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Variation in physical characters of fruits in F_1 hybrids of peach [*Prunus persica* L.]

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ABSTRACT

The improvement work on peach taken up in different parts of India has resulted in the development of some varieties which have been found suitable for cultivation only in local agro-climatic conditions. A local peach in Himachal Pradesh, known as "Kateroo" having late fruit maturity, was crossed with commercial cultivars to develop hybrids with late maturity and good fruit characters. In the present study, 76 hybrids were developed and evaluated for their physical characters. Considerable variation was observed in respect of physical characters of fruits in the progenies of different crosses of peach. The mean fruit length of different crosses varied from 43.64 to 58.10 mm, fruit breadth 43.88 to 61.34 mm, fruit weight 50.13 to 94.65 g, pulp to stone ratio 9.54 to 19.05, stone length 25.45 to 36.19 mm and stone breadth from 17.05 to 19.65mm. The fruit of round, ovate oblong and elongated shapes were observed in different hybrids. The ground colour of the fruit was recorded to be yellowish green group whereas the over colour of the fruit was red 52, red 42 and red 47 as per colour chart of Royal Horticultural Society.

Key words: F_1 hybrids, kateroo, peach, physical characters

Peach (*Prunus persica* L.) is an important fruit crop being grown in the mid hills zone of Himalayas extending from Jammu and Kashmir to North Eastern States at an altitude of 1000-2000 m ASL. It has wider climatic adaptability and now its cultivation has been successfully extended to various sub-tropical regions of the world. It is now commercially grown in USA, Italy, France, England, Australia and China but in India, Pakistan, Turkey, Japan, Germany and USSR its cultivation is done on a small scale. As per FAO statistics, the area and production of peach in the world was 15, 68,447 hectares and 20,315,245 tonnes; whereas, India produced 2, 37,931 tonnes peach from an area of 35,531 hectares in 2009. Fruits are rich in protein, sugar, minerals and vitamins. It has various uses as fresh fruit as well as processed product. Over the years, a large number of cultivars have been evolved through breeding in many countries to take best advantage of its diverse climatic adaptability and to make available the fresh fruits over a longer season. The improvement work on peach taken up in different parts of India has resulted in the development of some varieties which are suitable only to local agro-climatic conditions. In India, some attempts have also been made to develop some varieties through breeding. In the present study, the peach breeding programme has been initiated in 1997 in which crosses were made between July Elberta, Alton, J. H. Hale, Saharanpuri, Kanto-5 and Quetta with one local peach cultivar 'Kateroo' with an objective to evolve cultivars which are suitable to local agro-climatic conditions, having varied maturity period and resistance to insect pests and diseases. Hence, the results obtained in respect of physical characters of fruits are presented in this paper.

MATERIALS AND METHODS

In the present experiment, the cultivars viz. July Elberta, Alton, J. H. Hale, Kanto-5, Saharanpuri and Quetta were used as female parent and "Kateroo" as male parent. From the crosses, 76 hybrid seedlings were established in the experimental orchard following standard agronomic practices and were evaluated for different physical characters during the years 2006 and 2007. The experimental area had mild temperate climate at an altitude of 1220 meters above MSL. The important physical parameters recorded in this study include fruit length, breadth, shape, weight, pulp-stone ratio, ground and over colour, stone length and stone breadth. The coefficient of variation was calculated to know the extent of variability in each character of each cross. The t-test was applied to test the significance of differences between the means of different crosses. The methods were followed as suggested by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

Considerable variation was observed in respect of physical characters of fruits in the progenies of different crosses of peach. The mean of fruit length of different crosses varied from 43.64 to 58.10 mm. The proportions of hybrids with small fruits were larger in all the crosses which varied from 50.0 percent to 93.10%. However, the cross Alton x Kateroo did not produce any hybrid with small fruits. The hybrids producing medium fruits were maximum both in Alton x Kateroo and Saharanpuri x Kateroo crosses. Both of these crosses produced 50 per cent hybrids with medium fruits. The long fruits were obtained only in hybrids of July Elberta x Kateroo (20%) and, Alton x Kateroo (50%). The coefficient of variation ranged from 5.84 to 27.25% in different crosses. The differences were significant in the means of only four cross combinations (Table 1). The largest proportions of hybrids in different cross combinations were narrow in breadth whereas Alton x Kateroo did not produce any hybrid producing fruits with narrow and medium breadth.

