PROPAGATION OF SOAPNUT (*SAPINDUS MUKOROSSI*) BY CUTTINGS AND SEEDS

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Introduction

Soapnut (*Sapindus mukorossi* Gaertn.) belonging to family sapindaceae is a commercially important fast growing agroforestry species growing upto 1300 m elevation in the Himalayas from Sutlej eastward upto Assam (Troup, 1981). It is a multipurpose species most preferred in agroforestry and plantation forestry programmes particularly in northern India. The species is valued for its high saponin content in the fruits which form lather with water and is thus, the main constituent of different brands of herbal shampoos available in the market. The pulp of fruit is also used as a substitute for soap making employed in washing garments and ornaments. The oil from the kernel has medicinal and insect killing properties while, leaves are used as fodder. However, its seed germination is poor and slow under mid Himalaya. Studies on rootability and pre-sowing seed treatments were conducted to standardize propagation technique for large scale production of quality plant material for afforestation/ agroforestry programme.

Material and Methods

The present studies were conducted in the experimental nursery during 2008-2009. The first experiment explored the effect of donor stage, cutting type and auxin concentrations on rooting behavior in *Sapindus mukorossi*. The terminal cuttings were obtained from upper part of the shoot after excising the tip, while the sub-terminal ones were drawan 20 cm below the top. The cuttings of 15-20cm length and 0.5-1 cm thickness were then treated with different auxin concentrations prepared in talc medium and planted in polybags (16 cm x 7 cm size) filled with sterilized rive sand during monsoon (July-August) and spring (March-April) seasons. There were thus, twenty treatments comprising of two donor stages (S_1- sapling, S_2- tree), two cutting types (C_1- terminal, C_2- sub terminal) and five auxin concentrations (T_1- control-talc, T_2- 0.2% captan + 2% sucrose-talc, T_3- 0.2% NAA + 2% captan + 2% sucrose-talc, T_4- 0.4% NAA + 2% captan + 2% sucrose-talc, T_5- 0.6% NAA + 2% captan + 2% sucrose-talc) with 10 cuttings per plot each replicated thrice in randomized block design (factorial). Biochemical studies for sugar and starch (Dubois *et al.*, 1951), total carbohydrate, nitrogen (micro-kjeldahl) and C:N ratio were conducted as per standard practice. In another experiment, the seeds of the species were pre-treated with growth regulators and salt solutions viz., IBA (50 ppm, 100 ppm), IAA (50 ppm, 100 ppm), NAA (50 ppm, 100 ppm), GA_3 (50 ppm, 100 ppm), kinetin (50 ppm, 100 ppm), KCl 1%, $FeSO_4$ 1%, KNO_3 1%, $MgSO_4$ 1% and cold water 2-3°C (Table 4) as 12 and 24hrs. soak before sowing to assess its impact on germination and seedling growth. There were thus sixteen treatments including control each replicated thrice in RBD. The pre-treated seeds (including control) were sown in standard polybags filled with soil, sand and FYM (3:1:1) during April month. The nursery was regularly weeded and watered as per requirement. Final observation on germination (%) and seedling growth (height, collar diameter and root-shoot ratio) was recorded 200 days after sowing and data subjected to statistical analysis to draw necessary conclusions.

Results and Discussion

Cuttings propagation

It was quite evident from the data in Table 1 that sapling stage cuttings produced significantly highest rooting success (44.23%), mean root number (4.46) and mean root length (4.15 cm) as compared to tree stage cuttings during monsoon. The results are in agreement with the findings of Husen and Pal (2007) who reported that per cent sprouting and rooting in *Tectona grandis* cuttings decreased as age of donor plants increased. Hamooh (2004) and Bakshi and Pal (2007) also reported similar trend while working in *Ficus carica* and *Dalbergia sissoo* species respectively. The cuttings struck in spring showed similar pattern but with far inferior values as compared to monsoon cuttings. Similarly, sub-terminal cuttings (C_2) produced significantly highest rooting (46.23%), mean root number (4.86) and mean root length (4.42 cm) in monsoon than those from the upper type (C_2). These results are in agreement with Bhardwaj and Mishra (2005) who reported significantly better rooting performance in *Ulmus villosa* cuttings collected from the lower part of the shoot. Superiority of lower cutting portion over that of upper has also been reported by Kanwar *et al.* (1996) and Akoumianaki *et al.* (2004) while working with *Ulmus laevigata* and *Bauhinia variegata* respectively. The better rooting of sapling origin and

Table 1

Effect of donor stage, cutting type and auxin concentration on rooting behavior of Sapindus mukorossi in two different seasons

