DENDROBIOLOGY
2011, vol. 65, 63–71

Md. Aktar Hossain, Mandira Sen, Muhammed Ikhtiar Uddin Jewel, Md. Alamgir Kabir

Propagation of *Flacourtia jangomas*: an approach towards the domestication of a wild fruit species in Bangladesh

Received: 29 September 2010; Accepted 15 December 2010

Abstract: The study was carried out to investigate the domestication potential of *Flacourtia jangomas* (Lour.) Raeusch, a wild fruit species in Bangladesh, through nursery raising from seeds and clonal propagation by stem cutting. Air dried seeds were treated with four different pre-sowing treatments *i.e.,* control (T0), seeds soaked in cold water for 24 h (T1), 48 h (T2), or 72 h (T3) to explore the seed germination ability of the species. Pre-sowing treatments significantly enhanced the germination period, germination percentage and biomass production of seedlings. The early germination (least imbibition period), highest germination percentage (81.3) and total dry biomass (0.52 g) was observed in T2 (seeds soaked in cold water for 48 h) while the lowest germination percentage (53.7) and total dry biomass (0.23 g) was observed in T3 and T0 respectively. The plant species was highly amenable for rooting for clonal propagation. However, the rooting ability of cuttings was significantly affected by the application of IBA. The highest rooting percentage (100), maximum root number (5.63), the longest root length (3.28 cm) and best survival (85.0%) were obtained from the cuttings treated with 0.4% IBA solution followed by 0.2% IBA and the lowest was in cuttings without treatment. Therefore, pre-sowing treatment 'soaking of seeds in cold water for 48 h for nursery raising and '0.4% IBA treatment' of stem cuttings for clonal propagation may be recommended for mass production of quality planting stocks for the domestication of the species through homestead agroforestry or in fruit orchards.

Additional key words: Domestication, germination, rooting ability, seedling, stem cutting, wild fruit.

Addresses: M. A. Hossain, Mandira Sen, I.U. Jwel, Institute of Forestry and Environmental Sciences, University of Chittagong, Chittagong -4331, Bangladesh, e-mail: aktar_forestry@hotmail.com
M. Alamgir Kabir, Division of Biotechnology, College of Life sciences and Biotechnology, Korea University, Seoul 136-713, Republic of Korea, Department of Agroforestry, Patuakhali Science and Technology University, Patuakhali-8602, Bangladesh.

Introduction

Despite of substantial increasing of food production in the country over the past two decades, people of Bangladesh are still poorly nourished. Many of them suffer from malnutrition and its related diseases. Every effort is therefore needed to improve the nutritional status and to increase the food security, particularly for the rural poor (FAO 1992). Although the wild fruits derived from forest areas are not consumed in greater quantities compared to main food staples; they add variations in diets, improve the palatability of staple foods and provide essential vitamins, minerals, proteins, carbohydrates, fats and cal-

ories inexpensively. They are also used extensively as snack eaten, for example, while working in the fields or herding livestock. Wild fruit trees offer vital insurance against malnutrition or famine during the seasonal food shortage and/or emergencies such as drought, floods and wars.

Although the exact figure of the wild fruit species in the country is not known, Das (1987) compiled a list of sixty wild edible fruit species from the forest areas of Bangladesh. *Flacourtia jangomas* (Lour) Raeusch (Synonym*: Flacourtia cataphracta*; Family: *Flacourtiaceae*) commonly known as coffee plum, Indian plum or Indian cherry, Paniala, Puneala is one of the important wild fruit species in the country. It is a small (6-10 m tall) tropical deciduous tree (Fig. 1) native to Bangladesh, India and Myanmar commonly cultivated throughout the Southeast Asia, Eastern Malaya, Philippines and very limited way in Surinam, Trinidad, Puerto Rico and Southern Florida. In Bangladesh, this tree species occurs naturally in the forests of Chittagong, Chittagong Hill Tracts, Sylhet and Cox Bazar (Das 1987; FAO 1984).

The fruits of *F. jangomas* are round, about 1 cm in diameter, fleshy when fresh, dark red or purple to nearly black, smooth and enclosing 6–10 small flattened seeds (Fig. 1) (FAO 1984). The taste varies from acid to sweet; it can be eaten out of hand or made into juice or marmalade. The fruits are highly nutritious containing 3.9% (based on dry weight) protein, 2.2 mg g^{-1} vitamin C, 21% sucrose with a considerable amount of Ca, K, P, Fe and Mg (Kermasha et al. 1987). These fruits would be useful as supplements to a balanced diet. The fruits and leaves are used against diarrhea, dried leaves for bronchitis and roots against toothache. However, due to the indiscriminate felling of forest trees with conversion of forest land for agriculture, industries and housing, the species became one of the threatened species in the country. Under the circumstances, efforts are necessary for the preservation and propagation of the species for genetic conservation and fruit production. Domestication of wild fruit species is thought to be the potential option for protecting and conserving the endangered and threatened species as well as genetic improvement and mass production of fruits with quality.

