‘Kamphaeng Saen 1’, ‘Kamphaeng Saen 2’, and ‘Kamphaeng Saen 3’: New Ornamental *Jatropha* Cultivars Derived through an Interspecific Cross

Narathid Muakrong

Plant Breeding Program, Faculty of Agriculture at Kamphaeng Saen, Kasetsart University, Kamphaeng Saen, Nakhon Pathom 73140, Thailand

Patcharin Tanya and Peerasak Srinives¹

Department of Agronomy, Faculty of Agriculture at Kamphaeng Saen, Kasetsart University, Kamphaeng Saen, Nakhon Pathom 73140, Thailand

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The genus *Jatropha*, a member of Euphorbiaceae family, comprises ≈176 known species (Kumar and Sharma, 2008). This genus distributes widely in tropical, subtropical, and semiarid zones in the forms of woody trees, rhizomatous plants, geophytes, shrubs, and sub-shrubs (Dehgan, 1984). Two better known species, *Jatropha curcas* L. and *Jatropha integerrima* Jacq., are cultivated for different uses. *J. curcas* (jatropha, physic nut) is an oil-bearing tree native to Central America and later introduced to Africa and Asia. It is presently grown in many countries in tropical and subtropical regions, mainly as a natural fence or for seed oil used in biodiesel production. *J. integerrima* (peregrina) is native to India and grown for commercial ornamental potted plant and outdoor gardening (Lakshminarayana and Sujatha, 2001). Its flowers are of raceme type with deep red to pink florets setting year-round, whereas fruiting is rare giving small seeds. Interspecific hybridization among both species showed a potential for ornamental purpose in India (Sujatha and Prabakaran, 2003).

‘Kamphaeng Saen 1’, ‘Kamphaeng Saen 2’, and ‘Kamphaeng Saen 3’ are new ornamental *jatropha* cultivars improved by the *Jatropha* breeder team of Kasetsart University, Kamphaeng Saen campus, Thailand, for potted plants and gardening. The varieties flower year-round with unique flower colors. They are easily propagated by cutting or grafting. The cultivars were released in 2013 for ornamental growers to produce commercial potted plants in Thailand.

Origin

New ornamental *jatropha* cultivars Kamphaeng Saen 1, Kamphaeng Saen 2, and Kamphaeng Saen 3 were derived from interspecific hybridization made in the year 2007 between *J. curcas* var. ‘Cn’ and red-flowered *J. integerrima* var. ‘Jid’. ‘Cn’ is a local *jatropha* from Chai Nat province of Thailand with tall plant and prolific light green flowers (Fig. 1A). ‘Jid’ is a commercial dwarf type with prolific deep red flowers (Fig. 1B). One F₁ plant (plant number CnJid-4) with a pink corolla color (Fig. 1C) was self-pollinated in 2008 to obtain 74 F₂ plants in 2009. The F₂ plants were observed in a field for 1 year and plant numbers CnJid-4-3, CnJid-4-4, and CnJid-4-74 were initially chosen in 2010. The selected plants were consecutively evaluated for ornamental performance for 2 years and registered with Kasetsart University and the Department of Agriculture, Thailand, as ‘Kamphaeng Saen 1’, ‘Kamphaeng Saen 2’, and ‘Kamphaeng Saen 3’, respectively. The pedigrees of all three cultivars are given in Figure 2.

Description

To obtain desirable cultivars, individual plants are grown in a 40-cm diameter plastic pot filled with 10 kg commercial soil, kept outdoors under full sunlight, and watered regularly. The colors of their flowers and leaves were described on the Royal Horticultural Society (RHS) Color Chart (Royal Horticultural Society, 2007).

