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Research Paper

IDENTIFICATION OF ELITE LINES OF *JATROPHA CURCAS* (L.) GERMPLASM THROUGH SELECTION FOR IMPROVED OIL YIELD FOR UTILIZATION AS BIODIESEL CROP FOR WASTELANDS

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Abstract

Twenty three elite lines of *Jatropha curcas* (L.) were evaluated against check Chatrapati (the only released variety of *J. curcas* in India) consecutively for 3 years (2007-08 to 2009-10) at CRIDA, Hyderabad, the southern part of India. The seed yield varied from 287.8 kg/ha to 590.3 kg/ha between years, indicating the influence of environment and age of the plant. The rainfall during 2008-09 and 2009-10 was 43.5% and 24.9% more than that of 2007-08. However, the oil content was not influenced much by environmental variation during study period. The broad sense heritability was high for all the traits across years indicating that these traits were mainly controlled by genetic factor as compared to environmental component, although environment played an important role as in expression of these traits. Out of the 23 genotypes tested, five outperformed the check Chatrapati. The present study have clearly indicated that through selection for seed yield and oil content, could be enhanced by 43.9%, which is a significant impact of selection among 23 elite lines. With a superiority of 52.1 to 70.5% over the check Chatrapati, five elite lines viz. CRDJ-1 to CRDJ-5 was identified for superior oil yield.

Key words: *Jatropha curcas,* evaluation, seed yield, oil yield, oil content, heritability.

INTRODUCTION

The suitability of vegetable oils for the production of biodiesel is gaining national and international importance. Tree-borne oilseeds are the best and potential alternative to mitigate the current and future energy crisis and also to transform the vast stretches of wasteland into green oil fields. *Jatropha (Jatropha curcas* L.) is rapidly emerging as one of the potential tree-borne biofuel crop currently attracting a lot of interest and investments [10]. This stem-succulent [17] deciduous tree or shrub produces seeds rich in toxic oil [1]. The oil can be extracted easily with techniques of different sophistication levels [2, 19]. The crude *Jatropha* oil meets the fuel quality standards of rapeseed [3] and can be easily converted into biodiesel, meeting US and European standards [23, 21]. Although the downstream processing is well known, the species agronomy and as such, the suitable seed production technologies, is still shrouded in uncertainty. Popular claims on drought tolerance, low nutrient requirement, pest and disease resistance and high yields [8] have triggered a *Jatropha* hype [2, 9] with sky high expectations on simultaneous wasteland reclamation, fuel production, poverty reduction and large returns on investments [13]. However, many of these claims are yet to be supported by scientific evidence [2, 18]. Major knowledge gaps concerning basic, ecological and agronomic properties (growth conditions, input responsiveness of biomass production, seed yield and the species genetics), make seed yield poorly predictable [2, 9]. Indian government has been embarked on producing as much biodiesel as possible by taking up massive plantation of tree borne oilseeds including *Jatropha curcas* on available wastelands which necessitates identifying good promising germplasm. *Jatropha curcas* has been acclimatized well in the country. Some introductions from centers of diversity have also been made in early and mid-1980s [1]. Considering its potential as an important bioenergy crop, efforts are being made worldwide to enhance the genetic potential of *Jatropha* for economical biodiesel production. The availability of genetic variability and the knowledge of inter-relationships between different morphological and economic traits are a prerequisite for systematic *Jatropha* genetic improvement. An effort was made for identifying elite *Jatropha* lines in our collection against the only released variety in India i.e. Chatrapati in the present investigation.

MATERIAL AND METHODS

Twenty three elite lines of *Jatropha curcas* were procured from different institutes in India and have been evaluated against Chatrapati as check at Hayathnagar Research Farm of Central research Institute for Dryland Agriculture (CRIDA) Hyderabad for three years 2007-08, 2008-09 and 2009-10 (Table 1).

