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Grading and Estimation of Genetic Variability from Fresh and Stored Seeds of *Jatropha curcas* L.

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Abstract

Jatropha curcas L. belonging to family Euphorbiaceae originated from South America. The oil extracted from seeds can be converted into biodiesel by transestrification[4]. The present study involves 92 plants over 59 accessions to estimate variation and grading for seed characteristics. The variability in seed length was used as base to formulate seed grade (I to IX). The grading based on seed length and subclasses within unfilled and filled class of seeds in eight accessions revealed that grade I to IV with seed length of 1.3 to 1.6 cm constitute unfilled class of seeds called underdeveloped, where as grade V to IX with 1.7 to 2.1 cm length constitute filled class of seed called developed seeds. The seed traits of accessions under study have shown maximum seed range in the seed length, thickness and breadth (1.3 cm to 2.1 cm, 1.0 cm to 1.2 cm and 0.8 cm to 1.0 cm) is higher than reported[11,12]. The facts reveal that variation could be mainly due to genetic variation. The variation need to be screened to identify plants with higher length breadth and thickness and also to develop mechanical screening based on seed size to isolate desired grade for oil extraction.

Keywords: Jatropha, seed breadth, fresh and stored seeds, plus tree and seed grading.

Introduction

The genus name Jatropha derives from the Greek *iatros* (doctor) and *trophe* (food or nutrition), which has numerous medicinal uses. The common name for *Jatopha curcas* is Physic nut in Malabar, India[1]. It is also commonly known as Purging nut or Ratanjyot, belongs to the family Euphorbiaceae. Jatropha is a rich source of hydrocarbons. Its seed contain 40-50% of semidrying oil at 7% moisture[2, 3]. The oil from Jatropha can be converted into bio diesel by transestrification[4]. It is a drought tolerant plant and being received an extensive attention for its seed oil as a commercial source of fuel[5-7]. The oil in freshly harvested Jatropha fruits contains about 35-40% in shell and 60-65% in seed (by weight). The fruits are 2.5 cm long, ovoid, blackish and have 2-3 halves. Seed contains about 40-42% husk/hull and 58-60% kernels[8]. Over the past few years, biofuels in general and biodiesel in particular have attracted an increasing interest as potential solutions to pressing challenges including global warming as well as depletion of conventional crude oil reserves, Jatropha being a possible example[9]. Therefore, the present research has been planned to conduct study on variability for different seed charectristics to derive seed grades and generate information for developing laboratory grade sieves for grading and also to explain the possibility of mechanical grading of large quantity of feed stock (seed) for effective oil extraction high recovery and to establish inter-relationship amongst fruit and seed characteristics.

Material and Methods

The present investigation was conducted on seed harvests from existing plantation situated at Breeder's seed farm, Department of Plant Breeding and Genetics, J.N.K.V.V., Jabalpur, MP, India. Jabalpur is situated at 23.9^0 N latitude and 79.58^0 E longitudes at an altitude of 411.87 m above the mean sea level. It is a subtropical zone as a part of Satpura Plateau and Kymore Hills region of the agro climatic zones of India with extremes of summer and winter season[10]. The germplasm of *J. curcas* raised under the Jatropha Improvement Project was utilized for the experiment. Out of total 92 plants over 59 accessions 46 plants of *J. curcas* comprised the experimental material as fresh seed containing more than 150 seeds while one year stored seeds were selected for seed grading (Table-3).

Grading of stored and fresh seeds: Seeds were graded on the basis of size and weight and categorized into filled and unfilled seed classes. The seed size was measured for seed length, breadth and thickness with the help of vernier calliper. Filled seeds were sub-classed as fully developed, while unfilled seeds were sub-classed as underdeveloped, partially developed with pericarp and partially developed kernel. The unfilled seeds were cutoff with the help of hex blade from rounded end by holding the seed between thumb and fore finger in visualizing sides of seed on upper side and then whole seed was cut with slightly bended scissor. Seeds pooled class wise weighted in grams with the help of electronic balance. The statistical analysis was performed to interpret the

results as per the standard procedure. The range, mean, standard deviation and standard error of different characters were calculated by standard formulae.

Results and Discussion

Seed grading done in forty-six selected accessions based on availability of more than 150 seeds and in one year stored seeds (Weighted 2 kg). The variations in seed length, seed thickness and seed breadth of seeds across 46 accessions as well as in filled and unfilled classes across 8 accessions and between the fresh and stored seeds.

