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Screening of Dioecious Papaya Hybrids for Papain Yield and Enzyme Activity

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Abstract: An experiment was conducted at the Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, during 2003-2004 to evaluate the performance of hybrids of dioecious papaya (*Carica papaya* L.) for papain yield and enzyme activity. The study involved the evaluation of papain yield, enzyme activity, extent of heterosis in five dioecious hybrids viz., CO 2 x Pusa Giant, CO 2 x CO 5, CO 5 x 9-1 (D), 9-1 (D) x CO 5, Pusa Dwarf x 9-1 (D) along with their respective parents. The study revealed that the papain recovery per fruit was higher in Pusa Dwarf X 9-1(D) and 9-1(D) X CO5 but the enzyme activity was higher in CO 5 X 9-1(D). Pusa Dwarf x 9-1(D) recorded high positive significant heterosis and heterobeltiosis for papain recovery and the crosses 9-1(D) x CO 5 and CO 5 x 9-1(D) recorded high positive significant heterosis for papain activity.

Key words: Papaya, papain, enzyme activity, heterosis

INTRODUCTION

Papaya (*Carica papaya* L.) has become an important part of the diet in most tropical countries, as a breakfast fruit or as a puree in many other countries. Papaya is also cultivated for the proteolytic enzyme 'papain', which is used in meat tenderizers and in face and hair care products. It is also increasingly being used in pharmaceutical preparations and in such diverse manufacturing applications as leather, wool, rayon and beer [2].

Intensive research work carried out at Tamil Nadu Agricultural University, Coimbatore has resulted in the release of the seven varieties *viz*., CO 1, CO 2, CO 3, CO 4, CO 5, CO 6 and CO 7. Among them CO 3 and CO 7 are gynodioecious while the others are dioecious. The present study involves the evaluation of dioecious hybrids along with their parents for papain yield and enzyme activity.

MATERIALS AND METHODS

An experiment was conducted at the Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, during 2003-2004 to evaluate the performance of hybrids of dioecious papaya (*Carica papaya* L.) for papain yield and enzyme activity. The study involved the evaluation of papain yield and enzyme activity extent of heterosis in five dioecious hybrids viz., CO 2 x Pusa Giant, CO 2 x CO 5, CO 5 x 9-1 (D), 9-1 (D) x CO 5, Pusa Dwarf x 9-1 (D) along with their respective parents.

Seeds of the parents and the selected cross combinations were raised in nursery bags. Twelve plants in each of the cross combination was raised in F_1 generation in each replication along with the parents. Observations were carried out from four plants in each of the three replications for yield and quality parameters in each of these crosses and their parents. Polythene bags with 4-5 seedlings of 45 days age were transplanted in the pit in the main field at 1.8 x 1.8 m spacing. All other cultural operation was followed uniformly as per the standards.

Papain recovery per fruit: Latex from 85-90 days fruits old were tapped by making 3 mm longitudinal incisions on the fruit surface, from fruit stalk end to the tip of the fruit between 6.00 and 8.00 AM, when there was bright sun shine. Four cuts were uniformly spaced over the four sides of the fruit. The incisions were repeated 4 times, at three days interval. The latex was collected in specially made aluminum trays. The wet latex was dried in shade and the dry weight of this crude unrefined papain was recorded. For papain activity, the procedure suggested by Moore [6] was used for measuring the proteolytic activity with tyrosine as standard and expressed as tyrosine units per mg of papain.

Heterosis values were worked out by utilizing the overall mean of each parent or hybrid in all three replications for each character. Relative heterosis was estimated as the per cent deviation of the F_1 hybrid from its mid parental value. Heterobeltiosis for each character, in each hybrid combination was expressed as per cent increase or decrease of F_1 value over corresponding better parent value. The two types of heterosis were estimated using the following formulae.

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Relative Heterosis = di = $\frac{\bar{F}_1 - \overline{MP}}{\overline{MP}} \times 100$

Heterobeltiosis= dii= $\frac{\bar{F}_1 - \overline{BP}}{\overline{BP}} \times 100$

Where,

$\bar{F}_1$ = Mean of the hybrid
$\overline{MP}$ = Mean of two parents involved in the hybrid combination
$\overline{BP}$ = Mean of better parent of the hybrid combination

Significance for the heterosis was calculated by using the CD value at 1 and 5 per cent level.