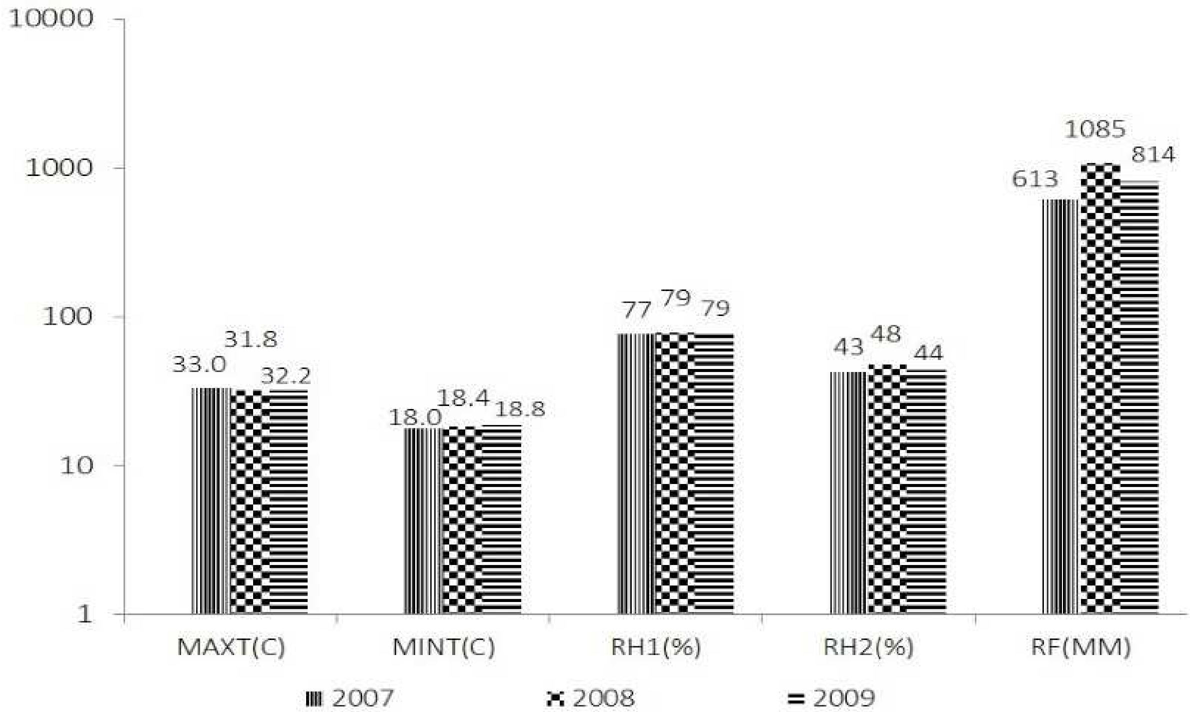

Figure 1. Meteorological data during experimental period at CRIDA, Hyderabad

The experiment was conducted at the Hayathnagar Research farm, CRIDA (17°27′N latitude and 78°35′E longitude and about 515 m above sea level), Hyderabad, India completely under rainfed conditions. The climate is semi-arid with hot summers and mild winters. The mean maximum air temperature during summer (March, April and May) ranges from 35.6 to 38.6°C; where as in winter (December, January and February) it ranges from 13.5 to 16.8 °C. Annual long-term rainfall for the site is estimated to 746.2 mm falling predominantly from June to October. The average minimum and maximum temperature, relative humidity and rainfall during the growing season were given in figure 1. The soils are medium-textured, red soil (Typic Haplustalf as per USDA soil classification) with neutral to slightly acidic soil pH.
Collection and establishment of superior plant material.
The stem cuttings of 23 superior planting materials of *Jatropha curcas* available at various research institutes that have been engaged in research on *J. curcas,* in India, and the national

check (Chatrapati) were collected during May-June 2006 and planted at Hayathnagar Research farm, CRIDA, Hyderabad during July-August, 2006. The precaution was taken to collect stem cuttings of same diameter and length as far as possible. Pits of size 45 cm^3 were dug during the month March 2006 and after exposing them to sun for 6 weeks they were refilled with half of the good dug out soil +2kg Compost + addition of 125g of NPK in the ratio of 1:4:1. To check termite attack 2% Chloropyriphos solution was added @20ml/pit. The spacing adopted was 2.5m x 2.5m with four rametes (cuttings) for each elite lines per replication. The treatments were replicated four times and the design followed was randomized complete block design (RCBD), resulting a total there were 16 rametes for each elite lines. The experiment was carried out under rainfed situation without resorting to irrigation at any stage of the crop. Spraying of insecticides was carried out to control pests like mealy bugs, Webber and stem borer as and when the insect damage crossed economic threshold level.

Data Recording

The plants started flowering and fruiting during first year of their establishment. The data on growth parameters and seed yield was recorded at the end of 1st (2007-08), 2nd (2008-09) and 3rd (2009-10) years after their planting. The dry weight of seeds was recorded in grams by electronic balance having accuracy of 0.01g. The oil content in seed was estimated by soxhlet extraction method.

Statistical analysis

The analysis of variance (ANOVA) for individual trial and pooled analysis over years was done using RBD with four replications. Analysis of variances was computed to compare the genotypes for each trait in experiment [4]. Variance components due to genotypes (σ^2_g) and error (σ^2_e) and their standard errors were determined. Broad sense heritability for each trait was estimated as $h^2 = \sigma^2_g / (\sigma^2_g + \sigma^2_e)$. For the pooled analysis, the homogeneity of variance was tested using Bartlett's test [22].

RESULTS

The analysis of variance for individual trials in each year revealed significant variances ($p<0.01$) due to treatment (genotypes) for all traits viz. seed yield, oil yield and oil content (%) (ANOVA not presented), indicating the presence of high genetic variability among genotypes. The pooled ANOVA also revealed highly significant variances ($p<0.01$) due to year, replication/year, treatments, and year × treatment interaction effect (Table 2) for all three traits studied. The significant variances due to genotype, year (environment) and their interaction for all the traits indicated that these traits were influenced by both genetic and environment factors.

The trial means, range, coefficient of variation (CV %) and broad sense heritability for all traits across different years of evaluation is presented in Table 3. The results showed high variation between genotypes across the years, while CV was relatively low and heritability was high for all traits. This indicates that there is a scope for improvement through selection for better genotypes.

