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Research Article

Characterization of *Jatropha* hybrid clones grown under subtropical conditions of south India

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Abstract

*Jatropha curcas* L. is a tree borne oilseed crop and growing as a shrub as a living fence in a farmers’ field. Characterization is an initial step for the development of any plant database. The characterization of plant characters (plant height and growth habit), stem characters (stem colour and young shoot colour) and leaf characters viz., juvenile leaf colour, leaf shape, leaf texture, leaf length, leaf width, petiole length and petiole colour was recorded in 56 *Jatropha* hybrids. There was no difference in stem characters and leaf shape in all the hybrids. The other traits viz., plant height, growth habit, juvenile leaf colour, leaf texture, leaf length, leaf width, petiole length and petiole colour showed variation and categorized qualitatively as per the PPV&FRA descriptors. The plant height varies from 65.6 cm (CJH 1 and CJH 22) to 162.8 cm (CBM 1) and mature leaf length ranged between 4.4 cm (CBM 5) and 17.7 cm (TNMC 7). The results obtained in the present study could be useful for making the plant database for the *Jatropha* hybrids.

Key words

*Jatropha*, Hybrids, Characterization, Distinctiveness, Uniformity, Stability

INTRODUCTION

*Jatropha curcas* L. is a shrub commonly known as physicnut that belongs to the family Euphorbiaceae. This shrub seed oil is processed to provide a diesel fuel substitute which made scientists to keep sight on this crop in tropical areas (Heller, 1996). Attempts are now being made to promote the cultivation of this underutilized and neglected crop for essential purpose. The centre of origin for physicnut is Mexican and Central America. But it is cultivated in Latin America, Asia and African countries grown as a hedge crop. When comparing with other oilseed species, *Jatropha* stands out for its economic and social viability for biodiesel production and despite being a perennial species it can reach the productive stage from the second year after growing. The potential of this crop was nowadays identified by scientists and it is being characterized and categorized for different traits. In India, *Jatropha curcas* L., has been prioritised as a promising Tree Borne Oilsseed (TBO) for biofuel production by the National Oilseeds and Vegetable Oils Development (NOVOD) Board and has identified fruiting, as one of the major constraints limiting collection and utilization of *Jatropha* (Anandalakshmi et al., 2015). Many studies on the botanical classification (Pimenta et al., 2014) and multiple uses of *Jatropha* have been reported. From its seeds, it is possible to produce insecticides, larvicides (Sakthivadivel and Daniel, 2008), fungicides (Cordova-Albores et al., 2014), and biodiesel (Kazembe and Chaibva, 2012). In 2001, the Indian government passed the Protection of Plant Varieties and Farmers’ Rights (PPV&FRA) Act. This provides for the registration of new varieties of agricultural plants if they conform to the criteria of distinctiveness, uniformity and Stability (DUS). The characterization is the critical step for the development guidelines for testing *Jatropha* hybrids for the utilization and protection of hybrids. This study made an attempt to record DUS traits in *Jatropha* hybrids for their utilization in the breeding programme.
MATERIALS AND METHODS
The experimental material includes 56 hybrids derived from *Jatropha curcas* and *J. integerrima* of *Jatropha* which were raised with a spacing of 3 x 3 m in Forest College and Research Institute, Mettupalayam in RBD with three replications. The 56 hybrid clones were maintained by applying fertigation once in 20 days and irrigation once in seven days. These hybrids were regularly pruned and maintained. DUS traits were observed during the 2nd year (2019-20) based on the PPV&FRA descriptors (http://www.plantauthority.gov.in/crop-guidelines.htm) for three plants in each replication before flowering for all the hybrids. The comparison of 56 hybrid clones for both quantitative and qualitative attributes as shown in Table 1.