‘Kamphaeng Saen 1’ (KPS1) is a medium bush, simple leaf of cordate–acuminate shape. A full-grown leaf is 7 to 9 cm wide and 8 to 11 cm long, four-lobed, and netted venation. The upper leaf surface is dark green (RSH 141A), whereas the lower surface is light green (RSH 143A) with spotted red–purple pigment (RSH 59B) covering ≈50% of the surface. The petiole is 8 to 9 cm long, spirally arranging in branches. The flowers were monoecious type with separate female and

male flowers locating on the same inflorescence. The inflorescence is a compound dichasium, 7 to 9 cm long from base to tip, and each bears three to four female flowers and 50 to 60 male flowers (Table 1; Fig. 1D–E). The female flowers bloom 1 to 2 d before male flowers. Both female and male flowers have five rotated corolla tubes with diameter of 1.4 to 1.6 cm. The corolla are red–purple (RHS 57C) in both male and female flowers with 10 yellow (RHS 13B) anthers and red–purple (RHS 64D) filaments. KPS1 sets only a few fruits, being green (RHS 141C) when young and yellow (RHS 8A) when ripening; each fruit contains two to three seeds.

‘Kamphaeng Saen 2’ (KPS2) is a medium bush bearing simple leaf of cordate–acuminate shape. A mature leaf is 5 to 6 cm wide and 6 to 8 cm long, two-lobed, and netted venation. The leaf upper surface is dark green (RHS 134A), whereas the lower surface is light green (RHS 143C) with spotted red–purple pigment (RHS 59B) covering ≈30% of the surface. The petiole is 4 to 5 cm long, spirally arranging in branches. The flowers are monoecious, having separate female and male flowers located on the same inflorescence. The inflorescence is a compound dichasium, 8 to 10 cm long from base to tip, and each bears three to six female flowers and 40 to 50 male flowers (Table 1; Fig. 1F–G). Female flowers bloom 1 to 2 d earlier than male flowers. Both male and female flowers have five rotated corolla tubes with a diameter of 1.4 to 1.5 cm. The corolla are light red–purple (RHS 65B) at the tip and red–purple (RHS 65A) at the base with 10 yellow (RHS 12B) anthers and white (RHS 155 B) filaments. This cultivar has no fruit set.

‘Kamphaeng Saen 3’ (KPS3) is a dwarf bush, bearing simple leaf of cordate–acuminate shape. A mature leaf is 6 to 8 cm wide and 8 to 10 cm long without a lobe with netted venation. The upper leaf surface is dark green (RHS 137A), whereas the lower surface is light green (RHS 138B). The petiole is 6 to 7 cm long spirally arranging in branches. The flowers are monoecious with separate female and male flowers on the same inflorescence. The inflorescence is a compound dichasium, 6 to 8 cm long from base to tip, and each bears two to three female flowers and 50 to 65 male flowers (Table 1; Fig. 1H–I). Female flowers bloom 2 to 3 d before male flowers. Both male and female flowers have five rotated corolla tubes with a diameter of 1.5 to 1.8 cm. The corolla are red (RHS 52A) in both male and female flowers; the 10 anthers are yellow (RHS 7A) with white (RHS 155C) filaments. This cultivar has no fruit set.

Testing Performance of the Cultivars

Testing performance as potted plants. We compared growth, number of inflorescences per plant, and propagation ability among three new ornamental *jatrophas* and peregrina. Ornamental characters of the cultivars were observed from 60-d-old grafted plants

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¹To whom reprint requests should be addressed; e-mail agrps@yahoo.com.

Fig. 1. (A) Light green flowers of *J. curcas* ('Cn'), a local accession from Chai Nat province, Thailand. (B) Red flowers of dwarf *J. integrerrima* ('Jid'), a commercial ornamental cultivar in Thailand. (C) Pink flowers of the F₁ hybrid plant CnJid-4 from a cross between 'Cn' and 'Jid'. (D) Inflorescences of ornamental jatropha 'Kamphaeng Saen 1'. (E) 'Kamphaeng Saen 1' grown in a pot at 90 d after grafting. (F) Inflorescence of ornamental jatropha 'Kamphaeng Saen 2'. (G) 'Kamphaeng Saen 2' grown in a pot at 90 d after grafting. (H) Inflorescence of ornamental jatropha 'Kamphaeng Saen 3'. (I) 'Kamphaeng Saen 3' grown in a pot at 90 d after grafting.