The seed yield, oil yield and oil content of 24genotypes including check Chatrapati for three years and pooled average is presented in Table 4. The average seed yield during 2007-08, 2008-09 and 2009-10 were 287.8, 590.3 and 582.1 kg/ha while the pooled yield over the years was 492.25 kg/ha. The lowest seed yield was recorded in the first year of fruiting (2007– 08), while the highest during 2008–09followed by 2009-10 which was almost similar yields to that of 2008-09. The yields during 2007-08 were around half of the next two years, which might be due to a very low rainfall in 2007-08 and or improper rainfall distribution and is influenced by variation in environmental condition at different years of evaluation. The average oil content during 2007-08, 2008-09and 2009-10were 31.4%, 30.2% and30.4% with overall average of 30.7%, indicating the overall oil content across years did not show high variation among genotypes although there was a difference in oil content between genotypes.

The average oil yield during the 3 years of testing were 91.4, 181.9 and 183.8 with pooled average of 152.4 kg ha^{-1}. In the first year (2007-08), oil yield was around half of next two years revealing the interaction of corresponding seed yield and oil content but influenced only by seed yield. Based on three years of evaluation, five genotypes were identified as statistically superior over check Chatrapathi viz; CRDJ-1 to CRDJ-5 when compared with LSD values at 1% level of significance (Table5). It is also interesting to note that average seed yield of these5 genotypes plus national check showed a seed yield of 389, 852.2 and 793.3 kg/ha with pooled average of 677.7 kg ha $^{-1}$and a similar trend was observed for all 23 genotypes with around half of the yields during first year as testing compared to the next two years. The oil content showed similar values in the 3 years as testing with 33.7%, 31.8%, and 32.1%respectively with pooled average of 32.5%. The oil yield was 131.5kg/ha during first year while it was 271.3 kg/ha and 254.7 kg/ha in 2nd and 3rd years with a pooled average of 219.3 kg ha^{-1}. The low oil yields during first year was due to low corresponding seed yields.

As compared to overall mean value of all 24 genotypes, the average of the selected genotypes including check showed 35.2% to 44.4% superiority with a pooled value of 37.7% for seed yield. The oil content showed only 5.1% to 7.3% with 6.0%as pooled indicating a better scope for improvement of seed yield as compared to oil content. Although small relative to seed yield, even this oil content advantage by 6% is equally important for oil content improvement. Together with seed yield improvement by 37.7% and oil by 6% in the pooled value over the years resulted in significant oil yield improvement with 43.9% increase in the overall oil yield improvement, ranging from 38.6% to 49.1% in the individual year. These results very clearly showed that significant improvement seed yield as well as oil yields possible through selection of clones among *Jatropha* lines available in the programme. The present investigation showed that oil yield could be improved to 43.9%, which was a significant impact of our selections from 23 genotypes.

The percentage increase of seed yield, oil content and oil yield of 5 selected genotypes over the check Chatrapathi are given in figure 2a, b and c. The results showed a range of 18.6% to 48.5% with 34.0% increase in the pooled seed yield, while oil content, the range was 17.3% to 29.3% with a pooled value of 23%. The oil yield showed a range 35.9% to 89% with pooled value of 62.3% (Table 6).

The impact of selection over check for seed yield, oil content, oil yield were 34.0%, 23.0% and 62.3% in the pooled average values of 5 selected genotypes respectively. CRDJ-1 showed a value 21.6, 40.7 and 70.5% increase for seed yield, oil content and oil yield respectively. CRDJ-2 revealed 40.2, 70.5 and 61.6% increase while CRDJ-3 showed 44.3, 15.3and 61.0%; CRDJ-4 revealed 32.6, 15.2 and 56.2%, while CRDJ-5 31.4, 17.1 and 52.1% for seed yield, oil content and oil yield respectively. CRDJ-1 has the highest value 70.5% increase over Chatrapati with respect to oil yield, while CRDJ-2, CRDJ-3, CRDJ-4 showed an increase of 61.6 to 52.1 % over the check. With a very clear cut superiority of 52.1 to 70.5 % over check Chatrapati necessitates for these superior genotypes as CRDJ-1 to CRDJ-5 be identified for superior oil yield.

