Genetical Studies in Papaya (*Carica papaya* L.)

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Abstract

Genetical studies in papaya were carried out using the variety Coorg Honey Dew. The purification programme in the variety Coorg Honey Dew was taken up and the data were recorded from the S_2 to S_4 generation of sibmated progenies. The variety Coorg Honey Dew yields big sized fruits of about 1.5-2.0 kg, pulp is yellow in colour and fruits are sweet to taste with a TSS of 12°Brix. The sibmated progenies were studied for uniformity in fruit size and shape. A total of ten half-sib families (25 trees/family) were used for the study. Genotypic variation and phenotypic variation was highest in S_2 generation, while in S_4 variation it was observed to be low. The PV and GV were observed to decline with the progress of the generation. The genotypic coefficient of variation was lesser than the phenotypic coefficient of variation implying the role of environment influencing the characters. High heritability was recorded for all the characters except inter nodal length and pulp thickness. Very little difference was noticed in the heritability values between S_3 to S_4 generation. Among the characters, high genetic advance as percent mean was recorded for the characters of fruit weight, fruit length and number of seeds, while other characters exhibit moderate to low. Heritability and genetic advance as percent mean was obtained high for the characters of fruit weight and fruit length. The correlation studies showed that plant height at first fruiting were positively correlated with fruit length and first flowering height. The study indicated that three generation of sibmating considerably reduced the variability in morphological and yield characters.

INTRODUCTION

Papaya (*Carica papaya* L.) is highly nutritious, rich in vitamin and minerals. Coorg Honey Dew is one of the earliest gynodioecious selections made in the country (Aiyappa and Nanjappa, 1959). The seed production technique is attempted through selfing or sib-mating to ensure the genetic purity in gynodioecious varieties. In the long run, the variety Coorg Honey Dew papaya lost the genetic purity due to contamination of foreign pollen. Hence, a research programme was initiated to purify the variety by sibmating. The present paper deliberates on deriving information on genotypic and phenotypic coefficient of variation, heritability, genetic advance as percent mean and correlation among the characters genetical studies from S_2 to S_4 progenies of Coorg Honey Dew papaya.

MATERIALS AND METHODS

The present study was conducted at Central Horticultural Experimental Station (IIHR), Chettalli, Kodagu, Karnataka during the year 2002-2007. The experiment was laid out in progeny row trial using the compact block of total ten half sib families with 25 trees/family. Initially, hermaphrodite trees were selected for selfing. Forty five days old seedlings of uniform growth and vigour were planted at a spacing of 2.1×2.1 m and standard package of practices were followed during the period of study. The progeny population was evaluated for the characteristics plant height at time of first fruiting, girth of the stem, number of leaves per plant, plant spread (East to West and North to South) and fruit and seed characters like fruit weight, length and diameter, fruit cavity index, TSS, pulp thickness, number of seeds per fruit and 100 seed weight. Statistical analysis

for the genotypic (GCV) and phenotypic coefficient of variation (PCV) were estimated as suggested by Burton (1952). Heritability and genetic advance as percentage of mean was determined according to the method suggested by Johnson et al. (1955). The estimation of correlation coefficient was analyzed according to the methods described by Natarajan and Gunasekaran (2008).

RESULTS AND DISCUSSION

Success of inbreeding programme depends on the quantum of variability present and the uniformity achieved in characters. A wide range of variation was noticed among the S_2 to S_4 generation of papaya with regard to different characters studied (Table 1). The phenotypic (PV) and genotypic variation (GV) were found to be highest in S_2 with regard to plant height at the time of first fruiting, stem girth, internodal length, length of petiole, number of leaves per plant, plant spread, fruit weight, length and diameter, pulp thickness, fruit cavity index, TSS and number of seeds. In the S_3 and S_4 generation variability was observed to be low for all the characters. Dinesh et al. (1991) observed similar results. The PV and GV values for all the characters were observed to decrease with the progression of generation.