Seed characteristics: The maximum seed length (2.1 cm) was observed for accession no. 107, thickness (1.2 cm) was observed for accession numbers 9, 10–1, 10–2, 68–1, 68–2, 80–1, 91, 120–2 and 403–1 and breadth (1.0 cm) was observed for accession number 80–1, 91, 149–1 and 403–1 respectively. Majority of accessions belongs to the seed length, thickness and breadth ranged from 1.3 cm to 2.1 cm, 1.0 cm to 1.2 cm and 0.8 cm to 1.0 cm, with mean value of 1.7 cm, 1.1 cm and 0.9 cm respectively. Seed size is approximately 2 cm long and 1 cm thick[11-14]. According to some researchers the seed characteristics at the mean value for length of seed (mm) is 16.22 ± 0.11[15]. The mean values for seed breadth (mm) of seed were 10.77 ± 0.05. The seed traits recorded by Mukta and Murthy (2008) as seed length (mm) ranged from 15.1 to 19.6 mm and seed width ranged from 10.2 to 11.8 mm[16]. The facts reveal that variation could be mainly due to genetic variation and biotic and abiotic stresses. The variation need to be screened to identify and isolate plants with higher length breadth and thickness and also to develop mechanical screening based on seed size to isolate desired grade for oil extraction.

The seed traits of accessions under study have shown maximum seed range in the seed length, thickness and breadth (1.3 cm to 2.1 cm, 1.0 cm to 1.2 cm and 0.8 cm to 1.0 cm) is higher than reported earlier[11-16].

Table-1
Range, mean, standard deviation and error for number of seeds in lengthwise (1.3 – 1.6 cm) graded seeds in selected accessions of *J. curcas*

S.No.	Seed Classes	No. of Seeds		
		Range	Mean ± SE	SD
1.	**Unfilled**			
	a. Underdeveloped	19 – 63	43.75 ± 10.87	21.75
	b. Partially developed with pericarp	13 – 59	39.50 ± 10.60	21.21
	c. Partially developed kernels	6 – 85	41.00 ± 23.27	40.26
2.	**Filled**			
	Fully developed	2 – 85	31.67 ± 26.75	46.29

Table-2
Range, mean, standard deviation and error for seed yield (g) graded lengthwise in seed classes of *J. curcas*

S.No.	Classes	Seed Grades	Range	Mean ± SE	SD
1.	Unfilled	I	0.59 – 1.45	0.96 ± 0.04	0.26
		II	0.69 – 2.72	1.47 ± 0.08	0.51
		III	0.85 – 7.01	2.94 ± 0.24	1.57
		IV	1.34 – 36.87	7.52 ± 0.95	6.30
2.	Filled	V	3.26 – 128.68	36.65 ± 3.42	23.19
		VI	18.27– 348.31	102.81 ± 10.58	71.73
		VII	2.09 – 161.35	38.61 ± 5.46	35.81
		VIII	1.20 – 19.73	6.98 ± 1.53	5.72
		IX	0.00 – 0.85	0.85 ± 0.00	0.00

Table-3
Grade wise classification of accessions into filled and unfilled seeds (%) against seed length for number of seed in *Jatropha curcas*

S.No.	Accession No.	Seed length (cm)	Percent of filled seed		% of unfilled seed
			Grade V to IX excluding VI	Grade VI	Grade I to IV
1.	9	1.8	47.35	46.24	6.41
2.	10–1	1.8	30.06	56.21	13.73
3.	10–2	1.8	47.75	47.52	4.73
4.	28–2	1.8	36.68	56.11	7.21
5.	53–1	1.8	43.30	38.18	18.52
6.	53–3	1.8	40.12	35.59	24.29
7.	68–1	1.8	33.25	53.03	13.72
8.	68–2	1.8	40.05	42.23	17.72
9.	68–3	1.8	33.19	48.23	18.58
10.	71–2	1.8	37.92	47.67	14.41
11.	72–2	1.7	20.81	41.04*	38.15
12.	73	1.7	39.07	41.39*	19.54
13.	77–1	1.8	29.90	59.49	10.61
14.	77–2	1.9	61.33	33.84**	4.83
15.	80–1	1.8	41.92	52.58	5.50
16.	87–1	1.8	42.48	42.20	15.32
17.	91	1.8	53.15	36.49	10.36
18.	92–1	1.8	37.57	46.41	16.02
19.	92–2	1.8	27.45	63.24	9.31
20.	93	1.8	38.54	40.81	20.65
21.	94	1.8	45.00	43.04	11.96
22.	97–1	1.8	38.28	44.89	16.83
23.	97–2	1.8	36.29	52.15	11.56
24.	103	1.8	44.92	44.31	10.77
25.	105	1.8	40.41	39.50	20.09
26.	106–1	1.8	30.18	30.18	39.64
27.	107	1.8	31.39	60.83	7.78
28.	116	1.8	44.91	50.30	4.79
29.	117	1.8	44.65	45.02	10.33
30.	120–2	1.8	53.50	44.59	1.91
31.	138–1	1.8	39.07	40.10	20.83
32.	138–2	1.8	32.04	41.99	25.97
33.	140	1.7	17.24	43.68*	39.08
34.	146–2	1.8	44.92	47.86	7.22
35.	149–1	1.8	21.72	68.54	9.74
36.	156	1.8	34.15	59.62	6.23
37.	159–1	1.8	33.13	54.82	12.05
38.	159–3	1.8	28.93	58.30	12.77
39.	343	1.8	41.03	53.98	4.99
40.	402–1	1.8	36.07	51.91	12.02
41.	402–2	1.8	34.97	52.44	12.59
42.	403–1	1.8	51.10	42.83	6.07
43.	403–3	1.8	28.24	63.17	8.59
44.	406–1	1.8	25.74	66.90	7.36
45.	406–3	1.7	27.90	44.21*	27.89
46.	411–1	1.8	33.94	51.58	14.48

