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Short Communication

Morphological and physical changes associated with growth and development of Pomegranate fruit

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Pomegranate (*Punica granatum* L.) is thought to be indigenous to the region of Iran where it was first cultivated in about 2000 B.C., but it spread to the Mediterranean countries at a very early date. Pomegranate is an important commercial fruit in India which is mainly grown in the Maharashtra, Gujrath, Karnataka, Rajasthan etc. Pomegranate flowers from late April until mid May, whereas maturity and ripening extends from mid September to November depending on the cultivars. Fruit growth is typically described as a single or double sigmoid curve reflecting changes in organ fresh weight. Other measures of growth (e.g. length, diameter) may give quite different growth curves (Commbe, 1976).

In the epidermis of pomegranate seeds, the cells are relatively very elongated in a radial direction and are rod-shaped and form edible parts termed arils. In recent times, the export of pomegranate from Maharashtra for world market has increased. Every year cracking, bruising, sunscald and variation in fruit size at harvest time render some fruits unmarketable. Therefore, some growers prefer to harvest large fruits sooner and allow others to grow more to obtain a bigger size. In order to maximize yield and get equal size of fruits, it is necessary to know the morphological and physical changes attributed during growth and development. There is little information available on the morphological and physical of fruit growth and development of pomegranate fruit. In view of the potential importance of this fruit, present study was conducted to study in detail its growth and development.

The two cultivars *viz.*, newly recommended variety Phule Bhagwa and promising Selection-4 were selected for the present studies along with cultivar Mridula. The trees were spaced 4.5 and 3 m between and along the rows respectively and received routine cultural care suitable for commercial fruit production including pruning, fertilization and irrigation. For studying the morphological and physical changes associated with growth and development of fruit, a large number of hermaphrodite flowers at uniform stage of development *i.e.* at anthesis stage were tagged in all the cultivars under study. For the assessment of various morphological and physical changes of fruit during the growth and development, five fruits were selected randomly from each cultivar at monthly interval upto 180 days. The duration from anthesis is taken upto 150 days in cv. Mridula and upto 180 days in Cv. Bhagwa and Sel-4. The observations were recorded at thirty days interval from anthesis till harvest maturity.

During the growth and development of pomegranate fruits significant morphological and physical changes were observed and presented in Table 1.

Morphological changes

The shape of pomegranate fruit changed from elongated oval to oval within 90 days period during the growth period and further it changed to spherical within 30 to 45 days when almost 70 to 80 per cent of the fruit growth was completed. After 150 days, slight suppressions were formed on the sides and angular edges were developed on fruit surface. At 180 days stage, the fruits had round shape with prominent suppressions on sides and the colour of rind became further intense.

The colour of fruit and arils are the two important factors which govern the consumers appeal. The colour of fruit changed from initial green to orange red and high red at maturity stage. As the fruits matured, orange colour intensified turning to high red with reddish patches in Sel-4 and cv. Bhagwa, while it was vivid or deep red with coral red in cv. Mridula.

Fruit colour of cv. Mridula at maturity stage was more intense than that noticed in Sel-4 and Bhagwa. With the development of fruit, the green colour started fading and turned to olive yellow with reddish brown and vivid red in cv. Mridula at 180 days. The changes in colour were indicative of fruit maturity. However, the colour acceptable for marketing was developed only after 150 days and it reached to intense level at 180 days stage in cv. Bhagwa and Sel-4 whereas the same was developed after 120 days and reached to intense level at 150 days stage in cv. Mridula.

These morphological changes are in confirmation with those of Al-Yahyai *et al.* (2009), Darade (1995), Shulman *et al.* (1984) who reported that the fruit colour, aril colour and shape changes with advancement maturity.

Physical changes

The results obtained in respect of physical exhibited continuous increase in these parameters from

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Table 1. Morphological and physical changes associated with growth and development of Pomegranate fruit