There are different methods of domestication of plant species including various stages of development as mentioned by Booth and Turnball (1994). Among the stages, regeneration or propagation of the species play vital roles in the domestication process. Plants can be regenerated through seed germination or vegetative means like budding, grafting, stem cuttings or tissue culture. However, very little is known about the regeneration of the *F. jangomas*. FAO (1984) mentioned that the species is naturally regenerated through seed dispersed by birds. To a limited extent the species is also propagated from seeds in nurseries. The seeds are slow to germinate; therefore propagation is usually by inarching or budding onto self-seedlings and with rare exception of *invitro* regeneration (Chandra and Bhanja 2002). The information about

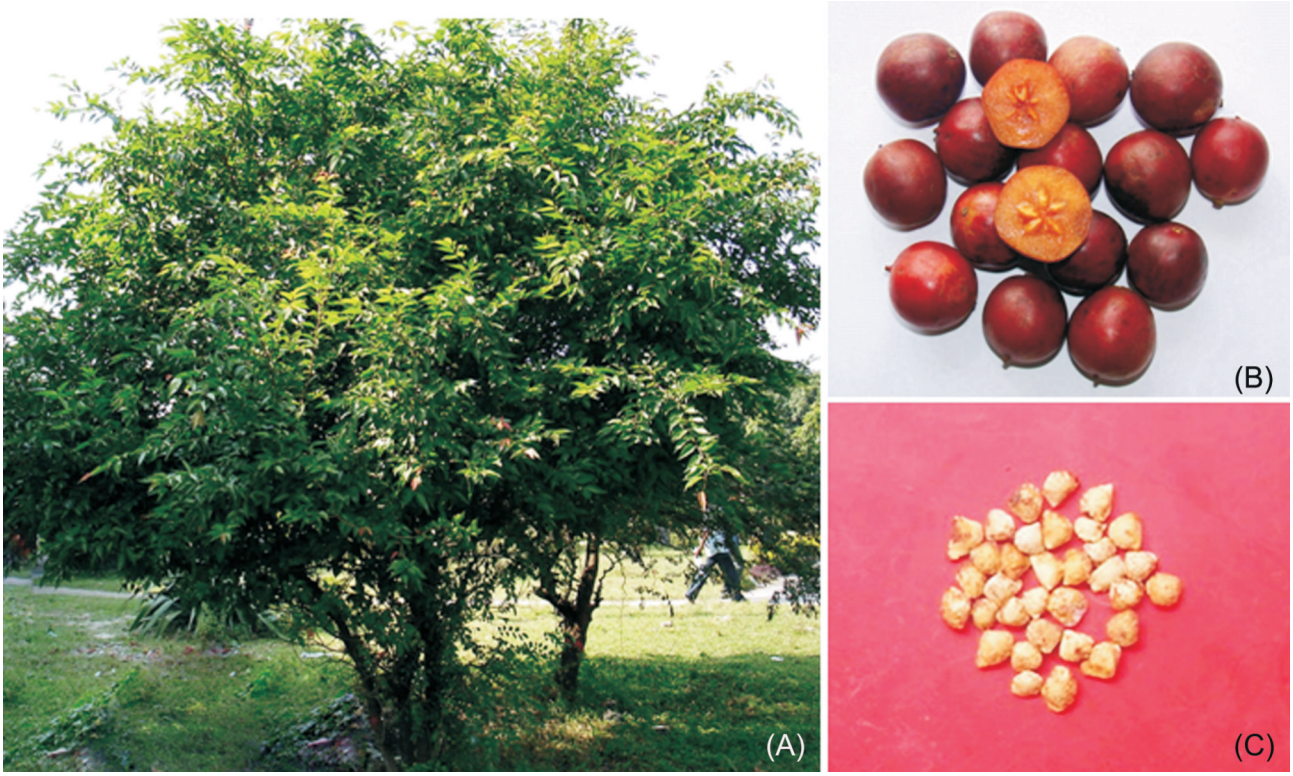

Fig. 1. Full grown trees (a), ripe fruits (b) and seeds (c) of *F. jangomas*

the artificial regeneration of the species through seed germination or vegetative propagation by stem cutting is very scarce and therefore extensive research in this aspect is needed. The regeneration of the *Flacourtia jangomas* through seed germination and clonal propagation through stem cuttings have been examined in this study with an aim to investigate the potentials of the species for domestication considering its role in rural livelihood.

