



E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2020; 9(1): 781-785
Received: xx-11-2019
Accepted: xx-12-2019

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Performance of different custard apple local selections (*Annona squamosa* L.) for yield and physical parameters

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Abstract

Evaluation of custard apple local selections was undertaken during 2018 at Department of Fruit Science, Kittur Rani Channamma College of Horticulture, Arabhavi, Belgaum district. Twenty five local selections of custard apple were evaluated with Balanagar variety as check for yield characters along with various physical characteristics of fruit. It was observed that selection CLS-9 recorded maximum number of fruits per plant (34.00) and fruit yield (4.36 kg/plant). Physical parameters *viz.* fruit length (8.49 cm), fruit breadth (8.44 cm), fruit volume (170.50 ml), fresh weight of the fruit (198.42 g) and ripe weight of the fruit (176.10 g) was recorded maximum in selection CLS-16 than the check variety Balanagar. However, Maximum pulp weight, pulp per cent and pulp-peel ratio was noticed in selection CLS-18 (75.32 g, 46.84% and 1.56 respectively). Minimum peel weight (36.79 g), minimum number of seeds per fruit (14.17) and seed weight (3.81g) was recorded in selection CLS-1.

Keywords: Custard apple, evaluation, yield and physical parameters

Introduction

Custard apple (*Annona squamosa* L.) is a tropical and subtropical fruit tree belongs to Annonaceae family (Nakasone and Marigulele, 1998) [16] and it has 40 to 50 genera and 119 species, of which only six species are of commercial importance (Popenoe, 1974 and Geurts, 1981) [18, 4]. Among annonaceous fruits, custard apple is most favourite in India (Thakur and Singh, 1967) [21]. Fruits are rich in calories and good source of iron. Generally, annonas are consumed as dessert but, also used in semi-processed and processed products like squash, nectar, ready-to-serve (RTS) beverage, toffee and ice cream. Pulp contains proteins, fatty acids, fibre, carbohydrates, minerals and vitamins (Lizana and Reginato, 1990) [12]. Day by day these products are gaining popularity among the consumers and also highly remunerative to the farmers.

Natural variability available in custard apple within the species is often explored to identify superior genotypes. Though the custard apple is hardy crop and has wider adaptability, only few varieties are commercially grown in our country like Balanagar, Island Gem and Arka Sahana. There is not much progress in the varietal development of custard apple. Considering these views evaluation was undertaken at Department of Fruit Science, Kittur Rani Channamma College of Horticulture, Arabhavi, Belgaum district with an objective to identify superior custard apple local selections for yield and quality. Arabhavi is situated in Northern Dry Zone (Zone-3) of Karnataka. The average rainfall of this area is about 522 mm, distributed over a period of five to six months (June to November) with a peak during October month.

Material and methods

Evaluation orchard of Arabhavi, having medium black soil with depth of 60 to 100 cm. Total twenty five local selections were evaluated in comparison with check variety Balanagar. The data for yield parameters *viz.* number of fruits per plant and fruit yield (kg/plant) was recorded after harvesting of fruits at physiological maturity from each replication of each treatment. Matured fruits from each replication of each treatment were collected and are used to record different physical parameters of fruit. Fresh weight was taken using digital balance. Vernier calliper was used to record the length and breadth of fruit. Fruit volume was measured by conventional water displacement method. The pulp was manually separated from the individual seeds and pulp weight, peel weight and seed weight per fruit was recorded using electronic balance. The number of seed per fruit was also recorded.

Result and Discussion

Yield parameters

Evident from the Table 1 that the number of fruits per plant and fruit yield per plant was found significant among the selections.

Number of fruits per plant

Significantly maximum number of fruits per plant was harvested in selection CLS-9 (34.00) followed by CLS-20 (26.67), CLS-12 (24.67), CLS-7 (23.67), CLS-21 (22.00) and CLS-19 (20.33) which are *on par* with each other with a mean of 12.84 fruits per plant. Whereas, minimum number of fruits per plant was harvested in selection CLS-1 (1.67). The check variety Balanagar also recorded minimum number of fruits (5.83/plant). Similar results were noticed by Varu and Barad (2011) [22]. This variation might be due to genetic diversity among number of shoot, shoot length and number of flowers per shoot, fruit set percentage and fruit retention percentage of different selections as well as due to climatic conditions.