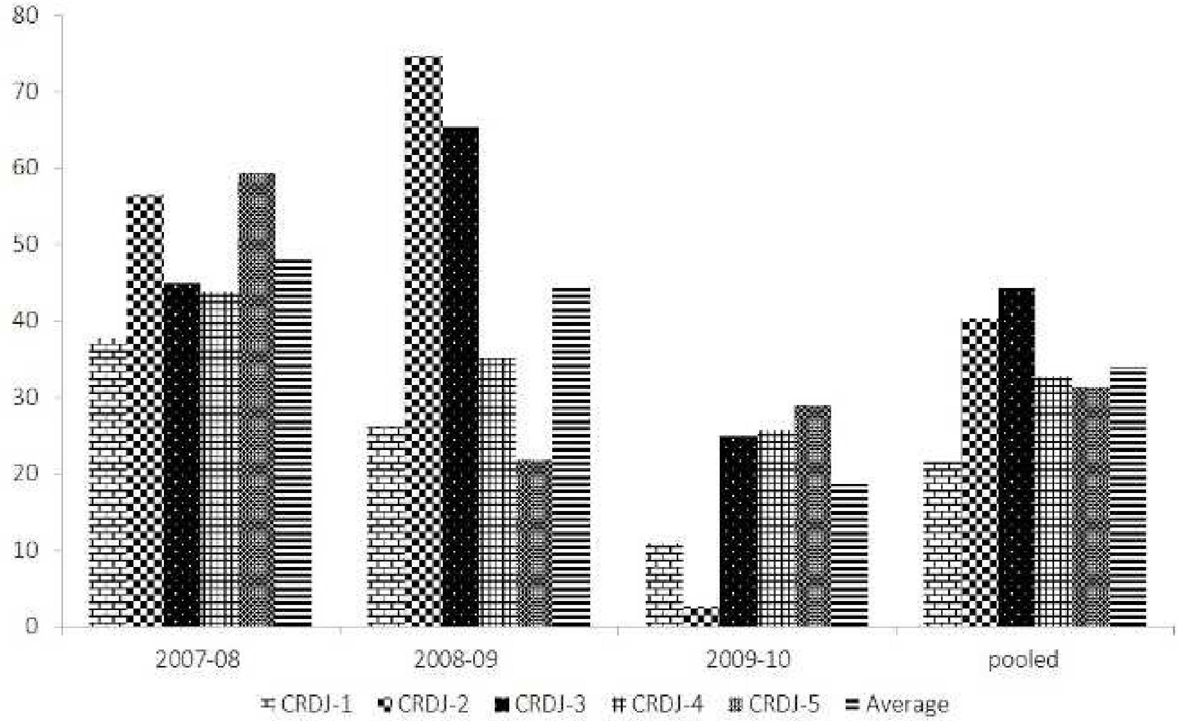

Figure 2a: Percent increase of seed yield (kg/ha) in selected genotypes of *Jatropha curcas* over the check Chatrapathi

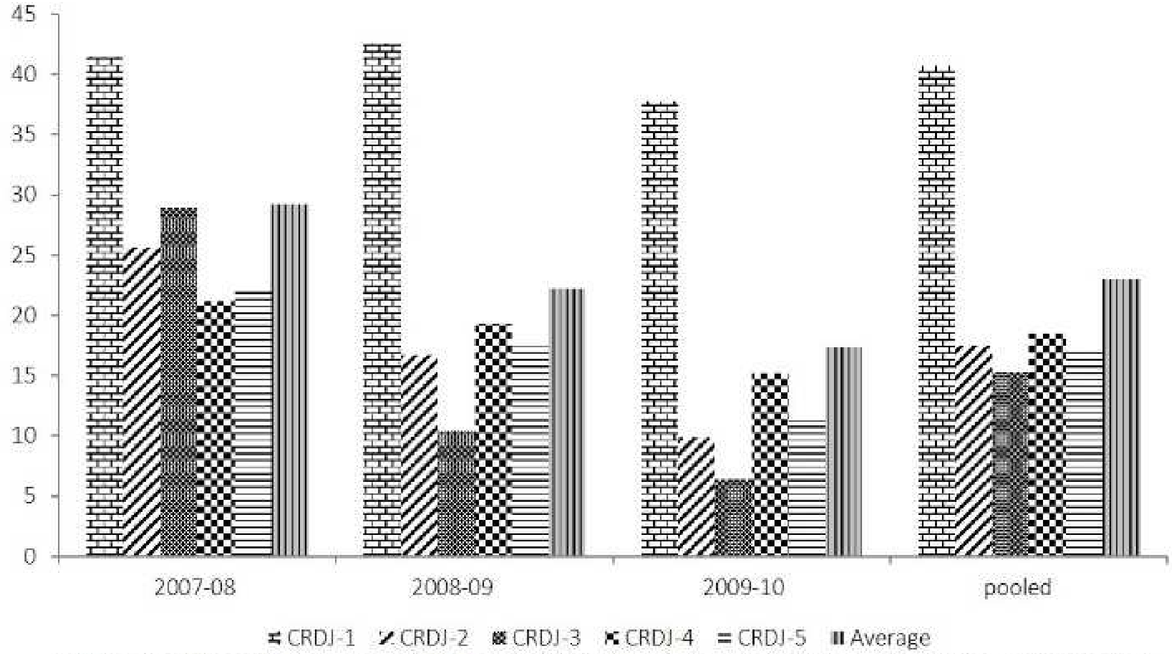

Figure 2b: Percent increase of oil content (%) in selected genotypes of *Jatropha curcas* over the check Chatrapathi