Fig. 2. Pedigree of ornamental jatropha cultivars Kamphaeng Saen 1, Kamphaeng Saen 2, and Kamphaeng Saen 3.

using *J. curcas* as the rootstock. The grafted plants were grown in 40-cm diameter plastic pots each filled with 10 kg commercial soil. Osmocote (14N-14P₂O₅-14K₂O) fertilizer

was applied three times, at 2, 5 and 8 months after transplanting. The experimental design was a completely randomized design (CRD) with three replications. Each experimental

unit consisted of five potted plants evaluated outdoor under full sunlight for 12 months during 2011–12 at Kasetsart University, Kamphaeng Saen campus, Thailand. Because the new jatropha cultivars were developed from interspecific crossing, their propagation ability may not be normal and thus had to be studied.

Ability in cutting propagation. To determine the propagating ability of the cultivars, their cuttings were treated with indole-3-butyric acid (IBA) at 0, 2000, 4000, 6000, and 8000 ppm. Stems and branches were cut to 20 to 25 cm long and soaked in a fungicide solution for 1 min. Then the basal end of the cuttings were dipped in each concentration of IBA for 1 min and air-dried for 2 to 3 min before transplanting individual cutting in a plastic bag containing 400 mL 1:1 sand and commercial soil. The cuttings were kept in a nursery under 50% sunlight at 28 to 30 °C controlled temperature and arranged in a completely randomized design with three replications. Each experimental unit consisted of 18 to 43 cuttings. Percentages of survival plants were recorded 3 months after planting of the cuttings.

Ability in grafting propagation. To determine grafting performance of the ornamental jatrophas, their branch tips (5 to 10 cm long) were grafted on to 75-d-old 'Cn' seedlings (1 to 1.5 cm stem base diameter) as rootstocks. The grafted seedlings were kept in a small plastic tunnel in a nursery under 80% control humidity and 50% sunlight. The experimental design was a CRD with three replications. Each experimental unit consisted of 18 to 43 grafted tips. Percentages of survival plants (successful grafting) were recorded 3 months after grafting.

Data Analysis

Analysis of variance and treatment mean comparison by Duncan's multiple range test were performed using the R freeware program (R Development Core Team, 2010).

Varietal Performance and Propagation Ability

All three cultivars started flowering 50 to 55 d after grafting the shoot tips and 60 to 65 d after planting the cuttings. Growth

performance and number of inflorescences of the cultivars and the male parent ('Jid') were different in all characters observed (Table 1). KPS1 has a medium canopy height

Table 1. Canopy height and width, canopy height/width ratio, and number of inflorescences per plant of three new ornamental jatrophas and the male parent peregrina ('Jid') after growing in pots for 1 year.^z

Cultivars	Ht (cm)	Width (cm)	Ht/width ratio	Inflorescences/plant ^x	Inflorescence length (cm)
Kamphaeng Saen 1	124.1 ± 7.0 b ^y	141.7 ± 11.8 b	0.9 ± 0.03 b	491 ± 35.3 b	8.40 ± 0.80 bc
Kamphaeng Saen 2	164.3 ± 8.2 a	215.8 ± 23.3 a	0.8 ± 0.05 c	606 ± 46.5 a	9.32 ± 1.43 b
Kamphaeng Saen 3	84.4 ± 3.4 d	97.8 ± 6.5 c	0.9 ± 0.03 b	417 ± 22.0 c	7.18 ± 0.94 c
Peregrina (Jid)	99.5 ± 2.8 c	105.9 ± 8.6 c	1.0 ± 0.08 a	391 ± 19.6 c	13.26 ± 1.56 a

^yMean of three replications; each consisted of five plants.

^zMeans within a column are compared by Duncan's multiple range test at $P \leq 0.05$.

