

Interspecific hybridization of *Jatropha curcas* L. and two wild *Jatropha* species

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Abstract

The hybridization of *Jatropha curcas* with *Jatropha integerrima*, *Jatropha podagrica* was carried out at Myanmar Industrial Crops Development Enterprise, Yangon in 2008. The habit of both hybrids was large stem with reduced branches. The leaf surface especially the lower surface has red patches. The leaves from both hybrids were more similar in size and shape but the petiole color of both hybrids were pale red color were observed from the hybridization. The calyx of both hybrids was green color although both of their parents *Jatropha podagrica* and *Jatropha integerrima* were scarlet color. The corolla of *Jatropha curcas* was greenish white with both male parents were red. The flowers of hybrids of *curcas* x *integerrima* was pure white and pink color but that of *curcas* x *podagrica* was pink. The pink color flower of *integerrima* and *podagrica* was exactly the same. The seeds of *Jatropha curcas* was large and black and ovoid, whereas *integerrima* was small, white mottle on light brown and *podagrica* was small, brown ovoid-ellipsoid. The seeds of both hybrids were intermediate in size, brown mottle on black and ovoid as in *curcas*. The fruits of both male parents were small, rounded and green while *Jatropha curcas* was big and green. The fruits of both hybrids were large, rounded and green, trigonous. In the hybridization, most characters of both hybrids were descendant from the female parent, *Jatropha curcas*. There was a point to note that *integerrima*, *podagrica* and pink hybrids, if the petal is pink, the carpels are also pink.

Key words: hybridization, hybrid

Introduction

In the recent times, efforts are being made to explore plant based fuel resources as a substitute for fossil fuels, which are renewable and environmentally safe. Among them, *Jatropha curcas*, an excellent shrub having natural spread across the globe, is one of the promising biofuel crops ideally suitable for growing in the wastelands comprising of 170 species, is a native of Mexico and Central America of the country (M. Paramathma, S. Reeja, 2009). Interspecific hybridization has been attempted between different species of *Jatropha* with limited success (Dehgan, 1948 and Sujatha, and Prabakaran, 1997). Hybridization has been attempted between *Jatropha curcas* and its related species of *Jatropha integerrima* and *Jatropha podagrica* (Parthiban, Senthil Kumar, 2009).

Jatropha curcas is a small tree or large shrub which can reach a height of up to 5m. It has 5 to 7 shallow lobed leaves with length and width of 6 to 15cm, which are arranged alternately (Heller, 1996). The plant is monoecious and flowers are unisexual (Dehgan and Webster 1979). Ten stamens are arranged in two distinct whorls of five each in a single column in the androecium. The seeds are black, 2cm long and 1cm thick (Wiegr, 1930 and Droit, 1932) *Jatropha integerrima* is an erect ornamental shrub, grows up to 6m tall, native to West Indies Petiole length 1 – 3cm long, glabrous, inflorescence terminal, peduncle 10cm long, scarlet or pinkish unisexual flower, monoecious, stamens 10, the outer 5 filaments united for two-thirds of their length Fruit 1cm in diameter, seeds are small, slender, ellipsoid to ovoid (Scott and Craig Thomas, 2000). *Jatropha podagrica* is a small shrub, up to 1m

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height, native of Panama. Often found in conservatories, gardens and parks but thrive well in rich soil fully exposed to the sun and regularly watered. Branched are soft and succulent, deeply scarred where the leaves have fallen away, 25 to 30cm length leaves, long petiolated, glabrous, glaucous 3 – 5 lobed, orange red or scarlet flowers on terminal, Long stalk, cymes, unisexual, monoecious, male flowers are more in number than female flowers. Stamens 6 – 8, seated in a yellow disc, furnished with 5 yellow glands, filaments red. Fruits which are 3cm long and initially green are turning brownish on maturity and dehiscent (Scott and Craing Thomas, 2000).

Materials and methods

Locally collected some *Jatropha* species namely; *Jatropha curcas*, *Jatropha integerrima* and *Jatropha podagrica* were used in this study. Hybridization was conducted at green house of Myanma Industrial Crops Development Enterprise, Mayangone Township, Yangon Region in 2008.

