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CHARACTERIZATION AND UTILIZATION OF INDIAN JATROPHAS

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Several species of the genus *Jatropha* found in India were collected and evaluated. Apart from their use as ornamental and energy crops, the genus *Jatropha* represents a potentially valuable source of germplasm for castor breeding as they possess very rare and beneficial characteristics, such as drought resistance, photoperiod insentivity, resistance to wilt and tolerance to lepidopteran insect pests besides, desirable oil quality. Tissue culture protocols developed for *Jatropha* offer scope not only for widening the genetic base of castor through somatic hybridization and genetic transformation but also in the improvement of *Jatropha per se* by both conventional and *in vitro* techniques as the available variability in the latter is quite narrow.

key words : *Jatropha* sp., characterization, utilization, interspecific hybridization, tissue culture

The genus *Jatropha* (family Euphorbiaceae) is morphologically diverse encompassing more than 200 species which are distributed chiefly in the seasonally dry tropical regions of America, Africa and India. Dehgan and Webster (1979) recognized two subgenera (*Jatropha, Curcas*), ten sections and ten subsections. About nine species have been recorded in India which mostly belong to the Subg. *Jatropha* except. *J. curcas* which belongs to the subg. *Curcas*. Several species are cultivated for their ornamental or curious leaves and flowers, while few are grown for their economic uses (Anonymous 1959). *Jatrophas* are rich sources of hydrocarbons (27.0 to 48.5% seed oil content) and in the recent past the species. *J. curcas* has evoked much interest all over the world as potential petrocrop besides being a drought tolerant perennial (Takeda, 1982; Martin and Mayeux, 1985). Certain members of the genus *Jatropha* have closer morphological resemblances with castor (*Ricinus communis* L.) besides possessing resistance to insect pests, diseases and livestock which led to the speculation of exploiting *Jatropha* in the genetic upgradation of castor belonging to a monotypic genus (Sathaiah and Reddy, 1985; Reddy *et al.*, 1987). However, systematic studies on screening for agronomically important traits in the genus are limited and attempts at wide hybridization between *Jatropha* and *Ricinus* met with limited success. Hence, the present investigation was undertaken to collect and characterize different species of *Jatropha* native to India and assess

the scope of their utilization in castor breeding programme and also the improvement of *Jatropha per se.*

Collection and Characterization

Jatropha species growing wild in non-arable lands or cultivated as ornamentals in horticultural gardens of the states of Andhra Pradesh and Tamil Nadu were collected and assembled in the species garden at the Directorate of Oilseeds Research. The plantings of four species, namely *J. curcas, J. gossypifolia, J. multifida* and *J. podagrica* were established through seeds, those of *J. integerrima* and *J. integerrima* var. Rosea, *J. tangorensis* from cuttings and *J. heterophylla* through tuberous root stock. The distinguishing and desirable characters of the species collected are presented in Table 1.

Detailed cytological and embryological studies were carried out to verify the chromosome number and assess the fertility status of the established plants.

Evaluation and Utilization

Jatropha species were evaluated for their reactions to biotic stresses and the results are summarized in Table 1. Under artificial inoculation conditions the species were found to be highly resistant to fusarial wilt caused by *Fusarium oxysporum* f. sp. *ricini.* Screening of the *Jatropha* species against major *lepidopteran* pests of castor viz., castor semilooper (*Achoea janata*), Red hairy caterpillar (*Amsacta albistriga*) and Bihar hairy caterpillar (*Spilosoma obliqua*) indicated varying levels of resistance with the species *J. integerrima* and *J. integerrima* var. Rosea conferring maximum resistance to the leaf eating caterpillars (Sujatha, 1996). Analysis of seed oil fatty acids showed the predominance of linoleic acid with a higher linoleic to oleic acid ratio in all specis of *Jatropha* except *J. curcas* which was rich in oleic acid (Singh *et al.* 1996). Controlled pollinations between *Jatropha* and *Ricinus* in both direct and reciprocal directions indicated the existence of strong pre- and post- fertilization barriers to sexual hybridization. Histological and pollen-pistil interaction studies revealed the absence of active pollen-recognition-rejection phenomenon in the intergeneric crosses suggestive of strong incongruity (Sujatha, 1996).

Owing to strong barriers to crossability, tissue culture protocols have been standardized for various *Jatropha* species as a prelude to parasexual hybridization. The first successful attempt at whole plant regeneration from different explants of *J. integerrima* and *J. curcas* was reported (Sujatha and Dhingra 1993; Sujatha and Mukta 1996). While the regenerations of *J. curcas* expressed no phenotypic abnormalities, the regenerants of *J. integerrima* from hypocotyl explants resulted in somaclonal variants for flower colour and male sterility at frequencies of 16.7 and 8.3%, respectively. Phenotypic variants for flower colour lacked brown pigmentation on the leaves and produced light