The significance of relative heterosis and heterobeltiosis were tested by the following formulae.

i.'t' for relative heterosis = $\frac{\bar{F}_1 - \overline{MF}}{\sqrt{\sigma^2 e/r \times 3/2}}$

ii.'t' for heterobeltiosis = $\frac{\bar{F}_1 - \overline{BF}}{\sqrt{\sigma^2 e/r \times 2}}$

Where,
$\sigma^2 e$ = error variance
r = number of replications

RESULTS AND DISCUSSIONS

The heterosis estimates in the different dioecious and gynodiocious hybrids were calculated over the mean performance of corresponding mid parental values and better parental values. The estimates so obtained for different traits are furnished below.

Papain Production:

Papain Recovery per Fruit: The papain recovery per fruit in dioecious parents and hybrids ranged from 3.29 g in CO 2 x Pusa Giant to 8.58 g in Pusa Dwarf x 9-1(D). The hybrid 9-1(D) x CO 5 and the parent CO 2 recorded a higher papain yield of 7.65 g and 7.29 g respectively which exceeded the population mean. The parent CO 5 recorded higher papain yield of 8.17 g per fruit and is on par with Pusa Dwarf and 9-1(D) (Table 1).

Enzyme Activity in Papain: The enzyme activity of crude papain in dioecious parents and hybrids ranged between 88.03 TU in Pusa Dwarf to 218.32 TU in CO5 x 9-1(D). Except the cross Pusa Dwarf x 9-1 (D), all other hybrids recorded higher enzyme activities over the population mean. Among the parents, the CO2 recorded higher enzyme activity (200.72 TU) over the population mean (Table 1).

Table 1: Mean performance of dioecious parents and their hybrids for papain recovery and papain activity

Parent	Papain recovery (g fruit $^{-1}$)	Papain activity (TU mg^{-1})
Parents		
CO 2	7.29	200.7
CO 5	8.17	109.2
Pusa Giant	6.92	98.6
Pusa Dwarf	5.24	88.0
9-1(D)	6.91	165.5
Hybrids		
CO 2 x Pusa Giant	3.29	172.5
CO 2 x CO 5	4.16	154.9
9-1(D) x CO 5	7.65	190.2
CO 5 x 9-1(D)	6.13	218.3
Pusa Dwarf x 9-1(D)	8.58	126.8
Mean	6.44	152.5
SEd	0.283	0.226
CD 0.5%	0.594	0.474
CD 0.1%	0.814	0.650

Table 2: Heterosis for papain yield and papain activity

	Papain recovery (g/fruit)		Papain activity (TU/mg)	
Dioecious crosses	di	dii	di	dii
CO 2 x Pusa Giant	-53.69**	-54.87	15.29**	-14.04**
CO 2 x CO 5	-46.18**	-49.08	-0.01	-22.81**
9-1(D) x CO 5	1.46	-6.36	38.46**	14.89**
CO 5 x 9-1(D)	-18.70**	-24.97**	58.97**	31.92**
Pusa Dwarf x 9-1(D)	41.23**	24.17**	0.00	-23.40**
CD 0.05%	0.51	0.59	0.41	0.47
CD 0.01%	0.70	0.81	0.57	0.65

Heterosis:

Papain Recovery per Fruit: The heterosis and heterobeltiosis in dioecious hybrids for papain recovery ranged between -53.69 to 41.23 and -54.87 to 24.17 per cent respectively. The hybrid Pusa Dwarf x 9-1(D) recorded high positive significant heterosis and heterobeltiosis (Table 2).

Enzyme Activity in Papain: Among the dioecious hybrids, the heterosis ranged between -0.01 to 58.97 per cent and -23.40 to 31.92 per cent over mid and better parental values. The hybrids 9-1(D) x CO5 and CO5 x 9-1(D) recorded high positive significant heterosis over both mid and better parental values (Table 2).

None of the hybrids registered positive heterosis for papain recovery except for the cross Pusa Dwarf x 97 (D). The cross 9-1 (D) x CO 5 though registered no heterosis over mid parent or better parent, it registered a moderately high papain recovery (7.65 gm) and higher papain activity 190.15TU). In its reciprocal combination, moderate papain recovery of 6.13g but a still higher papain activity of 218.32 TU was recorded. This may be due to the positive influence of CO 5 in increasing the papain content in these crosses. These two crosses can be chosen for further evaluation. Comparatively higher number of fruits at first harvest and higher means for fruit length observed in these crosses further enhanced their rating for papain

production. Variability in papain production has been earlier reported [1, 3, 4, 5].

Conclusion: The study revealed that the papain recovery per fruit was higher in Pusa Dwarf X 9-1(D) and 9-1(D) X CO5 but the enzyme activity was higher in CO 5 X 9-1(D). Pusa Dwarf x 9-1(D) recorded high positive significant heterosis and heterobeltiosis for papain recovery and the crosses 9-1(D) x CO 5 and CO 5 x 9-1(D) recorded high positive significant heterosis for papain activity.

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