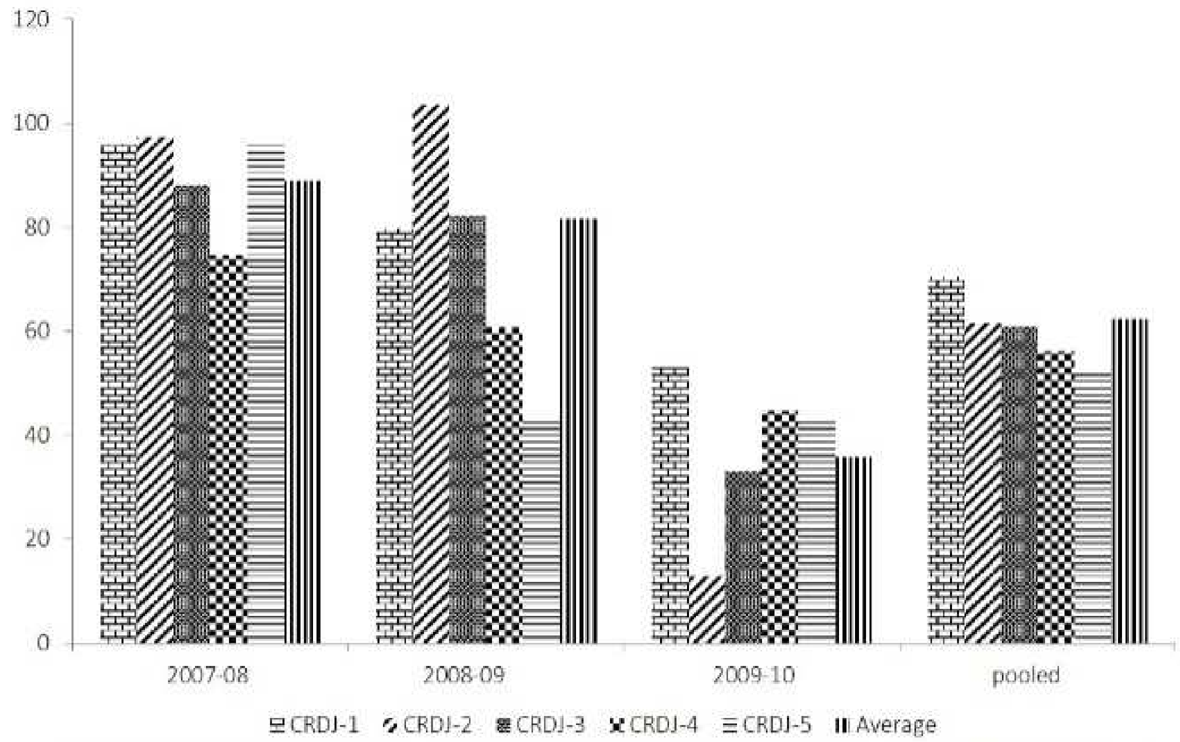

Figure 2c: Percent increase of seed oil yield (kg/ha) in five genotypes of *Jatropha curcas* over the check Chatrapathi

Table 1: List of Jatropha genotypes with their source used in the study

Sl.	Genotypes	Pedigree	Source
1	CRDJ-1	CRIDA-JJ-06	CRIDA, HYDERABAD
2	CRDJ-2	CRIDA-JL-06	CRIDA, HYDERABAD
3	CRDJ-3	CRIDA-JR-06	CRIDA, HYDERABAD
4	CRDJ-4	NBRI - J-18	NBRI, LUCKNOW
5	CRDJ-5	NBPGR-HAR-HAU-0306-Hisar Local	NBPGR, NEW DELHI
6	CRDJ-6	NBRI - J-05	NBRI, LUCKNOW
7	CRDJ-7	CSMCRI-GUJ-Banas-1205-C2	CSMSRI, BAVANAGAR
8	CRDJ-8	NBPGR-GUJ-SKN-0605-Hansraj	NBPGR, NEW DELHI
9	CRDJ-9	CSMCRI-OR-Ganj-1205-C4	CSMSRI, BAVANAGAR
10	CRDJ-10	NBPGR-GUJ-SKN-0605-SKN-Big	NBPGR, NEW DELHI
11	CRDJ-11	FRI-UA-Teh-1005-DD-EL-1	FRI, DEHRADUN
12	CRDJ-12	PAPL -JPH009	PAPL INDUSTIRES , MUMBAI
13	CRDJ-13	FRI-UA-Deh-0705-DD-EL-3	FRI, DEHRADUN
14	CRDJ-14	NBPGR-GUJ-SKN-0605-Urlikanchan	NBPGR, NEW DELHI
15	CRDJ-15	PAPL -JPH108	FRI, DEHRADUN
16	CRDJ-16	FRI-UA-Har-0805-DD-EL-5	FRI, DEHRADUN
17	CRDJ-17	FRI-UA-Teh-1005-DD-EL-2	FRI, DEHRADUN
18	CRDJ-18	CSMCRI-GUJ-Panch-0106-C3	CSMSRI, BAVANAGAR
19	CRDJ-19	CSMCRI-GUJ-Banas-1205-C1	CSMSRI, BAVANAGAR
20	CRDJ-20	CSMCRI-OR-Ganj-1205-C5	CSMSRI, BAVANAGAR
21	CRDJ-21	EXCEL-GUJ-BHV-0105-C-1	EXCEL INDUSTIRES, MUMBAI
22	CRDJ-22	FRI-UA-Deh-0805-DD-EL-4	FRI, DEHRADUN
23	CRDJ-23	NBPGR-GUJ-SKN-0605-SKNJ-2	NBPGR, NEW DELHI
24	Chhatrapat i	NBPGR-GUJ-SKN-0605-Chhatrapati	NBPGR, NEW DELHI

Table 2:- ANOVA for Seed yield, oil content & oil yield of *Jatropha curcas* genotypes during 2007-2010

Source	df	Mean Sum of Square		
		Seed yield	Oil content	Oil yield
Year	2	3014002.17**	36.64**	267203.96**
Replications (year) 3	9	96461.8**	337.55**	9175.55**
Treatment	23	329320.05**	102.52**	41403.13**
Year × Treatment	46	84765.42**	5.06**	8060.41**
Error	207	633.71	0.23	72.7
SEm ±		7.27	0.14	2.46
CD @ 1%		26.72	0.51	9.05
CV (%)		5.11	1.56	5.60

