Short Communication

Performance evaluation of passion fruit (*Passiflora edulis* Sims.) genotypes

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Abstract

A study was conducted at the Fruits Crops Research Station, Kerala Agricultural University, Vellanikkara, Thrissur, during September 2018 - September 2019 to evaluate the genotypes of passion fruit collected from different areas in Kerala. The experiment was laid out in randomised block design with eight treatments and three replications. The study revealed that considerable variability existed among the genotypes of passion fruit. The number of fruits per vine per year was high in genotype 4 (155.33). Peak fruiting was observed from the month of June to September. Genotype 3 (yellow) and genotype 4 (purple) were found to be superior in fruit characters. Genotypes 2, 4, 5 and 8 with high juice content and thin rind can be utilized for processing and value addition. Genotype 5 with high non-reducing sugar (5.92 %), sugar acid ratio (4.97), TSS (17.33 æ%Brix), total sugars (13.55 %) and lower acidity (2.73 %) was identified as a superior selection based on quality parameters. Correlation studies showed that yield/vine had significant and positive correlation with fruit diameter, fruit girth, fruit weight, pulp weight and juice weight. Rind thickness was found to have significant positive correlation with shelf life. The genotypes which recorded high yield *viz*., Genotype 2, 4 and 6 can be used for further crop improvement programmes to develop superior passion fruit varieties.

Keywords: Fruit characteristics, Genotypes, Passion fruit, Quality characters.

Passion fruit (*Passiflora edulis* Sims.) is a perennial woody vine with axillary tendrils belonging to the family Passifloraceae comprising of about 500 species. There are mainly two types of passion fruit under cultivation. They are the yellow passion fruit (*Passiflora edulis* f. *flavicarpa* Degener), suited to tropical conditions or the plains and the purple passion fruit (*Passiflora edulis* f. *edulis* Sims) which grows best under sub-tropical conditions or high altitudes. Passion fruit with excellent aroma and taste is appreciated for fresh consumption and also for the preparation of various processed products like squash, syrup, juice, jam, *etc*. High nutritional and therapeutic components make passion fruit a healthy addition to the diet since it contains good amount of vitamins, minerals, dietary fibre, antioxidants and different phytochemical components. It has got various health benefits like cytotoxic, antioxidant, antihypertensive, antimicrobial and gastroprotective effects (Ripa et al., 2009).

In India, passion fruit is being cultivated in Mizoram, Nagaland, Manipur, Sikkim, Karnataka, Kerala and Tamil Nadu in an area of 0.19 lakh ha, with a production of 1.29 lakh tonnes and productivity of 7 t ha^{-1} (NHB, 2017). Recently, there is a trend among Kerala farmers to shift from

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traditional cash crops to fruit crop cultivation due to highly volatile nature of market price of cash crops. Due to adaptability of passion fruit under humid tropical regions, it is gaining commercial importance in Kerala (Sulladmath et al., 2012). Even though, passion fruit has high production potential in Kerala, there is lack of suitable varieties and research work related to scientific cultivation aspects is meagre.

Studying the existing genetic variability helps in characterization and conservation of different genotypes in passion fruit. Farmers have selected and started cultivating morphotypical types which perform best in a given locality based on yield and quality parameters. These types show difference in performance when grown in different agro climatic conditions and have variations in their biochemical and physical characteristics. Studies at Pineapple Research Station, Vazhakulam have shown wide morphological and biochemical variations among different genotypes (PRS, 2015). The physico-morphological and biochemical characterization of different genotypes grown in various parts of Kerala and identification and categorization of the superior genotypes suitable for fresh consumption as well as processing purpose will be highly useful for further crop improvement programmes. Information regarding the relation between the yield and the fruit characters has significance in selecting the breeding material. Knowledge of correlation between different traits is a prerequisite in fruit breeding which is necessary for planning appropriate breeding strategy for the crop.

In this context, the present investigation was undertaken with the objective to evaluate the various genotypes of passion fruit collected from different parts of Kerala, and to categorize them based on flower and fruit production including, biochemical and morphological characters which will also supplement to further crop improvement programmes.