Table 1. Species diversity in *Jatropha* found in India

Jatropha species	Place of occurrence	Chromosome No.	Fertility status	Distinct morphological features	Desirable attributes
J. curcas L.	Throughout the country	22	Fertile	Tree, highly branching, cordate-palmately lobed leaves, greenish- yellow flowers, distinct coflorescence, tardily dehiscent fruits with black, large sized ecarunculate seeds	High oil content, drought resistant, frost tolerant, less attacked by insect pests, resistant to fusarial wilt.
J. integerrima jacq. (*J. opanduraefolua* Andr., *J. acuminata* Desv., *J. hastata griseb. Manihot diversifolia* Sweet)	Throughout the country	22	Fertile	Shrub, sparsely branched, ovate fiddle shaped leaves, crimson-red flowers, dehiscent capsules, seeds small carunclate brown with spots	Xerophytic adaptation, resistant to diseases and pests except leaf webber and scale, photoperiod insensitive
J. integerrima var Rosea	Throughout the country	22	Partially sterile	Shrub, freely branching, green ovate leaves with no brown pigmentation, light pink flowers	Ornamental, resistant to scale and *lepidopteran* insect pests
J. glandulifera Roxb. (*J. glauca* Vahl.)	S. India, Uttar Pradesh, Bengal	22	Fertile	Shrub, profuse branching, obovate leaves with glandular hairs on all vegetative parts, glandular corymbose cyme, greenish-yellow flowers; dehiscent capsules with small shining black carunculate seeds	Resistant to pests and diseases

(*Cont. on next page*)

Jatropha species	Place of occurrence	Chromosome No.	Fertility status	Distinct morphological features	Desirable attributes
J. gossypifolia L.	Throughout the country	22	Fertile	Shrub, profuse branching, cordate leaves, glandular plant parts, dark crimson-purple flowers, violently dehiscent capsules with small brown carunculate seeds	Resistant to scale, mites and leaf eating caterpillars, tolerant to salinity
J. multifida L.	Throughout the country	22	Fertile	Shrub/tree, uniform branching, leaves divided into 11 lobes, long petiole, long pedunculate flat topped cyme, coral red flowers, non dehiscent capsules with medium sized light brown earunculate seeds	Ornamental, photoperiod insensitive, non dehiscent capsules, resistant to *fusarial* wilt
J. heterophylla (J. heynii)	S. India	22	Fertile	Rhizomatous shrub, leaves ovate-cuneate, paniculate cyme, greenish- yellow flowers	Ephemeral
J. podagrica Hook.	Throughout the country	22	Fertile	Caudiciform shrub, cordate leaf with peltate base, flat topped corymbose cyme, bright scarlet flowers, violently dehiscent capsules with brown ecarunculate seeds	Ornamental and adapts well to xerophytic conditions, photoperiod insensitive, resistant to fusarial wilt.
J. tanjorensis	Coastal Tamil Nadu	22	Completely sterile	Shrub, profuse branching, cordate-palmately lobed leaves, margins distinctly serrate, greenish-yellow flowers with crimson red tinge, no fruit set	Used as live fence

pink coloured flowers unlike the parent with brownish-red leaves and crimson-red flowers.

Interspecific crosses among the different species of *Jatropha* in all possible combinations produced viable hybrids only in a few species crosses (Table 2). Barriers to interspecific crossability were weak in crosses involving *J. curcas* as the female parent and alternatively, with *J. integerrima* as the pollen parent. Reciprocal differences existed with regard to seed set and pollen germination. Histological examination of pollinated styles showed pollen germination ranging from 51 to 100%. Characterization of morphological and reproductive features of the interspecific hybrids revealed an interesting feature in the F_1 s of the cross between *J. curcas* x *J. integerrima*. While the hybrids expressed phenotypic intermediacy for various characteristics, the corolla color varied from dark pink through light pink to white. This distinct flower color variation has the scope of being utilized as a new ornamental plant since one of its parental species (*J. integerrima*) is widely known for its ornamental value. With the standardized protocol for rapid multiplication through *in vitro* techniques, these hybrids can be propagated easily.

Table 2. Cross-compatibility between different *Jatropha* species

	J. curcas	*J. gossypifolia*	*J. integerrima*	*J. integerrima* var. Rosea	*J. podagrica*	*J. multifida*
J. curcas	S	H	H	H	X	H
J. gossypifolia	H	S	X	X	X	X
J. integerrima	X	X	S	X	X	X
J. integerrima var. Rosea	X	X	X	*	X	X
J. podagrica	X	X	H	X	S	H
J. multifida	X	X	H	X	X	S

H-Successful X-Unsuccessful S-Selfed *- No fruit set

Interestingly, *J. integerrima* var. Rosea failed to set seed following selfing and crossing. Failure of fruit development in this species was established to be solely physiological. *J. tanjorensis*, a species found abundant in certain tracts of Tamil Nadu and grown as a fence plant due to its luxuriant growth habit showed intermediacy in phenotypic characters of *J. curcas* and *J. gossypifolia*. A detailed survey at its place of occurrence supplemented with cytological and biochemical evidences revealed this new species reported by the Botanic survey of India (Ellis and Saroja, 1961) to be a naturally occurring interspecific hybrid between *J. curcas* and *J. gossypifolia*. Abnormal meiotic divisions in the hybrids due to the parental genomic differences results in very poor male and female fertility leading to failure of fruit set.

In spite of strong reproductive isolation barriers between *Jatropha* and castor, *Jatropha* still has an important place in castor improvement since they possess many desirable attributes like pest and disease resistance which are lacking in the available castor germplasm. With the advent of modern biotechnological tools like somatic hybridization and genetic engineering, vast scope exists to transfer these desirable traits into castor. Since several species of *Jatropha* are cultivated for their ornamental flowers and a few for their potential as fuel substitute, any improvement in these species will have far reaching and positive implications.

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