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# Variability studies of fruit and seed characteristics in Jatropha (*Jatropha curcas* L) in Himachal Pradesh

**SANDEEP SHARMA and ARUN KUMAR**

**Himalayan Forest Research Institute**
**Conifer Campus, Panthaghati, Shimla 171009 HP**
**Email for correspondence: sharmas@icfre.org**

## ABSTRACT

*Jatropha curcas* L as bio-diesel plant can prove very important to Indian economy owing to continuously increasing energy demand. The seeds of this plant yield oil suitable as biofuel for diesel engines. Jatropha plants are found to grow at various places in Himachal Pradesh at different altitudinal/microhabitat conditions in their wild state. The present study was conducted to determine the variation in fruit and seed characteristics in eleven phenotypic superior plants of *Jatropha curcas* selected under Department of Biotechnology (DBT) funded project during 2008-2009. The studies conducted through the estimation of range, mean, phenotypic and genotypic coefficient of variability, heritability, genetic advance and genetic gain. Significant variations were recorded in all the studied parameters. The extent of variations in number of seeds/fruit and seed weight was higher as compared to fruit width, seed width, fruit length and seed length. Owing to high heritability in seed length (79.04%), fruit length (66.61%), fruit width (66.33%) and seed weight (47.55%) there is scope for considerable genetic gain through individual plant selection. On an average Jatropha plant selections namely HP-31 and HP-35 were found to be better on the basis of fruit and seed morphological characteristics.

**Keywords:** Variability; seed characteristics; genetic advance; genetic gain; Jatropha

## INTRODUCTION

India is growing as a fast developing country and with this the fuel need of the country is also increasing but the non-renewable fuel resources are constant and depleting very quickly. There is a need to find out the alternate for these depleting non-renewable resources which are less hazardous to our changing environment. Jatropha is considered as a best alternate energy resource. There are two species of Jatropha one is *Jatropha curcas* L and another is *J glandulifera* Roxb. Out of these two species *J glandulifera* is better known for its beautiful flowers and *J curcas* is known for its oil extracted from the seeds and considered highly promising species as a source of energy. *J curcas* which is commonly known as physic nut or Ratanjot belongs to family Euphorbiaceae. It is a native of Mexico and Central America. The

physic nut is tree or bush with maximum height of five meters. *J curcas* is very undemanding in terms of climate and soil. It is drought resistant plant and requires 500-600 mm of rainfall. This plant is very partial to warm weather and tolerates only light frost. It is resistant to high degree of aridity, allowing it to grow in deserts. Its seed contains 27-40 per cent oil (Achten et al 2007). The plant is growing in different habitats with very less cultural activities going on (Behera et al 2010, Jangschaap et al 2007). Pandey et al (2010) studied the performance of different accession in tropical climate of Madhya Pradesh and reported considerable variability in seed characteristics. Seed source variability was also reported by Ginwal et al (2005) in *J curcas* collected from Central India. Mahapatra and Panda (2010) studied the variability on growth, phenology and seed characteristics in a progeny trial under tropical monsoon climatic conditions of Bhubnashewar. Das et al (2010) also studied fruit and seed characteristics in three trials of 16 genotypes of *J curcas* and found same significant result. Kaushik et al (2007) studied the genetic variability and divergence studies in seed traits and oil content of *J curcas*. It has been observed that most of the traits in plants are controlled by more than one gene and have environmental effect. So it is difficult to find out whether variability shown by various traits in *J curcas* is heritable or due to some environmental factors. Studying genetic variability is very important in improving this species in future selections. The present study reports the findings of morphological variations in fruit and seed characteristics within 11 phenotypically superior plants of Jatropha identified by Himalayan Forest Research Institute, Shimla under Department of Biotechnology funded project.

## MATERIAL AND METHODS

The study was conducted at Seed Laboratory of Himalayan Forest Research Institute, Shimla, HP during 2007 and 2008.

**Seed collection:** Fruits were collected from eleven phenotypically superior plants of *Jatropha curcas* situated in Bilaspur district of Himachal Pradesh. The detail of geographical locations related to those selected plants is given in Table 1. Fruits when fully ripened during Oct-Nov were collected and kept separately and were brought to seed laboratory for further studies.

**Fruit Size:** Three replications of 10 fruits per replication were taken at random from each lot and measured for length and width in millimeters and subsequently opened to count the number of seeds per fruit.

**Seed Size:** Three replications of 10 seeds per replication were randomly selected from each seed lot and measured for seed length and seed width in millimeters.