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Interspecific hybridization between *Jatropha curcas* and *Jatropha integerrima*, *Jatropha podagrica* were conducted to develop a new promising variety. Reciprocal cross combination between *J. curcas* and *J. integerrima* and *J. podagrica* were performed. An intensive hybridization programmed has been attempted to develop new variety with higher female flowers and improved seed setting.

Crosses among different species was performed by using parents having prominent different phenotypes such as habit, leaves shapes, stigmatic surface, petals, sepals, fruits and seeds etc. Hundreds of flowers were used in hybridization. Pollen anthesis time is during 8:30 to 10:00 am and thus crossing was carried out at that time. Female flowers are not needed to emasculate because Genus *Jatropha* is monoeious. To prevent unnecessary pollen to stigma, nearly full grown female flower which petals are still closed were selected. Before pollen grains were put onto stigma, petals were carefully removed by forceps.

The male flowers were selected by checking pollen anthesis. The whole male flower was cut and pollen grains were placed on the stigmatic surface of the female for pollination. After pollination, the inflorescences were covered with paper bag. Hybridity was checked by using seedling characteristics such as habit, the plant height, leaf shape, and pigment on the lower surface of leaves, petiole length and colour, inflorescence, flower colour, stamen character, ovary and locule, stigmatic surface and fruits.

Results

Fertile fruits were formed after hybridization. Mature seeds were collected 42 days after pollination. Hybridity was checked by using seedling characteristics such as the size and shape of the leaves, and pigment on lower surface of leaves. Almost all fruits resulting from the hybridization of *Jatropha curcas* and *Jatropha integerrima* and that of *Jatropha curcas* and *Jatropha podagrica* derivatives abscised at early developmental stage, and a few fruits matured without any seed.

Morphology of *Jatropha curcas* Linn. , *Jatropha integerrima* Jacq. and their F1 hybrids

Table 1.1 Habit of *Jatropha curcas*, *J. integerrima* and their hybrid

Habit		
<i>Jatropha curcas</i>	<i>Jatropha integerrima</i>	Hybrid (<i>J. curcas</i> x <i>J. integerrima</i>)
Shrub	Shrub	Shrub
Highly branching	2 to 3 branches	unbranches
Latex present	Latex present	Latex present
Plant height = 173 cm	Plant height = 156 cm	Plant height = 170 cm
Gird = 14 cm	Gird = 9.5 cm	Gird = 11 cm



Jatropha curcas



Jatropha integerrima



Hybrid
(*J. curcas* x *J. integerrima*)

Figure 1.1 Habit of *Jatropha curcas*, *J. integerrima* and their hybrids

Table 1.2 Characteristics of leaf of *Jatropha curcas*, *Jatropha integerrima* and their Hybrid

Characteristics of Leaf		
<i>Jatropha curcas</i>	<i>Jatropha integerrima</i>	Hybrid (<i>J. curcas</i> x <i>J. integerrima</i>)
Simple	Simple	Simple
Alternate, 4 – 6 lobed	Alternate, pinnate leaves	Alternate, 3 lobed
Leaf length=13 cm	Leaf length=13 cm	Leaf length=16 cm
Leaf width=15 cm	Leaf width=5 cm	Leaf width=17 cm
Petiole length=6 cm	Petiole length=3 cm	Petiole length =15 cm
Petiole color =green	Petiole color = green to pink	Petiole color = green to pink



Figure 1.2 Adaxial view of *J. curcas*,
J. integerrima and their hybrid



Figure 1.3 Abaxial view of *J. curcas*,
J. integerrima and their hybrid

Table 1.3 Characteristics of male flowers of *Jatropha curcas*, *Jatropha integerrima* and their hybrid

