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Studies on Genetic Variability Parameters in Backcross Population of Jatropha (Jatropha Curcas)

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ABSTRACT: *J. curcas can be considered the most promising oilseed for biodiesel production. An investigation was carried out in 179 BC_4F_1 progenies of a cross Jatropha curcas and Jatropha integerrima. A detailed study on variability was carried out for BC_4F_1 generation to understand the variability available for oil yield and oil yield traits to formulate a selection index for the oil yield improvement program. Analysis of variance showed significant differences among all the characters. It indicates the presence of significant variability in the experimental materials. Studies on variability revealed that phenotypic and genotypic coefficients of variation exhibited wide range for all 28 characters. Canopy volume, number of branches per plant, number of fruits per bunch, capsule weight per plant, seed yield per plant and oil yield per plant were recorded high PCV (phenotypic coefficient of variation) and GCV (genotypic coefficient of variation) values. Moderate to high heritability and genetic advance was observed for the characters canopy cover in rows, canopy cover between rows, canopy volume, number of branches per plant, fruit length and fruit aspect ratio.*

Keywords: *Jatropha, bio-diesel, heritability, genetic advance*

INTRODUCTION

The worldwide demand for clean, renewable and sustainable fuels to replace or supplement fossil fuels has made biofuels a great alternative. *Jatropha curcas* L also called as Barbados nut, purging nut which is a promising energy species for its high yield and high-quality oil is native to Mexico and Central America, and is currently being naturalized in many tropical and subtropical areas including India, Africa, North America, and South-East Asia. Jatropha is a small perennial tree or large shrub, which can reach a height of 3 to 10 m. The plant shows articulated growth straight trunk, thick branchlets with a soft wood and a life expectancy of up to 50 years. Flowering occurs during the wet season often with two flowering peaks, i.e. during summer and autumn. Flowers are unisexual, monoeceious, greenish yellow colored in terminal long, peduncled paniculate cymes. The fruits are trilocular and the seed oil content ranges between 25 to 48% by weight. Understanding the genetic relationships and genetic structure in *J. curcas* is important for enabling efficient management, conservation, characterization and utilization of the species. The early views that inter-specific hybridization would be a panacea for all tree improvement problems have largely been dispelled. Heterosis in hybrids, far from being a common phenomenon, is rare. Probably the more promising, and most useful contribution of inter-specific hybridization is in transferring desirable genes from one species to another, e.g. Populus, Eucalyptus. Other added advantage is the propensity of *J. curcas* towards interspecific hybridization, supported by propagation both through seeds and vegetative propagule, which helps in rapid multiplication and acceleration of the breeding programs. Therefore the present study was undertaken with the objective to evaluate the variation in vegetative and reproductive traits for 179 BC_4F_1 progenies of a cross *Jatropha curcas* and *Jatropha integerrima.*

MATERIAL AND METHODS

The experimental materials for the present investigation were generated by interspecific hybridization between *Jatropha curcas* L x *Jatropha integerrima* L and subsequent four backcrossing with *Jatropha curcas* L. The 179 BC_4F_1 populations along

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with check variety TNMC 7 were raised under field condition during the year 2010-2012 at Millets Breeding Station, Tamil Nadu Agricultural University, Coimbatore. The experiment was laid out in randomized block design with three replications. Each genotype was planted with a spacing of 3m x 2m. Recommended management practices (FYM 2-3kg/pit, 20:120:16 g of NPK (Nitrogen, Phosphorous and potassium)/pit/year and cultural practices (2-3 manual weeding per year, irrigation during dry period) were undertaken.

Observations were recorded for 28 characters viz., plant height, collar diameter, leaf length, leaf width, leaf length width ratio, canopy cover in rows, canopy cover between rows, canopy volume, number of branches per plant, days to flowering, number of male flower per inflorescence, number of female flower per inflorescence, male to female flowers ratio, number of bunches per branch, number of fruits per bunch, number of seeds per fruit, fruit length, fruit width, fruit aspect ratio, seed length, seed width, seed aspect ratio, capsule weight per plant, hundred seed weight, shelling percent, oil content, seed yield per plant and oil yield per plant at 6 months interval on 179 progenies and one check variety in three replications.