**Seed weight:** Three replications of 10 seeds per replication were measured for weight in grams.

Table1. Geographical locations of 11 phenotypically superior plants of *Jatropha curcas* L in Himachal Pradesh

| S No | Plant code | Location | Latitude (ºN) | Longitude (ºE) | Altitude (m) |
|---|---|---|---|---|---|
| 1 | HP-31 | Panjgain, Bilaspur, HP | 31°22' | 76°50.6' | 782 |
| 2 | HP-32 | Panjgain, Bilaspur, HP | 31°22' | 76°50.6' | 782 |
| 3 | HP-33 | Panjgain, Bilaspur, HP | 31°22' | 76°50.6' | 782 |
| 4 | HP-34 | Panjgain, Bilaspur, HP | 31°22' | 76°50.7' | 786 |
| 5 | HP-35 | Panjgain, Bilaspur, HP | 31°22' | 76°50.7' | 786 |
| 6 | HP-36 | Panjgain, Bilaspur, HP | 31°22' | 76°50.8' | 786 |
| 7 | HP-37 | Panjgain, Bilaspur, HP | 31°22' | 76°50.8' | 786 |
| 8 | HP-39 | Ghumarwin, Bilaspur, HP | 31°23' | 76°46.1' | 665 |
| 9 | HP-40 | Ghumarwin, Bilaspur, HP | 31°23' | 76°55.7' | 573 |
| 10 | HP-41 | Ghumarwin, Bilaspur, HP | 31°23' | 76°45.4' | 524 |
| 11 | HP-42 | Ghumarwin, Bilaspur, HP | 31°22' | 76°45.5' | 560 |

The data thus obtained were subjugated to analysis of variance (ANOVA) to establish the significance of differences between the seed sources. The least significant difference (LDC) was calculated and seed sources were ranked for variables studied using computer programme 'SX'.

Coefficient of variation and heritability were calculated using the method of Kempthorne (1957).

## RESULTS AND DISCUSSION

Table 2 depicts the data pertaining to fruit and seed characters. Analysis of variance (ANOVA) indicated statistically significant differences among the 11 superior plants for all studied parameters. The selected plant namely HP-35 had maximum fruit length (26.52 mm) though it was at par with HP-36, HP-41 and HP-31 selections while HP-42 selection had smallest fruit length (23.37 mm). Fruit width was observed maximum (20.95mm) in HP-41 plant which was statistically observed at par with HP-35, HP-31, HP-34 and HP-40 plant selections while it was minimum in HP-42 (18.57 mm) plant. The number of seeds/fruit was recorded maximum (2.83) in HP-35 selection which was statistically at far with HP-36 and HP-34 selections. The minimum number of seeds/fruit was recorded in HP-42 (2.16) plant. Similarly seed length was found maximum in HP-40

Table 2. Variation in fruit and seed characteristics in selected plants of *Jatropha curcas*

| Plant code | Fruit length (mm) | Fruit width (mm) | No of seeds/ fruit (mm) | Seed length (mm) | Seed width (mm) | Wt of 10 seeds (gm) |
|---|---|---|---|---|---|---|
| HP-31 | 25.91 | 20.87 | 2.56 | 18.68 | 11.03 | 8.25 |
| HP-32 | 25.58 | 19.32 | 2.50 | 15.89 | 10.18 | 7.09 |
| HP-33 | 25.40 | 19.41 | 2.30 | 18.65 | 11.31 | 7.81 |
| HP-34 | 25.53 | 20.78 | 2.76 | 18.29 | 10.84 | 7.03 |
| HP-35 | 26.52 | 20.93 | 2.83 | 18.06 | 1.61 | 7.46 |
| HP-36 | 25.99 | 20.58 | 2.80 | 17.55 | 1.73 | 7.35 |
| HP-37 | 24.58 | 18.82 | 2.56 | 17.23 | 10.10 | 6.88 |
| HP-39 | 24.32 | 19.90 | 2.40 | 17.31 | 10.56 | 6.72 |
| HP-40 | 24.85 | 20.70 | 2.66 | 18.74 | 11.52 | 6.55 |
| HP-41 | 25.92 | 20.95 | 2.63 | 18.01 | 10.69 | 7.43 |
| HP-42 | 23.37 | 18.57 | 2.16 | 17.70 | 11.14 | 6.24 |
| SE m± | 0.34 | 0.14 | 0.07 | 0.10 | 0.08 | 0.13 |
| $CD_{0.05}$ | 0.71 | 0.29 | 0.15 | 0.22 | 0.16 | 0.28 |

(18.74mm) plant followed by HP-31 (18.68 mm) and HP-33 (18.65 mm) and these were on par with each other. The minimum seed length was recorded in HP-32 (15.89 mm) plant. The selected plant namely HP-40 had maximum seed width (11.52 mm) while HP-37 plant had minimum seed width (10.10 mm). Seed weight (10 seeds) was observed maximum (8.25 g) in HP-31 selection and was statistically superior as compared with all other plants. The HP-42 plant depicted smallest seed weight ie 6.24 g.