The phenotypic variation in S_2, S_3 and S_4 generation were 96.15, 32.37 and 24.53 for plant height at the time of first fruiting; 28.11, 9.19 and 7.24 for stem girth; 0.122, 0.082 and 0.075 for fruit weight; and 15.38, 5.21 and 2.86 for fruit cavity index respectively. The same trend also was observed in genotypic variation for plant height at the time of first fruiting (86.61, 23.05 and 16.61), stem girth (25.15, 5.09 and 5.31), fruit weight (0.10, 0.05 and 0.06) and fruit cavity index (11.99, 4.17 and 2.05) in the S_2, S_3 and S_4 generation respectively.

The results revealed that phenotypic coefficient of variation (PCV) for all the characters were higher than the genotypic coefficient of variation (GCV). Very little difference was noticed between the values of PCV and GCV in S_4 generation for the quantitative characters plant height at the time of first fruiting, stem girth, internodal length, fruit weight, fruit length and fruit diameter. This indicates less influence environment while a medium degree of disparity was recorded for number of seeds, which probably were influenced by the environment. Data on S_2 generation showed medium degree of GCV and PCV, while the variation was observed to be low in the S_4 generation. The PCV and GCV values were lower in S_3 generation compared to S_2 generation. However, these values did not vary much in the S_3 and S_4 generations.

The phenotypic coefficient of variation and genotypic coefficient of variation in S_2 generation were 11.03 and 10.08 for first flowering height; 10.69 and 10.15 for plant height at the time of first fruiting; 13.21 and 12.49 for stem girth; 16.36 and 14.74 for fruit weight; and 18.60 and 16.98 for fruit cavity index respectively. In S_4 generation PCV and GCV values were 7.12 and 6.21 for first flowering height, 5.29 and 4.36 for plant height at the time of first fruiting, 7.18 and 6.15 for stem girth, 13.24 and 11.54 for fruit weight and 5.63 and 4.16 for fruit cavity index respectively. The results indicated that selection and sib mating reduced the variation among the population.

The magnitude of heritability indicates the reliability of genotypes with which they can be identified with their phenotypic expression. Heritability estimates are the true indications of genetic potentiality of individual which act as a tool in selection (Johnson et al., 1955). The traits with high heritability are less influenced by environment and therefore direct selection for these characters on the basis of phenotypic performance will be worthwhile**.** High heritability values were obtained for first flowering height, plant height at the time of first fruiting, stem girth, length of petiole, number of leaves per plant, plant spread, fruit cavity index, number of seeds per fruit and 100 seed weight. Moderate heritability was noticed for pulp thickness and internodal length. Similar results have been reported in different set of material in papaya by Dash et al. (1998) and Yadav et al. (1993).

Among the characters studied genetic advance as percent of mean was observed to be high for fruit weight, fruit length and number of seeds, while other characters, first

flowering height, stem girth, fruit diameter and fruit cavity index showed moderate genetic advance, the remaining characters recorded low genetic advance as percent of mean. The data showed high values for both heritability and genetic advance as percent of mean in the case of fruit weight and fruit length. Hence, selection for these characters will be effective as these are predominantly controlled by additive gene action. Ram and Akhtar (1993) reported similar result for fruit length and fruit yield characters and Jana et al. (2006) have also reported similar results for the fruit length, fruit yield and number of fruits per plant in papaya. From the table it is evident that high heritability was recorded in S_2 generation. However, it declined with the progression of the generations for the characters of stem girth, length of petiole, fruit weight, length and diameter, TSS and number of seeds per fruit. Little difference was observed in heritability values between S_3 and S_4 generation. The genetic advance as percent mean showed same trend as that of heritability results.

The characters like fruit weight, fruit length, first flowering height, stem girth, fruit diameter, fruit cavity index, TSS and number of seeds had high to moderate heritability and moderate genetic advance as percent mean indicating less influence of environment on these characters. Similar observation was also reported by Jana et al. (2006). The traits with moderate value may be ascribed to additive gene effect and the selection for this character will bring about improvement in papaya (Dash et al., 1998).

