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Morphological Markers Related to Sex Expression in Papaya (*Carica papaya* L.)

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ABSTRACT

Papaya is a commercial fruit crop cultivated throughout the tropical and sub-tropical regions of the India, belongs to the family Caricaceae.Being a polygamous plant, it has three types of sex forms, viz. male, female and hermaphrodite. Sex form is one of the most important traits for genetic improvement and production in papaya. This investigation which was carried out at the Division of Fruits and Horticultural Technology, ICAR-Indian Agricultural Research Institute, New Delhi during 2014-2015 to identify the morphological markers associated with sex expression in papaya. The dark brown colour exhibited higher number of male plants among the dioeceious genotypes (Pusa Nanha and P-7-2 x SAM). However black colour seeds were exhibited greater number of the female plants in case of Pusa Nanha and P-7-2 × SAM and the higher number of male plants observed in a range of 3.1 to 3.6 mm thickness of petiole in Pusa Nanha and P-7-2 × SAM. From the present study it is concluded that Among morphological traits, black and brown seed colour was most reliable in predicting female and hermaphrodite plants.

Key words: *Papaya, Sex expression, Seed colour, Petiole length, Stem colour.*

INTRODUCTION

The papaya (*Carica papaya* L.) is a native of Central and South America and belongs to the family Caricaceae. It is a commercial fruit crop cultivated throughout the tropical and sub-tropical regions of the India**.**The production and consumption of papaya fruits has rise in the several folds in the last two decades along with the purchasing power of people. In papaya Seed propagation is commercial method of raising the crop and being a polygamous plant growers cannot identify the productive and unproductive plants at nursery stage, so as to have of male and female plants, thus confronted with the problem of selecting the right type of plant material for commercial plantation. Identification of the desirable plants at seedling stage would help in raising the orchard with appropriate design. Several morphological characters such as seed coat colour, root morphology etc. found they to be associated with the sex types in papaya[1].

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Male and female plants can be identified exclusively by the presence of three-lobed /five-lobed leaves or predominantly three-lobed leaves in males or predominantly five-lobed leaves in females. The male seedlings, also exhibit slow growth rate with more number of three-lobed leaves, whereas the female seedling exhibited more vigour and faster growth[2].

MATERIALS AND METHOD

To study the relationship between aforesaid morphological traits and sex expression, the plants of four genotypes were grouped in male (M), female (F) and hermaphrodite (H) making eight treatments, *i.e.*, Pusa Nanha (F), Pusa Nanha (M), P-7-2 x SAM (F), P-7-2 x SA M (M), Red Lady (F), Red Lady (H), P-9-5 (F) and P-9-5(H) were taken. 50 seeds of each genotype were sown in plastic trays. After germination 20 (25 for seed colour) seedlings were maintained for the investigation of morphological character. The remaining seedlings were planted with a spacing of 1.5 m x 1.5 m in the net house and sex expression was recorded accordingly.

In Seed colour fifty seeds of each genotype were selected for among five classified categories, *i.e*. Light brown, Dark brown, Black, Grey and unasserted colour and finally 25 seedlings in each genotype were studied individually for sex expression at the time of flower initiation and in seedling stem colour different colours, *viz.* light green, green, light purple, purple and unasserted were designated for taking observation. The orientation between main shoot and the petiole of the 4th, 5th and 6th leaves of the seedling measured with the help of a protractor and observation were tabulated.

RESULTS

The efforts were made to identify morphological parameters related to sex expression among morphological traits, black and brown seed colour was most reliable in predicting female and hermaphrodite plants. As in Figure 1 the dark brown colour exhibits higher number of male plants among the dioecious genotypes (Pusa Nanha and P-7-2 × SAM), whereas same colour showed higher number of hermaphrodite plants in P-9-5 and female plants in Red Lady. However, black colour seeds exhibited greater number of the female plants in case of Pusa Nanha and P-7-2 × SAM, whereas, grey and light brown colour seed shows lower level of sex expression among the dioecious and gynodioecious genotypes studied. As evident from Figure 2, there was wide distribution of the male, female and hermaphrodite plants in different range of petiole thickness across the genotypes. The maximum female plants were distributed in a range of 3.7 to 4.2 mm petiole thickness for Pusa Nanha and P-7-2 ×SAM genotypes, whereas higher number of female plants were observed in the range 3.1 to 3.6 mm of petiole thickness in Red Lady and P-9-5. Interestingly, higher number of male plants was identified in a range of 3.1 to 3.6 mm petiole thickness in PusaNanha and P-7-2 × SAM plants was also higher in the same range in case of Red Lady and P-9-5. However, the trends shown in the graph did not indicate any promising and consistent pattern for the sex expression in papaya.