Material and methods

The study was conducted in the nursery at Chittagong University campus (located at the intersection of 22°30'N and 91°50'E), Bangladesh which enjoys typically tropical climate characterized by hot humid summer and cool dry winter. The mean monthly temperature varies from 21.8°C to 29.2°C maximum and from 15°C to 26°C minimum. Relative humidity is minimum (64%) in February and maximum (95%) in June to September. Mean annual rainfall of the area is about 300 cm, which mostly takes place between June and September. The day length varies from 10 h 45 min in December to 13 h 25 min in June.

Propagation by seeds

Fruit collection and seed extraction

Fully ripe fruits of *F. jangomas* were collected in early June from selected trees from the forest areas of Rangamati Hill District. Fruits uniform in size were used in this study to reduce the non-treatment variations at the germination stage since germination percentage and seedling vigor was found positively correlated to seed size (Indira et al. 1999). Collected fruits were kept in water for a week to allow flesh pulp rotting and depulping. Extracted seeds were dried and stored in an airtight container until pre-sowing treatments were started.

Pre-sowing treatments and setting up the experiment

Dried and stored viable seeds (at 12% moisture content) were treated under four different pre-sowing treatments in water. Seeds were soaked in cold water (25 ± 2°C) for 0 h (control; T0), 24 h (T1), 48 h (T2) or 72 h (T3). A Completely Randomized Block Design was adopted for the experiment with three replications for each treatment. Three trays (each contained 50 seeds served as a plot) were used for 3 replications per treatment. Thus each treatment consisted of 150 seeds (3×50) and a total of 600 seeds were subjected to 4 different pre-sowing treatments. Seeds were dibbled at a depth of 0.5 cm and covered with thin layer of soil.

The effects of pre-sowing treatments were explored by recording imbibition period and counting germinated seeds to determine the seed germination pattern. The seed germination criterion was visible protrusion on the surface of soil at least 0.5 cm of the cotyledons and hypocotyl of the seedlings. Germination period, cumulative germination (recorded in every alternative day) and germination percentage (from the day of sowing till ending of the germination totaling 72 days) were determined from germination data. For each assessment date, daily germination was summed up to obtain cumulative germination number for each treatment. Germination percentage was determined as the number of seeds germinated out of 100 from the beginning to the end of germination trial.

To determine the growth performance, 20 seedlings from each treatment were randomly uprooted four months after sowing the seeds and measured for total length, shoot length, root length, number of leaves and root collar diameter. The seedlings were then separated into shoot, root and leaf components and dried in electric oven at 70°C for 48 h for dry weight assessment. Vigor index of the seedlings was calculated according to Abdul-Baki and Anderson (1973) as germination percent × seedling total length (*i.e.* total of shoot and root length).

Clonal propagation by stem cutting

Growing of stockplants, preparation of cuttings and setting up the experiments

Shoots of *F. jangomas* were collected from 2-year old stockplants raised in the nursery orchard. Two-node cuttings with two leaves trimmed to half were prepared and immersed briefly in a solution of fungicide Diathane M45 (Rohm and Co. Ltd., France; 2 g L^{-1} in water) to avoid fungal infection. The cuttings were then rinsed and kept under shade for 10 min in open air. The cutting length and diameter were kept uniform to avoid non-treatment variation. The average length and diameter of the cuttings were 5.5 to 6.5 cm and 2.3 to 2.7 mm respectively.

Rooting ability was tested by treating the cuttings with 0% (control), 0.2%, and 0.4% IBA solutions. Cuttings were treated by dipping the cutting base into IBA solution and planted into perforated plastic trays (12 cm depth) filled with coarse sand mixed with fine gravel. The trays containing the cuttings were then placed into a non-mist propagator (Kamaluddin 1996) for rooting following a complete randomized block design.

A total of 180 cuttings were placed under three different treatments with three replications. Treated cuttings were planted in 18 trays, 6 trays for each treatment (0%, 0.2% and 0.4% IBA solution) and each tray (containing 10 cuttings) served as a plot. Thus the number of replicate cuttings per treatment was 60. The cuttings were watered once only just after setting into the propagator. A light water spray

was done every morning with a hand spray till the transferring the rooted cuttings from the propagator.