The results of phenotypic correlation presented in Table 2 indicated that plant height at first fruiting was positively correlated with fruit length, first flowering height and TSS. Fruit weight had a significant positive correlation with plant spread and pulp thickness. Fruit length was correlated with the fruit diameter, number of seeds and hundred seed weight. The study clearly indicates that by sibmating and going in for subsequent selection purification can be achieved in papaya.

CONCLUSIONS

The purification programme taken up in the papaya variety Coorg Honey Dew showed that sibmating followed by selection can bring about improvement of characters. Wider variation was observed from the S_2 to S_4 generation with regard to genetic parameters. Phenotypic coefficient of variation was higher than the genotypic coefficient of variation for all the characters. The influence of environment was found to be subdued as the differences between PCV and GCV was observed to be lower. The estimates of heritability and genetic advance as percent mean was high for fruit weight and fruit length. Therefore, selection and sibmating would be effective for improving and achieving uniformity for most of the characters.

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Tables

Table 1. Variance (PV and GV), phenotype (PCV) and genotypic (GCV) coefficient of variation, heritability (h^2) and genetic advance percent as mean (GA) of different characters of papaya cv. Coorg Honey Dew.

Characters/generation	Mean	PV	GV	h^2	GA	GA%	PCV	GCV
Plant height at first fruiting (cm)								
S_2	91.705	96.146	86.612	90.084	18.196	19.842	10.692	10.148
S_3	92.289	32.369	23.045	71.195	8.344	9.041	6.165	5.202
S_4	93.568	24.532	16.607	67.794	6.907	7.382	5.293	4.358
Stem girth (cm)								
S_2	40.156	28.117	25.148	90.402	9.875	24.375	13.205	12.488
S_3	41.273	9.193	5.097	55.448	3.463	8.391	7.346	5.470
S_4	37.497	7.243	5.313	73.358	4.067	10.846	7.177	6.147
Internodal length (cm)								
S_2	4.159	0.278	0.253	91.340	0.991	23.834	12.677	12.094
S_3	4.008	0.147	0.121	82.386	0.652	16.259	9.566	8.679
S_4	4.050	0.056	0.032	56.396	0.278	6.805	5.843	4.417
Length of petiole (cm)								
S_2	91.203	37.386	32.253	86.272	10.866	11.915	6.704	6.227
S_3	91.684	25.084	18.142	72.324	7.46	8.139	5.463	4.646
S_4	91.605	23.185	18.531	79.926	7.928	8.654	5.256	4.699
No. of leaves								
S_2	56.531	33.506	29.605	88.355	10.536	18.637	10.239	9.625
S_3	55.634	22.548	19.672	87.242	8.534	15.339	8.535	7.972
S_4	57.153	11.047	8.808	79.731	5.459	9.552	5.815	5.193
Plant spread (E-W) (cm)								
S_2	257.370	711.671	376.063	91.350	38.181	14.835	10.365	7.535
S_3	262.300	171.572	154.677	90.153	24.326	9.274	4.994	4.741
S_4	253.394	172.479	131.281	76.114	20.592	8.125	5.183	4.522
Plant spread (N-S) (cm)								
S_2	259.621	199.893	145.623	72.850	21.218	8.173	5.446	4.648
S_3	268.513	144.400	101.810	70.505	17.453	6.500	4.475	3.758
S_4	263.014	145.216	98.073	67.536	16.766	6.374	4.582	3.765
Fruit weight (kg)								
S_2	2.135	0.122	0.099	81.977	0.590	27.619	16.360	14.737
S_3	2.097	0.082	0.056	67.696	0.400	19.054	13.656	11.285
S_4	2.069	0.075	0.057	75.954	0.429	20.729	13.236	11.539

Table 1. Continued.