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Table 1: Classification of peach hybrids in respect of fruit length

Crosses	Number of hybrids	Small (<50mm) (%)	Medium (>50-57 mm) (%)	Long (>57mm) (%)	Mean of the cross (mm)	Coefficient of variation (%)
July Elberta x Kateroo	30	70.00	10.00	20.00	48.13	18.83
Alton x Kateroo	2	0.00	50.00	50.00	58.10	5.84
J.H.Hale x Kateroo	29	93.01	3.45	3.45	43.64	14.25
Kanto-5 x Kateroo	2	50.00	0.00	50.00	51.28	27.25
Saharanpur x Kateroo	2	50.00	50.00	0.00	46.80	18.13
Quetta x Kateroo	11	81.82	18.18	0.00	46.70	9.24

Test of Significance

Mean of Pairs	t-value
July Elberta x Kateroo and Alton x Kateroo	3.475*
July Elberta x Kateroo and J.H.Hale x Kateroo	2.335
July Elberta x Kateroo and Kanto-5 x Kateroo	0.315
July Elberta x Kateroo and Saharanpuri x Kateroo	0.214
July Elberta x Kateroo and Quetta x Kateroo	0.699
Alton x Kateroo and J.H.Hale x Kateroo	5.483*
Alton x Kateroo and Kanto-5 x Kateroo	0.671
Alton x Kateroo and Saharanpuri x Kateroo	1.748
Alton x Kateroo and Quetta x Kateroo	4.179*
J.H.Hale x Kateroo and Kanto-5 x Kateroo	0.769
J.H.Hale x Kateroo and Saharanpuri x Kateroo	0.518
J.H.Hale x Kateroo and Quetta x Kateroo	1.795
Kanto-5 x Kateroo and Saharanpuri x Kateroo	0.388
Kanto-5 x Kateroo and Quetta x Kateroo	0.460
Saharanpuri x Kateroo and Quetta x Kateroo	0.016

*Note : *Significant at 5 per cent level of probability*

The hybrids with medium breadth of fruits varied from 17.24% in J. H. Hale x Kateroo cross to 50.0% both in Kanto-5 x Kateroo and Saharanpuri x Kateroo crosses. The hybrids with long fruits varied from 3.45 to 50.0% whereas crosses Saharanpuri x Kateroo and Quetta x Kateroo which did not produce any hybrid with long fruits. The means of the cross varied from 39.95 to 61.34 mm and coefficient of variation from 7.30 to 22.65%. The differences were significant between the means of six cross combinations in respect of fruit breadth (Table 2). With respect to fruit shape, the largest proportions of hybrids were having ovate fruits in all the crosses except the Alton x Kateroo and Saharanpuri x Kateroo crosses did not produce hybrids with ovate shaped fruits. The round fruits were obtained only in Alton x Kateroo (100%) and J. H. Hale x Kateroo (10.34%). The hybrids with oblong fruits varied between 3.45 to 100.0% whereas Alton x Kateroo, Kanto-5 x Kateroo and Quetta x Kateroo did not produce any hybrid with oblong fruits. The hybrids with elongated fruits was obtained only in 3.34% hybrids of the crosses between July Elberta x Kateroo (Table 3). Most of the hybrid seedlings produced small fruits. However, Kanto-5 x Kateroo and Saharanpuri x Kateroo produced 50% progenies with medium sized fruits but no hybrids with large fruits were produced by these cross combinations. The progenies with large fruits were 100% in case of Alton x Kateroo cross whereas it varied from 3.44 to 16.67%. The mean values of the crosses varied from 47.5 to 94.65 g and coefficient variation from 1.72 to 57.74%. The differences between mean of different crosses were significant only in 4 cross combinations (Table 4).