Fruit yield per plant (kg)

Fruit yield was found maximum in selection CLS-9 (4.36 kg/plant) followed by CLS-20 (3.56 kg/plant), CLS-12 (3.12 kg/plant), CLS-16 (2.92 kg/plant), CLS-19 (2.75 kg/plant), CLS-21 (2.63 kg/plant) and CLS-7 (2.52 kg/plant) which are *on par* with each other. While, minimum fruit yield was noticed in CLS-1 (0.12 kg/plant) which is followed by CLS-14 (0.23 kg/plant), CLS-3 (0.41 kg/plant), CLS-5 (0.46 kg/plant) and CLS-4 (0.49 kg/plant). The mean yield recorded among the selection was 1.71 kg per plant. However, the check variety Balanagar produced yield of 0.76 kg/plant. Some genotypes produce less yield even after more number of fruits per plant, this might be due to lesser accumulation of photosynthetic products in custard apple fruit, as it also reported by Dubey, (2000) [2] in sweet orange. These findings are in accordance with the earlier reports of Kaur *et al.* (2014) [10] in mango. Yield being the polygenic and complex character is determined by various vegetative and reproductive characters as also reported by Shete *et al.* (1991) [20] in custard apple.

Physical parameters of fruit

The data pertaining to fruit physical parameters were recorded and presented in Table 2 and 3 are found statistically significant.

Fruit length (cm)

Maximum fruit length was recorded in selection CLS-16 (8.49 cm) followed by CLS-10 (7.83 cm) which are *on par* with each other followed by CLS-17 (7.25 cm), CLS-18 (7.17 cm), CLS-12 (7.11 cm), CLS-20 and CLS-24 (7.05 cm each). While, minimum fruit length was observed in CLS-1 (4.40 cm) followed by CLS-4 (5.58 cm), CLS-8 (5.83 cm), CLS-3 and CLS-7 (5.97 each). The variety Balanagar recorded medium length of fruit (5.98 cm). 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 an 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 *et al.* (2005) [13] and Bakane *et al.* (2015) [1] in custard apple and Githai *et al.* (2016) [16] in mango.

Fruit width (cm)

Significantly highest fruit width was noticed in selection CLS-16 (8.44 cm) which is followed by CLS-18 and CLS-17 (7.50 and 7.32 cm respectively) whereas, CLS-1 recorded the lowest fruit width of 4.35 cm followed by CLS-4 (5.75 cm), Balanagar (6.02 cm) and CLS-3 (6.04 cm) with a mean fruit width of 6.22 cm. The climatic and edaphic condition influences the fruit size. Variation in fruit width might also 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 influences the size of the fruit. Similar results were also reported by Thakur and Singh (1967) [21] and Mathaka, (2005) [13] in custard apple and Jadhao (2012) [7] in sweet orange.

Fresh weight (g)

Maximum fresh fruit weight was recorded in selection CLS-16 (198.42 g) followed by selection CLS-18 (179.34 g), CLS-12 (172.81 g), CLS-17 (170.69 g) which are *on par* with each other with a mean fruit weight of 126.40 g. Whereas, lowest fruit weight was recorded in CLS-1 (75.48 g). This variation in fruit weight may be due to higher canopy spread which contribute 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) [2], Kad *et al.* (2016) [9] in custard apple, Patil (2004) [17] and Mohar *et al.* (2011) [15] in sweet orange.

Fruit volume (ml)

Fruit volume was recorded significantly maximum in CLS-16 (170.50 ml) followed by CLS-18 and CLS-12 (144.20 and 141.58 ml respectively). The minimum fruit volume was recorded in CLS-1 (57.50 ml). Whereas, Balanagar recorded fruit volume of 116.24 ml.