Characters/generation	Mean	PV	GV	h^2	GA	GA%	PCV	GCV
Fruit length (cm)								
S_2	28.408	9.116	7.932	87.004	5.142	19.049	10.628	9.914
S_3	28.985	2.754	1.821	66.103	2.260	7.797	5.725	4.656
S_4	29.570	6.874	5.977	86.953	4.696	15.882	8.867	8.268
Fruit diameter (cm)								
S_2	40.686	5.345	3.433	64.225	8.059	7.519	5.682	4.554
S_3	40.346	3.656	2.139	58.488	2.304	5.710	4.739	3.625
S_4	43.560	6.480	4.480	67.830	3.550	8.170	5.844	4.859
Pulp thickness (cm)								
S_2	3.427	0.093	0.073	78.233	0.491	14.339	8.899	7.884
S_3	3.297	0.074	0.049	66.409	0.371	11.266	8.251	6.714
S_4	3.227	0.033	0.018	55.549	0.207	6.407	5.629	4.158
Fruit cavity index (%)								
S_2	20.395	14.382	11.991	83.378	6.514	31.938	18.595	16.979
S_3	19.513	5.207	4.179	80.253	3.772	19.333	11.694	10.476
S_4	19.293	2.859	2.048	71.622	2.495	12.931	8.764	7.418
TSS (°Brix)								
S_2	10.734	0.531	0.420	81.883	1.208	11.255	6.789	6.038
S_3	10.765	0.471	0.331	70.242	0.993	9.228	6.375	5.344
S_4	10.570	0.461	0.362	78.512	1.098	10.394	6.424	5.692
No. of seeds								
S_2	344.060	9025.429	7557.441	83.735	163.873	47.639	27.612	25.267
S_3	379.127	6803.610	4346.790	63.890	108.559	28.634	21.756	17.390
S_4	378.502	2982.357	2029.076	68.036	76.539	20.221	14.428	11.901
Hundred seed weight (g)								
S_2	2.425	0.036	0.028	79.193	0.307	12.676	7.824	6.990
S_3	2.490	0.042	0.029	69.758	0.294	11.779	8.230	6.839
S_4	2.500	0.029	0.019	66.701	0.233	9.335	6.812	5.514

Table 2. Simple correlation coefficient for different characters in papaya cv. Coorg Honey Dew.

Characters	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Plant height at first fruiting (cm)	1000														
2. Stem girth (cm)	0.074	1000													
3. Inter nodal length (cm)	-0.006	-0.344	1000												
4. Spread (EW) (cm)	0.182	-0.474*	0.162	1000											
5. Spread (NS) (cm)	0.139	-0.388	0.142	0.930**	1000										
6. Fruit length (cm)	0.450*	-0.006	-0.060	0.120	0.123	1000									
7. Fruit diameter (cm)	0.073	-0.151	0.376	-0.070	0.036	0.463*	1000								
8. Pulp thickness (cm)	0.101	-0.033	-0.011	-0.440*	-0.533*	0.277	0.146	1000							
9. TSS (°Brix)	0.547*	0.443*	-0.179	0.075	0.066	0.164	-0.486*	-0.153	1000						
10. Fruit cavity index (%)	0.192	-0.075	-0.511*	0.323	0.269	0.160	-0.233	0.004	0.109	1000					
11. Hundred see weight (g)	0.428*	0.107	0.048	0.128	0.085	0.575**	0.082	0.123	0.331	0.101	1000				
12.First flowering height (cm)	0.631**	-0.102	0.221	0.139	0.251	0.270	0.170	0.029	0.287	-0.122	0.488*	1000			
13. Petiole length (cm)	-0.313	-0.209	0.433*	0.145	0.127	0.156	0.157	-0.079	-0.059	-0.525*	0.212	0.065	1000		
14. Fruit weight (kg)	-0.074	-0.355	0.412	0.632**	0.681**	-0.204	-0.315	-0.548*	0.168	-0.186	-0.017	0.024	0.096	1000	
15. No. of seeds per fruit	0.292	0.359	-0.239	-0.057	-0.017	0.806**	0.247	0.130	0.456*	0.033	0.302	0.276	0.291	-0.212	1000

*Correlation significant at the 5% level.
**Correlation significant at the 1% level.