The data exhibited in Figure 3 shows the prediction of male, female and hermaphrodite sex forms in range of 6.5 to 11.6 cm petiole length. The higher number of female plants were recorded in P-7-2 × SAM followed by PusaNanha in a range of 9.5 to 10.4 cm petiole length, whereas greater male plants were recorded in range of 8.5 to 9.4 cm in P-7-2 ×SAM followed by PusaNanha in 9.5 to 10.4cm. However, maximum plants of gyndioecious types (female and hermaphrodite) exhibited their predicted sex forms in a range of 7.5 to 10.4 cm for hermaphrodite. The over analysis of the graph did not show any significant trends across the genotype and type of sexes.

The data in Figure 4 exhibited wide range of variation for the sex expression among different colour of stem. The greater number of female plants expressed their sex type in light green colour of stem at seedling stage. The unique purple colour was noticed in

P-9-5 and higher numbers of the hermaphrodite plants were observed in green purple colour at the base of the stem. Among the dioecious and gynodioecious genotypes, the light purple colour may be useful morphological markers for the P-9-5 to enhance the prediction of female or hermaphrodite plants within the genotype.

The data pertaining in Table 1 showed wide range of variation among genotypes with respect to petiole orientation. The maximum number of plants expressed their sex types in a range of 46-60^{0}orientation. The wide ranges of variation were observed among the dioecious and gynodioecious papaya types. There was no uniform trend for sex expression in a particular range of petiole orientation or in a particular genotype. However, maximum female plants were recorded equally in PusaNanha, P-9-5 and P-7-2 × SAM in (54-60^0) range of orientation and whereas it was in (54-60^0) Red Lady. The higher numbers of hermaphrodite plants were recorded in a range of (54-60^0) orientation. The maximum male plants were observed in thepetiole orientation range of 50-54^0 under PusaNanha and P-7-2× SAM.

Table 1: Range of petiole orientation with stem in relation to sex expression at seedling stage

Orientation (degrees)	Pusa Nanha (F)	Pusa Nanha (M)	P-7-2 x SAM (F)	P-7-2 x SAM (M)	Red Lady (F)	Red Lady (H)	P-9-5 (F)	P-9-5 (H)
41-45	-	--	0	1	1	1	1	-
46-50	2	1	1	3	1	2	3	1
50-54	3	3	2	3	5	2	2	2
54-60	4	2	4	2	2	4	4	3
60-64	2	1	2	1	1	2	2	2
65-70	1	1	0	0	-	-	1	-