Field experiment was laid out with eight treatments, each with three replications and four plants per replication at Fruits Crops Research Station, Kerala Agricultural University, Vellanikkara. The experimental site was situated at 10Ú 31’ North latitude and 76Ú 3’ East longitude at an altitude of 22.25 m above mean sea level, having typical warm humid tropical climate of Kerala. Rooted cuttings of three-month-old were planted at a spacing of 4m x 4m and the cultural practices were given as per the *ad hoc* Package of Practices Recommendations by PRS, Vazhakulam (PRS, 2011). These genotypes were evaluated for flower and fruit production, including fruit characters and quality parameters. Eight different genotypes (yellow and purple types) of passion fruit collected from research stations and farmers’ fields from four districts in Kerala used for the experiment (Table 1).

Number of flowers and fruits produced in a vine in a month was counted starting from the month of flowering and fruiting initiation. Fruits were harvested at maturity when they started turning yellow or purple depending on the type of genotype. Rind colour and pulp colour was identified based on visual observation. Rind thickness was measured

Table 1. Passion fruit genotypes collected from different parts of Kerala

Genotype	Place of collection	Rind colour	Pulp colour
Genotype 1 (T_1)	Kuthukuzhi, Ernakulam	Purple with white specks	Yellowish orange
Genotype 2 (T_2)	Vazhakulam, Ernakulam	Purple with white specks	Yellowish orange
Genotype 3 (T_3)	Puttady, Idukki	Yellow with white specks	Deep yellow
Genotype 4 (T_4)	Kovilkadavu, Idukki	Purple with white specks	Yellowish orange
Genotype 5 (T_5)	Ambalavayal, Wayanad	Purple with white specks	Yellowish orange
Genotype 6 (T_6)	Ambalavayal, Wayanad	Yellow with white specks	Yellowish orange
Genotype 7 (T_7)	Madakkathara, Thrissur	Yellow with white specks	Deep yellow
Genotype 8 (T_8)	Pazhayanoor, Thrissur	Purple with white specks	Yellowish orange

Table 2. Flower production in passion fruit genotypes

Genotype	Number of flowers /vine								
	February '19	March '19	April '19	May '19	June '19	July '19	August '19	September '19	Total
Genotype 1 (P)	6.67	14.67	4.33	22.33	25.33	35.00	19.00	37.00	164.33
Genotype 2 (P)	0.00	0.00	18.67	31.67	34.67	32.00	28.67	36.00	181.67
Genotype 3 (Y)	0.00	0.00	2.33	29.33	21.00	26.67	36.67	19.67	135.67
Genotype 4 (P)	29.00	25.33	17.33	14.00	28.33	22.33	22.67	31.67	190.67
Genotype 5 (P)	14.00	16.00	16.67	13.00	7.67	18.00	20.00	33.00	138.33
Genotype 6 (Y)	21.67	16.67	4.67	30.67	27.00	29.00	13.00	37.67	180.33
Genotype 7 (Y)	13.33	12.67	11.67	12.67	6.67	27.67	21.67	34.33	140.67
Genotype 8 (P)	9.33	13.00	12.33	12.67	21.67	28.33	22.33	32.33	152.00
CD (0.05)	10.03	6.98	10.89	12.81	8.60	NS	NS	NS	14.09

using digital Vernier calliper and was expressed in centimetre.

Ripe fruits of each genotype were subjected to quality analysis. Total soluble solids (TSS) and titrable acidity were determined by the procedure proposed by Ranganna (1997) and titrable acidity was expressed as percent anhydrous citric acid. The total sugars, reducing sugars, non-reducing sugars, ascorbic acid and total carotenoid content of the passion fruit pulp was determined using the method described by AOAC (1998). Number of days from ripening to the stage when fruit skin shrinks and become unsuitable for consumption was recorded as shelf life of fruits at ambient condition. Data was analysed statistically in Randomized Block Design and significance was tested using analysis of variance technique (Panse and Sukhatme, 1985).

