39	18.74	51.07	0.06	19.72
18	Total sugar (%)	14.35	10.00	21.00	14.49	17.33	26.51	28.99	83.60	7.17	49.94
19	Reducing sugar (%)	11.47	7.00	17.73	15.08	18.28	33.83	37.25	82.48	7.26	63.30
20	Non reducing sugar (%)	2.85	1.75	3.77	0.16	0.44	14.36	23.40	37.69	0.519	18.17

High heritability was recorded for stem girth, canopy spread E-W, canopy spread N-S, fruit length, fruit width, fruit weight, number of fruits per plant, yield per plant, pulp weight, peel weight, number of seeds per fruit, TSS, total sugar and reducing sugar remaining other parameters recorded moderate heritability indicating the predominance of additive gene action and hence direct phenotypic selection is useful with respect to these traits. These traits were less influenced by environmental factors. Similar findings were reported by Islam *et al*. (1991) [7], Singh *et al.* (1997) [10] and Wang *et al.* (2001) [11].

All parameters in this study showed highest genetic advance as percent over mean whereas, titrable acidity, non reducing sugar, plant height, leaf length and stem girth recorded moderate genetic advance as percent over mean. Similar result was reported by Islam *et al*. (1991) [7] and Arivazhagan *et al.* (2019) [1]. On the basis of information obtained from the present study, it indicates that there is an existence of greater amount of variability for all the characters in different genotypes, which can be efficiently utilized for further improvement of custard apple genotypes by choosing effective breeding program based on genetic makeup of different traits.

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