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Research Article

Estimation of Genetic Variability in *Jatropha Curcas* L. Genotypes for Vegetative Traits and Seed yield

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Abstract

Twenty five *Jatropha curcas* genotypes collected from the foothills of the Shivalik range of the Himalayas in a narrow belt called Tarai were grown in Randomized Block Design with three replications at Medicinal Plant Research and Development Centre, G. B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand and evaluated for 8 characters. The genotypes showed significant differences in most of traits. The phenotypic coefficient of variation was the highest for seed yield/ plant, followed by 100 seed weight (gm) and collar diameter (cm). Similarly, the genotypic coefficient of variation was the highest for seed yield/plant, followed by 100 seed weight (gm) and collar diameter (cm).Very high level of broad sense heritability was observed for seed yield /plant, 100 seed weight, Number of Secondary branches/plant, Collar diameter, Flower initiation (days) after 31st July, Number of Primary branches/plant, Plant Height, Oil content. High estimates of genetic gain as per cent mean were recorded for Flower initiation (days) after 31st July, Oil content, while low estimates of genetic gain as per cent were recorded for plant Height. Selection for Number of Primary branches/plant, Number of Secondary branches/plant, collar diameter, seeds/fruit and 100 seed weight would result in some improvement in yield. Thus, the ideotype to achieve high yield in Jatropha should have more number of flowering bunches/plant and fruits per plant and moderate to high value for seeds/fruit and 100 seed weight.

Keywords: Genetic Variability, Vegetative Traits, *Jatropha curca*, Seed yield

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Introduction

Jatropha curcas Linn. (Physic nut or Ratanjot) is a crop tree-borne oil seed crop. It is native to Tropical America and belongs to family Euphorbiaceae. Global increase in demand for renewable energy to combat the greenhouse effect and rapid depletion of ozone layer as a result of discharge of harmful gases into the environment, couple with the depletion of reserved fossil fuel has mandated the use of biomass energy feedstock for sustainable production of biofuel. Biofuel has been known to be a good alternative to fossil fuel due to its cheap, sustainable and environmental friendly properties [1]. This newly introduced crop which grows abundantly in wild and abandoned land has its seed and oil yield unpredictable especially in tropical climate. Favorable environmental conditions that affect its production has yet to be known [2] and [3]. In spite of the great potentials and attributes of Jatropha as a biodiesel crop, the full potentials of Jatropha have not been realized. One of the reasons for this, apart from the agronomic, social economic and institutional constraints is the facts that there is presently no planned rational conventional breeding and genetic programs. [4] reported that, for the fact that Jatropha has adapted itself to wide range of environmental and ecological conditions suggests that, there exists considerable amount of genetic diversity yet to be detected for potential realization. [5] reported variability observed in *J. curcas* in Central India which was mainly limited to seed source variation in morphology, germination and seedling growth. [6] have reported divergence in seed oil traits of *J. curcas* from a limited number of locally collected accessions. Since heritability estimate in perennial plants decrease with age because of compounded environmental effects masking genotypic differences, there is an urgent need for the knowledge of these estimates in the progenies.

However, one of the limitations to this conventional breeding programme work is the wide genetic diversity, which has to be evaluated before selection of suitable accessions could be possible. Also breeding of high yielding variety is not possible without knowing the extent of variation that exists among the available germplasm in India, the growth, yield and extent of environmental influence on these factors, heritability and genetic gain of the material.

Therefore, the present work was undertaken to evaluate the twenty five genotypes of of *J. curcas* L. with the aim of selection for future breeding programme.

Material and Methods

The present study was undertaken in the PCPGR, and, G.B. Pant University of Agriculture & Technology, Pantnagar. Pantnagar is geographically situated at 29ºN latitude, 79.3ºE longitude and at an altitude of 243.84 m above mean sea level. It falls under humid subtropical climate zone and is located at the foothills of the Shivalik range of the Himalayas in a narrow belt called Tarai.

The experimental materials for the present investigation consisted of 25 genotypes of Jatropha developed and maintained at M.R.D.C, Pantnagar. The list of materials has been depicted in **Table 1**.

