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Research Article

HARNESSING THE GENETIC VARIABILITY OF SEED RELATED TRAITS IN JATROPHA (*Jatropha curcas* L.)

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Abstract: Jatropha (*Jatropha curcas* L.), commonly known as Ratanjyot is widely distributed in the world. In recent years it has been in news in global market owing to the utilization of its seed oil in biodiesel production. In view of its industrial importance twenty Jatropha accessions collected from different locations of U.P. were analyzed for various biometrical, physical and biochemical characteristics of seed. As regards biometrical parameter, the accessions K9 recorded largest seed (18.14mm) as well as highest seed length/breadth ratio (1.15). These were also identified as bolder seed accessions as they recorded highest seed index of 64.65g/100 seed. Seed index of various Jatropha accessions illustrated a significant variability from 45.45 to 64.65 g /100seeds depicting a mean value of 56.10g per 100 seeds. Amplitude of 2.70g in respect of seed index of different accessions indicates fair scope in identifying bolder seed sources for multiplication through breeding trials. K8 was identified as boldest seed bearing accessions as it differed significantly with rest of the accessions. It was interesting to note that K7, K8, K9, K13, 14, K15, K19, K21, K22, K24 and K25 also recorded seed index of more than 56.10g/100 and can be considered as bolder seed bearing accessions.

Keywords: *Jatropha, Accessions, Seed index, Biodiesel*

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Introduction

In recent years *Jatropha curcas* plant has attained a great significance owing to the presence of high levels of non-edible oil in its seeds that can be processed to produce biodiesel. The biodiesel, thus formed can be used as fossil diesel substitute in a diesel engine without any modification as most of the physicochemical properties of the biodiesel are close enough to the standard specifications of fossil diesel [1]. Deoiled cake, obtained after oil extraction, is a rich source of protein, carbohydrate, minerals however, it cannot be utilized for edible purpose due to intrinsic presence of toxic protein, curicin [2]. If detoxified, seed cake can act as protein rich feed for animals and fishes. During the process of biodiesel production by transesterification reaction, glycerol is obtained as a valuable by product. Like other oilseeds, seeds of Jatropha accessions exhibit wide variations in respect of various economically important seed characteristics, physical characteristic and biochemical characteristics including oil content, fatty acid composition, protein content etc which has direct bearing on its utilization as biodiesel, medicine and other industrial products. These characteristics have been found to be considerably influenced by genetic, climatic and agronomic factors. Existence of genetic variability in different Jatropha accessions provides a great scope in identifying high oil containing accessions /cultivars having appropriate fatty acid composition suitable for its use as biodiesel and other industrial commodities [3].

Materials and Methods

In view of this fact present investigation was undertaken which involve studies on certain physical, biochemical and biodiesel characteristics of seeds of twenty Jatropha accessions obtained from different locations of Uttar-Pradesh *viz.* Allahabad, Mahoba, Kanpur, Kannauj, Farukhabad, Mirjapur, Izzat nagar, Auraiya, Lucknow and Baraily.

Table-1 *Detailed information of Jatropha Accessions used in the study*

SN	Accessions	Location	SN	Accessions	Location
1	K1	Mahoba	14	K14	Allahabad
2	K2	Mahoba	15	K15	Allahabad
3	K3	Mahoba	16	K16	Mirzapur
4	K4	Kanpur	17	K17	Mirzapur
5	K5	Kanpur	18	K18	Allahabad
6	K6	Kanpur	19	K19	Allahabad
7	K7	Kannauj	20	K20	Auraiya
8	K8	Kannauj	21	K21	Auraiya
9	K9	Izzat nagar	22	K22	Allahabad
10	K10	Izzat nagar	23	K23	Kanpur
11	K11	Lucknow	24	K24	Kanpur
12	K12	Lucknow	25	K25	Farrukhabad
13	K13	Bareilly			

Results

Seed is the ultimate propagule of a plant produced through the union of male and female gametes. It has been regarded as an important input in agriculture. Seed size is of great agronomic and commercial significance having direct association with oil yield. Large seeds of Jatropha are preferred for easy crushing and oil extraction. Moreover, in tree breeding improvement can be achieved by identifying seed sources and plus trees on the basis of high seed yield coupled with oil content and seed size. Biometric characteristics such as seed length, breadth, length/breadth ratio, seed index *etc.* are some of the important seed characteristics having direct bearing towards identifying improved planting stock and furnishing information on basic seed material quality. The basic information thus, generated might be useful in establishing correlation of these characteristics with important biochemical characteristics including oil yield of the seed.