Propagator environment, aftercare and transplanting

Relative humidity was maintained at around 85% in the propagator. The propagator was opened twice a day, early in the morning and the late afternoon to facilitate gaseous exchange. After six weeks in the rooting medium, the rooted cuttings in the propagator were weaned before transferring them into poly bags, particularly towards the end of rooting period during root lignification. For weaning, the propagator was kept open at night for three consecutive days and then at day and night for another three days. The weaned rooted cuttings were then transferred into poly bags filled with soil and decomposed cowdung at a ratio of 3:1. Before planting into the poly bags, rooted cuttings were measured for rooting percentage, number of roots developed per cutting and the length of longest root.

To explore steckling capacity (the survival ability of the rooted cuttings after transferring into poly bags), transplanted poly bags were kept in shade for a week before placing them in sun for normal growth. After four months, the initial growth performance of the rooted cuttings was assessed by measuring total height, collar diameter and leaf number for all cuttings.

Data analysis

All data were analyzed with Microsoft Excel and SPSS. Possible treatment variations were explored by Analysis of Variance (ANOVA) and Duncan's Multiple Range Test (DMRT). Germination percentage values and rooting percentage were adjusted accordingly using arc sign transformation formula before putting the data into analysis of variance since both the germination percentages and rooting percentages were distributed between the range 30 and 100.

Results and discussions

Regeneration from seeds

Germination period

Different pre-sowing treatments significantly affected the germination period and germination percentage of *F. jangomas* seeds (Table 1). The fastest seed germination (started at day 22 and ended at day 66) with highest germination percentage (82.7) was observed when seeds were soaked in cold water for 48 h (T2) followed by 72 h (T3). On the other hand, the slowest germination (started at day 32 and ended at day 69) with lowest germination percentage (61.3) was in control (T0). Seed soaking in water is known to enhance the germination by reducing the imbibition period. For instance, Hossain et al. (2005a, 2005b) reported the fastest germination of depulped seeds of *Terminalia belerica* and *T. chebula* (31days and 29 days after sowing seeds respectively) soaking in cold water for 48 h compared to 41 days and 45 days respectively in controlled seeds. However, Uddin (2005) mentioned that early germination of *T. belerica and T. chebula* was observed in seeds soaked in cold water for 72 h. The enhanced germination percentage of seeds after soaking in water was supported by the studies of many authors. Hossain et al. (2005a, 2005b) reported that the highest germination of *T. belerica and T. chebula* (88.9% and 66.7% respectively) was in depulped seeds soaked in cold water for 48 h followed by 24 h. The lowest germination (58.9%) was in the control variant. Rashid et al. (1990) reported that seeds of *T. chebula* and *T. belerica* pre-treated by soaking in cold water for 48 h with successive treatment by 10% sulfuric acid for 20 min showed up to 70% germination. Similar result was reported by Ara et al. (1997) who mentioned 70–75% germination in *T. belerica* seeds after soaking in water for 48 h and depulping the fruits thereafter. Again, Uddin (2005) reported the highest germination percentage in depulped seeds, soaked in cold water for 48 h for both the species *T. chebula* (73.3) and *T. belerica* (93).

Seed germination pattern

Mean daily germination percent varied in different days for different pre-sowing treatments for *F. jangomas* seeds (Fig. 2). The highest mean daily germina-

Table 1. Germination period of *F. jangomas* seeds as a result of various pre-sowing treatments

Variables	Treatment				*p*
	T0	T1	T2	T3	
Germination initiation (Day)	$31.0\pm0.57^{a*}$	24.0 ± 0.00^{b}	22.0 ± 0.57^{c}	22.0 ± 0.57^{c}	.000
Germination completion (Day)	69.7 ± 0.33^{a}	68.0 ± 0.57^{ab}	66.0 ± 0.57^{b}	60.0 ± 1.15^{c}	.000
Germination percentage	61.3 ± 2.88^{b}	73.3 ± 2.90^{b}	82.7 ± 2.88^{a}	63.7 ± 2.88^{c}	.031

Note: * Means followed by the same superscript letter (s) in each row are not significantly different at $p<0.05$, according to Duncan's Multiple Range Test (DMRT). ± indicates the standard error of means.

