Minimal descriptors for characterization and evaluation of *Jatropha curcas* L. germplasm for utilization in crop improvement

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ABSTRACT

Jatropha curcas germplasm collected from peninsular region of India as well as germplasm augmented from various parts of the country was characterized for various agro-morphological traits at 3 locations for 3 years. Variability was evident for 38 traits which included both qualitative and quantitative traits. Important yield influencing traits such as plant canopy, branching habit, number of primary branches, peduncle branching, peduncle length, inflorescence compactness, flower ratio, inflorescence abundance, flowering, fruits per cluster, 100-seed weight and oil content showed a wide range of variability in the germplasm under study. Number of leaf lobes also showed variation and accordingly were categorised as 0—2, 3—5, >6. The branching pattern varied widely and has been categorised as basal, intermediate, top and entire. The male to female flower ratio ranged from 10:1 to >20:1, and was categorized into three categories as 10:1, 11—20:1 and >20:1. The seed oil content which is of commercial importance in *J. curcas* also exhibited wide variability ranging from 17.5 to 41.6% and the descriptor has been categorized accordingly as 0—20, 21—30, 30—40 and ≥40%. Based on the variability observed in the traits, a set of 38 minimal descriptors has been suggested for characterization and evaluation of *Jatropha*.

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1. Introduction

Jatropha has adapted itself to various eco-geographical zones in India and it has since accumulated lot of variability over many decades. Documentation of the variation in morphological traits is necessary to effectively tap the available diversity in the crop improvement programmes. In furtherance of this objective, an attempt was made to study the crop in detail for various traits under uniform agro-climatic conditions. Based on such a study, the minimal descriptors have been developed and a simple working botanical classification has been provided for convenience of researchers working on *Jatropha curcas*. The consequent descriptor and descriptor states is an initial step and not an exhaustive one as there exists still an unexplored and untapped genetic potential for the crop at large. The minimal descriptor list helps in characterization of germplasm for development of a dataset of the collected material for utilization in the *J. curcas* improvement programmes.

1.1. Challenges in Jatropha germplasm collection

Germplasm collection of *Jatropha* has its own set of challenges and since the species is not native to India, lack of information and experience in identification of the areas of its availability are the major limitations. The plant produces seed throughout the year which results in collection of small quantity of seeds. Besides, fruiting coincides with cool and wet weather which favours the growth of moulds on the collected seeds and often results in delayed maturation. The plants differ in maturity period which affects collection and choice of the explorer. The pods persist for a long period on the plant after maturity which frequently results in collection of remnants of previous season pods leading to poor storage, viability and erroneous oil estimation. During exploration, harvesting of pods is a challenge as the plants are found on periphery of wet land as hedge plants along cultivated fields and along the scrub vegetation besides, lack of improvised harvesting and processing equipment. Plant latex is a major hindrance in seed collection as it leaves a stubborn stain. In villages, uniform plant types were observed as the plants were raised from cuttings and hence, it was advisable to collect 2—3 accessions from a particular village ecosystem as it represents the variation existing there. The common feature observed in surveyed areas was the wide spread infection of mosaic virus among the plant populations.

2. Materials and methods

The *J. curcas* germplasm used for establishing minimal descriptors comprised of accessions from diverse agro-ecological regions of the country ranging from Uttarakhand, Rajasthan, Chattisgarh, Andhra Pradesh, Tamil Nadu and Kerala [1]. The germplasm was raised at the experimental station of the NBPGR Regional station, Hyderabad, India under uniform soil conditions and subjected to uniform package of practices. Three-year-old plantations, spaced at 2×2 m in an Augmented Block Design without any interventions like pruning were characterized. The material was replicated at two other centres *viz.,* Acharya N.G.Ranga Agricultural University (ANGRAU), Rajendranagar, Hyderabad and Central Research Institute for Dryland Agriculture (CRIDA), Hyderabad, India for documentation of the characteristics for 3 consecutive years. An initial dose of 2 kg of farm yard manure (FYM) per pit and recommended fertilizer doses viz. 5 g of nitrogen, 10 g of phosphorus and 8 g of potash fertilizers were applied at the time of transplantation. The plants were given irrigation as and when required. The experimental site is characterised by red sandy loam soils with pH of 7.2 and located at an altitude of 542 above mean sea level. Mean air temperature ranged from a minimum of 14 °C (during December and January) to a maximum of 40 °C (during April and May). The average rainfall ranged between 700 and 800 mm with maximum rains received from South-West monsoon during the months of June to August. However, occasionally rains in the month of October and November were received due to North-East monsoon. The fruits were harvested at physiological maturity stage (yellow), seed was extracted and shade dried for a week. The oil content was analysed by Soxhlet method, which involved well mixed *Jatropha* seed (5.0 g) ground and transferred into an extraction thimble and the top portion covered with cotton. This packed thimble was placed in the extraction chamber of SER 148 Solvent Extractor (VELP Scientifica, Italy). Around 70 ml of hexane was taken in the extractor and the temperature of the solvent heating block was adjusted to 130 °C (Recommended set point for hexane). The thimble was socked in hexane and the solvent was refluxed over a period of 1 h. After 1 h, the thimble was lifted from the solvent and the solvent was allowed to pass through the bed of ground seeds for 15 min. This operation ensures washing of the thimble with fresh solvent. Hexane was distilled off to recover *Jatropha* oil. A recovery of 1.72 g corresponds to 34.4%.

Details were documented on 38 growth traits such as, growth habit, plant canopy, leafiness, branching habit and pattern, number of primary branches, stem colour, latex colour, pigmentation of emerging leaves, petiole base pigmentation, leaf blade size, petiole length, leaf colour, number of lobes, phyllotaxy, leaf alignment, peduncle branching, peduncle length, inflorescence position on the branches and compactness, flower colour, flower size, flower ratio, inflorescence, seasonality of flowering, length of fruit stalk, number of fruits per cluster, average no. of seeds per fruit, pod length, pod breadth, pod width, seed length, seed breadth, seed width, 100-seed weight (g), seed surface, fruit shape and oil content. During peak flowering period, traits such as the number of inflorescences, type of inflorescence, female:male flower ratio, flower size, etc. were recorded. Branching habit was recorded during the autumn season as the plant sheds its leaves which are convenient to make such observations. Post rainy season prior to the onset of winter season was chosen for recording fruit and associated traits. Other morpho-physiological traits were recorded during peak growth stages of the respective traits. Canon digital SLR (350 D) 10 mega pixel camera was used to take the photographs and wherever necessary standard centimetre scale was used to measure the various traits under study.

3. Results and discussion

3.1. Minimal descriptors developed for characterization and evaluation based on variability observed

3.1.1. Growth habit
The growth habit of accessions under study was recorded on three-year-old plantations raised under uniform agronomic practises, soil and weather conditions (Fig. 1).

1. Shrub (<5 m)
2. Tree (>5 m)

3.1.2. Plant canopy
The plant canopy was recorded on three-year-old plantations raised under uniform agronomic practises, soil and weather conditions (Fig. 2).

1. Narrow
2. Intermediate
3. Spreading