Table 1. The morphological characterization of *Jatropha* hybrids clones

| Traits          | Description of the trait                                                                 | Type of trait |
|-----------------|-----------------------------------------------------------------------------------------|---------------|
| **Plant characters** |                                                                                          |               |
| Plant height    | The observation on the plant height was made on mature plants with a fully developed stem and crown and classified as short (<130 cm), medium (130-200 cm) and tall (>200 cm). | Quantitative trait |
| Growth habit    | The growth habit measured on mature plants with a fully developed stem and crown with complete foliage and classified as erect, spreading and bushy. | Qualitative trait |
| **Stem characters** |                                                                                          |               |
| Stem bulginess  | The stem bulginess observed on the mature plants for their presence or absence.             | Qualitative trait |
| Young shoot colour | The developing young shoot colour from the mature plants recorded and categorized as green and pinkish red. | Qualitative trait |
| **Leaf characters** |                                                                                          |               |
| Juvenile leaf colour | Juvenile leaf colour was observed on actively growing spring flush in the mature plant and sorted as dark pink, green and greenish pink | Qualitative trait |
| Leaf shape      | The shape of leaf is grouped as cordate and palmate.                                      | Qualitative trait |
| Leaf texture    | The leaf texture was recorded based on the touch sensitiveness of the observer and categorized as smooth, coarse, rough and leathery | Qualitative trait |
| Leaf length     | The length of the mature leaf was measured on the central part of leaf and grouped as short leaf (<8.0 cm), medium leaf (8.0-15.0 cm) and long leaf (>15.0 cm). | Quantitative trait |
| Leaf width      | The width of the mature leaf was measured on the central part of leaf and sorted as narrow leaf (<7.0 cm), medium leaf (7.0-14.0 cm) and broad leaf (>14.0 cm). | Quantitative trait |
| Petiole length  | The length of petiole was measured on the leaf in which the leaf length and width measured and classified the length as short (<10.0 cm), medium (10.0-16.0 cm) and long (>16.0 cm) | Quantitative trait |
| Petiole colour  | Based on the visual observation, the petiole colour was recorded on the leaf on which the petiole length was measured. The colour is grouped into greenish pink and green | Qualitative trait |

RESULTS AND DISCUSSION
*Jatropha* plant is a shrub used as bio-diesel and classified as tree borne oilseeds (TBOs). This little shrub is nowadays getting more attention on the research platform due to its oil quality for diesel engines. This shrub was raised in farmers’ field as bio-fence for many crops protection from animals damage.

The characterization of *Jatropha* hybrids was essential to differentiate the hybrids for distinctiveness in each plant trait and for the precise plant database. The *Jatropha* hybrids were characterized for plant traits (2), stem traits (2) and leaf traits (7). These hybrids exhibited a difference in all traits except stem bulginess, young shoot colour and leaf shape. The height of the plant varies from 65.6 cm (CJH 1 and CJH 22) to 162.8 cm (CBM 1). The hybrids were classified as short plant height in 42 hybrids (<130 cm) and medium plant height in the remaining 14 hybrids (130 to 200 cm) (Fig.1). Plant height plays a major role in lodging due to stem thickness and fruit weight. Among the hybrids, 75 per cent of hybrids showed short height, 25 per cent of hybrids exhibited medium plant height (Table 2). Being a shrub, short height hybrids were preferable due to lodging problem. When the fruiting starts in *Jatropha* shrub, due to fruit weight the branches will be bending and the fruit yield would be lost. The plant height of *Jatropha* hybrids varies from 40 to 150.67 cm as reported by (George et al., 2016) and 117.4 to 225.4 cm in 16 genotypes of *Jatropha* by (Das et al., 2010). Maftuchah and Zainudin (2018) reported a maximum height of 178 cm and a minimum of 118.17 cm in *Jatropha* genotypes.
The growth habit was observed as a qualitative trait and the hybrids were grouped as bushy, spreading and erect. Bushy type plant growth was recorded in 17 hybrids, spreading type in two hybrids (CJH 3 and CJH 7) and erect type of plants in the remaining 37 hybrids (Table 2). Growth habit was categorized as bushy type in 30 per cent hybrids, 4 per cent hybrids in spreading type and 66 per cent hybrids in an erect type of growth. The plant canopy in two years old *Jatropha* plantations were observed and categorized as narrow, intermediate and spreading (Sunil et al., 2013). The plant growth habit was sorted into tall erect, bushy and spreading in the *Jatropha* hybrid clones (George et al., 2016).