Variation refers to the observable differences in individuals for a particular trait. These differences may partly be due to the genetic factors and partly due to the environmental effects. The observed value of a trait is the phenotypic value of that individual. The related magnitude of these components determines the genetic properties of any particular species (Jain

1982). Table 3 shows that extent of variation in number of seeds/fruit and seed weight was more as compared to the fruit width, seed width, fruit length and seed length. Extent of variability is also assessed by genotypic and phenotypic coefficient of variation (Subramanian et al 1995). In the present study fruit length, fruit width, seed length and seed width (Table 3) gave comparable values for genotypic and phenotypic coefficient of variability indicating that these parameters are under genetic control. Higher values of environmental coefficient of variability were observed as compared to genotypic coefficient of variability for parameters namely number of seeds/fruit and seed weight indicating that those are under strong environmental influence. The observed variation in a character is partly composed of genetic (heritable) variation and partly non- genetic (non-heritable). The proportion of total variation which is heritable is termed as heritability in broad sense (Lush 1937). The knowledge of its magnitude provides an idea about the scope of effecting genetic improvement through selection. Johnson and Combstock (1955) observed that a high genetic gain is usually more useful than the heritability value alone in predicting the resultant effect from selecting the best individual/seed source and therefore a heritability estimate alone does not necessarily mean an increase genetic advance.

Heritability values for seed length (79.04%), fruit length (66.61%), fruit width (66.33%) and seed weight (47.55%) were observed to be high (Table 4) as compared to low values obtained for number of seeds/ fruit (25.90%) and seed width (20.52%). In all the studied parameters genetic gain was recorded maximum in seed weight (9.74%) followed by seed length (8.26%) and fruit width (7.74%). The minimum genetic gain (1.93%) was recorded for seed width parameter. These results are in conformity with the findings of Kedarnath et al (1969) that most growth attributes of teak are heritable. Moderately high heritability estimates associated with moderate genetic advance have earlier been reported for plant height by Srivastava et al (1993) in *Terminalia arjuna*, for plant height and stem diameter in *Grewia optiva* by Sharma and Sharma (1995), in *Eucalyptus grandis* by Subramanian et al (1995) and for collar diameter and survival percent in *Tectona grandis* by Gera et al (2001).

There is some scope of genetic improvement in *Jatropha curcas* based on studied parameters. The high value of heritability in case of seed length, fruit length, fruit width and seed weight indicates that they are under genetic control. However genetic advance and genetic gain in all studied parameters is quite low. This may be due to the fact that all the selected

Table 3. Co-efficient of variability in different fruit and seed characters in selected plants of *Jatropha curcas*

| S no | Trait | Coefficient of variation (%) | Phenotypic coefficient of variability | Genotypic coefficient of variability | Environmental coefficient of variability |
|---|---|---|---|---|---|
| 1 | Fruit length | 2.37 | 4.10 | 3.35 | 2.37 |
| 2 | Fruit width | 3.29 | 5.66 | 4.61 | 3.29 |
| 3 | No of seeds/fruit | 9.94 | 11.54 | 5.87 | 9.93 |
| 4 | Seed length | 2.32 | 5.07 | 4.50 | 2.32 |
| 5 | Seed width | 2.55 | 4.57 | 3.79 | 2.55 |
| 6 | Seed Weight | 7.20 | 9.94 | 6.85 | 7.20 |

Table 4. Measures of genetic parameters in selected plants of *Jatropha curcas*

| S no | Trait | $h^2$ (%) | Genetic advance | Genetic gain (%) |
|---|---|---|---|---|
| 1 | Fruit length | 66.61 | 1.4257 | 5.64 |
| 2 | Fruit width | 66.63 | 1.5535 | 7.74 |
| 3 | No of seeds/fruit | 25.90 | 0.1579 | 6.16 |
| 4 | Seed length | 79.04 | 1.4719 | 8.26 |
| 5 | Seed width | 20.52 | 0.2086 | 1.93 |
| 6 | Seed Weight | 47.55 | 0.6979 | 9.74 |

superior plants of Jatropha were located in nearby areas of Bilaspur district of Himachal Pradesh and can thus be considered homogenous or originated from same population. At this stage genetic improvement on the basis of seed weight and seed length parameters can be recommended for narrow genetic base populations in *J curcas*. Besides this on an average individuals namely HP-31 and HP-35 were found to be better on the basis of fruit and seed morphological characteristics for consideration in future genetic improvement programmes of this species.

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