Significant variation was observed in mean flower production per vine in February, March, April, May and June (Table 2). In Genotype 3, August was found to be the peak flowering month and in all other genotypes it was September. Total flower production per vine varied significantly among the genotypes (Table 2) which ranged from 135.67 to 190.67. Beena and Beevi (2016) reported that the species like *P. edulis* var. *edulis*, *P. ligularis, P. subpletata* and *P. leshnoultii*, habitating in high ranges bloomed from April to September. The significant differences in total flower production per vine per year among different genotypes might be due to the inherent nature and varying responses of genotypes to prevailing climatic conditions. According to Borges and Lima (2003) day light played an important role in growth and development of passion fruit. An increase in day length duration enhanced photosynthetic activity, which resulted in increased plant vigour. They also reported that flower production was heavy in areas where day length was more than 11 hours. The favourable day length available in plains of Thrissur would have caused the genotypes to flower profusely.

Fruit production per vine in March, May and June showed significant difference among the genotypes

Table 3. Fruit production in passion fruit genotypes

Genotype	Number of fruits/vine								
	February '19	March '19	April '19	May '19	June '19	July '19	August '19	September '19	Total
Genotype 1 (P)	5.33	9.33	3.33	19.00	20.67	28.33	17.00	33.67	136.67
Genotype 2 (P)	0.00	0.00	13.33	27.67	29.00	26.00	24.33	29.00	149.33
Genotype 3 (Y)	0.00	0.00	2.00	24.33	16.67	20.33	29.00	16.33	108.67
Genotype 4 (P)	12.33	22.33	14.00	10.67	23.67	26.33	22.00	24.00	155.33
Genotype 5 (P)	8.33	16.33	9.67	8.67	5.67	18.00	15.33	27.67	109.67
Genotype 6 (Y)	10.67	13.67	3.00	24.67	23.33	26.00	12.00	33.33	146.67
Genotype 7 (Y)	6.67	5.33	9.67	10.00	4.67	23.00	16.00	28.67	104.00
Genotype 8 (P)	0.00	2.67	11.33	11.00	13.67	24.67	21.67	26.67	111.67
CD (0.05)	NS	6.41	NS	11.55	7.64	NS	NS	NS	13.61

(Table 3). According to Ataide et al. (2012) harvesting time and fruit production showed differences in *Passiflora* species throughout the year depending on the changes in flowering behavior. The variations in monthly fruit production and total fruit production might be due to the variations in flowering response and different genetic behaviour of the genotypes. Peak fruiting month was found to be September in all most all genotypes, except for Genotype 3 and Genotype 4. In Genotype 3 peak fruit production was observed in the month of August and for Genotype 4, July was the peak fruiting month. In the case of Genotype 2, June and September were the peak fruiting months. Statistical analysis of total fruit production per vine per year showed significant differences among the genotypes (Table 3). Maximum fruit production per vine per year was observed in Genotype 4 (155.33) and the minimum in Genotype 7 (104.00). Occurrence of two flowering seasons in a year and the two times of harvest in *P. edulis* cv. Panama Red has been reported by Beena and Beevi (2016) which might have contributed to the increased yield of the genotype, adding to its value for commercial cultivation. Accordingly, in the present study, Genotypes 2, 4 and 6 with high yield can be used for commercial cultivation.

The results of the effect of different genotypes of passion fruit on fruit characters are presented in Table 4. The study has shown that all the fruit characters studied varied significantly among the different genotypes collected.

Statistical analysis of fruit diameter showed significant difference among the different genotypes and it varied from 6.00 to 7.40 cm. Sema and Maiti (2006) also reported the variations in fruit diameter in different types passion fruit which are in line with the results of the present study. According to Ghosh et al. (2017) purple types have an average fruit diameter of 3-5 cm, which may be due to genotypic and environmental factors which affected the size of fruits. In a study for evaluating promising passion fruit genotypes at CHES, Chettalli, variations in fruit diameter had been reported by Tripathi et al. (2014). They reported fruit diameter variation in the range of 5.03 cm in CHES PF-2-11 to 7.08 cm in CHES PF-7, which is in conformity with the observed values of fruit diameter in the various genotypes in the present study.

Fruit girth exhibited same trend as that of fruit diameter. Fruit girth among different genotypes varied significantly ranging from 18.83 cm to 23.30 cm. According to Charan et al. (2018), fruit girth ranged from 18.30 to 21.16 cm and 19.20 to 22.83 cm in yellow and purple passion fruits respectively, which is in line with the present findings. The significant variations in fruit girth might also be due to the variations in fruit diameter of passion fruit genotypes as observed earlier.