Pulp and peel characters

Pulp weight of fruit was significantly maximum in selection CLS-18 (75.32 g) over other selections which is followed by CLS-16 and CLS-17 (69.99 and 61.41 g respectively). While, lowest pulp weight was recorded in CLS-1 (23.61 g). Maximum pulp per cent was recorded in selection CLS-18 (46.84%) followed by CLS-21 (42.85%), CLS-17 (41.64%) and CLS-11 (40.52%) they are *on par* with each other. Minimum pulp per cent was noticed in CLS-23 (30.42%). The check Balanagar recorded pulp content of 34.26 per cent with a mean of 34.38 per cent. Higher pulp weight is essential character for fruit to fetch higher market price. Many factors attribute to higher pulp weight *viz.*, fruit weight, fruit size, thin peel and less number of seeds. These results are in accordance with the findings of Mathakar *et al.* (2005) [13], Dikshit *et al.* (2008) [2] in custard apple and Meena *et al.* (2013) [14] in guava.

The peel weight was significantly minimum in CLS-1 (36.79 g) followed by CLS-4 (49.71 g), CLS-3 (54.01 g) and CLS-7 (51.07 g). Whereas, maximum peel weight was recorded in CLS-16 (91.74 g) which is *on par* with CLS-12 (83.13 g), CLS-10 (80.66 g), CLS-17 (76.13 g) and CLS-18 (74.64 g). Significantly maximum pulp-peel ratio was recorded in CLS-18 (1.56) followed by CLS-21 and CLS-17 (0.86 and 0.80 respectively). While, minimum pulp-peel ratio was noticed in CLS-23 and CLS-8 (0.53 each). Peel is not edible part in

custard apple hence, minimum peel weight is utmost importance for selecting the superior genotype. Peel weight was significantly minimum in selection CLS-1 (36.79 g) and maximum in selection CLS-16 (89.88 g). But, these local selections had less pulp weight in comparison to their peel weight, and is not only the factor to consider superiority therefore we have to compare per cent pulp recovery it was found highest in selection CLS-18 (46.84%). This result is in agreement with the reports of Mathakar (2005)^[13] and Dikshit *et al.* (2008)^[2] in custard apple.

Seed parameters

Number of seeds per fruit

Minimum number of seeds per fruit was observed in CLS-1 (14.17) followed by CLS-19 (18.53), CLS-17 (21.15), CLS-14 (23.15) and CLS-5 (27.67) and maximum number of seeds were recorded in CLS-7 (53.60) which is *on par* with CLS-11 (47.44). Balanagar variety used as check recorded 42.35 number of seeds per fruit. Usually lesser number of seeds per fruit preferred for table and processing purpose. 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 might be due to higher pulp per cent. The results are in conformity with Shete *et al.* (1991)^[20], Jalikop and Kumar (2000)^[8], Mathakar (2005)^[13] and Kumar (2015)^[11] in custard apple.

Seed weight (g)

The seed weight was significantly lowest in CLS-1 (3.81g), CLS-19 (4.72 g), CLS-14 (6.62 g) and maximum seed weight was observed in CLS-18 (17.60 g). The variety Balanagar recorded seed weight of 12.76 g per fruit. Minimum seed weight might be due to the accumulation of lesser photosynthates into the seeds. The data indicated that 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)^[2] and Rao *et al.* (2010)^[19] in custard apple.

Table 1: Yield parameters of different custard apple local selections

Local selections	Fruit yield	
	Number/plant	Kg/plant
CLS-1	1.67 (1.44)*	0.12 (0.78)*
CLS-2	0.00 (0.70)	0.00 (0.70)
CLS-3	3.67 (1.94)	0.41 (0.94)
CLS-4	4.17 (2.14)	0.49 (0.99)
CLS-5	3.67 (1.96)	0.46 (0.97)
CLS-6	0.00 (0.70)	0.00 (0.70)
CLS-7	23.67 (4.89)	2.52 (1.73)
CLS-8	12.67 (3.62)	1.64 (1.46)
CLS-9	34.00 (5.87)	4.36 (2.20)
CLS-10	12.83 (3.61)	1.97 (1.55)
CLS-11	18.50 (4.20)	2.52 (1.70)
CLS-12	24.67 (4.97)	3.12 (1.90)
CLS-13	11.83 (3.48)	1.49 (1.40)
CLS-14	2.00 (1.56)	0.23 (0.86)
CLS-15	13.00 (3.16)	1.64 (1.35)
CLS-16	15.17 (3.86)	2.92 (1.81)
CLS-17	13.33 (3.53)	2.30 (1.61)
CLS-18	5.17 (2.37)	0.94 (1.19)
CLS-19	20.33 (4.50)	2.75 (1.78)
CLS-20	26.67 (5.14)	3.56 (1.98)
CLS-21	22.00 (4.69)	2.63 (1.75)
CLS-22	17.50 (4.23)	1.95 (1.54)
CLS-23	12.50 (3.59)	1.66 (1.46)
CLS-24	16.17 (4.06)	2.24 (1.63)
Balanagar	5.83 (2.45)	0.76 (1.11)
Mean	12.84 (3.32)	1.71 (1.40)
SE m ±	3.80 (0.47)	0.55 (0.16)
CD @ 5%	10.82 (1.36)	1.58 (0.47)