Table-2 *Range, mean values and best performing accessions of jatropha in respect of seed length, breath and seed length /breadth ratio*

Parameters	Range of Variation	Mean	Best Performing Accessions
Seed Length (mm)	12.81-18.48	16.50	K2, K3, K6, K7, K9, K15, K25
Seed Breadth (mm)	12.16-16.43	15.45	K9, K18, K25
Seed Length/Breadth Ratio	0.87-1.34	1.14	K2, K4, K6, K13, K16, K17

Table-3 *Range, mean values and best performing accessions of jatropha in respect of moisture content and seed volume*

Parameters	Range of Variation	Mean	Best Performing Accessions
Moisture Content (%)	3.32-4.47	3.94	K3, K5, K9, K10, K12, K13, K15, K16, K17, K18, K19, K20, K25
Seed Volume (ml/seed)	3.10-5.70	4.14	K1, K3, K4, K8, K9, K10, K12, K13, K14, K25

Table-4 *Range, mean values and best performing accessions of jatropha in respect of seed-index and seed yield*

Parameters	Range of Variation	Mean	Best Performing Accessions
Seed-Index (100 Seed wt in g.)	45.45-64.65	56.10	K7, K8, K9, K13, 14, K15, K19, K21, K22, K24, K25
Seed yieldm(kg/ plant)	1.45-3.42	2.70	K3, K8, K9, K18, K22, K23, K25

Table-5 *Range, mean values and best performing accessions of jatropha in respect of kernel content, seed coat and kernel: seed coat ratio*

Parameters	Range of Variation	Mean	Best Performing Accessions
Kernel Content (%)	38.75-58.84	53.01	K2, K6, K8, K10, K17, K19, K22
Seed Coat (%)	27.79-42.48	35.64	K1, K5, K11, K13, 14, K19, K20
Kernel: Seed Coat Ratio	1.20-1.87	1.51	K2, K3, K8, K9, K15, K17, K25

Data on seed source variations for seed characteristics may prove useful in identifying quality seed material for breeding purpose. Therefore, seed characteristics, mentioned above, have been determined to identify relatively superior seed material among the accessions taken up in the present studies.

Seed length, breadth and length/breadth ratio

Seed length of Jatropha accessions varied from 12.81 mm to 18.48 mm with a mean value of 16.50 mm while, seed breadth ranged from 12.16 to 16.43 mm having a mean of 15.45 mm as shown in [Table-2].

The amplitude of variability in respect of Seed length/Breadth Ratio was as high as 1.34 mm (K2) which provides a great scope in identifying seeds having larger length. However, the amplitude of variation in seed breadth of different accessions was relatively less compared to seed length. Variations recorded for seed length and breadth were highly significant at 5% level. The accessions K7 (18.48mm) collected from Kannauj possessed maximum seed length while, accessions K25 (16.43mm) from Farukhabad contained maximum seed breadth. It was interesting to note that five accessions namely K2, K3, K6, K7, K9, K15, K25 possessed more than 16.50mm seed length and hence identified as longer seed containing accessions. On the other hand, seed of accessions K9, K18 and K25 were identified as larger seed breadth bearing accessions having more than 14.45mm of seed breadth [4]. The ratio of seed length and breadth (L:B ratio) was also calculated which revealed mean value of 1.14. The minimum L:B ratio of 0.87 was recorded by the seeds of accession K22 collected from Ganja, Allahabad while maximum value of 1.34 was observed in K2 from Kamlikhera which was followed by K16(1.16), K17(1.19), K4(1.20), K6(1.29) and K13(1.30). The variations recorded for L:B ratio were statistically significant at 5% level.

Similar studies on seed length, breadth and L:B ratio of seeds of 63 Jatropha accessions collected from different district of Andhra Pradesh have also been recorded by many researchers [5] which revealed a range of 15.1 to 19.6 mm for seed length,10.2 to 11.8mm for seed breadth and 1.4 to 1.82 for L:B ratio of the seeds which is in accordance with the results reported by the author. Others have also recorded values for seed length and breadth of various Jatropha accessions collected from different locations which are in good agreement with the results observed by the author [6]. Differences in the seed length, breadth and L:B ratio of Jatropha accessions reported in the thesis with those of others may be attributed to the effect of locations and climate on the seed size.