In terms of colour of the fruits, the largest proportions of hybrid seedlings were having fruit of yellow orange ground colour. In this category, the hybrids ranged between 42.28 to 100%. The crosses J. H. Hale x Kateroo and Quetta x Kateroo produced 51.72 and 100% hybrids, respectively with yellow green ground colour. All six crosses did not produce any hybrid seedling having yellow colour (Table 5). It is apparent from the results presented in Table 5 that the largest proportions of hybrid seedlings were having fruit over colour of red 42 group in the crosses Saharanpuri x Kateroo (100%), Kanto-5 x Kateroo and Alton x Kateroo (50%). The proportion of hybrids with red 47 group of over colour was minimum in all the crosses. The crosses of Saharanpuri x Kateroo and Alton x Kateroo did not produce any hybrid seedling having red 47 groups.

Table 2: Classification of peach hybrids in respect of fruit breadth

Crosses	Number of hybrids	Narrow (<43mm) (%)	Medium (43-53mm) (%)	Broad (>53mm) (%)	Mean of the cross (mm)	Coefficient of variation (%)
July Elberta x Kateroo	30	50.00	23.34	26.66	45.68	22.65
Alton x Kateroo	2	0.00	0.00	100.00	61.34	7.30
J.H.Hale x Kateroo	29	79.31	17.24	3.45	39.95	14.21
Kanto-5 x Kateroo	2	50.00	50.00	0.00	44.36	21.86
Saharanpur x Kateroo	2	50.00	50.00	0.00	43.88	16.36
Quetta x Kateroo	11	63.64	36.36	0.00	40.99	7.41

Test of Significance

Mean of Pairs	t-value
July Elberta x Kateroo and Alton x Kateroo	4.297*
July Elberta x Kateroo and J.H.Hale x Kateroo	2.778*
July Elberta x Kateroo and Kanto-5 x Kateroo	0.186
July Elberta x Kateroo and Saharanpuri x Kateroo	0.334
July Elberta x Kateroo and Quetta x Kateroo	2.320*
Alton x Kateroo and J.H.Hale x Kateroo	6.437*
Alton x Kateroo and Kanto-5 x Kateroo	3.319
Alton x Kateroo and Saharanpuri x Kateroo	2.249
Alton x Kateroo and Quetta x Kateroo	4.551*
J.H.Hale x Kateroo and Kanto-5 x Kateroo	8.883*
J.H.Hale x Kateroo and Saharanpuri x Kateroo	0.637
J.H.Hale x Kateroo and Quetta x Kateroo	1.647
Kanto-5 x Kateroo and Saharanpuri x Kateroo	0.228
Kanto-5 x Kateroo and Quetta x Kateroo	0.067
Saharanpuri x Kateroo and Quetta x Kateroo	0.560

*Note : *Significant at 5 per cent level of probability*

Table 3: Classification of peach hybrids in respect of fruit shape

Crosses	Number of hybrids	Round (%)	Ovate (%)	Oblong (%)	Elongated (%)
July Elberta x Kateroo	30	0.00	83.33	13.33	3.34
Alton x Korero	2	100.00	0.00	0.00	0.00
J.H.Hale x Kateroo	29	10.34	86.21	3.45	0.00
Kanto-5 x Kateroo	2	0.00	100.00	0.00	0.00
Saharanpur x Kateroo	2	0.00	0.00	100.00	0.00
Quetta x Kateroo	11	0.00	100.00	0.00	0.00

Table 4: Classification of peach hybrids in respect of fruit weight

Crosses	Number of hybrids	Small (<60g) (%)	Medium (60-80g) (%)	Large (>80g) (%)	Mean of the cross (g)	Coefficient of variation (%)
July Elberta x Kateroo	30	70.00	13.33	16.67	54.60	45.53
Alton x Kateroo	2	0.00	0.00	100.00	94.65	1.72
J.H.Hale x Kateroo	29	82.27	13.79	3.44	71.17	44.37
Kanto-5 x Kateroo	2	50.00	50.00	0.00	47.50	53.59
Saharanpur x Kateroo	2	50.00	50.00	0.00	50.13	46.91
Quetta x Kateroo	11	72.73	18.18	9.09	60.11	57.74