* The value in the parenthesis indicates square root transformed values.

Table 2: Physical parameters of fruits of different custard apple local selections

Local selections	Physical parameters of fruit			
	Length (cm)	Width (cm)	Fresh weight (g)	Volume (ml)
CLS-1	4.40 (2.21)*	4.35 (2.20)*	75.48 (8.72)*	57.50 (7.60)*
CLS-2	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)
CLS-3	5.97 (2.54)	6.04 (2.56)	119.55 (10.95)	100.49 (10.03)
CLS-4	5.58 (2.47)	5.75 (2.50)	116.73 (10.82)	96.67 (9.85)
CLS-5	6.65 (2.67)	7.05 (2.75)	129.25 (11.39)	106.73 (10.34)
CLS-6	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)
CLS-7	5.97 (2.54)	6.77 (2.70)	107.67 (10.40)	93.33 (9.68)
CLS-8	5.83 (2.51)	6.85 (2.71)	130.50 (11.43)	110.01 (10.50)
CLS-9	6.29 (2.61)	6.98 (2.73)	133.99 (11.60)	111.70 (10.63)
CLS-10	7.83 (2.89)	7.27 (2.79)	152.46 (12.36)	136.72 (11.71)
CLS-11	6.43 (2.63)	6.80 (2.70)	140.60 (11.87)	127.58 (11.31)
CLS-12	7.11 (2.76)	7.11 (2.76)	172.81 (13.16)	141.58 (11.90)
CLS-13	5.96 (2.54)	6.87 (2.72)	125.38 (11.21)	105.20 (10.27)
CLS-14	7.01 (2.78)	7.17 (2.77)	121.90 (11.04)	101.33 (10.08)
CLS-15	6.02 (2.55)	6.19 (2.59)	127.60 (11.32)	107.90 (10.41)
CLS-16	8.49 (2.30)	8.44 (2.99)	198.42 (14.10)	170.50 (13.07)
CLS-17	7.25 (2.78)	7.32 (2.79)	170.69 (13.08)	140.52 (11.85)
CLS-18	7.17 (2.76)	7.50 (2.82)	179.74 (13.30)	144.20 (11.93)
CLS-19	5.98 (2.54)	6.58 (2.66)	135.64 (11.67)	112.85 (10.64)
CLS-20	7.05 (2.74)	7.11 (2.75)	130.21 (11.42)	106.25 (10.32)
CLS-21	6.30 (2.60)	6.68 (2.68)	119.92 (10.97)	101.86 (10.10)
CLS-22	6.35 (2.61)	6.93 (2.72)	140.56 (11.88)	119.75 (10.97)
CLS-23	6.26 (2.60)	6.53 (2.65)	132.13 (11.52)	115.78 (10.78)
CLS-24	7.05 (2.74)	7.16 (2.76)	167.08 (12.90)	132.31 (11.51)
Balanagar	5.98 (2.54)	6.02 (2.55)	131.70 (11.49)	116.24 (10.80)
Mean	5.97 (2.84)	6.22 (2.53)	126.40 (10.80)	106.28 (9.89)
SE m ±	0.22 (0.03)	0.20 (0.03)	9.43 (0.35)	6.88 (0.28)

CD @ 5%	0.62 (0.11)	0.57 (0.10)	26.81 (1.03)	19.55 (0.84)
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* The value in the parenthesis indicates square root transformed values