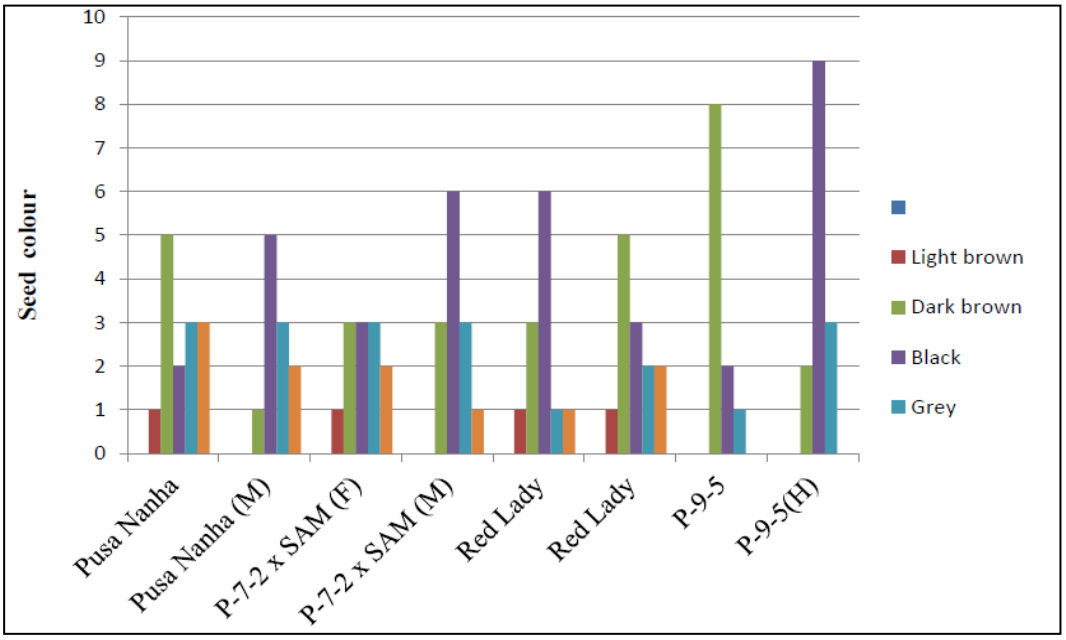

Fig. 1: Seed colour and sex expression in papaya

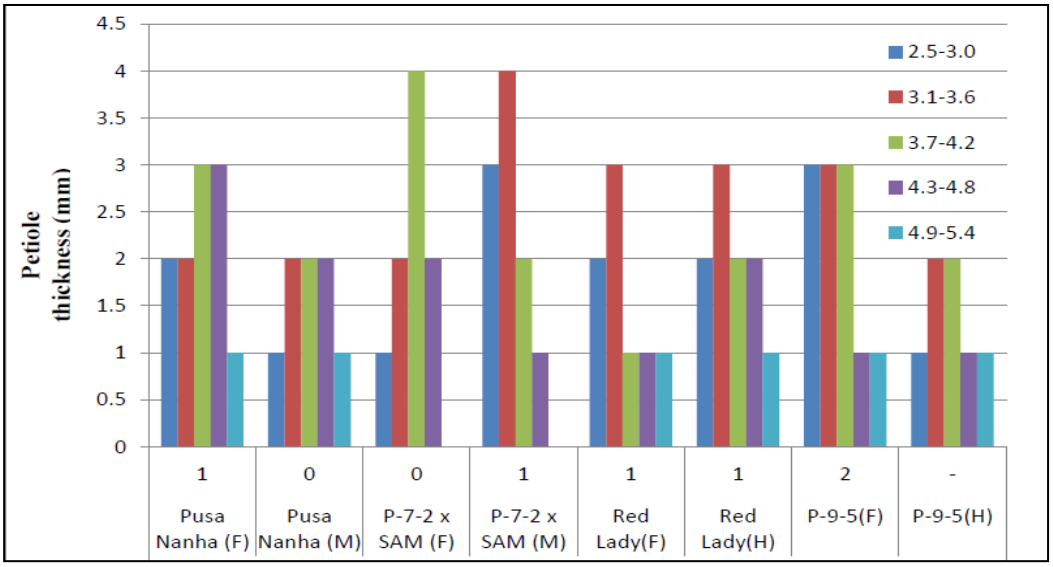

Fig. 2: Petiole thickness at seedling stage and sex expression in papaya

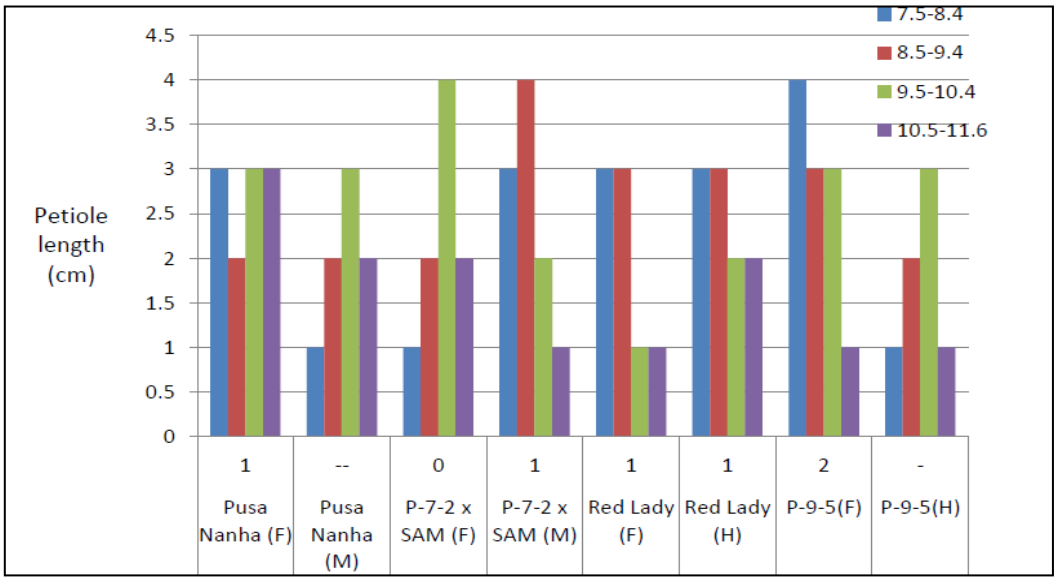

Fig. 3: Petiole length and sex expression in Papaya

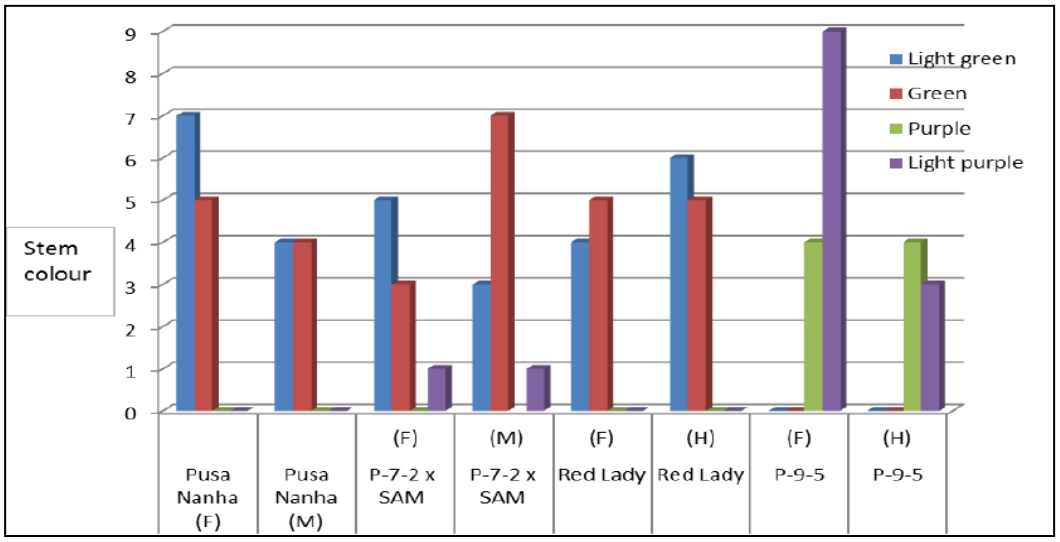

Fig. 4: Stem colour at seedling stage and sex expression in papaya

DISCUSSION

The higher frequency of the female and hermaphrodite plants in black and dark brown colour across the genotypes. The dark brown colour exhibited higher number of male plants among the dioecious genotypes (Pusa Nanha and P-7-2 × SAM). However black colour seeds were exhibited greater number of the female plants in case of Pusa Nanha and P-7-2 × SAM, whereas grey and light brown colour seeds show lower level of sex expression among the dioecious and gyndioecious genotypes studied. The higher number of the black and brown seeds developed as productive plants might be due to pollination of such flowers between female and hermaphrodite or selfing of the hermaphrodite[3,4].

The higher number of male plants observed in a range of 3.1 to 3.6 mm thickness of petiole in Pusa Nanha and P-7-2 × SAM and plants were also higher in the same range in case of Red Lady and P-9-5. However, analysis of graph did not indicate a promising and consistent trend for the sex expression in papaya. The higher number of female plants were recorded in P-7-2 × SAM followed by Pusa Nanha in a range of 9.5 to 10.4 cm length of petiole. However, maximum plants of gyndioecious genotypes (female and hermaphrodite) exhibit their sexes in a range of 7.5 to 10.4 cm hermaphrodite. The greater number of female plants expressed their sex type in light green colour of stem at seedling stage. The unique purple