The various genetic parameters like mean, variability, GCV, PCV, heritability and genetic advance as per cent mean were calculated by adopting the formulae given by Johnson *et al.* (1955).

RESULTS AND DISCUSSION

The develpoment of improved cultivars through hybridization has made a major contribution to increased productivity and quality of plants.The backcross breeding programme was aimed at transfering genes for resistant to root rot and to increase oil content and seed yield.

Genetic variability studies provide basic information regarding the genetic properties of the population based on which various breeding methods are formulated for further improvement of the crop. Attempts to improve a character by selection would be futile unless a major portion of the variation is heritable. Thus it is imperative to have information on both phenotypic and genotypic coefficient of variation to get an idea regarding the heritability of the character. Selection of characters with high heritability coupled with high genetic advance will be advantageous for improving yield and also for future breeding programme. The phenotypic and genotypic coefficients of variation exhibited wide range for all characters studied.

The variability and genetic parameters of vegetative and reproductive characters estimated are presented in Table 1 and 2. The GCV was found to be less than PCV for all the traits studied Fig1 and 2. Among the characters studied plant height, canopy cover in rows, canopy cover between rows, canopy volume, number of branches per plant, number of male flower per inflorescence, number of female flower per inflorescence, male female flower ratio, number of bunches per branch, number of fruits per bunch, capsule weight per plant, seed yield per plant and oil yield per plant recorded high phenotypic coefficient variation. The similar kind of results was obtained by many workers (Das *et al.* 2010, Prasanthi *et al.* 2009, Ranwah *et al*. 2009, Parthiban *et al*. 2011). The characters such as canopy volume, number of branches per plant, number of fruits per bunch, capsule weight per plant, seed yield per plant, and oil yield per plant recorded high phenotypic coefficient variation and high genotypic coefficient variation. Contrary to this, the characters *viz.,* fruit length, fruit width, fruit aspect ratio, seed length, seed width, seed aspect ratio exhibited low PCV and GCV values. The similar kind of result was obtained by Ramachandran (2010).

Large differences between PCV and GCV for most of the traits suggested considerable influence of environment variables on the expression of all the traits under study. The results indicated that sufficient level of variability has been created for most of the traits in this population.

The heritability and genetic advance (Fig. 3 and 4) provide the proportion of heritable variation exist and the genetic gain can be obtained in subsequent generations. The character number of branches per plant recoded high heritability with high genetic advance. High heritability with low genetic advance was found for the traits days to first flowering, capsule weight per plant, seed yield per plant, oil content and oil yield per plant. Moderate to high heritability accompanied with high GAM were observed for canopy cover in rows, canopy cover between rows, canopy volume, number of branches per plant, fruit length and fruit aspect ratio. Moderate heritability with low genetic advance as percent mean was exhibited by number of female flower per inflorescence, hundred seed weight and shelling per cent.

The traits like leaf length, leaf width, leaf length width ratio, number of male flower per inflorescence, male female flower ratio, number of seeds per fruit, recorded low heritability and low genetic advance.

Table 1
Variability Parameters for Vegetative Characters

Characters	*Mean*	*Minimum*	*Maximum*	*PCV(%)*	*GCV (%)*	*h^2(%)*	*GAM (%)*
Plant height (cm)	142.60	88.33	190.67	20.02	7.42	13.73	0.07
Collar diameter (cm)	18.65	12.47	25.50	19.29	9.90	26.34	1.49
Leaf length (cm)	7.60	6.00	9.33	11.84	4.68	15.60	1.67
Leaf width (cm)	7.62	6.43	9.77	12.01	4.03	11.23	1.02
Leaf length width ratio	1.00	0.74	1.20	9.42	4.20	19.89	18.23
Canopy cover in rows (m)	0.95	0.47	1.44	25.25	15.65	38.42	51.58
Canopy cover between rows (m)	0.92	0.44	1.43	25.61	16.18	39.91	56.62
Canopy volume (m^3)	1.10	0.17	2.75	55.06	34.36	38.95	47.13
Number of branches/plant	5.53	2.00	10.33	31.99	26.16	66.87	20.41