** Significant at 1%

Table 3: Trial mean, range, coefficient of variation (CV %) and heritability for seed yield, oil yield (kg/ha), oil content (%) during three years of evaluation

Characters	Year of evaluation	Trial mean	Range of means	SEd	CV (%)	Heritability (H^2)
Seed yield	2007-08	287.8	193-440	2.7	5.1	0.99
	2008-09	590.3	47-1085	5.6	4.5	0.99
	2009-10	582.1	44-886	6.8	6.4	0.96
Oil yield (kg/ha)	2007-08	91.4	60-148	2.2	4.3	0.97
	2008-09	181.9	14-342	2.1	2.0	0.99
	2009-10	183.8	38-297	6.8	6.4	0.96
Oil content (%)	2007-08	31.4	271.1-38.6	1.2	0.3	0.98
	2008-09	30.2	25.1-38.5	2.3	0.5	0.95
	2009-10	30.4	25.2-39.0	2.0	0.4	0.96

Table 4: Mean for seed yield, oil yield (kg/ha), oil content (%) and average over three years of evaluation

Genotypes	Seed yield (kg/ha)					Oil yield (kg/ha)					Oil content (%)				
	2007-08	2008-09	2009-10	Overall	Ranking	2007-08	2008-09	2009-10	Overall	Ranking	2007-08	2008-09	2009-10	Overall	Ranking
CRDJ-1	380	784	762	642	5	147	302	297	249	1	38.6	38.5	39	38.7	1
CRDJ-2	432	1085	704	740	2	148	342	281	236	2	34.3	31.5	31.1	32.3	6
CRDJ-3	400	1027	858	762	1	141	306	279	235	3	35.2	29.8	30.1	31.7	9
CRDJ-4	397	839	863	700	3	131	270	258	228	4	33.1	32.2	32.6	32.6	4
CRDJ-5	440	757	886	694	4	147	240	232	222	6	34.3	35.4	35.8	35.2	2
CRDJ-6	310	949	647	635	7	106	336	254	225	5	33.4	31.7	31.5	32.2	7
CRDJ-7	240	1027	653	640	6	70	300	219	188	7	29.3	29.2	29.8	29.4	14
CRDJ-8	288	634	825	582	9	93	198	212	182	8	32.3	31.2	30.8	31.4	11
CRDJ-9	267	759	44	491	13	88	245	209	159	9	32.8	32.2	32.5	32.5	5

CRDJ-10	287	631	560	493	12	90	198	196	155	10	31.5	31.4	31.6	31.5	10
CRDJ-11	300	572	652	508	11	93	169	195	153	11	31.1	29.6	30.1	30.3	13
CRDJ-12	247	678	840	588	8	68	174	194	151	12	27.4	25.6	25.2	26.1	24
Chhatrapati	276	621	687	528	10	75	168	181	146	13	27.3	27	28.3	27.5	21
CRDJ-13	251	457	655	454	14	80	145	177	145	14	32	31.7	31.9	31.9	8
CRDJ-14	193	566	481	413	17	68	196	168	144	15	35.2	34.7	35	35	3
CRDJ-15	256	454	561	423	15	81	136	167	128	16	31.8	30	29.7	30.5	12
CRDJ-16	295	510	458	421	16	88	136	153	116	17	29.9	26.6	27	27.8	20
CRDJ-17	237	313	609	386	18	69	92	149	114	18	29.1	29.3	29.7	29.4	15
CRDJ-18	298	346	482	376	19	87	100	145	109	19	29.2	29	29.2	29.1	17
CRDJ-19	231	224	515	323	22	67	64	141	93	20	29	28.4	28.9	28.8	18
CRDJ-20	230	435	381	349	20	74	109	124	93	21	32	25.1	25.5	27.5	22
CRDJ-21	220	213	560	331	21	60	59	97	90	22	27.1	27.6	27.3	27.3	23
CRDJ-22	215	239	135	196	23	60	67	45	55	23	27.9	28.1	28	28	19
CRDJ-23	217	47	153	139	24	63	14	38	41	24	29	29.63	29.1	29.2	16
Average	**287.8**	**590.3**	**582.1**	**492.3**		**91.4**	**181.9**	**183.8**	**152.4**		**31.4**	**30.2**	**30.4**	**30.7**	

Table 5: Selected superior genotypes over checked Chatrapathi

Superior genotypes	Seed Yield (Kg/ha)				Oil content (%)				Oil yield (Kg/ha)			
	2007-08	2008-09	2009-10	pooled	2007-08	2008-09	2009-10	pooled	2007-08	2008-09	2009-10	pooled
CRDJ-1	380	784	762	642	38.6	38.5	39	38.7	147	302	297	249
CRDJ-2	432	1085	704	740	34.3	31.5	31.1	32.3	148	342	219	236
CRDJ-3	400	1027	858	762	35.2	29.8	30.1	31.7	141	306	258	235
CRDJ-4	397	839	863	700	33.1	32.2	32.6	32.6	131	270	281	228
CRDJ-5	440	757	886	694	33.4	31.7	31.5	32.2	147	240	279	222
Chhatrapati (C)	276	621	687	528	27.3	27	28.3	27.5	75	168	194	146
Average of 6 genotypes	389	852.2	793.3	677.7	33.7	31.8	32.1	32.5	131.5	271.3	254.7	219.3
Average of 24 genotypes	287.7	590.3	582.1	492.3	31.4	30.2	30.4	30.7	91.4	181.9	183.8	152.4
Advantage of selection	35.2	44.4	36.3	37.7	7.3	5.1	5.6	6	43.8	49.1	38.6	43.9