Characteristics of male flower		
<i>Jatropha curcas</i>	<i>Jatropha integerrima</i>	Hybrid (<i>J. curcas</i> x <i>J. integerrima</i>)
10 stamens 5 glands on disc, the glands yellow color Greenish-yellow flower pentamerou	10 stamens no glands - Scarlet flower Pentamerous	10 stamens 5 glands on disc, the glands yellow two kinds of flower (pink and white) ,Pentamerous



Figure 1.4 Characteristics of male flowers of *J. curcas*, *J. integerrima* and their hybrid

Table 1.4 Characteristics of female flowers of *Jatropha curcas*, *Jatropha integerrima* and their hybrid

Characteristics of female flower		
<i>Jatropha curcas</i>	<i>Jatropha integerrima</i>	Hybrid (<i>J. curcas</i> x <i>J. integerrima</i>)
stigma 3, style 3 very short 5 glands on disc, the glands yellow color Greenish-yellow flower	Stigma 6 fids Style short, stout no glands - Scarlet flower	Stigma 6 fids Style short, stout 5 glands on disc, the glands yellow color two kinds of flower



Figure 1.5 Characteristics of female flowers of *Jatropha curcas*, *Jatropha integerrima* and their hybrid

Table 1.5 Characteristics of fruits of *Jatropha curcas*, *Jatropha integerrima* and their Hybrid

Characteristics of fruit		
<i>Jatropha curcas</i>	<i>Jatropha integerrima</i>	Hybrid (<i>J. curcas</i> x <i>J. integerrima</i>)
Big, rounded	Small, green	Intermediate, trigonous

*Jatropha curcas**Jatropha integerrima*

Hybrid

Figure 1.6 Characteristics of fruits of *Jatropha curcas*, *Jatropha integerrima* and their hybrid**Table 1.6 Characteristics of seeds of *Jatropha curcas*, *Jatropha integerrima* and their Hybrid**

Characteristics of Seed		
<i>Jatropha curcas</i>	<i>Jatropha indegerrima</i>	Hybrid (<i>J. curcas</i> x <i>J. integerrima</i>)
Big, black ellipsoid	Small Brown with spots	Intermediate ellipsoid

*Jatropha curcas*

Hybrid

*Jatropha indegerrima*Figure 1.7 Characteristics of seeds of *Jatropha curcas*, *Jatropha integerrima* and their hybrid

Table 1.7 Characteristics of ovaries of *Jatropha curcas*, *Jatropha integerrima* and their Hybrid

Characteristics of Ovary		
<i>Jatropha curcas</i>	<i>Jatropha indegerrima</i>	Hybrid (<i>J. curcas</i> x <i>J. integerrima</i>)
3 carpels	3 carpels	3 carpels
Syncarpous	Syncarpous	Syncarpous
One ovule in each locule	One ovule in each locule	One ovule in each locule

*Jatropha curcas**Jatropha indegerrima*

Hybrid

Figure 1.8 Characteristics of ovaries of *Jatropha curcas*, *Jatropha integerrima* and their hybrid**Morphology of *Jatropha curcas* L., *Jatropha podagrica* Hook. and their hybrid****Table 1.8 Habit of *Jatropha curcas*, *Jatropha podagrica* and their hybrid**

Habit		
<i>Jatropha curcas</i>	<i>Jatropha podagrica</i>	Hybrid (<i>J. curcas</i> x <i>J. podagrica</i>)
Shrub	Shrub	Shrub
Highly branching	1 to 3 branches	3 branch
Latex present	Latex present	Latex present
Plant height = 173 cm	Plant height = 33 cm	Plant height = 193 cm
Gird = 14 cm	Gird = 25 cm	Gird = 10 cm

*Jatropha curcas**Jatropha podagrica*Hybrid
(*J. curcas* x *J. podagrica*)Figure 1.9 Habit of *Jatropha curcas*, *Jatropha podagrica* and their hybrid

Table 1.9 Characteristics of leaf of *Jatropha curcas*, *Jatropha podagrica* and their hybrid