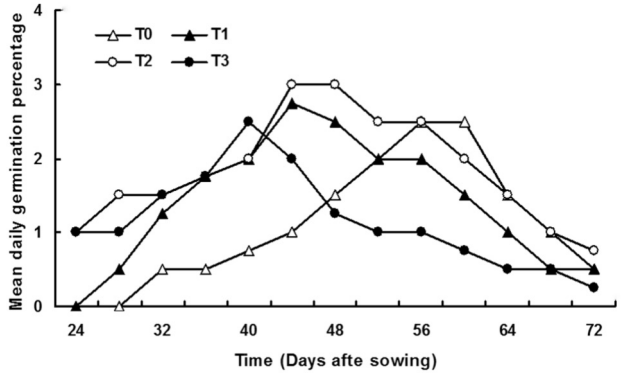

Fig. 2. Mean daily germination percentage of *F. jangomas* seeds treated with various pre-sowing treatments

tion percentage of seeds in T2 (3.0), T1 (2.8), T3 (2.5) and T0 (2.5) was observed at 44, 44, 40 and 56 days after sowing respectively. The cumulative germination percent in treatments rose sharply from 48 days to 66 days after sowing the seeds and remained constant up to the end of the germination test (Fig. 3). The germination pattern of seeds of *F. jangomas* under different treatments was not possible to compare with other authors due to lack of related literature.

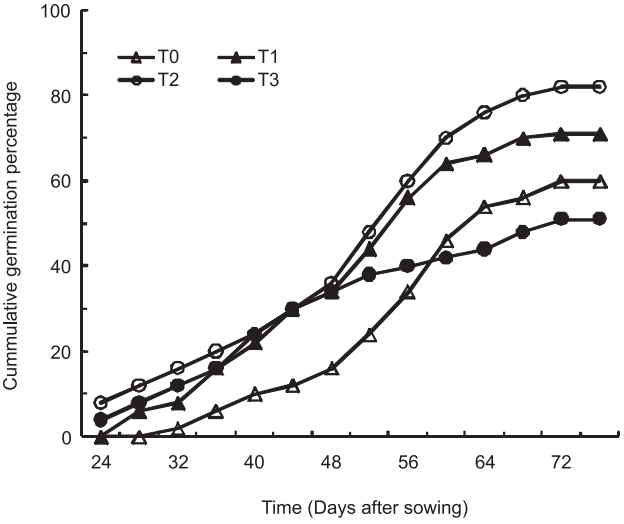

Fig. 3. Cumulative germination percentages of *F. jangomas* seeds soaked in cold water for various periods of time of *F. jangomas* seeds treated with various pre-sowing treatments

Growth performance

Different pre-sowing treatments significantly enhanced the growth performance of seedlings as measured by vigor index and biomass production of seedlings (Table 2, Fig. 4). The vigor index was maximum (2426.9) in the T2 followed by T1 (1968.6) and the lowest (1399.6) was in T0. The result of the present study was supported by Hossain et al. (2005a, 2005b) and Uddin (2005). They obtained highest vigor index for *T. belerica* and *T. chebula* seedlings developed from the depulped seeds soaked in cold water for 48 h. The lowest was in controlled seeds.

Shoot biomass (dry weights) was the maximum in T2 followed by T1 and it was the lowest in T0 (Table 2). The finding of the present study was supported by reports from Hossain et al. (2005a, 2005b) who found maximum shoot dry weights for *T. belerica* and *T. chebula* in seedlings germinated from the seeds soaked for 48 h. Though Uddin's (2005) work agreed with the current report for *T. chebula*, the result for *T. belerica* was different. He mentioned that the shoot dry weight was significantly higher in the seedlings of *T. belerica* when the seeds were soaked in cold water for 72 h than that of the other treatments.

The average leaf dry weights per seedling also varied remarkably in various treatments (Table 2). Similar results were reported by Hossain et al. (2005a) for *T. belerica* and Hossain et al. (2005b) for *T. chebula*. However, Uddin (2005) did not observe significant variation in leaf dry weight of *T. belerica* and *T. chebula* among the soaking treatments.

The mean dry weight of roots for different treatments significantly differed among the seeds subjected to the soaking periods (Table 2). Hossain et al. (2005b) and Uddin (2005) however, mentioned that the average root dry weight of *T. chebula* and *T. belerica* seedlings respectively from the seeds soaked for 48 h in cold water was significantly higher than the other treatments. Again, in *T. chebula* seedlings, it was highest in seedlings grown from the seeds soaked in cold water for 24 h as reported by Uddin (2005).

Table 2. Dry weight of shoot, root, leaf and total dry weight of seedlings under different pre-sowing treatments four months after sowing the seeds

Variable	Treatment				*p*
	T0	T1	T2	T3	
Vigor index	1399.6±3.3^{b}	1968.6±11.5^{ab}	2426.9±36.8^{a}	1560.0±16.8^{b}	.000
Shoot weight (g)	0.06±0.01^{c}	0.09±0.03^{b}	0.13±0.06^{a}	0.12±0.03^{a}	.041
Root weight (g)	0.04±0.015^{b}	0.06±0.01^{b}	0.10±0.03^{a}	0.11±0.03^{a}	.026
Leaf weight (g)	0.13±0.01^{b}	0.21±0.05^{ab}	0.28±0.12^{a}	0.25±0.06^{a}	.041
Total weight (g)	0.23±0.02^{c}	0.36±0.09^{b}	0.52±0.22^{a}	0.48±0.13^{a}	.021

Note: *Means followed by the same superscript letter (s) are in each row not significantly different at $p<0.05$, according to Duncan's Multiple Range Test (DMRT). ± indicates the standard error of mean.