Table 1 List of Jatropha genotypes

S.No.		S.No.	
1.	IGAU, Raipur	9.	Pant J. Sel-1
2.	IGAU, Bilaspur	10.	Pant J. Sel-2
3.	TNMC-3	11.	PKVJ-MKV-1
4.	TNMC-4	12.	Danibunger-28
5.	TNMC-7	13.	Danibunger-27
6.	Sagar (SFRI, Jabalpur)	14.	Kamaluaganja-24
7.	Indore (SFRI, Jabalpur)	15.	Kamaluaganja-22
8.	TFRI-1	16.	Kaladungi rd-15
17.	Kaladungi rd-16	22.	Low Dhearti
18.	Golapar-9	23.	Pant J. Sel.-31
19.	Lamachaur-5	24.	Lamachaur-3
20.	Jajhar Kotali	25.	Lamachaur-6
21.	Lower Sowan Cheack		

Data collection on the vegetative traits commenced one month after of transplanting. The vegetative characters for each plant per genotypes include plant height, collar diameter (cm) number of primary and secondary branches while the yield trait taken on flower initiation (days) after 31st July, oil content (%), 100 seed weight (gm) and seed yield/plant (Kg) were collected. Data on plant height were taken using calibrated measuring collar diameter was measured by using measuring tape and 100 seed weight was calculated by electrical balance. Oil extraction was carried after the seeds were milled using soxhlet extraction method with hexane as the solvent. Analysis of variance the data were analyzed by using the following model as suggested by the [7].

Results and Discussion

In plant breeding programme, evaluation of germplasm is the first step in exploring genetic variability. The extent of genetic variability for desired traits in the available germplasm is needed in developing high yielding varieties in a particular crop species to achieve the goal of self reliance in food production. The development of crop varieties with desired character is an essential requisite. The major concern of plant breeder is to improve the best available genotypes for various traits, which contribute to high economic yield.

The raw material on which plant breeding procedures have been based is the genetic variability. If large variation is present, then there are better chances of developing improved genetic recombinants. Besides, other parameters like coefficient of variation, predicted genetic advance, heritability, magnitude of genetic divergence and correlation between various characters are considered helpful in deciding the breeding strategy.

Keeping in view the above facts the present investigation was design with the aim to estimate the relative variability, heritability, and for screening of jatropha genotype for the identification of superior genotype which can directly be used as high yielding variety for general cultivation or may be used as potential donors in future breeding programme to improve the yield and its related traits under direct seeded condition.

In the present study, 25 genotypes of jatropha have been studied for yield and other important yield related characters to work out for further use in genetic improvement in jatropha cultivation. Analysis of variance for 8 characters revealed that the mean square among the genotypes for most of the characters via: Plant Height (cm), Collar diameter (cm), No. of Primary branches/plant, No. of Secondary branches/plant, Oil content (%), Seed yield/plant (Kg), Flower initiation (days) after 31st July, 100 seed weight (gm) were highly significant. **Table 2** revealed the presence of highly significant variability among the genotypes for the characters studied indicating sufficient scope for further improvement in these characters.

Table 2 Analysis of variance (ANOVA) for different characters in Jatropha

Mean square									
Source of variation	**Degree of freedom**	**Plant Height (cm)**	**Collar diameter (cm)**	**No. of Primary branches/ plant**	**No. of Secondary branches/ plant**	**Flower initiation (days) after 31st July**	**Oil content (%)**	**100 seed weight (gm.)**	**Seed yield/ plant (Kg)**
Replication	2.0	0.976	2.06	1.848	0.490	0.5147	0.31	0.99918	0.1935
Treatment	24.0	30.38**	104.80**	74.063**	250.568**	91.257**	34.23**	2367.917**	5726.57**
Error	48.0	44.36	0.29	1.3184	1.527	1.9827	0.66	0.1379244	4.8670