Test of Significance	
Mean of Pairs	**t-value**
July Elberta x Kateroo and Alton x Kateroo	8.943*
July Elberta x Kateroo and J.H.Hale x Kateroo	2.488*
July Elberta x Kateroo and Kanto-5 x Kateroo	0.383
July Elberta x Kateroo and Saharanpuri x Kateroo	0.260
July Elberta x Kateroo and Quetta x Kateroo	0.487
Alton x Kateroo and J.H.Hale x Kateroo	15.603*
Alton x Kateroo and Kanto-5 x Kateroo	2.614
Alton x Kateroo and Saharanpuri x Kateroo	2.672
Alton x Kateroo and Quetta x Kateroo	3.281*
J.H.Hale x Kateroo and Kanto-5 x Kateroo	0.346
J.H.Hale x Kateroo and Saharanpuri x Kateroo	0.529
J.H.Hale x Kateroo and Quetta x Kateroo	1.729
Kanto-5 x Kateroo and Saharanpuri x Kateroo	0.107
Kanto-5 x Kateroo and Quetta x Kateroo	0.606
Saharanpuri x Kateroo and Quetta x Kateroo	0.508

*Note : *Significant at 5 per cent level of probability*

Table 5: Classification of peach hybrids in respect of fruit ground colour and over colour

Crosses	Number of hybrids	Fruit ground colour			Fruit over colour		
		Yellow green group (%)	Yellow orange group (%)	Yellow green group (%)	Yellow orange group (%)	Yellow green group (%)	Yellow orange group (%)
July Elberta x Kateroo	30	36.67	63.33	0.00	10.00	36.67	53.33
Alton x Kateroo	2	50.00	50.00	0.00	50.00	50.00	0.00
J.H.Hale x Kateroo	29	51.72	48.28	0.00	51.72	37.94	10.34
Kanto-5 x Kateroo	2	0.00	100.00	0.00	0.00	50.00	50.00
Saharanpur x Kateroo	2	50.00	50.00	0.00	0.00	100.00	0.00
Quetta x Kateroo	11	100.00	0.00	0.00	81.82	0.00	8.18

Among all crosses, majority of hybrids produced fruits with low pulp to stone ration except in Alton x Kateroo. In these crosses the percentage ranged from 36.36 in Quetta x Kateroo to 100% in Saharanpuri x Kateroo. The crosses Quetta x Kateroo and Kanto-5 x Kateroo produced the highest proportions (45.46 and 50%) of hybrids with medium pulp to stone ratio. The proportions of hybrids with high pulp to stone ratio were minimum in all the crosses except in Alton x Kateroo. The crosses Kanto-5 x Kateroo did not produce any hybrid seedling having ratio. The mean of the cross varied from 9.54 to 19.05 and coefficient of variation between 3.34 to 42.74% in different crosses. Seven mean of pair were found significantly different from each other (Table 6). The largest proportions of hybrid seedlings were having medium stone length. The hybrids with short seeds were minimum in all the crosses but July Elberta x Kateroo and Saharanpuri x Kateroo did not produce any hybrid having short stone.