Table 3: Pulp, peel and seed characters of custard apple local selections

Local selections	Pulp weight (g)	Pulp (%)	Peel weight (g)	Pulp-peel ratio	No. of seeds /fruit	Seed weight (g)
CLS-2	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)
CLS-3	41.87 (6.51)	39.34 (6.30)	54.01 (7.38)	0.77 (1.12)	29.83 (5.50)	8.30 (2.96)
CLS-4	34.63 (5.92)	37.30 (6.15)	49.71 (7.08)	0.70 (1.09)	31.50 (5.65)	7.26 (2.78)
CLS-5	48.09 (6.97)	39.89 (6.35)	63.88 (8.02)	0.76 (1.12)	27.67 (5.30)	8.14 (2.93)
CLS-6	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)
CLS-7	38.65 (6.25)	38.55 (6.24)	51.07 (7.16)	0.78 (1.12)	53.60 (7.35)	11.41 (3.44)
CLS-8	37.82 (6.18)	32.11 (5.70)	70.85 (8.44)	0.53 (1.01)	34.27 (5.83)	8.12 (2.93)
CLS-9	48.37 (7.01)	39.57 (6.33)	63.13 (7.97)	0.78 (1.12)	42.61 (6.56)	8.52 (3.00)
CLS-10	46.27 (6.83)	33.34 (5.82)	80.66 (9.01)	0.58 (1.03)	40.44 (6.39)	10.99 (3.38)
CLS-11	53.53 (7.34)	40.52 (6.40)	68.91 (8.32)	0.77 (1.12)	47.44 (6.92)	9.57 (3.16)
CLS-12	52.57 (7.28)	35.04 (5.96)	83.13 (9.15)	0.63 (1.06)	43.67 (6.62)	12.56 (3.61)
CLS-13	45.28 (6.76)	37.28 (6.14)	63.20 (7.95)	0.76 (1.16)	32.00 (5.67)	7.83 (2.88)
CLS-14	35.83 (6.02)	34.44 (5.91)	60.80 (7.81)	0.54 (1.02)	23.15 (4.86)	6.62 (2.66)
CLS-15	40.03 (6.36)	33.56 (5.84)	68.92 (8.33)	0.58 (1.04)	41.25 (6.45)	9.98 (3.23)
CLS-16	69.99 (8.40)	39.76 (6.35)	91.74 (9.60)	0.77 (1.13)	49.54 (7.07)	13.99 (3.79)
CLS-17	61.41 (7.86)	41.64 (6.49)	76.13 (8.75)	0.80 (1.14)	21.15 (4.65)	7.72 (2.86)
CLS-18	75.32 (8.70)	46.84 (6.84)	74.64 (8.41)	1.56 (1.43)	45.67 (6.78)	17.60 (4.25)
CLS-19	43.76 (6.65)	35.59 (6.00)	73.36 (8.59)	0.59 (1.04)	18.53 (4.36)	4.72 (2.28)
CLS-20	42.69 (6.57)	36.98 (6.12)	62.34 (7.92)	0.69 (1.08)	45.07 (6.74)	10.41 (3.30)
CLS-21	47.18 (6.90)	42.85 (6.58)	54.59 (7.42)	0.86 (1.16)	40.44 (6.39)	8.24 (2.95)
CLS-22	45.03 (6.74)	35.2 (5.98)	71.90 (8.50)	0.62 (1.06)	39.11 (6.29)	9.61 (3.17)
CLS-23	37.54 (6.16)	30.42 (5.56)	70.82 (8.44)	0.53 (1.01)	37.00 (6.17)	11.91 (3.52)
CLS-24	52.25 (7.26)	38.60 (6.25)	73.99 (8.62)	0.71 (1.09)	35.67 (6.01)	10.31 (3.28)
Balanagar	41.94 (6.51)	34.26 (5.88)	68.06 (8.28)	0.62 (1.05)	42.35 (6.54)	12.76 (3.64)
Mean	42.55 (6.31)	34.28 (5.07)	61.31 (7.54)	0.67 (1.08)	33.45 (5.57)	8.82 (2.94)
SE m ±	1.47 (0.10)	2.04 (0.16)	5.91 (0.32)	0.04 (0.01)	2.10 (0.17)	0.50 (0.07)
CD @ 5%	4.17 (0.30)	5.81 (0.46)	16.80 (0.94)	0.11 (0.05)	5.97 (0.50)	1.42 (0.21)

* The value in the parenthesis indicates square root transformed values.

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