** Significance at 1% level of probability *Significance at 5% level of probability

Table 3 Mean performance of 25 *Jatropha curcas* genotypes

Sl. No.	**GENOTYPE**	**Plant Height (cm)**	**Collar diameter (cm)**	**No. of Primary branches/ plant**	**No. of Secondary branches/ plant**	**Flower initiation (days) after 31st July**	**Oil content (%)**	**100 seed weight (gm.)**	**Seed yield/ plant (Kg)**
1	IGAU, Raipur	376.38	23.91	9.00	106.48	18.15	34.76	62.12	.57133
2	IGAU, Bilaspur	442.94	21.34	7.40	104.10	16.02	34.87	75.01	.73300
3	TNMC-3	431.42	20.28	6.70	101.30	17.53	32.72	53.33	.57633
4	TNMC-4	418.46	21.55	6.43	99.63	16.55	33.72	75.02	.75499
5	TNMC-7	432.33	20.83	7.19	99.02	17.61	32.88	55.02	.38300
6	Sagar (SFRI, Jabalpur)	443.12	21.63	7.33	91.47	18.13	33.75	68.33	.15200
7	Indore (SFRI, Jabalpur)	505.76	18.61	6.70	105.99	18.36	31.76	38.33	.45700
8	TFRI-1	428.71	21.59	8.46	87.42	17.66	31.77	45.04	.35633
9	Pant J. Sel-1	438.09	22.55	7.36	102.67	17.79	34.36	55.04	.76600
10	Pant J. Sel-2	431.09	21.68	7.19	90.60	18.36	33.22	50.33	.63300
11	PKVJ-MKV-1	440.15	21.15	7.33	65.20	16.76	33.04	31.66	.25500
12	Danibunger-28	426.52	26.62	7.30	75.90	21.56	28.62	62.53	.65200
13	Danibunger-27	448.26	17.92	7.40	84.46	14.40	28.32	58.33	.61600
14	Kamaluaganja-24	443.65	24.55	7.13	72.11	17.71	31.77	58.62	.56500
15	Kamaluaganja-22	436.39	25.05	7.73	82.68	15.54	32.01	53.23	.38300
16	Kaladungi rd-15	437.54	22.72	7.76	108.49	18.55	32.58	58.43	.51600
17	Kaladungi rd-16	444.55	25.73	6.83	100.35	18.72	28.67	66.46	.16500
18	Golapar-9	449.78	26.77	8.50	93.75	22.50	29.87	45.12	.15400
19	Lamachaur-5	417.66	23.41	9.53	98.75	17.57	28.35	61.54	1.7330
20	JajharKotali	422.48	28.17	7.40	92.25	18.42	35.38	55.28	.88300
21	Lower SowanCheack	421.42	29.81	6.46	80.64	19.35	35.58	55.82	1.6020
22	Low Dhearti	422.99	23.08	6.26	82.35	19.52	33.85	41.44	.84500
23	Pant J. Sel.-31	420.48	30.59	5.23	87.16	18.45	34.58	60.36	.84400
24	Lamachaur-3	419.16	23.47	7.40	95.12	15.63	26.42	49.07	1.2230
25	Lamachaur-6	431.13	26.21	7.30	96.00	18.38	28.82	61.25	1.1330
	Gm	433.22	23.57	7.336	92.159	17.971	32.07	55.870	.6780
	S. Em±	3.843	.31	.1030	.7134	.1810	.47	.214	.5375
	C.D. (5%)	10.93	.89	.2929	2.0287	.5146	1.34	.6096	.153
	C.D. (1%)	14.586	1.19	.3908	2.706	.6865	1.79	.813	.204
	C.V. (%)	1.537	2.30	2.4325	1.340	1.744	2.55	.665	1.3731

The mean performance of 25 jatropha genotypes and the range of variation among them for the various characters are given in **Table 3**. The Plant Height (cm) varied from 376.38-505.76, however, the Collar diameter (cm) ranged from 17.92- 30.59, Number of Primary branches/plant, Number of Secondary branches/plant, Oil content (%), Flower initiation (days) after 31st July, Seed yield/plant (Kg), 100 seed weight (gm.) ranged from 5.23 to 9.53, 65.20 to 108.49, 26.42 to 35.58, 15.54 to 22.50, 0.152 to 1.733, 31.66 to 75.02 respectively. The CV was recorded highest for oil content i.e. 2.55 and lowest for 100 seed weight (0.665).The value of phenotypic coefficient of variation (PCV) is greater than genotypic coefficient of variation (GCV) and environmental coefficient of variation (ECV). The values of PCV, GCV and ECV for all the characters under study are presented in **Table 4**. The highest coefficient of variation value was observed for oil content (2.55%), followed by No. of Primary branches/plant (2.43%) and Collar diameter (2.30%) similar results were observed in the findings of [4], [5] and [8].

Table 4 Genetic parameter of vegetative traits and yield component traits in *J. curcas*

Character	Range	GM	SEm±	PCV	GCV	ECV	h^2 (%)	G_A	G_A in % of mean
Plant Height (cm)	376.38-505.76	433.221	3.843	5.050	4.811	0.239	90.74	40.899	9.441
Collar diameter(cm)	17.92 - 30.59	23.57	.31	13.74	13.54	0.201	97.21	6.48	27.50
No. of Primary branches/plant	5.23-9.53	7.336	.1030	12.249	12.005	0.244	96.06	1.778	24.237
No. of Secondary branches/plant	65.20 - 108.49	92.159	.7134	12.303	12.230	0.073	98.82	23.081	25.044
Flower initiation (days) after 31st July	15.54 - 22.50	17.971	.181	9.726	9.568	0.158	96.79	3.485	19.392
Oil content (%)	26.42 – 35.58	32.06	.47	8.76	7.72	1.0335	77.73	4.51	14.02
100 seed weight (gm.)	31.66 - 75.02	55.870	.214	18.683	18.671	0.012	99.87	21.476	38.439
Seed yield/plant (Kg)	0.152 - 1.733	0.678	.537	60.006	59.990	0.016	99.95	0.838	123.547