Moisture Content and Seed Volume

Moisture content of the seed provides useful information regarding seed viability and shelf life of the seed. At industrial level before bulk extraction of oil, seed moisture affects the oil content and therefore, seeds are dried to up to a specific moisture level to get maximum oil recovery. It has been found that increase in moisture level of Jatropha seeds from 3.32 to 4.47% altered the mean diameter and sphericity of the seeds, affecting its biometric characteristics. Normally, seeds of Jatropha accessions have been found to contain low moisture level affording better shelf life and as such the seeds can be preserved for longer duration without significant losses in the levels of seed oil content.

With this view moisture content in the seeds of various Jatropha accessions was determined which varied from 3.32% in K4 (from Kanpur) to 4.47% in K16 (from Chilla) as depicted in [Table-3]. Mean value of 3.94% for moisture level indicate safe limit for the seeds in the context of its shelf life. As such seeds of all the accessions can be preserved for longer duration without and detoriation [7].

Data on average volume of seed of different Jatropha accessions is given in [Table-3] which revealed variations from 3.10 to 5.70 ml/seed with a mean value of 4.14 ml/seed. Lowest seed volume was recorded by K2 from Kamlikhera while, maximum seed volume of 5.70 ml/seed was observed in ten accessions, namely K1, K3, K4, K8, K9, K10, K12, K13, K14 and K25. Similar, observation with regard to seed volume of Jatropha accessions have also been reported which indicate variability from 0.29 to 0.55 ml per seed which is in agreement with our results.

Seed Index

Healthy and bold seeds of industrial crops attract fair price as compared to wrinkled and lighter seeds. Therefore, seed index (100-seed weight in g) is of considerable economic value. With this view seed index of different accessions of J.curcas was determined the range, mean values and best performing Jatropha accessions in respect of seed index is presented in [Table-4].

Seed index of various Jatropha accessions illustrated a significant variability from 45.45 to 64.65 g /100seeds depicting a mean value of 56.10g per 100 seeds. Amplitude of 2.70g in respect of seed index of different accessions indicates fair scope in identifying bolder seed sources for multiplication through breeding trials. K8 was identified as boldest seed-bearing accessions as it differed significantly with rest of the accessions. It was interesting to note that K7, K8, K9, K13, 14, K15, K19, K21, K22, K24 and K25 also recorded seed index of more than 56.10g/100 and can be considered as bolder seed-bearing accessions. Minimum value of seed index was observed in K1. Results obtained by many researchers for seed index from 35.7 to 85.0g /100seeds are in good agreement with the results obtained by the author in the present study. Similarly, findings of are also in accord with the results obtained by the authors [8].

Seed yield per plant

In economically important oilseed crops, major emphasis has been laid upon increasing seed production to get higher oil yield. However, despite having ability to produce seed oil of economic significance, Jatropha plants have not regularly been cultivated for seed production, so far. Negligible efforts are being made to undertake systematic cultivation of *Jatropha curcas* plants and very little efforts have so far been made to improve the production of *Jatropha curcas* seeds on commercial basis. On practical level, very little is known regarding the seed yield of Jatropha accessions as it is mostly recorded in the scattered plantations on

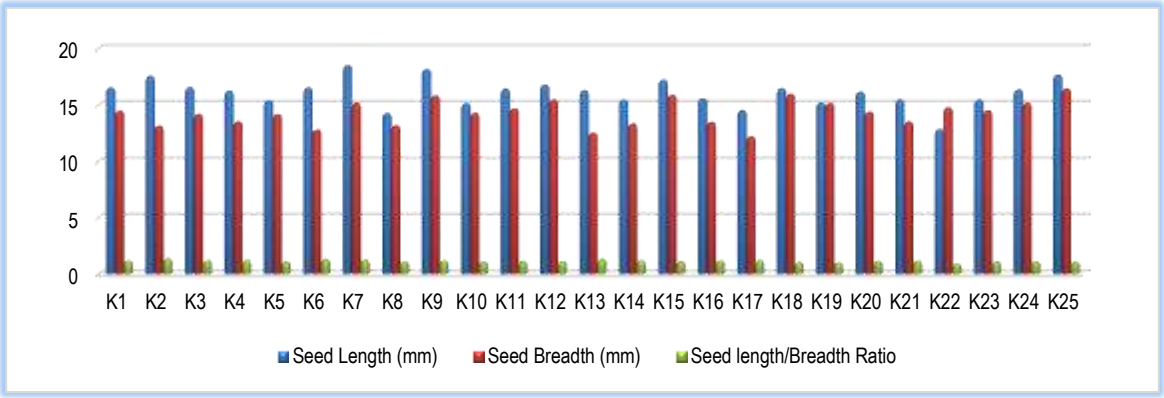

Fig-1 Variability in seed length, breadth and length breath ratio of different accessions of *Jatropha curcas* (L)