Table 2. DUS plant characters of *Jatropha* hybrids

| Traits       | Category | Name of the hybrids                                                                 | Per cent of variation | Type of assessment |
|--------------|----------|-------------------------------------------------------------------------------------|-----------------------|--------------------|
| Plant height | Short    | CJH 1, CJH 2, CJH 3, CJH 5, CJH 6, CJH 7, CJH 8, CJH 9, CJH 10, CJH 11, CJH 12, CJH 13, CJH 14, CJH 15, CJH 16, CJH 17, CJH 18, CJH 19, CJH 20, CJH 21, CJH 22, CJH 23, CJH 24, CJH 25, CJH 26, CJH 27, CJH 28, CJH 29, CJH 30, CJH 31, CJH 32, CJH 33, CJH 34, CJH 35, TNMC 7, DOPS 101, DOPS 102, BCGSA 101, BCGSA 102, BCGSA 103, UACH 102, TNAU 101, MJH 1, MJH 2, CJ 1, CBM 5 and CBM 9 | 75        | MG     |
| Tall         | Medium   | CJH 4, CJH 14, CJH 22, CJH 23, CJH 24, UACH 101, TNAU 102, MJH 3, CBM 1, CBM 2, CBM 4, CBM 6, CBM 8 and HC 4 | 25        | -      |
| Erect        | Tall     | CJH 1, CJH 2, CJH 5, CJH 12, CJH 13, CJH 15, CJH 16, CJH 17, CJH 18, CJH 19, CJH 20, CJH 22, CJH 25, CJH 26, CJH 27, CJH 28, CJH 29, CJH 30, CJH 32, CJH 34, CJH 35, DOPS 101, DOPS 102, BCGSA 101, BCGSA 102, BCGSA 103, UACH 102, TNAU 101, TNAU 102, MJH 1, MJH 2, MJH 3, CBM 2, CBM 4, CBM 6, CBM 8 and CBM 9 | 66        | VG     |
| Growth habit | Bushy    | CJH 4, CJH 6, CJH 8, CJH 9, CJH 10, CJH 11, CJH 14, CJH 21, CJH 23, CJH 24, CJH 33, TNMC 7, UACH 101, CJ 1, CBM 1, CBM 5 and HC 4 | 30        | -      |
|              | Spreading | CJH 3 and CJH 7                                                                  | 4         | -      |

**MG**: Measurement by a single observation of a group of plants or parts of plants

**MS**: Measurement of a number of individual plants or parts of plants

**VG**: Visual assessment by a single observation of a group of plants or parts of plants

**VS**: Visual assessment by observation of individual plants or parts of plants

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Stem bulging and young shoot colour are described under stem characters as per the descriptors and these two traits had no difference in the 56 hybrids studied. The trait stem bulging was absent in all 56 *Jatropha* hybrids. The young shoot colour was found to be a green colour in all the hybrids. The observation on the main stem colour was grouped as green and grey colour (Sunil et al., 2013). The young stem colour was recorded as light green, green, light greyish green and light greyish brown in 27 *Jatropha* hybrid clones by Parthiban et al., (2009).