Fig. 4. Growth performance of *F. jangomas* seedlings four months after sowing the seeds given with different pre-sowing treatments

The total dry weight per plant increased significantly with increasing soaking period up to 48 h (Table 2). Similar trend of total dry weight of the seedlings was reported by Hossain et al. (2005a, 2005b) for *T. belerica* and *T. chebula* seedling. Uddin (2005) mentioned that the total dry weight of the *T. chebula* seedling was highest in seedlings developed from seeds soaked in cold water for 48 h but for *T. belerica* was the maximum in seeds treated with 72 h soaking in cold water.

Clonal propagation by stem cutting

Rooting ability

Rooting percentage of cuttings was significantly enhanced by exogenous auxin (IBA) (Table 3, Fig. 5). The highest rooting percentage (100%) was obtained from the cuttings treated with 0.4% IBA solution followed by cuttings treated with 0.2% IBA (96.7). The lowest rooting percentage (70.0) was in cuttings without treatment (control).

Applied rooting hormone IBA is known to intensify the rooting percentage of cuttings as cited by many authors. For examples, Hossain et al. (2002) reported that the exogenous auxin (0.4% IBA) significantly enhances the rooting percentage of cuttings of jackfruit. Similar result was reported by Abdullah et al. (2005) for *Baccaurea sapida* mature stem cuttings. The effect of IBA on the rooting of stem cuttings of *Platanus acerifolia* was studied by Dias et al. (1999). They found that the cuttings treated with 6000 ppm IBA were better rooted than the control cuttings. Rosa et al. (1997) observed that Tachi-branco (*Sclerolobium paniculatum*) cuttings treated with 4000 ppm IBA were rooted best and the cuttings without treatment were rooted worst. Kamaluddin et al. (1996) recorded significant increases both in percentage rooting and number of roots with the application of IBA for *Artocarpus heterophyllus*. Again Kamaluddin et al. (1998) found that applied auxin significantly increased rooting ability of *Chickrassia velutina* cuttings.

Fig. 5. Rooting ability of cuttings of *F. jangomas* treated with various concentrations of IBA solution

In this work root number of cuttings enhanced significantly due to the applied IBA (Table 3, Fig. 5). The maximum number of roots (5.6) was developed in 0.4% IBA treated cuttings and minimum (2.14) in cuttings without IBA treatment.

The findings of several authors supported the enhanced number of roots developed due to the IBA treatment. For instance, Hossain et al. (2002) mentioned that that exogenous auxin (0.4% IBA solution) significantly increased the root number of cuttings in

Table 3. Rooting percentage of *F. jangomas* cuttings as affected by the various concentrations of IBA solution

Variable	Treatment			*p*
	control	0.2% IBA	0.4% IBA	
Rooting percentage	70.0±2.88[b]	96.7± 3.33[a]	100.0±.0[a]	0.021
Root number	2.1± .16[c]	4.4± .51[b]	5.6± .24[a]	0.004
Root length (cm)	2.3±.21[b]	3.0±.33[ab]	3.3±.08[a]	0.042

Note: *Means followed by the same superscript letter (s) in each row are not significantly different at $p<0.05$, according to Duncan's Multiple Range Test (DMRT). ± indicates the standard error of mean.

Table 4. Effect of IBA concentrations on survival, cutling height, leaf number and shoot length of *F. jangomas* three months after transferring into the polybags

Variable	Treatment			*p*
	control	0.2% IBA	0.4% IBA	
Survival percentage	40.0±5.77[c]	71.7±4.41[b]	85.0±2.88[a]	0.000
Cutling height (cm)	6.3±.88[b]	9.1±.99[ab]	9.6±.84[a]	0.047
Leaf number	7.0±1.52[a]	10.4±1.04[a]	10.6±.57[a]	0.109
Shoot length (cm)	3.7±.66[b]	6.3±.63[a]	6.6±.94[a]	0.043

Note: *Means followed by the same superscript letter (s) in each row are not significantly different at $p<0.05$, according to Duncan's Multiple Range Test (DMRT). ± indicates the standard error of mean.