Table 4. Fruit characters of passion fruit genotypes

Genotype	Fruit diameter (cm)	Fruit girth (cm)	Fruit weight (g)	Pulp weight (g)	Rind weight (g)	Fresh seed weight (g)	Juice weight (g)	Rind thickness (cm)	Shelf life (days)
Genotype 1 (P)	6.00	18.83	66.00	28.41	37.59	5.67	22.82	0.47	12.33
Genotype 2 (P)	7.21	22.67	98.33	46.67	51.67	8.17	38.50	0.50	13.33
Genotype 3 (Y)	7.40	23.30	120.33	52.00	68.33	9.67	42.33	0.91	15.67
Genotype 4 (P)	7.32	23.00	110.00	48.17	58.50	8.20	43.30	0.60	14.17
Genotype 5 (P)	6.47	20.33	83.67	39.67	44.00	8.50	31.17	0.78	15.33
Genotype 6 (Y)	6.21	19.50	73.33	31.70	41.63	6.17	25.53	0.67	14.33
Genotype 7 (Y)	6.36	20.00	74.83	31.77	43.33	5.67	26.10	0.53	13.67
Genotype 8 (P)	7.12	22.37	98.67	44.00	55.67	7.00	37.00	0.58	14.00
CD (0.05)	0.34	1.08	9.43	6.60	6.76	1.75	6.44	0.14	1.10

Fruit weight of passion fruit genotypes varied significantly and was the highest in Genotype 3 (120.33 g) while the lowest fruit weight was observed in Genotype 1 (66.00 g). Similar research finding was reported by Patel et al. (2008) who evaluated different passion fruit genotypes under mid hill conditions of Meghalaya and found that fruit weight varied from 36.33 to 117.90 g. There are many reports regarding the fruit weight of passion fruit as a varietal character. Wide variation in fruit size has been reported by Kishore et al. (2011), who reported that the average size of fruits of passion fruit was 35.00 g and 70.00 g respectively. The present results of fruit weight are comparable with the reports of Tripathi et al. (2014). They conducted a study at CHES, Chettali to evaluate passion fruit genotypes and found that fruit weight varied from 44.10 g in CHES PF-2-11 to 99.10 g in CHES PF-7, thus deriving a conclusion that there were genotypic differences in fruit weight. According to Beena and Beevi (2016) the fruit weight was 15±0.023 g, 20±0.024 g, 26±0.021 g in *P. edulis* var. *edulis*, *P. edulis* f. *flavicarpa* and *P. edulis* cv. Panama Red respectively. The values of fruit weight observed were very low which might be due to the varied climatic conditions and difference in the genotypes, which they used. Mendoza et al. (2018) reported that fruit volume is a variable that contributed to 80 per cent phenotypic variations among 60 genotypes of passion fruits evaluated at Colombia. Fruit volume is an important factor contributing to fruit weight. The phenotypic variations might have contributed to the weight differences in the fruits in the present study.

Data on pulp weight of different genotypes indicated significant variations and it ranged from 28.41 g in Genotype 1 to 52.00 g in Genotype 3. According to Vieira and Carneiro, (2006) fruit characteristics can be used as selection criteria for yield potential in yellow passion fruit. Pulp weight, one of the important fruit characteristics, has been recorded in the present study, as superior in Genotype 3, Genotype 4 and Genotype 2 and hence could be selected as superior in terms of yield potential also. In a study for evaluation of promising passion fruit genotypes at CHES, Chettalli variations in pulp weight has been reported by Tripathi et al. (2014). They reported pulp weight variation in the range of 13.10 g in CHES PF-2-11 to 50.10 g in CHES PF-3, which is in conformity with the observed values of pulp weight in the present study. Extensive variations within and among the passion fruit species has been recorded in pomological characters like fruit size and weight of the fruit (Beena and Beevi, 2016). Such variations were observed in the present study with regard to fruit weight.

Among the different components of fruits, rind contributes a major share to the fruit weight. Statistical analysis showed that rind weight varied from 37.59 g in Genotype 1 to 68.33 g in Genotype 3, which also had the highest fruit weight. According to the studies conducted at PRS (2015) among 14 genotypes evaluated at Pineapple Research Station, Vazhakulam, the average rind weight was 40.65 g. In the present study the average rind weight observed was 50.10 g, which might be due to the differences in the genotypes selected.