Note: (*) Values for grade–V (1.7 cm) and (**) value for grade–VII (1.9 cm)

Grading based on seed length and sub classes within unfilled *vs.* filled class of seeds: The number of seeds was studied in 8 accessions of *J. curcas* during November 2008 for the different seed classes based on lengthwise grades. The seed length 1.3 cm to 1.6 cm was observed as unfilled class grade, where as seed length from 1.7 cm to 2.1 cm was observed as with developed seeds. A perusal of the data revealed that the highest mean value (41.69%) for number of seed in subclass as underdeveloped from unfilled class fall in the seed length ranging from 1.3 to 1.6 cm. The grading and rejection of this lot would improve oil extraction and minimize losses due to absorption of oil from unproductive seeds. There is no record or any report on this trait.

Grading based on seed length and number of seeds and seed yield: A perusal of the data revealed maximum [(12), (35), (31), (100), (263), (582), (252), (27) and (1)] number of seeds in accession number/grades in 406–1 (I), 106–1 (II), 106–1 (III), 411–1 (IV), 411–1 (V), 406–1 (VI), 403–1 (VII), 10–2 (VIII) and 107 (IX). The highest seed yield [(1.45 g), (2.75 g), (7.01 g), (36.87 g), (128.68 g), (348.31 g), (161.35 g), (19.73 g) and (0.85 g)] was obtained in accession no. of grades 406–1 (I), 106–1 (II), 411–1 (III), 411–1 (IV), 411–1 (V), 411–1 (VI), 403–1 (VII), 10–2 (VIII) and 107 (IX). The number of seed within and across grades exhibited variation from 1 to 582 and seed yield from 0.85 g to 348.31 g.

The perusal of data revealed that grade VI (1.8 cm) possesses highest number of seed as well as seed yield against all the grades. There is no record or any report available on this trait. The development of hand sieve for experimental purposes and graders for grading of large quantity of feedstock could be developed based on this information.

Classification of accessions into filled and unfilled seeds (%) for seed number and yield: The filled and unfilled seeds expressed in percent with the assignment of grades based on length for number of seeds revealed that out of 46 accessions in grade VI (1.8 cm) 26 accessions exhibited higher value than grade V to IX excluding grade VI. The grade VI covers about 56% of accessions. The second such grade of accessions are either at par to grade VI or higher than VI considering number of seeds in conjunction with the grade. Similarly, the filled and unfilled seeds expressed in percent with the assignment of grades based on length for seed yield revealed that out of 46 accessions in grade VI (1.8 cm) 31 accessions exhibited higher value than grade V to IX excluding grade VI. The grade VI covers major number of accessions *i.e.,* 67% for seed yield. Rarely few accessions *viz.,* 72–2, 106–1 and 140 for both characters *viz.,* number of seeds and seed yield exhibited values were either higher than one or both the cluster of grades.

Conclusion

Identification of accessions with economic traits based on relative performance of three seed characters revealed that accessions over 46 under study inherit the combination of traits to isolate candidate plus tree. Only three accessions exhibited two character combinations out of eleven. The accessions with two character combination are 80(1), 91 and 403(1) which exhibits seed thickness and breadth. However, only one accessions 107 showed superiority in seed length. The accessions with economic traits and seed grade based on relative performance of number of seeds and seed yield over 46 accessions revealed consistent expression of traits within accession no. 411–1 and 10–2 for seed length coupled with number of seeds and seed yield. The grading of seed from bulk harvest is tried based on this study for commercialization to efficiently extract oil from the feed stock for bio diesel.

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