colour was noticed in P-9-5 and higher numbers of the hermaphrodite plants were observed in green purple colour at the base of the stem. Among the dioecious and gynodioecious papaya genotypes, There light purple colour may be useful morphological markers for the P-9-5 to enhance the prediction of female or hermaphrodite plants within the genotype. The maximum number of plants expressed their sex type in a range of 46-600 orientation. The wide ranges of variation were 30 observed among the dioecious and gynodioecious genotypes of papaya. There was not a uniform trend of sex prediction in a particular range of orientation or in a particular genotype. However, maximum female plants were recorded equally in Pusa Nanha, P-9-5 and P-7-2 ×SAM in (54-600) range of orientation. Among morphological traits, black and brown seed colour was most reliable in predicting female and hermaphrodite plants. The over analysis of the graph did not show any significant trends across the genotype and type of sexes. The findings are in close conformity with report[1] However, results are in partial conformity with reports of[5,6].

CONCLUSION

The study was concluded as the higher frequency of the female and hermaphrodite plants in black and dark brown colour across the genotypes. The dark brown colour exhibited higher number of male plants among the dioceious genotypes (Pusa Nanha and P-7-2 x SAM). However black colour seeds were exhibited greater number of the female plants in case of Pusa Nanha and P-7-2 × SAM. Among morphological traits, black and brown seed colour was most reliable in predicting female and hermaphrodite plants and the higher number of male plants observed in a range of 3.1 to 3.6 mm thickness of petiole in Pusa Nanha and P-7-2 × SAM.

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