Characteristics of Leaf		
<i>Jatropha curcas</i>	<i>Jatropha podagrica</i>	Hybrid (<i>J. curcas</i> x <i>J. podagrica</i>)
Simple	Simple	Simple
Alternate, 4 – 6 lobed	Palmate lobed	Alternate, 3- lobed
Leaf length = 13cm	Leaf length = 23cm	Leaf length = 13cm
Leaf width =15cm	Leaf width= 24cm	Leaf width = 15cm
Petiole length = 6cm	Petiole length = 21cm	Petiole length = 6cm
Petiole color = green	Petiole color = green to pink	Petiole color = green

Figure 1.10 Adaxial view of *Jatropha curcas*, *Jatropha podagrica* and their hybridFigure 1.11 Abaxial view of *Jatropha curcas*, *Jatropha podagrica* and their hybrid**Table 1.10 Characteristics of male flower of *Jatropha curcas*, *Jatropha podagrica* and their hybrid**

Characteristics of male flower		
<i>Jatropha curcas</i>	<i>Jatropha podagrica</i>	Hybrid (<i>J. curcas</i> x <i>J. podagrica</i>)
10 stamens	8 stamen	10 stamens
Distinct in two whorls	no gland	Distinct in two whorls
5 glands on disc,	Pentamerous	5 glands on disc,

Figure 1.12 Characteristics of male flower of *Jatropha curcas*, *Jatropha podagrica* and their hybrid

Table 1.11 Characteristics of female flower of *Jatropha curcas*, *Jatropha podagrica* and their hybrid

Characteristics of female flower		
<i>Jatropha curcas</i>	<i>Jatropha podagrica</i>	Hybrid (<i>J. curcas</i> x <i>J. podagrica</i>)
stigma 3, style 3very short. 5 glands on disc, the glands yellow color	Stigma 6 fids Style short, stout no gland	Stigma 6 fids Style short, stout 5 glands on disc, the glands yellow color

Figure 1.13 Characteristics of female flower of *Jatropha curcas*, *Jatropha podagrica* and their hybrid**Table 1.12 Characteristics of fruit of *Jatropha curcas*, *Jatropha podagrica* and their Hybrid**

Characteristics of Fruit		
<i>Jatropha curcas</i>	<i>Jatropha podagrica</i>	Hybrid (<i>J. curcas</i> x <i>J. podagrica</i>)
Big rounded	Small rounded	Small trigonous

*Jatropha curcas**Jatropha podagrica*Hybrid
(*J. curcas* x *J. podagrica*)Figure 1.14 Characteristics of fruit of *Jatropha curcas*, *Jatropha podagrica* and their hybrid

Table 1.13 Characteristics of seed of *Jatropha curcas*, *Jatropha podagrica* and their

Hybrid		
Characteristics of Seed		
<i>Jatropha curcas</i>	<i>Jatropha podagrica</i>	Hybrid (<i>J. curcas</i> x <i>J. podagrica</i>)
Big rounded	Small rounded	Small trigonous
		

Figure 1.15 Characteristics of seed of *Jatropha curcas*, *Jatropha podagrica* and their hybrid.**Table 1.14 Characteristics of ovaries of *Jatropha curcas*, *Jatropha podagrica* and their**

Hybrid		
Characteristics of Ovary		
<i>Jatropha curcas</i>	<i>Jatropha podagrica</i>	Hybrid (<i>J. curcas</i> x <i>J. podagrica</i>)
3 carpels Syncarpous	3 carpels Syncarpous	3 carpels Syncarpous
		
<i>Jatropha curcas</i>	<i>Jatropha podagrica</i>	Hybrid (<i>J. curcas</i> x <i>J. podagrica</i>)

Figure 1.16 Characteristics of ovaries of of *Jatropha curcas*, *Jatropha podagrica* and their hybrid

Discussion

Jatropha curcas is shrubs, having simple, alternate leaves with 4-6 lobed. The flowers are monoecious and greenish white color. The character of male flower had 10 stamens in two distinct whorl, 5 glands on yellow color disc. The female flowers have 3 carpels and 3 stigmas and 5 glands on disc. The seeds are big, rounded and black. The morphology of *Jatropha integerrima* is shrub, the leaf simple, alternate and pinnate. The flowers are scarlet color. The male flower has 10 stamens in two distinct whorls. The female flowers contains 6 fids stigma, style short, stout, no glands. The seeds are small and dark brown with white spots. The morphology of

Jatropha podagrica is shrub, simple, palmate lobed. The flowers are monoecious. The male flowers have 8 stamens and no gland. The female flower contains 6 fids stigma, style short, and stout. The seeds are small and brown color.