### Table 3. DUS leaf characters of *Jatropha* hybrids

| Traits | Category | Name of the hybrids | Per cent of variation | Type of assessment |
|--------|----------|---------------------|-----------------------|-------------------|
|        | Dark pink | CJH2 and CJH 26     | 4%                    |                   |
| Juvenile leaf colour | Green | CJH 8, CJH 9, CJH 10, CJH 19, CJH 21, CJH 23, CJH 30, DOPS 101, DOPS 102, BCGSA 101, BCGSA 102, UACH 102, MJH 2, CBM 2, CBM 4, CBM 6, CBM 8, CBM 9 and HC 4 | 34 | VS |
|        | Greenish pink | CJH 1, CJH 3, CJH 4, CJH 5, CJH 6, CJH 7, CJH 11, CJH 12, CJH 13, CJH 14, CJH 15, CJH 16, CJH 17, CJH 19, CJH 20, CJH 22, CJH 24, CJH 25, CJH 27, CJH 28, CJH 29, CJH 32, CJH 33, CJH 34, CJH 35, TNMC 7, BCGSA 103, UACH 101, TNAU 101, TNAU 102, MJH 1, MJH 3, CJ 1, CBM 1, CBM 5 | 62 |                   |
|        | Cordate | Nil                   |                       |                   |
| Leaf shape | Palmate | CJH 1, CJH 2, CJH 3, CJH 4, CJH 5, CJH 6, CJH 7, CJH 8, CJH 9, CJH 10, CJH 11, CJH 12, CJH 13, CJH 14, CJH 15, CJH 16, CJH 17, CJH 18, CJH 19, CJH 20, CJH 21, CJH 22, CJH 23, CJH 24, CJH 25, CJH 26, CJH 27, CJH 28, CJH 29, CJH 30, CJH 32, CJH 33, CJH 34, CJH 35, TNMC 7, DOPS 101, DOPS 102, BCGSA 101, BCGSA 102, BCGSA 103, UACH 101, UACH 102, TNAU 101, TNAU 102, MJH 1, MJH 2, MJH 3, CJ 1, CBM 1, CBM 2, CBM 4, CBM 5, CBM 6, CBM 8, CBM 9, HC 4 | 100 | VG |
|        | Smooth | CJH 1, CJH 9, CJH 10, CJH 12, CJH 13, CJH 14, CJH 15, CJH 17, CJH 18, CJH 19, CJH 22, CJH 25, CJH 26, CJH 27, CJH 29, CJH 30, TNAU 101, MJH 1, MJH 2 and CBM 9 | 36 |                   |
| Leaf texture | Coarse | CJH 2, CJH 3, CJH 4, CJH 5, CJH 6, CJH 7, CJH 8, CJH 11, CJH 12, CJH 13, CJH 14, CJH 15, CJH 16, CJH 17, CJH 18, CJH 19, CJH 20, CJH 21, CJH 22, CJH 23, CJH 24, CJH 25, CJH 26, CJH 27, CJH 28, CJH 29, CJH 30, CJH 32, CJH 33, CJH 34, CJH 35, TNMC 7, DOPS 101, BCGSA 102, BCGSA 103, UACH 101, UACH 102, TNAU 102, MJH 3, CBM 1, CBM 2, CBM 4, CBM 5, CBM 6 and HC 4 | 52 | VG |
|        | Rough | CJH 16, CJH 20, CJH 21, DOPS 102, BCGSA 101, CJ 1 and CBM 8 | 12 |                   |
|        | Leathery | Nil                   |                       |                   |
|        | Short | CJH 2, CJH 13, CJ 1 and CBM 5 | 7 |                   |
| Leaf length | Medium | CJH 1, CJH 3, CJH 4, CJH 5, CJH 6, CJH 7, CJH 8, CJH 9, CJH 10, CJH 11, CJH 12, CJH 14, CJH 15, CJH 16, CJH 17, CJH 18, CJH 19, CJH 20, CJH 21, CJH 22, CJH 23, CJH 24, CJH 25, CJH 26, CJH 27, CJH 28, CJH 29, CJH 30, CJH 32, CJH 33, CJH 34, CJH 35, DOPS 101, DOPS 102, BCGSA 101, BCGSA 102, UACH 101, UACH 102, TNAU 101, MJH 1, MJH 3, CBM 1, CBM 2, CBM 4, CBM 5, CBM 6, CBM 9 and HC 4 | 84 | MG |
|        | Long | TNMC 7, BCGSA 103, TNAU 102, MJH 2 and CBM 8 | 9 |                   |
|        | Narrow | CJH 11, CJ 1 and CBM 5 | 5 |                   |
| Leaf width | Medium | CJH 1, CJH 2, CJH 4, CJH 5, CJH 7, CJH 8, CJH 9, CJH 10, CJH 12, CJH 13, CJH 14, CJH 15, CJH 16, CJH 17, CJH 18, CJH 19, CJH 20, CJH 22, CJH 23, CJH 25, CJH 26, CJH 27, CJH 29, CJH 30, CJH 32, CJH 33, CJH 35, TNMC 7, DOPS 101, BCGSA 101, BCGSA 102, UACH 102, TNAU 101, MJH 2, MJH 3, CBM 2, CBM 4, CBM 6 and HC 4 | 70 | MG |
|        | Broad | CJH 3, CJH 6, CJH 21, CJH 24, CJH 28, CJH 34, DOPS 102, BCGSA 103, UACH 101, TNAU 102, MJH 1, CBM 1, CBM 8 and CBM 9 | 25 |                   |