jackfruit. Abdullah et al. (2005) reported the highest root number in cuttings of *B. sapida* treated with 0.8% IBA solution. Dias et al. (1999) reported the highest number of root developed in the cuttings of *P. acerifolia* treated with 6000 ppm IBA in greenhouse. The number of roots increased with increasing IBA concentration as well as number of roots in the Neem (*Azadirachta indica*) cuttings treated with 0.2% or 0.4% IBA (Kamaluddin and Ali 1996). In a separate experiment for *A. indica*, Kamaluddin and Ali (1996) recorded significantly increased number of roots by IBA treatment. Again Kamaluddin et al. (1998) found that applied auxin significantly increased rooting ability of *C. velutina* cuttings.

Root length was also significantly affected with the increasing IBA concentration (Table 3, Fig. 5). The longest root (7.5 cm) was found in cuttings rooted with 0.4% IBA treatment, whereas the shortest root was recorded from the control cuttings. Similar result was reported by Abdullah et al. (2005) for *B. sapida*.

It is evident from the present study that the cuttings of *F. jangomas* rooted well even without any IBA treatment (70%). However, the rooting ability of cuttings in respect to rooting percentage, root number and longest root length was significantly enhanced with the application of 0.2–0.4% IBA solution. Applied auxin (IBA) increasing rooting ability of cuttings was reported by many authors including Hossain (1999), Hossain et al. (2002), Hossain et al. (2004), Abdullah et al. (2005), Dias et al. (1999), Rosa et al. (1997), Kamaluddin et al. (1996), Kamaluddin and Ali (1996) and Kamaluddin et al. (1998).

Steckling capacity

Survival percentage of the cutlings (the rooted cuttings) enhanced significantly by exogenous hormone (IBA) application (Table 4, Fig. 6). The highest survival percentage (85%) was for the cuttings treated with 0.4% IBA followed by 0.2% IBA solution (71.7%). The result of the present study is in the line with the results of Nath and Barooah (1992).

Cutling growth performance

Average height of cutling was also significantly enhanced due to the application of exogenous hormone (IBA) for rooting (Table 4). However, the result in respect to the cutling height was not possible to compare with other authors due to lack of related references. Average shoot number of cutlings was not significantly enhanced by exogenous rooting hormone (IBA) application. The result of the present study differs from that reported by Dias et al. (1999) in this regard.

Shoot height was significantly affected with the increase of IBA concentration (Table 4). The longest shoot (6.6 cm) was observed in cutlings treated with 0.4% IBA solution followed by 6.3 cm in 0.2% IBA treatment. However, this result was not possible to compare with other authors due to lack of related references.

Fig. 6. Growth performance of *F. janogomas* cutlings rooted as IBA treatment three months after transferring into polybags

Conclusion

Flacourtia jangomas is one of the highly nutritious and valuable wild fruit species in Bangladesh deserving domestication in homesteads for many reasons. Although propagation by seed is the prime method of plant multiplication, the presence of inadequate seeds with inferior quality is the major constraint that hampers plantation programs in the tropics. Therefore for the production of maximum number of vigorous seedlings at minimum cost, time and labor, the seed treatments required are carefully assessed and applied for a particular plant species. In the present study germination performance of *F. jangomas* in terms of early germination, germination percentage, initial growth performance (biomass production) and vigor index was found maximum in T2 (seeds soaked in cold water for 48 h). Besides the seedling production in the nursery, the species is also amenable for clonal propagation through stem cuttings. The species found potential for clonal propagation even without application of any rooting hormone. However, the best result in respect of rooting percentage, root number, root length and steckling capacity of cutlings was observed in cuttings treated with 0.4% IBA solution. Seed treatment with cold water for 48 h for nursery raising and stem cutting with 0.4% IBA treatment for clonal propagation might be effective methods for multiplication and domestication of this species. More study is, however needed to assess the growth performance, fruit production and fruit quality of the planting stocks of the domesticated wild fruit species through the process.

References

Abdul-Baki A.A., Anderson J. D. 1973. Vigor determination in Soybean seed by multiple criteria. Crop Science 13: 630–633.

Abdullah A.T.M., Hossain M.A., Bhuiyan M.K. 2005. Propagation of Latkan (*Baccaurea sapida* Muell.Arg.) by mature stem cutting. Research Journal of Agriculture and Biological Sciences 1: 129–134.

Ara R., Merry S. R., Siddiqi N.A. 1997. Cultivation and uses of twelve medicinal plants of Bangladesh. Bulletin 7, Minor Forest Products Series, Bangladesh Forest Research Institute, Chittagong, 27–31 pp.