PCV - Phenotypic coefficient of variation GCV - Genotypic coefficient of variation h^2-Heritability
GAM -Genetic advance as per cent of mean

Table 2
Variability Parameters for Reproductive Characters

Characters	*Mean*	*Minimum*	*Maximum*	*PCV (%)*	*GCV (%)*	*h^2(%)*	*GAM (%)*
Days to first flowering	91.88	64.67	118.00	14.15	12.34	76.00	1.48
Male flower/inflorescence	167.11	112.33	281.11	23.74	11.74	24.44	0.15
Female flower/inflorescence	11.34	6.33	20.67	26.97	17.01	39.80	4.56
Male female flower ratio	15.30	10.28	22.95	21.19	8.77	17.14	0.96
Number of bunches/branch	1.63	0.89	2.44	24.37	13.12	29.00	19.78
Number of fruits/bunch	6.93	3.22	17.33	31.98	24.97	60.98	14.14
Number of seeds/fruit	2.37	1.80	3.00	14.60	3.89	7.11	1.65
Fruit length (cm)	2.31	1.80	3.08	8.93	5.73	41.15	23.58
Fruit width (cm)	1.91	1.54	2.27	8.11	4.23	27.17	15.27
Fruit aspect ratio	1.21	1.05	1.50	8.24	4.85	34.70	34.76
Seed length (cm)	1.69	1.43	1.88	7.28	3.70	25.86	16.04
Seed width (cm)	1.07	0.86	3.98	8.34	3.74	20.16	17.95
Seed aspect ratio	1.63	1.18	2.02	8.36	4.12	24.29	15.12
Capsule weight/plant (g)	115.13	16.46	272.05	45.38	41.45	83.43	1.36
Hundred seed weight (g)	54.01	26.27	72.93	17.90	10.67	35.50	0.80
Shelling percent	54.84	33.22	68.40	13.80	7.81	32.00	0.68
Oil content (%)	31.60	22.34	39.50	13.95	12.11	75.42	4.27
Seed yield/plant (g)	64.35	7.13	161.43	48.57	44.84	85.24	2.52
Oil yield/plant (g)	21.61	2.19	55.14	52.85	49.69	86.29	7.66

PCV - Phenotypic coefficient of variation GCV - Genotypic coefficient of variation h^2 - Heritability GAM -Genetic advance as per cent of mean