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### Table 3

| Petiole length | Petiole colour |
|----------------|---------------|
| CJH 1, CJH 2, CJH 11, CJH 12, CJH 13, CJH 14, CJH 16, CJH 19, CJH 20, CJH 25, CJH 26, CJH 30, CJH 32, CJH 33, CJH 35, BCGSA 102, UACH 101, MJH 2, MJH 3, CJ 1, CBM 2, CBM 4, CBM 5, CBM 6 and HC 4 | Short | 45 |
| CJH 3, CJH 4, CJH 5, CJH 6, CJH 7, CJH 8, CJH 9, CJH 10, CJH 15, CJH 17, CJH 18, CJH 21, CJH 22, CJH 23 | Medium | 52 |
| BCGSA 101, UACH 102, BCGSA 103, UACH 101, MJH 1, CBM 1, CBM 8 and CBM 9 | Long | 3 |
| CJH 1, CJH 8, CJH 9, CJH 10, CJH 11, CJH 19, CJH 21, CJH 22, CJH 25, CJH 26, CJH 30, DOPS 101, DOPS 102, BCGSA 101, UACH 101, TNAU 102, MJH 2, CBM 2, CBM 4, CBM 8, CBM 9 and HC 4 | Green | 39 |
| CJH 2, CJH 3, CJH 4, CJH 5, CJH 6, CJH 7, CJH 12, CJH 13, CJH 14, CJH 15, CJH 16, CJH 17, CJH 18, CJH 20, CJH 23, CJH 24, CJH 27, CJH 28, CJH 29, CJH 32, CJH 33, CJH 34, CJH 35, TNMC 7, BCGSA 102, BCGSA 103, UACH 102, TNAU 101, MJH 1, MJH 3, CJ 1, CBM 1 and CBM 6 | Greenish pink | 59 |
| CBM 5 | Pink | 2 |

The leaf characters namely juvenile leaf colour, leaf shape, leaf texture, leaf length, leaf width, petiole length and petiole colour were observed and has variation in the hybrids except for leaf shape. The leaf characters for 56 hybrids were presented in Table 3.

The freshly opened flush in the mature plant was observed as dark pink in two hybrids (CJH 2 and CJH 26), green colour in 19 hybrids and greenish pink in 35 hybrids (Fig. 2). The variation was categorized as dark pink (4%), green (34%) and greenish pink (62%). In the present study, the juvenile leaf colour was grouped as dark pink in 4 per cent hybrids, green colour in 34 per cent hybrids and greenish pink in 62 per cent hybrids. Pigmentation in emerging leaves was classified as green, green-grey purple, yellow green and greyed purple as grouped by Sunil et al. (2013). Pale green and light green tender leaf colour was reported in *Jatropha* hybrid clones by Parthiban et al., (2009). The leaf shape of all *Jatropha* hybrids was palmate. There is no difference in the leaf shape in the hybrids but there was difference in leaf lobes. The leaf shape as the heart and round shaped was recorded in eight *Jatropha* genotypes by (Maftuchah and Zainudin, 2018) and cordate leaf shape in *Jatropha* hybrids by George et al. (2016).