Booth T. H., Turnbull J. W. 1994. Domestication of lesser – known tropical tree species: the Australian experience. In: Tropical Trees :the potential for domestication and rebuilding of forest resources, pp. 189–193.

Chandra I., Bhanja P. 2002. Study of organogenesis *in vitro* from callus tissue of *Flacourtia jangoma*s (Lour.) Raeusch through scanning electron microscopy. Current Science 83: 476–479.

Das D.K. 1987. Edible fruits of Bangladesh. Bulletin-3 Plant Taxonomy Series, Bangladesh Forest Research Institute ,Chittagong, 19 pp.

Dias R. M. S. L., Fronco E. T. H., Dias C. A. 1999. Rooting of stem cuttings of different diameters of *Platanus acerifolia* (Aiton) Willdenow. Ciencia Florestal 9: 127–136.

FAO 1984. Food, Nutrition and Agriculture. Food and Agriculture Organization of the United Nations, Rome, 44: 68–215.

FAO 1992. Forests,Trees and Food. Food and Agriculture Organization of the United Nations, Rome, 26pp.

Hossain M.A. 1999. Rooting ability of cuttings as influenced by preconditioning of stockplants to light. M.Sc. thesis. Institute of Forestry and Environmental Sciences, University of Chittagong, Chittagong, Bangladesh, 80pp

Hossain M.A., Islam M.A., Hossain M.M. 2004. Rooting ability of cuttings of *Swietenia macrophylla* King and *Chukrasia velutina* Wight et Arn. as influenced by exogenous hormone. International Journal of Agriculture and Biology 6: 560–564

Hossain M.A., Rahman M. M., Kamaluddin M. 2002. Rooting ability of cuttings as influenced by etiolation of stockplants and auxin. SUST Studies 4: 55–65.

Hossain M. A., Arefin M.K., Khan B.M., Rhaman M.A. 2005a. Effects of different seed treatments on germination and seedling growth attributes of a medicinal plant Bohera (*Terminalia belerica* Roxb.) in Nursery. International Journal of Forest Usufructs Management 6: 28–37.

Hossain M. A., Arefin M.K., Khan B.M. Rahman M.A. 2005b. Effects of seed treatments on germination and seedling growth attributes of Horitaki (*Terminalia chebula* Retz.) in the nursery. Research Journal of Biological Sciences 1: 135–141.

Indira E. P., Basha S. C. 1999. Effects of seeds from different sources on germination and growth in Teak (*Tectona grandis* L. f.) in the nursery. Annals of Forestry 7: 39–44.

Kamaluddin M., Miah M.E., Pandit S. 1998. Propagation of *Chickrassia velutina* by cutting: response to applied auxin and shoot production. Malaysian Forester 61: 92–100.

Kamaluddin M., Ali M. 1996. Effect of leaf area and auxin on rooting and growth of rooted stem cuttings of neem. New Forests 12: 11–18.

Kamaluddin M. 1996. Clonal propagation of Eucalyptus and Acacia hybrid by stem cuttings. Research Report. Institute of Forestry and Environmental Sciences.

Kamaluddin M., Ali M., Bhuiyan M. K. 1996. Effect of auxin rootability of cuttings and growth of

stecklings of Jackfruit (*Artocarpus heterophyllus* Lam.). Chittagong University Studies Part II. 20: 71–75.

Kermasha S., Barthakur M., Mohan A. 1987. Chemical composition and proposed use of two semi-wild tropical fruits. Dep. Food Science and Agricultural Chemistry, Macdonald College of McGill University, pp. 145–170.

Nath J.C., Barooah S. 1992. Propagation of some minor fruits of Assam by rooting of stem cuttings. Horticultural-Journal 5: 109–113.

Rashid M. H., Mohiuddin M., Ara R. and Alam M.J. 1990. Medicinal plant and its cultivation. Bulletin 4, Minor Forest Products Series, Bangladesh Forest Research Institute, Chittagong. 17 pp. (in Bangla).

Rosa L., Dos S. 1997. Promotion of rooting in stem cuttings of Tachi-branco (*Sclerolobium paniculatum* Vogel) by application of different concentrations of indole-3-butyric acid. Boletim da Faculdade de Ciencies Agraries do Para 28: 81–91.

Uddin M.S. 2005. Seed Germination and seedling growth attributes of *Terminalia belerica* Roxb. and *T. chebula* (Gaertn.) Retz under different pre-sowing treatments. B.Sc. Disertation, Institute of Forestry and Environmental Sciences, Chittagong University. pp. 76 (Unpublished).