Cultivar	Days after anthesis	Morphological changes			Physical changes				
		Shape of fruit	Colour of fruit	Colour of arils	Length of fruit (cm)	Diameter of fruit (cm)	Weight of fruit (g)	Volume of fruit (ml)	Specific gravity fruit (g/ml)
Sel-4	30	Elongated oval	Green with Cuba	Pearl white	5.80	4.10	25.63	26.67	0.978
	60	Elongated oval	Olive yellow with reddish orange	Yellowish white	7.77	5.20	70.12	69.17	1.013
	90	Oval	Orange red with yellow shed	Reddish gray	8.47	7.33	148.11	141.23	1.049
	120	Spherical	Maize yellow with Scarlet and raspberry red tinge	Pinkish	8.70	7.40	149.76	142.07	1.054
	150	Round with suppressions on sides	Reddish yellow	Reddish pink	9.50	8.43	227.59	223.56	0.985
	180	Round with prominent suppressions on sides	High red with light orange	Red	10.43	9.27	358.69	370.00	0.970
Bhagwa	30	Elongated oval	Green with cuba	Milky white	6.43	4.37	34.30	33.67	1.027
	60	Elongated oval	Olive yellow	Yellowish white	8.03	5.27	78.46	79.95	0.981
	90	Oval	Brownish orange with Reddish Yellow	Yellowish white	8.47	7.23	141.04	130.73	1.079
	120	Spherical but slight suppressions on sides	Maize Yellow with High Red	Patel Red	8.90	7.43	168.83	174.33	0.969
	150	Round with suppressions on sides	Brownish Red with Reddish Yellow	Cherry Red	9.53	7.53	214.48	219.74	0.976
	180	Round with suppressions on sides	High Red with Reddish orange	High Red with deep Red	9.50	8.80	272.87	288.67	0.947
Mridula	30	Elongated oval	Dark brown	Dull white	5.73	3.77	22.86	22.00	1.040
	60	Oval	Olive Yellow with brownish Red	Yellow white	7.53	5.50	72.42	71.59	1.011
	90	Oval	Olive Yellow with Reddish brown	Pastel Red	8.40	6.73	136.73	126.70	1.080
	120	Spherical	Deep Red	Pastel Red with Vivid red	8.47	7.40	168.43	144.70	1.165
	150	Round with prominent suppressions on sides	Vivid Red with Coral Red	Violet brown with Cherry Red	9.83	9.40	312.87	315.04	0.993
	S.E. ±	-	-	-	0.21	0.14	6.21	7.42	0.04
	CD at 5 %	-	-	-	0.61	0.39	17.92	21.40	0.12

anthesis till the harvest maturity in all the cultivars of pomegranate. The growth and development of pomegranate fruit was rapid during initial period, from anthesis upto 90 days. During this period maximum fruit size was attained in all the cultivars (*viz*., Sel-4, Bhagwa and Mridula) of pomegranate. Similar to the fruit length and diameter, the weight and volume of fruit was found to increase upto 150 days stage. The weight of fruit attained during this period was to the extent of 78.60 per cent in cv. Bhagwa and 63.45 per cent in Sel-4. At 150 days of fruit development the maximum weight of fruit was observed in cv. Mridula. The volume of the fruit at 150 days of fruit development was 76.12 per cent in cv. Bhagwa and 60.42 per cent in Sel-4. At 150 days of fruit development the maximum fruit volume was observed in cv. Mridula.

These results showed that within a period of 150 days from anthesis, the growth of fruit to the extent of about 70 to 90 per cent was completed. The growth rate in respect of length of fruit was faster than that of diameter and this was evidenced in all the cultivars. The growth in respect of weight and volume of the fruit was slightly slower than that of the length and diameter of fruit. The specific gravity increased upto 90 days in cv. Bhagwa and upto 120 days in cv. Mridula and Sel-4 and then decreased to less than one. At 150 days stage, specific gravity was less than one in all cultivars and declined further with the advancement in the age of fruit. This indicated that the fruits became more puffy with the advancement of maturity.

The results indicated that remaining 10 to 15 per cent growth of fruit was completed within a period of last 45 days. However, at 180 days stage, the fruit growth to the extent of 98 to 99 per cent was completed in cultivar Bhagwa and Sel-4, while in Mridula 98 to 99 per cent growth was completed at 150 days stage. Hence, this indicated that the fruits of cv. Bhagwa and Sel-4 were fully matured and ready for harvest at this stage. At maturity stage at 180 days of fruit development the fruit of Sel-4 were more in length and diameter, heavier in weight and bigger in volume as compared to those of cv. Bhagwa. At 150 days of fruit development the fruits of cv. Mridula were more in length and diameter, heavier in weight and bigger in volume as compared to cv. Bhagwa and Sel-4.

These results are in agreement with several earlier workers and prominent amongst them are Kumar and Purohit (1989), Malhotra *et al*. (1983), Mirdehghan and Rahemi (2006), Varasteh et al. (2008) who reported that the fresh weight of the pomegranate fruit increased continuously till harvest time and the growth pattern followed a simple sigmoid curve.

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