Rind thickness, which is a contributing factor towards shelf life varied from 0.47 cm (Genotype 1) to 0.91 cm (Genotype 3). Similar variation in rind thickness from 0.46 cm to 0.70 cm in yellow types and 0.46 cm to 0.96 cm in purple types had been reported by Charan et al. (2018). Silva et al. (2015) recorded a rind thickness of 0.56 cm to 0.58 cm in passion fruit.

The study revealed that fresh seed weight and juice weight also varied significantly with respect to different genotypes of passion fruit. The minimum seed weight was observed in Genotype 1 and Genotype 7 (5.67 g) and juice weight significantly varied from 22.82 g (Acc 1) to 43.30 g (Acc 4). According to Beena and Beevi (2016) considerable variations were observed in the number of seeds, which directly contributed to the seed weight among the wild and cultivated *Passiflora* species studied, *viz.*, *P. foetida and P. edulis*. Ramaiya et al. (2013)

reported that juice weight varied from 22.96±2.61 g to 73.44±1.80 g in passion fruit. The results of the present study are in conformity with the findings of Ramaiya et al. (2013), where the juice weight recorded varied from 22.82 g to 43.30 g. The variations in the juice weight might be due to the variations in the genotypes and climatic conditions of the region.

Different genotypes had significant effect on shelf life of passion fruits at ambient conditions. Genotype 3 had the longest shelf life of 15.67 days followed by Genotype 5 and Genotype 6, which might be attributed to the increased rind thickness. Physical components of passion fruit*, viz.,* juice, rind and seed per cent varied significantly among the genotypes evaluated. Juice per cent varied from 34.05 (Genotype 7) to 39.34 per cent (Genotype 4). High juice recovery is of importance in the processing industry and value addition. Juice per cent varied from 15.27 per cent to 46.46 per cent in different passion fruit genotypes evaluated by Charan et al. (2018). This is in agreement with the values of juice per cent observed in the present findings where a narrow range could be observed from 34.05 to 39.34 per cent, which might be due to the genotypic variations.

Rind which constitutes the major waste portion in passion fruit, ranged from 52.55 per cent in Genotype 5 to 57.86 per cent in Genotype 7. Similar variations in rind weight per cent has been reported by other scientists also. The reports of Arjona et al. (1991) is in conformity with the findings of the present study.

Seed, which is another constituent of passion fruit, also showed significant variation among the different genotypes studied, content of which ranged from 7.08 % in Genotype 8 to 10.15 % in Genotype 5. Charan et al. (2018) found seed per cent difference in the range of 6.58 to 15.52 per cent in yellow genotypes and 9.84 to 18.47 per cent in purple genotypes, which is in consonance with the findings of the present study, where a range of 7.08 per cent to 10.15 per cent was noticed. Genotypes like Genotype 4, 2, 8 and 5 with highest juice recovery and lower rind per cent may be exploited for processing industries, since they will be highly suitable for the preparation of value added products and beverages.

Rind colour was yellow with white specks in Genotype 3, Genotype 6 and Genotype 7 and purple with white specks in all other genotypes. Pulp colour was deep yellow in Genotype 3 and Genotype 7, while it was yellowish orange in all other genotypes (Table 1).

Genotypes like 3 (yellow) and 4 (purple) with superior fruit characters like fruit girth, fruit diameter, fruit weight, pulp weight and juice weight could be used for commercial cultivation as well as crop improvement programmes.

Results of the statistical analysis of quality characteristics showed significant difference among various genotypes (Table 5). TSS varied significantly among the genotypes and the maximum TSS was observed in Genotype 4 (18.33° Brix). Ramaiya et al. (2013) reported a TSS range of 10.70° Brix to 17.20° Brix among the different passion fruit genotypes evaluated. While evaluating promising passion fruit genotypes at CHES, Chettalli variations in TSS from 12.20° Brix in CHES PF-7 to 18.10° Brix in CHES PF1-6 has been reported by Tripathi et al. (2014), which is in conformity with the present reports.