Table 6: Percent increase of seed yield (kg/ha), oil yield (kg/ha) and oil content (%) in five genotypes of *Jatropha curcas* over the check Chatrapathi

Superior genotypes	Seed Yield (Kg/ha)				Oil content (%)				Oil yield (Kg/ha)			
	2007-08	2008-09	2009-10	pooled	2007-08	2008-09	2009-10	pooled	2007-08	2008-09	2009-10	pooled
CRDJ-1	37.7	26.2	10.9	21.6	41.4	42.6	37.8	40.7	96	79.8	53.1	70.5
CRDJ-2	56.5	74.7	2.5	40.2	25.6	16.7	9.9	17.5	97.3	103.6	12.9	61.6
CRDJ-3	44.9	65.4	24.9	44.3	28.9	10.4	6.4	15.3	88	82.1	33	61
CRDJ-4	43.8	35.1	25.6	32.6	21.2	19.3	15.2	18.5	74.7	60.7	44.8	56.2
CRDJ-5	59.4	21.9	29	31.4	22.3	17.4	11.3	17.1	96	42.9	43.8	52.1
Average	**48.5**	**44.7**	**18.6**	**34.0**	**29.3**	**22.3**	**17.3**	**23**	**89**	**81.6**	**35.9**	**62.3**

DISCUSSION

The elite lines collected from different institutes including NBPGR showed high variability for seed and oil yield. The low yield during 2007-08, which was around half of the next two years which might be due to a very low rainfall (613mm) 2007-08 compared to 2008-09 (1085mm) and 2009-10 (814mm).Though the crop was one year older in 2009-10 compared to 2008-09 the yield was slightly more in 2008-09 because of more rainfall. The similar influence of rainfall on seed yield of Jatropha was reported by other authors [18, 2 and 6].

The average oil content during three years of evaluation did not show high fluctuation, which might be due to the fact that it was not influenced as much as seed yield due to environmental variations. It is reported that the oil content of *Jatropha* seed varied from 18.4–42.3 percent [7] but generally lies in the range of 30–35 percent. The Energy and Resources Institute (TERI) has shown a variation in oil content from 25-38 per cent [11]. In the present study the oil content varied from 30.7 to 31.4% indicating, that it may be a stable character as compared to seed yield which is influenced by climatic factors, mostly by rainfall. [15, 16] demonstrated that in oilseed lupin, the variation in total oil content and fatty acid composition was more dependent on the genotype than on genotype environment (G×E) interaction in a study of six cultivars from Spain, France and Italy that were assessed in three different climates. This suggested limited variability in these traits among the *J. curcas* accessions exhibiting high genetic similarity.Similar observations were reported earlier in wide variety of tree borne oilseeds [5, 12, 14, 20]. The five genotypes which were superior over check Chatrapathi were CRDJ-1 to CRDJ-5. There were increasing pattern of yield improvement as the age of the plant increases, which showed similar trends in all the 24 genotypes tested including check. This is because as plant becomes older it gives more yields compared to previous year during initial stages. The increase in seed yield during 2nd year of study (2008-09) may be because of good rainfall received compared to 2007-08.Marginal decrease in seed as well as oil yield during the year 2009-10 compared to 2008-09 may also be because of less rainfall received during latter year [24]. Concluded that habitat and prevailing environmental conditions were more important than genotype in determining yield variation in *Jatropha.* As compared to overall mean of 24 genotypes, the mean of the selected genotypes including check showed seed yield improvement by 37.7% and oil content by 6% over the years and resulted in significant oil yield improvement of 43.9% in the pooled oil yield (ranging from 38.7 to 49.1% in the individual years). The impact of selection in percentage increase of 5 genotypes for seed yield, oil content, and oil yield was very clear with superiority of 52.1 to 70.5 % over check Chatrapati. These superior genotypes viz, CRDJ-1 to CRDJ-5 may be identified as superior *Jatropha* lines for further utilization. The study identified 5 better genotypes of *Jatropha curcas* having better yield and oil content. Therefore, the best genotypes selected will improve the poor sites for agroforestry systems and energy plantations in the wastelands. The three year study of evaluating 23 elite lines of *Jatropha* against check Chatrapathi indicated 5 genotypes (CRDJ-1 to CRDJ-5) outperformed the check Chatrapati in terms of total oil yield.