^xMean of inflorescences set on each plant per year.

Table 2. Survival percentages of stem cuttings of three new ornamental jatrophas and the male parent peregrina ('Jid') after dipping with different concentrations of IBA.^z

IBA (ppm)	Cultivars			
	Kamphaeng Saen 1	Kamphaeng Saen 2	Kamphaeng Saen 3	Peregrina (Jid)
0	33.3 d ^y	21.7 c	11.7 b	13.4 d
2000	60.0 bc	73.3 ab	15.0 b	25.1 cd
4000	78.3 ab	70.0 ab	18.3 ab	30.0 c
6000	85.0 a	80.0 a	23.4 a	61.7 b
8000	46.7 cd	65.0 b	23.3 a	80.0 a
% cv	18.79	10.62	22.27	18.95

^yPercentages of survival plants averaged from three replications, each with 20 cuttings. Data were recorded 3 months after keeping the cuttings in a nursery under 50% sunlight.

^zMeans within a column were compared by Duncan's multiple range test at $P \leq 0.05$.

IBA = indole-3-butyric acid.

Table 3. Survival percentages of three new ornamental jatrophas and the male parent peregrina ('Jid') grafted on *J. curcas* female parent ('Cn') rootstocks.^z

Cultivars	No. of grafted plants	No. of survival plants	Survival (%) ^y
Kamphaeng Saen 1	80	74	93.3
Kamphaeng Saen 2	125	118	94.6
Kamphaeng Saen 3	73	67	91.7
Peregrina (Jid)	55	45	81.6

^yNumber of grafted plants were combined from three replications, each with 18 to 43 scions. Data were recorded 3 months after keeping the grafted plants in a nursery under 50% sunlight.

^zSurvival percentages of the grafted scions are not different as compared by Duncan's multiple range test at $P \leq 0.05$.

and width averaging 124 cm tall and 142 cm wide with a height/width ratio of 0.9. KPS2 has a tall and wide canopy, averaging 164 cm tall and 215 cm wide with a height/width ratio of 0.8. Both cultivars are taller and wider than 'Jid', which is 100 cm tall, 106 cm wide, with a height/width ratio of ≈ 1.0 . KPS3 is the smallest cultivar showing the canopy height of 85 cm and width of 98 cm with a height/width ratio of 0.9. Its canopy is narrower than KPS1 and KPS2 but not different from 'Jid'. KPS1 and KPS2 give a high number of inflorescences per plant per year, averaging 491 and 606, respectively. KPS3 gives an average of 417 inflorescences a year, which is not different from 'Jid' (391 inflorescences).

The suitable concentration of IBA for high survival rate of stem cuttings in the ornamental jatropha cultivars is 6000 ppm, giving 85% survival in KPS1 and 80% in KPS2. A rather poor performance was observed in KPS3, giving only 23.4% survival (Table 2). However, all cultivars showed equally high performance in grafting propagation using *J. curcas* cv. Cn (the female parent) as the rootstock (Table 3), giving over 90% survival. The stem tissues of root stock and scion are very compatible.

In summary, 'Kamphaeng Saen 1', 'Kamphaeng Saen 2', and 'Kamphaeng Saen 3' are new ornamental jatrophas developed from a cross between *J. curcas* cv. Cn and

a commercial dwarf *J. integerrima* ('Jid') from Thailand. The new cultivars are unique in flower colors, which are not found in the current commercial ornamental peregrina. The cultivars come in three different sizes, i.e., KPS2, KPS1, and KPS3 with large, medium, and small canopies, respectively. The cultivars are flowering year-round and easy to propagate. KPS1 and KPS2 can be propagated by either cutting or grafting, whereas KPS3 should be propagated by grafting.

Availability

The three new ornamental jatropha cultivars Kamphaeng Saen 1, Kamphaeng Saen 2, and Kamphaeng Saen 3 were registered at Kasetsart University and the Department of Agriculture of Thailand in 2013 and made available to the public since then.

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