Acidity of passion fruit genotypes ranged from 2.37 to 3.99 per cent. Reis et al. (2018) reported that acidity content in yellow type was 9.06 per cent whereas purple type had an acidity of 2.83 per cent. Present study also revealed that yellow genotypes had high acidity when compared to purple genotypes which is in conformity with the above research finding. According to Kishore et al. (2011), TSS and titratable acidity in purple passion fruit pulp were 15.30 °Brix and 3.80 per cent respectively. Pongener et al. (2013) evaluated the

Table 5. Quality characters of passion fruit genotypes

Genotype	TSS (° Brix)	Titrable acidity (%)	Total sugar (%)	Reducing sugar (%)	Non reducing sugar (%)	Sugar/ acid ratio	Ascorbic acid (mg/100g)	Total carotenoids (mg/100g)
Genotype 1 (P)	16.17	3.15	10.86	6.66	4.20	3.44	24.52	1.17
Genotype 2 (P)	17.45	2.37	9.47	5.94	3.52	4.00	20.17	1.27
Genotype 3 (Y)	14.17	3.54	9.43	7.84	1.97	2.68	16.12	1.99
Genotype 4 (P)	18.33	3.23	12.32	10.34	1.98	3.81	31.15	1.57
Genotype 5 (P)	17.33	2.73	13.55	7.63	5.92	4.97	20.55	2.40
Genotype 6 (Y)	13.00	3.99	11.85	9.14	2.71	2.99	21.14	1.90
Genotype 7 (Y)	14.83	3.43	8.58	5.92	2.66	2.53	18.03	3.38
Genotype 8 (P)	17.80	2.86	10.50	6.75	3.75	3.68	15.53	2.34
CD (0.05)	1.51	0.50	1.27	0.91	0.98	0.47	2.92	0.59

physicochemical attributes such as TSS and titratable acidity in purple passion fruit, as 16.2° Brix and 2.34 per cent respectively, which is comparable with the results of the present study.

Data regarding the total sugar content revealed significant difference among the genotypes which was in the range of 8.58 per cent in Genotype 7 to 13.55 per cent in Genotype 5. Total sugar content was higher in purple genotypes compared to yellow genotypes as reported by many research workers. Since purple genotypes had higher total sugar and lower acidity, purple types were sweeter compared to yellow genotypes. Patel et al. (2014) also observed a similar trend in passion fruit. Charan et al. (2018) reported that total sugar content varied from 4.98 to 10.80 per cent in yellow genotypes and 6.31 to 13.04 per cent in purple genotypes. The present findings are in conformity with the earlier reports. Reducing sugars, glucose and fructose which are primarily responsible for adding to the sweetness varied significantly among the genotypes and was in the range of 5.92 to 10.34 per cent. Non reducing sugar and sugar acid ratio also varied significantly among the genotypes evaluated. An average non reducing sugar value of 6.58 per cent was recorded in a study to evaluate fifty passion fruit genotypes (PRS, 2015). In the present finding, the non-reducing sugar ranged from 1.98 per cent to 5.92 per cent, which might be due to the differences in genotypes selected and the growing conditions. Sugar/ acid ratio also varied significantly among different genotypes which ranged from 2.53 in Genotype 7 to 4.97 in Genotype 5.

The antioxidant activity of passion fruit is mainly attributed to its ascorbic acid content and in the present study ascorbic acid content ranged from 15.53 mg $100g^{-1}$ (genotype 8) to 31.15 mg $100g^{-1}$ (genotype 4) which might be due to the genetic variations. Studies in similar lines in passion fruit genotypes also indicated variations in the ascorbic acid content. Patel et al. (2014) reported that ascorbic acid in passion fruit cultivars ranged from 22.5 mg $100g^{-1}$ to 48.75 mg $100g^{-1}$. According to Anjana and Joy (2016) ascorbic acid content ranged between 27.49 and 46.31 mg $100g^{-1}$. The variation could be due to various environmental factors which affect the vitamin C levels in fruits as reported by Genovese et al. (2008). Total carotenoid in any fruit is affected mainly by cultivar and level of maturity. In this study, variation in total carotenoids in the different genotypes was observed and it was in the range of 1.17 - 3.38 mg $100g^{-1}$. According to Charan et al. (2018) ascorbic acid content ranged from 16.98 to 30.50 mg $100g^{-1}$ and total carotenoids varied between 1.07 and 2.81 mg $100g^{-1}$ in passion fruit. Thus, the variations in ascorbic acid and carotenoid contents observed in the present study are in line with the above research findings.