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REFERENCES
[1] Achten W.M.J., Mathijs, E., Verchot, L., Singh, V.P., Aerts, R. and Muys, B., 2007, *Jatropha* biodiesel fueling sustainability? Biofuel, Bioprod. Bior., 1 (4), 283–291.
[2] Achten W.M.J., Verchot, L. and Franken, Y.J., 2008, *Jatropha* bio-diesel production and use, Biomass Bioenerg.32 (12), 1063–1084.
[3] Azam, M.M., Waris, A. and Nahar, N.M., 2005, Prospects and potential of fatty acid methyl esters of some non-traditional seed oils for use as biodiesel in India, Biomass Bioenergy, 29 (4), 293–302.
[4] Bartlett, M.S., 1937, Properties of sufficiency and statistical tests, Proceedings Royal Statistical Soc. Series A, 160, 268–282.
[5] Boschin, G., Agostina, A.D., Annicchiarico, P. and Arnoldi, A., 2008, Effect of genotype and environment on fatty acid composition of *Lupinus albus* L. seed, Food Chemistry,108, 600-606.
[6] Daey Ouwens, K., Francis, G., Franken,Y.J., Rijssenbeek,W., Riedacker, N.F., Jongschaap, R.E.E. and Bindraban, P.S., 2007. State of the art, small and large Scale Project Development, Wageningen: FACT Foundation
[7] Development. Position paper on *Jatropha curcas*... Expert seminar on *Jatropha curcas* L. Agronomy and genetics. 26-28 March, Wageningen, the Netherlands. Published by FACT Foundation.
[8] Fairless, D., 2007, Biofuel: the little shrub that could – maybe, Nature, 449 (7163), 652–655.
[9] Francis, G., Edinger, R. and Becker, K., 2005, A concept for simultaneous wasteland reclamation, fuelproduction, and socio–economic development in degraded areas in India: need, potential and perspectives of *Jatropha* plantations, Nat.Resour. Forum., 29 (1), 12–24.
[10] Gexsi, 2008, Global Market Study on Jatropha –Final Report, Global Exchange for SocialInvestment LLP, Berlin, Germany.
[11] Heller, J, 1996, Physic Nut *Jatropha curcas* L., Promoting the conservation and use of Underutilized and Neglected Crops. 1st Edn. International Plant Genetics and Crop Plant Research Institute (IPGRI), Rome, Italy, pp 66.
[12] Johansson, A.K., Kuusisto,P.H., Laakso,P.H., Derome, K.K., Sepponen,P.J.,Katajisto, J.K. and Kallio, H.P., 1997, Geographical variations in seed oils from Rubus chamaemorus and Empetrum nigrum. Phytochemistry, 44, 1421–1427.
[13] Jongschaap, R.E.E., Corré, W.J., Bindraban, P.S. and Brandenburg, W.A., 2007, *Claims and Facts on* Jatropha curcas *L.* Plant Research International, BV Wageningen, The Netherlands.
[14] Kaura, S.K., Gupta, S.K., and Chowdhury, J.B., 1998, Morphological and oil content variation in seeds of *Azadirachta indica, A. Juss.* (Neem) from northern and western provenances of India. J Plant Foods Hum Nutr (Formerly Qualitas Plantarum), 52, 132–136.
[15] Kaushik, N., Adholey, A. and Singh. R., 2006, Quality considerations in *Jatropha curcas* In Biofuels: towards a greener and secure energy future, pp 173-180, edited by P P Bhojvaid.New Delhi. TERI Press. 2006, 281 pp.
[16] Kaushik, N., Singh, G.B., Tomar, U.K., Naik, S.N., Satya, V., Bisla, S.S., Sharma, S.K., Banerjee, S.K. and Thakkar, P., 2007, Regional and habitat variability in azadirachtin content of Indian Neem (*Azadirachta indica A Juss.*), Curr. Sci., 92 (10), 1400-1406.
[17] Maes, M.H., Achten, M.M.J., Reubens, B., Samson, R. and Muys, B., 2009, Plant-water relationships and growth strategies of *Jatropha curcas L.* saplings under different levels of drought stress, J. Arid Environ, 73 (10), 877–884.

[18] Maes, W.H., Trabucco, A., Achten, W.M.J. and Muys, B., 2009, Climatic growing conditions of *Jatropha curcas* L. Biomass and Bioenergy, 33, 1481e1485.
[19] Messemaker, L., 2008, The green myth? Assessment of the Jatropha Value Chain and its Potential for Pro-poor Biofuel Development in Northern Tanzania. MSc dissertation at Utrecht University, The Netherlands. FACT Foundation (2006) Jatropha Handbook. FACT Foundation, Eindhoven, the Netherlands.
[20] O'Neill, C.M., Gill, S., Hobbs, D., Morgan, C. and Bancroft, I., 2003, Natural variation for seed oil composition in Arabidopsis thaliana, Phytochemistry, 64, 1077–1090.
[21] Openshaw, K., 2000, A review of *Jatropha curcas*: an oil plant of unfulfilled promise, BiomassBioenergy, 19 (1), 1–15.
[22] Steel, R.G.D., and Torrie, J.H., 1984, Principles and procedures of statistics. A biometric approach. 2nd ed. McGraw Hill Book Co., New York, USA.
[23] Tiwari, A.K., Kumar, A. and Raheman, H., 2007, Biodiesel production from Jatropha (*Jatropha curcas*) with high free fatty acids: an optimized process, Biomass Bioenergy, 31 (8), 569–575.
[24] Vollmann, J., Moritz, T., Kargl, C., Baumgartner, S. and Wagentrist, H., 2007, Agronomic evaluation of camelina genotypes selected for seed quality characteristics, Ind Crops Prod., 26, 270-277.