Table 6: Classification of peach hybrids in respect of pulp to stone ratio

Crosses	Number of hybrids	Low (<12.0) (%)	Medium (2.0-16.0) (%)	High (>16.0) (%)	Mean of the cross (g)	Coefficient of variation (%)
July Elberta x Kateroo	30	43.30	30.03	26.67	12.92	33.08
Alton x Kateroo	2	0.00	0.00	100.00	19.05	3.34
J.H.Hale x Kateroo	29	55.18	31.03	13.79	11.84	26.80
Kanto-5 x Kateroo	2	50.00	50.00	0.00	10.36	25.33
Saharanpur x Kateroo	2	0.00	0.00	0.00	9.54	10.90
Quetta x Kateroo	11	45.46	45.46	18.18	13.36	42.74

Test of Significance	
Mean of Pairs	**t-value**
July Elberta x Kateroo and Alton x Kateroo	7.044*
July Elberta x Kateroo and J.H.Hale x Kateroo	1.160
July Elberta x Kateroo and Kanto-5 x Kateroo	1.282
July Elberta x Kateroo and Saharanpuri x Kateroo	3.233*
July Elberta x Kateroo and Quetta x Kateroo	0.235
Alton x Kateroo and J.H.Hale x Kateroo	10.01*
Alton x Kateroo and Kanto-5 x Kateroo	4.557*
Alton x Kateroo and Saharanpuri x Kateroo	11.014*
Alton x Kateroo and Quetta x Kateroo	3.196*
J.H.Hale x Kateroo and Kanto-5 x Kateroo	0.765
J.H.Hale x Kateroo and Saharanpuri x Kateroo	2.488*
J.H.Hale x Kateroo and Quetta x Kateroo	0.840
Kanto-5 x Kateroo and Saharanpuri x Kateroo	0.411
Kanto-5 x Kateroo and Quetta x Kateroo	1.186
Saharanpuri x Kateroo and Quetta x Kateroo	2.040

*Note : *Significant at 5 per cent level of probability*

Table 7: Classification of peach hybrids in respect of stone length

Crosses	Number of hybrids	Short (<20 mm) (%)	Medium (20-35 mm) (%)	Long (>35 mm) (%)	Mean of the cross (g)	Coefficient of variation (%)
July Elberta x Kateroo	30	0.00	90.00	10.00	36.19	143.79
Alton x Kateroo	2	10.00	100.00	0.00	26.88	7.24
J.H.Hale x Kateroo	29	10.00	86.56	3.44	27.45	11.94
Kanto-5 x Kateroo	2	10.00	50.00	40.00	31.44	17.70
Saharanpur x Kateroo	2	0.00	100.00	0.00	29.46	17.26
Quetta x Kateroo	11	10.00	90.00	0.00	25.45	7.44

Test of Significance	
Mean of Pairs	**t-value**
July Elberta x Katerooand Alton x Kateroo	1.016
Julu Elberta x Katerooand J.H.Hale x Kateroo	0.963
July Elberta x Katerooand Kanto-5 x Kateroo	0.481
July Elberta x Katerooand Saharanpuri x Kateroo	0.691
July Elberta x Katerooand Quetta x Kateroo	1.183
Alton x Katerooand J.H.Hale x Kateroo	0.383
Alton x Katerooand Kanto-5 x Kateroo	1.095
Alton x Katerooand Saharanpuri x Kateroo	0.671
Alton x Katerooand Quetta x Kateroo	0.963
J.H.Hale x Katerooand Kanto-5 x Kateroo	1.004
J.H.Hale x Katerooand Saharanpuri x Kateroo	0.552
J.H.Hale x Katerooand Quetta x Kateroo	2.460*
Kanto-5 x Katerooand Saharanpuri x Kateroo	0.372
Kanto-5 x Katerooand Quetta x Kateroo	1.508
Saharanpuri x Katerooand Quetta x Kateroo	1.103

*Note : *Significant at 5 per cent level of probability*

The hybrids with long stone varied between 3.44 to 40%, however, Alton x Kateroo, Saharanpuri x Kateroo and Quetta x Kateroo did not produce any hybrid under this category. The mean of the cross varied between 25.45 to 36.19 and coefficient of variation from 7.24 to 143.79%. The differences between mean pairs were significant only in J. H. Hale x Kateroo and Quetta x Kateroo cross combinations (Table 7). The largest proportions of hybrid seedlings were having broad stone in all the crosses. The percentage ranged from 86.66 to 100%. All the crosses did not produce any hybrid seedling having narrow and medium stone except in July Elberta x Kateroo. The mean of the cross varied from 17.20 to 19.65 and coefficient of variation of variation from 5.98 to 28.58 percent. Five means of pairs were found only to have significant differences from each other (Table 8). No definite conclusion can be drawn in the present study regarding the inheritance pattern. This may be due to the small number of progenies under each cross and highly heterozygous nature of the cultivations, age of the tree and crop load are also responsible for such variation in fruit and stone size. In similar kind of studies, Neagu and Georgescu (1972) used eight varieties and noted variation in respect of fruit size, colour, juice,