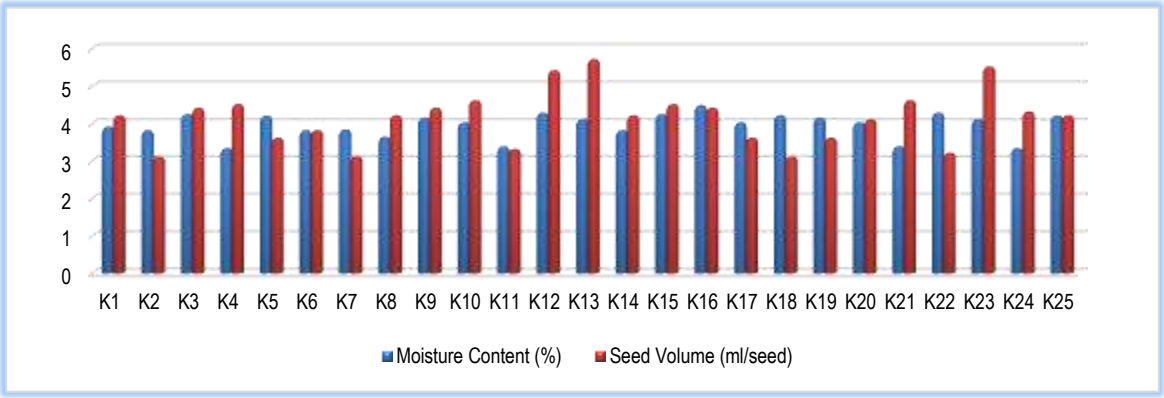

Fig-2 Levels of moisture content and seed volume in different Jatropha accessions