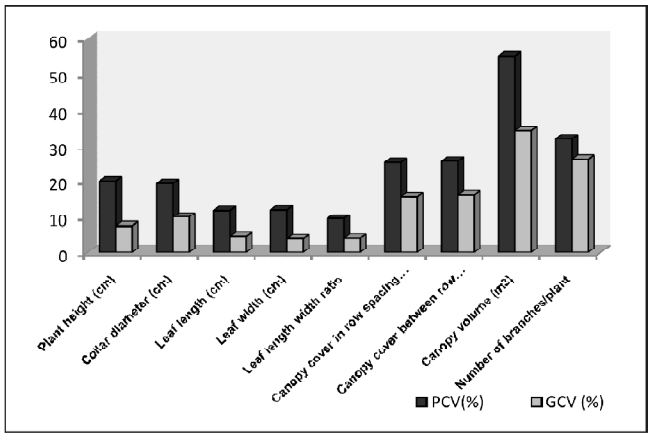

Figure 1: PCV and GCV for Vegetative characters

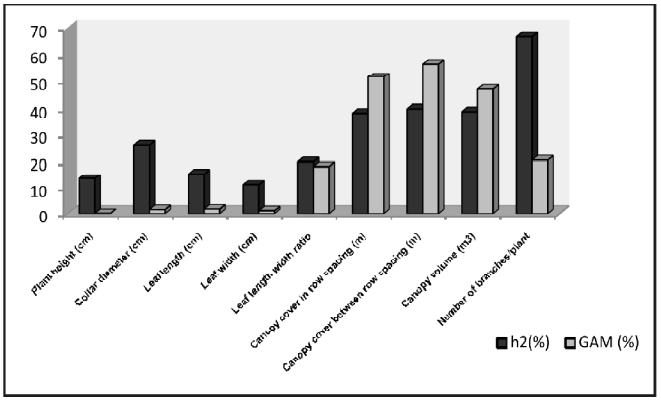

Figure 2: Heritability and Genetic advance as per cent of mean for vegetative characters

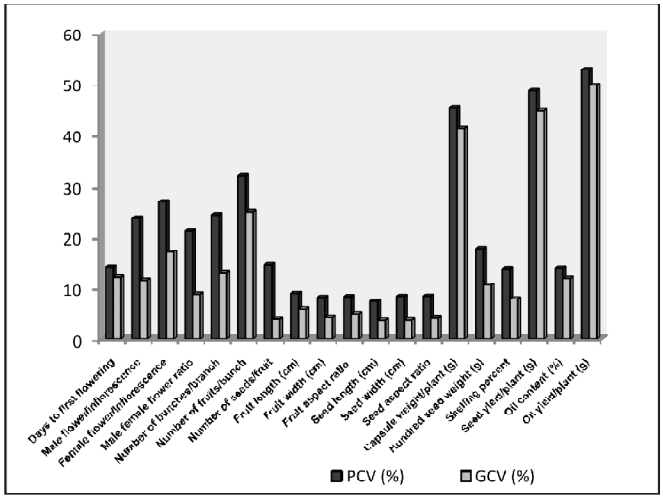

Figure 3: PCV and GCV for reproductive characters

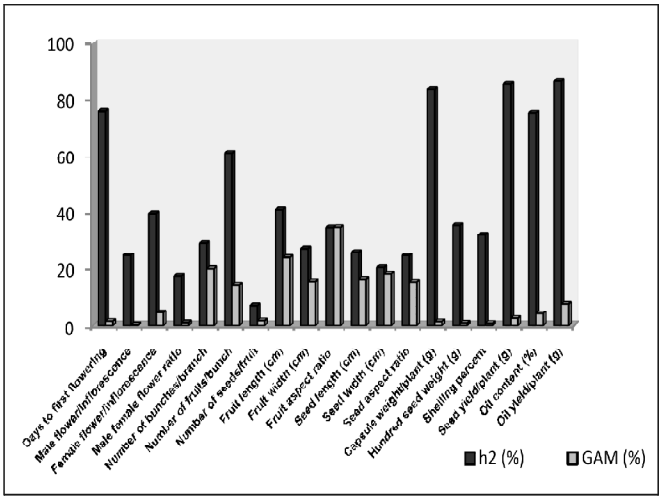

Figure 4: Heritability and Genetic advance as per cent of mean for reproductive characters

Hence, it could be suggested that improvement of these traits might be difficult through selection.

In the present investigation Jatropha hybrid clones expressed high PCV and GCV for canopy volume, number of branches per plant, capsule weight per plant, oil yield per plant and seed yield per plant hence these traits can improve by directional selection. High to moderate heritability value for number of branches per plant, canopy cover in rows, canopy cover between rows, canopy volume, capsule weight per plant, seed yield per plant, oil content and oil yield per plant which indicates that a considerable portion of variance is additive. The estimates of broad sense heritabilities for growth traits indicate that a considerable portion of variance is additive. High additive genetic variance and large variation between seed sources offer good scope for genetic improvement of this species.

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