The correlation between different characters was computed and correlation coefficients are presented in Table 6. Association of different characters with yield should be understood thoroughly for the success of crop improvement programmes. The correlation coefficient can provide information on the characters which are important in assessing genotypes (Norman et al., 2011). Thus, correlation

Table 6. Correlation matrix for different characters of passion fruit genotypes

Traits	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10
X1	1									
X2	0.80*	1								
X3	0.80*	1.00*	1							
X4	0.76*	0.97*	0.97*	1						
X5	0.68	0.94*	0.94*	0.98*	1					
X6	0.77*	0.97*	0.97*	0.98*	0.93*	1				
X7	0.61	0.78*	0.78*	0.85*	0.79*	0.90*	1			
X8	0.84*	0.98*	0.98*	0.98*	0.93*	0.98*	0.83*	1		
X9	0.08	0.31	0.31	0.50	0.53	0.47	0.71	0.37	1	
X10	0.15	0.41	0.41	0.55	0.56	0.54	0.72*	0.46	0.95*	1

X1 Yield/vine (kg) X2 Fruit diameter (cm) X3 Fruit girth (cm) X4 Fruit weight (g) X5 Rind weight (g)
X6 Pulp weight (g) X7 Seed weight (g) X8 Juice weight (g) X9 Rind thickness (cm) X10 Shelf life (days)
* significant at 5% level

analysis helps to design selection strategies to improve yield and can be categorized further for getting high yield varieties. In the present study, correlation studies were done for yield and fruit characters.

Correlation coefficient matrix shows highly significant positive correlation of yield per vine with fruit diameter (0.80), fruit girth (0.80), fruit weight (0.76), pulp weight (0.77) and juice weight (0.84). Fruit weight had significant and positive correlation with rind weight (0.98), pulp weight (0.98), seed weight (0.78) and juice weight (0.98). Shelf life was positively and significantly correlated with rind thickness (0.95). Juice weight which is the commercial useful proportion is significantly and positively correlated with fruit diameter (0.98), fruit girth (0.98), rind weight (0.93), pulp weight (0.98) and seed weight (0.83).

In grapes positive and significant correlations between fruit characters like bunch weight with bunch length (r = 0.76), width of bunch (r = 0.86), weigh of berry (r = 0.76), length of berry (r = 0.61) and diameter of berry (r = 0.76) has been reported by Leao et al. (2011). Highly significant positive correlation of bunch weight with fruit characters like number of fingers, pedicel strength index and number of hands was recorded by Joseph (2017) in Nendran banana. Joseph (2017) also reported that weight of finger had significant and positive correlation with fruit characters like fullness index, girth of finger and fruit curvature, which is in line with the results of the present study. From the correlation studies, it can be concluded that yield can be improved by exercising selection for the characters like fruit weight (0.76), fruit diameter and fruit girth (0.80), pulp weight (0.77) and juice weight (0.84).

Different genotypes showed difference in physicochemical characters which helps to identify the suitable types for fresh consumption as well as for utilization in the processing industry. The wide diversity among the different genotypes found in the present investigation which can be attributed to changes in environmental factors and inherent characters of the genotype can be used as selection indices in breeding programs. Therefore, Genotype 4, which is superior in yield, as well as better fruit characters and with high values for most of the quality characters can be considered superior and used for commercial cultivation and crop improvement programmes. Due to low levels of acidity and high TSS purple types was found to be sweeter compared to yellow genotypes. Genotypes like 2, 4, 5 and 8 which are having highest juice recovery with the lower rind per cent may be exploited for processing industries, since they will be highly suitable for the preparation of value added products. The Genotype 4 (purple type) with highest TSS (18.33° Brix), higher total sugar (12.32 %), highest reducing sugar (10.34 %) and highest ascorbic acid (31.15 mg/100g) can be selected as a superior genotype based on quality parameters. Based on the evaluation of passion fruit genotypes in the present study, further crop improvement programmes can be initiated to develop varieties suitable for fresh consumption and for processing industries by utilizing the genotype which have the required characteristics.

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