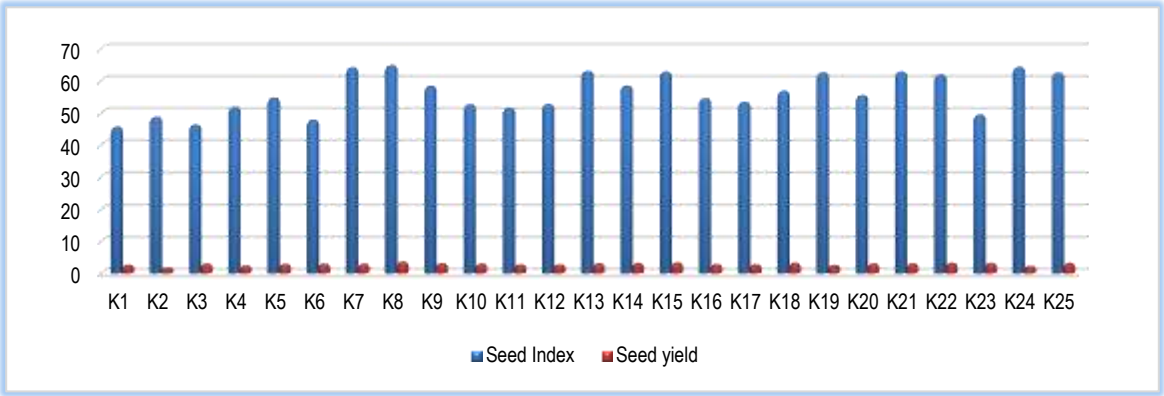

Fig-3 Variability in seed index and seed yield of different Jatropha accessions

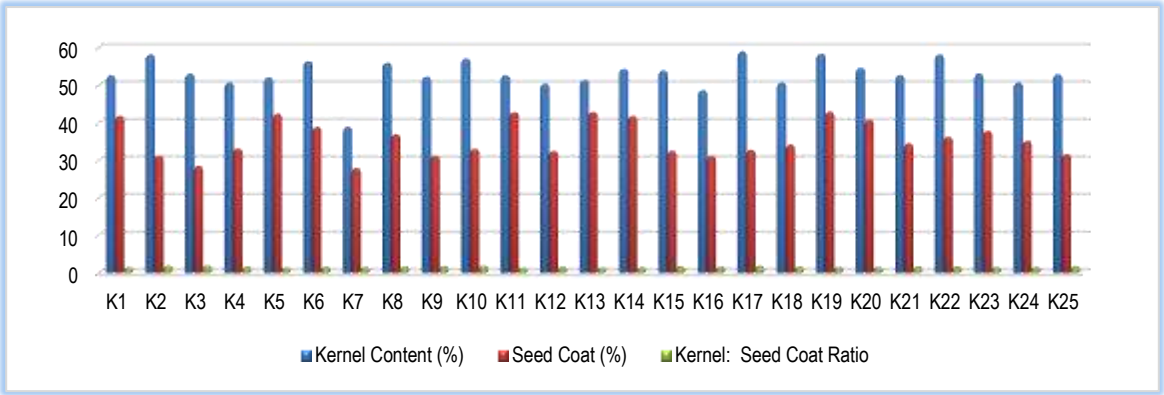

Fig-4 Variation in kernel content (%), seed coat (%) and kernel: seed coat ratio in different jatropha accessions

seed yield per plant basis. Being a rich source of commercial grade oil, Jatropha seed production is of great concern not only to farmers but also to consumers willing it to utilise it for oil extraction and subsequent processing into biodiesel [9]. With this view data on seed production per plant of different Jatropha accessions collected from different locations of U.P. was recorded as shown in [Table-4]. Data on relative performance of different accessions range and mean value in respect of seed yield per plant is presented in [Table-4].

Seed yield of different Jatropha accessions varied from 1.45 to 3.42 kg per plant with a mean of 2.70 kg per plant indicating statistically significant differences among different accessions.

Maximum seed yield kg per plant was recorded in as much as seven accessions namely, K3, K8, K9, K18, K22, K23 and K25. Similarly, minimum seed yield of 3 kg per plant was observed in five K1, K2, K4, K8 and K24. Variations from 0.5 to 5kg per tree per season in respect of Jatropha seed yield has been reported by many researchers [10] have also reported seed yield of Jatropha accessions from 0.4 to 10 kg per plant per year. Differences in the seed yield have been attributed to the effect of soil, climate and age of plant.

Kernel Content and Kernel/Seed Coat Ratio

Research conducted across the world to indicate that Jatropha oil is an important, emerging, low cost and smokless alternative of petrodiesel and is viewed with a mixture of optimism and prudence. With this view cultivation of Jatropha has begun world over but there is a lack of availability of quality planting material. In order to run a successful programme on cultivation and biodiesel production from Jatropha oil it is necessary to work out each and every aspect of the planting material including seed morphology and characteristics. With this view data on kernel content, seed coat content and kernel: seed coat ratio was worked out as shown in [Table-5]. Moreover, kernels were also required to determine oil content in the same.

Kernel content of different Jatropha accessions recorded significant variability from 38.75 to 58.84% with a mean of 53.01% indicating very high amplitude (20.09) of variability. Similarly seed coat content of different accession indicated a range of 27.79% to 42.48% with a mean of 35.64%. Seeds of K2(58.06), K6(56.22), K8(55.84), K10(56.93), K17(58.84), K19(58.18) and K22(58.07) were identified as high kernel containing accessions. Similar variability in kernel content from 53.9 to 71.8% have also been observed by several researchers which is in agreement with our results [9].

Based on kernel and seed coat contents, kernel:seed coat ratio was worked out which varied from 1.20 to 1.87 with a mean value of 1.51 indicating significant variability in kernel:seed coat ratio. Similar type of variability from 1.22 to 1.43 and 0.36 to 2.18 in respect of kernel: seed coat ratio has also been recorded by many researchers in different Jatropha accessions collected from different zones of India which are in good agreement with the results obtained by the author. It was interesting to note that K2 (1.87) closely followed by K2, K3, K8, K9, K15, K17 and K25 were among higher kernel/seed coat ratio containing accessions.

Conclusion

On the basis of seed traits *viz*., seed length, seed breadth, seed length/breadth ratio, seed volume, moisture content, seed index and seed yield the accessions K3, K5, K8, K12, K18 and K24 shows best accessions.

Application of research:

Research Category: Agriculture Biochemistry

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Author statement: All authors read, reviewed, agreed and approved the final manuscript. Note-All authors agreed that- Written informed consent was obtained from all participants prior to publish / enrolment

Study area / Sample Collection: Uttar Pradesh, India

Cultivar / Variety / Breed name: Jatropha (*Jatropha curcas* L.)

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.
Ethical Committee Approval Number: Nil

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