Hybrid plants of *J. curcas* x *J. integerrima*, and *J. curcas* x *J. podagrica* are tall. The stem girth of hybrid plants are larger than that of *J. integerrima*, but lesser than those of *J. carcus* and *J. podagrica*. The size and shape of the leaves from the hybrids are almost the same with *J. carcus* but larger than that of *J. integerrima* but smaller in size and lobe number than that of *J. podagrica*. The abaxial view of both hybrid (*Jatropha curcas* x *Jatropha integerrima* and *Jatropha curcas* x *Jatropha podagrica*) are red colour. The petiole colors of both hybrids are pale red although their female parent has green and the male parents are pink to red color. Segregation in petiole colour is observed as a result of hybridization. Therefore, it is assumed that the petiole color of hybrids may be descended from their male parents.

The size of flower of the hybrid of *Jatropha curcas* and *Jatropha integerrima* showed that they are larger than that of *J. carcus* but smaller than that of *J. integerrima*. On the other hand, the size of flower of the hybrid of *J. carcus* and *J. podagrica* were slightly larger than those of *J. carcus* and *J. podagrica*. Although the calyx of both hybrids are green color even both parents (*Jatropha pidagrica* and *Jatropha integerrima*) are scarlet color. The corolla of *Jatropha curcas* is greenish white but both male parents are red. The petal color of the hybrid of *Jatropha curcas* and *Jatropha integerrima* are pink and white while that of from *J. carcus* and *J. podagrica* are only pink color was observed from the crosses. The pink color flowers of both hybrids are exactly the same with their parents. The fruits of both male parents are small, rounded and green while *Jatropha curcas* is big and green in young but when mature the fruits color turned to yellow then black. But the fruit of *Jatropha integerrima*, *Jatropha podagrica* and both hybrids are green. The F₁ progeny has exhibited the vigorous growth, but its fruit is small in size resembling as *Jatropha integerrima* (Krishnan and Paramathma 2009). The fruits of both hybrids are intermediate, trigonous and green. The seeds of *Jatropha curcas* are large, black and ovoid, whereas *J. integerrima* is small, brown color with spots, mottle on brown and the seed of *J. podagrica* is small, brown, and ovoid-ellipsoid. The seeds of both hybrids are intermediate, black and ovoid as in *curcas*. In the hybrid, most characters are descendant from the female parent, the *Jatropha curcas*. However, the locule colour of both hybrids is pink.

Both hybrids are found to be vigorous growth at all stages of growth and that was resembled to their maternal parent *Jatropha curcas*. The branching pattern, leaf shape, leaf size and increased number and proportion of male and female flower of both hybrids are resembled to their male parent (*Jatropha integerrima*) but their flower color is in intermediate colour. The flower colour among the hybrids varied from greenish white to pure white and pink. The flower size of hybrids also ranged from small to medium. Generally the fruit size of F₁ is smaller as in *J. integerrima* whereas its size is similar to *J. curcas*. In few hybrids, the F₁ seeds showed slight mottling as in *J. integerrima* and are smooth (Paramathma, *et al.*, 2006).

The characters of hybrid has consensus with previous research work of Parthiban *et al.* (2009) who conducted the hybridization of *Jatropha curcas* x *Jatropha integerrima* and *Jatropha curcas* x *Jatropha podagrica*. In conclusion, most of characters possessed in the hybrids were descended from the female parent, the *Jatropha curcas*. There was a fact to note that the carpels of the male parents (*J.*

podagrica and *J. integerrima*) and the resulted hybrids are pink, it may be due to the presence of pinkish corolla which were present in both male parents.

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