Where, PCV= Phenotypic Coefficient of variation, GCV= Genotypic Coefficient of variation, ECV= Environmental Coefficient of variation, h^2 = Heritability, G_A= Genetic Advance

The highest phenotypic coefficient of variation (PCV) was observed in Seed yield/plant (60.006%) while the lowest value was recorded in Plant Height (5.05%). The phenotypic coefficient of variation for 100 seed weight (18.68%), Collar diameter (13.74%) were relatively higher compared to No. of Secondary branches/plant (12.30%), No. of Primary branches/plant (12.24%), Flower initiation (days) after 31st July (9.72%), Oil content (8.76%), Plant height (5.05%).Relatively high phenotypic coefficient of variation was recorded for seed size characters compared to other morphological traits. The genetic coefficient of variation (GCV) for 8 morphological traits ranged from 4.81 to 59.99%. The maximum value was recorded for Seed yield/plant (41.45%) and the minimum for Plant Height (4.81%). The genotypic coefficient of variation for Flower initiation (days) after 31st July, Oil content, Plant height was relatively lower compared to 100 seed weight, collar diameter and other vegetative characters.

The highest environmental coefficient of variation (ECV) was observed in oil content (1.033%) and lowest in 100 seed weight (0.012%).The similar PCV, GCV results were reported by [8] and [9].

The heritability refers to as an index of transmissibility, to measure the genetic relationship between the parents and their offspring. Heritability infers as to how much emphasis should be placed in for selection in case of a particular trait. The estimate of heritability and expected genetic advance are presented in table 4. Heritability estimates and genetic advance are important genetic parameters. The knowledge of heritability coupled with expected genetic advance for a trait will help us in deciding the scope of improvement of that particular trait through selection [10]. The genetic advance indicates the expected genetic progress for a particular trait under a selection cycle and measures the extent of its stability under selection pressure. Very high level of broad sense heritability was observed for Seed yield/plant (99.95%) followed by 100 seed weight (99.87%), No. of Secondary branches/plant (98.82%), Collar diameter (97.21%), Flower initiation (days) after 31st July (96.79%), No. of Primary branches/plant (96.06%), Plant Height (90.74%), Oil content (77.73%). Broad sense heritability was higher in general and exceeded more than 75% for all the traits studied. These results are in accordance with various other reports of [4], [5], [9] and [11]. In these results, the morphological traits including oil content, plant height, Number of Primary branches/plant, and Number of secondary branches/plant had the high estimation of broad sense heritability and lower percentages of genetic advance. This is an indication of non-additive gene effects and higher genotypic and environment interactions for these morphological traits. Similar studies were reported by [7] and [12]. Genetic coefficients of variation together with heritability estimates would give the best picture of expected genetic advance from selection. So, information of genetic coefficient of variation, heritability and genetic advance between germplasm sources offer good scope for genetic improvement of these *J. curcas* accessions.

Eight morphological traits, Seed yield/plant, 100 seed weight, Collar diameter, Number of Secondary branches/plant and Number of Primary branches/plant had relatively high values of genotypic coefficient of variation, broad sense heritability and genetic advance. These findings of the estimation of broad sense heritability for various characters were in agreement with reports of [5] and [6]. It seems to be easy to improve these characters in the tested genotypes through selection.

Conclusion

The highest broad sense heritability was recorded on seed yield/plant (99.95%) followed by 100 seed weight (99.87%), Number of Secondary branches / Plant (98.82%) and collar diameter (97.21%). The impact of environmental factors was very low. The low values of ECV suggest that the characters are not much influenced by the environment. The highest range of ECV (environment coefficient variation) observed for Oil content (1.03%) and lowest for 100 seed weight (0.012%) suggested that the oil content can be improved under favorable environment conditions. In conclusion, genotypes with large number of primary branches and secondary branches, high collar diameter, Seed yield/plant and 100 seed weight are good for selection since these are the traits that result into high yield.

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