![Fig. 2. Variation in juvenile leaf colour](https://doi.org/10.37992/2021.1201.032)
The texture of mature leaf was measured based on the sensitivity of the observer. The hybrids were grouped as coarse texture in 29 hybrids, rough texture in seven hybrids and smoothness observed in 20 hybrids. The variations for leaf texture for coarse type in 52 per cent, rough type in 12 per cent and smooth type in 36 per cent. Parthiban et al, (2009) and George et al. (2016) sorted the texture of leaf into velvety, coarse, leathery and smooth in hybrid clones.

The length of the mature leaf ranged between 4.4 cm (CBM 5) and 17.7 cm (TNMC 7). Short leaf length (<8.0 cm) was recorded in four hybrids (CJH 2, CJH 13, CJ 1 and CBM 5), 47 hybrids recorded medium leaf length (8.0 – 15.0 cm) and the remaining five hybrids classified in long leaf length (>15.0 cm). The variation in leaf length categorized as short in seven per cent, medium in 84 per cent and long in nine per cent hybrids. The longest leaf length was 11.43 cm and the shortest length was 6.52 cm in *Jatropha* was reported by Maftuchah and Zainudin, (2018). George et al. (2016) reported the leaf length ranged from 12.5 cm (HC 27) to 7.6 cm (HC 19) in *Jatropha* clones and the length varied from 7.6 to 12.5 cm in hybrid clones as reported by Parthiban et al. 2009 and the leaf length varied between 13.6 to 18.1 cm in four *Jatropha* species (Nwokocha et al., 2012).

The width of mature leaf variation was found to be narrow in five per cent hybrids (<7.0 cm), medium width in 70 per cent (7.0 – 14.0 cm) and broad in 25 per cent (>14.0 cm). The leaf width ranged between 3.6 cm in CBM 5 and 16.4 cm in BCGSA 103. The leaf width of the mature leaf was found to be narrow in three hybrids (CJH 11, CJ 1 and CBM 5), medium width in 39 hybrids and broad in 14 hybrids. HS-49 genotype has the shortest leaf width (7.71 cm) and SM-35 has the broader width (13.01 cm) as reported by Maftuchah and Zainudin, (2018). The mean leaf breadth of hybrids was 10.2 cm and varied from 13.2 cm (HC 5) to 7.0 cm (HC 19) (George et al., 2016).

The petiole length of hybrids varied between 5.2 cm (CJH 13) to 17.0 cm (BCGSA 103). The hybrids were grouped in short length in 25 hybrids (45%), a medium length in 29 hybrids (52%) and long in two hybrids (3%) (Fig.3). The hybrids were grouped in short length in 25 hybrids, medium length in 29 hybrids and long in two hybrids. (Sunil et al., 2013) categorized petiole length into small (<12 cm), medium (12-22 cm) and large (>22 cm) in *Jatropha* plantations, Maftuchah and Zainudin, (2018) observed the petiole length ranged from 9.86 cm to 12.51 cm in eight *Jatropha* genotypes and Nwokocha et al., (2012) also observed the length of petiole varied between 15.3 to 27.5 cm.

There was a difference in the petiole colour in the 56 hybrids (Fig. 4). The hybrids sorted as green in 22 (39%), greenish pink in 33 (59%) and pink in one hybrid (CBM 1). The hybrids petiole colour was sorted as green in 22, greenish pink in 33 and pink in one hybrid. George et al. (2016) also reported petiole colour as light green with green ends, light green with pink ends, green and brown. The petiole base pigmentation was categorized into green, purple and brown in *Jatropha* as given by Sunil et al. (2013).

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**Fig.3. Variation in petiole length**

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Based on the descriptors, the plant, stem and leaf characters were recorded for all 56 hybrids. Among all the traits observed, three traits (Stem bulginess, young shoot colour and leaf shape) showed variation in 56 hybrids and the remaining traits showed variation in all hybrids. This information could be useful for making the plant database for the *Jatropha* hybrids.

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