taste and aroma which resulted in the development of 12 hybrids. Salunkhe *et al.* (1968) reported that Saharanpur Prabhat peach has pinkish blush, medium in size, round in shape with good taste and better keeping quality. The fruits were similar to Flordasun in shape which is one of its parents. Dora resulted from a cross of Elberta and springtime, has large fruits, reddish and flattened shape. The fruit has yellow ground colour with carmine red blush over 50-60% of the surface covered with light pubescence. The stone is medium sized and free (Ogasanovic *et al.*, 2002). Zhang *et al.* (2003) selected Jinshiji from a hybrid seedling of a Dongui and Xuetao cross made in 1989. It is clingstone, fruit very large, have smooth yellow skin with a red blush covering 30-50% of the surface.

Table 8: Classification of peach hybrids in respect of stone breadth

Crosses	Number of hybrids	Narrow (<5mm) (%)	Medium (5-15mm) (%)	Large (>15mm) (%)	Mean of the cross (mm)	Coefficient of variation (%)
July Elberta x Kateroo	30	6.67	6.67	86.66	17.20	28.58
Alton x Kateroo	2	0.00	0.00	100.00	17.75	5.98
J.H.Hale x Kateroo	29	0.00	0.00	100.00	17.43	18.87
Kanto-5 x Kateroo	2	0.00	0.00	100.00	19.65	22.67
Saharanpur x Kateroo	2	0.00	0.00	100.00	19.20	16.94
Quetta x Kateroo	11	0.00	0.00	100.00	17.05	10.69

Test of Significance

Mean of Pairs	t-value
July Elberta x Katerooand Alton x Kateroo	10.010*
Julu Elberta x Katerooand J.H.Hale x Kateroo	4.557*
July Elberta x Katerooand Kanto-5 x Kateroo	11.014*
July Elberta x Katerooand Saharanpuri x Kateroo	3.196*
July Elberta x Katerooand Quetta x Kateroo	0.765
Alton x Katerooand J.H.Hale x Kateroo	2.488*
Alton x Katerooand Kanto-5 x Kateroo	0.840
Alton x Katerooand Saharanpuri x Kateroo	0.411
Alton x Katerooand Quetta x Kateroo	1.186
J.H.Hale x Katerooand Kanto-5 x Kateroo	2.040
J.H.Hale x Katerooand Saharanpuri x Kateroo	0.484
J.H.Hale x Katerooand Quetta x Kateroo	0.222
Kanto-5 x Katerooand Saharanpuri x Kateroo	0.753
Kanto-5 x Katerooand Quetta x Kateroo	0.816
Saharanpuri x Katerooand Quetta x Kateroo	0.148

*Note : *Significant at 5 per cent level of probability*

Fruits had a rich sweet flavour and flesh was golden yellow, non-melting and moderately juicy. The variation in physical charaters has also been reported by Chadha and Sankhyan (1974) and Nitransky (1980). Several workers have worked on the physical aspect of peach fruit and variation has been reported in different cultivars (Sud et al., 1975; Moras, 1980: Kumar and Chitkara, 1983). In the present study, considerable variation was observed for various physical parameters in different cross combinations depending upon the cultivar used in a particular cross. Most of the progenies produced fruits medium in size in crosses where medium and large sized fruits were larger in crosses where small sized female parents were crossed with 'Kateroo' a local peach having small sized fruit. Similar trend was found for stone and other physical characters.

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