Treatments	Monsoon (July -August)			Spring (March -April)		
	Rooting* (%)	Mean number of roots	Mean root length (cm)	Rooting* (%)	Mean number of roots	Mean root length (cm)
Donor stage (D)						
D_1	44.23	4.46	4.15	36.33	3.78	4.00
D_2	(41.45)	3.99	3.82	(36.50)	3.34	3.53
	39.33			31.00		
	(38.30)			(32.79)		
SE(d)	0.89	0.10	0.08	0.93	0.12	0.08
$CD_{0.05}$	1.81	0.20	0.16	1.89	0.24	0.16
Cutting type(C)						
C_1	37.33	3.59	3.56	29.33	3.09	3.24
C_2	(37.01)	4.86	4.42	(31.63)	4.04	4.29
	46.33			38.00		
	(42.74)			(37.66)		
SE(d)	0.89	0.10	0.08	0.93	0.12	0.08
$CD_{0.05}$	1.81	0.20	0.16	1.89	0.24	0.16
Auxin concentration (T)						
T_1	19.16	2.30	1.92	13.33	1.72	1.51
T_2	(25.64)	3.16	3.28	(20.31)	2.55	2.75
T_3	25.84	4.24	4.29	22.50	3.54	4.08
T_4	(30.39)	5.91	5.42	(28.10)	5.29	5.39
T_5	39.16	5.52	5.04	35.00	4.70	5.09
	(38.68)			(36.22)		
	64.16			51.67		
	(53.37)			(45.99)		
	60.84			45.84		
	(51.31)			(42.60)		
SE(d)	1.41	0.16	0.13	1.48	0.19	0.12
$CD_{0.05}$	2.86	0.32	0.26	2.99	0.39	0.25

* Figures in parentheses are arc sine transformed values

lower type cuttings might be attributed in such cuttings to the higher initial level of sugars, starch, carbohydrates and C/N ratio (Table 2).

As far as the best auxin concentration was concerned 0.4% NAA + 2% captan + 2% sucrose- talc (T_4) resulted in highest 64.16 per cent and 51.67 per cent rooting respectively in monsoon and spring seasons. A more or less similar trend was observed for mean number of roots in both the seasons with higher value (5.91) for monsoon than spring struck cuttings. Similarly, root growth was better in monsoon than spring cuttings with 0.4% NAA + 2% captan + 2% sucrose- talc (T_4) giving significantly higher value of 5.42 cm in the cuttings.

A perusal of the data in Table 3 revealed that auxin concentration x cutting type x donor stage (TxCxD) interaction exerted marked influence on rooting and root characteristics in both the seasons. A significantly highest rooting of 73.33 per cent was achieved when lower type of cuttings from sapling donor were treated with 0.4% NAA + 2% captan + 2% sucrose- talc in monsoon (July-August) season. This was however followed by $T_5C_2D_1$ and $T_4C_2D_2$ combinations each giving 66.67 per cent rooting success in the cuttings. The corresponding high value of rooting (63.33 %) in spring was found to be inferior as compared to that of monsoon struck cuttings. The results thus obtained, are in accordance with the Shamet and Kaundal (2005) who reported that application of 0.8% NAA-activated charcoal resulted in significantly maximum rooting of 67.50 per cent in Seabuckthorn. There is voluminous literature showing the usefulness/ efficacy of various chemicals

Table 2

Initial biochemical and Nitrogen status of Sapindus mukorossicuttings during two different seasons

	Monsoon (July-August)					Spring (March April)				
Sugar (%)		Starch (%)	Total carbo hydrate (%)	Nitro gen (%)	C/N ratio	Sugar (%)	Starch (%)	Total carbo hydrate (%)	Nitro gen (%)	C/N ratio
Donor stage (S)										
S_1	2.35	2.15	4.50	1.70	2.64	2.24	2.07	4.31	1.67	2.57
S_2	2.21	1.99	4.21	1.66	2.53	2.09	1.93	4.03	1.61	2.50
Cutting type (C)										
C_1	2.20	2.01	4.22	1.67	2.52	2.13	1.93	4.06	1.60	2.53
C_2	2.36	2.12	4.49	1.69	2.65	2.20	2.07	4.28	1.64	2.60

Table 3

Effect of auxin x cutting type x donor (TxCxD) interaction on the rooting characteristics of Sapindus mukorossi during two different seasons

	Monsoon (July-August)			Spring (March-April)		
Treatments (TxCxD)	Rooting* (%)	Mean number of roots	Mean root length (cm)	Rooting* (%)	Mean number of roots	Mean root length (cm)
$T_1C_1D_1$	16.67(23.85)	1.90	1.71	10.00 (18.43)	1.33	1.06
$T_2C_1D_1$	23.33(28.78)	2.90	2.80	20.00 (26.57)	2.40	2.51
$T_3C_1D_1$	36.67(37.32)	3.80	3.98	33.33 (35.21)	3.33	3.67
$T_4C_1D_1$	60.00(50.86)	5.30	5.03	46.67 (43.07)	4.84	5.00
$T_5C_1D_1$	60.00(50.78)	5.00	4.96	46.67 (43.07)	4.67	4.97
$T_1C_1D_2$	13.33(21.14)	1.83	1.65	6.67 (12.41)	1.00	0.63
$T_2C_1D_2$	20.00(26.57)	2.26	2.58	16.67 (23.86)	2.16	2.00
$T_3C_1D_2$	33.33(35.21)	3.50	3.53	30.00 (33.21)	3.00	3.28
$T_4C_1D_2$	56.67(48.85)	4.90	4.96	43.33 (41.15)	4.16	4.94
$T_5C_1D_2$	53.33(46.93)	4.56	4.41	40.00(39.23)	4.00	4.40
$T_1C_2D_1$	26.67(30.99)	2.86	2.20	20.00 (26.56)	2.46	2.33
$T_2C_2D_1$	33.33(35.21)	2.90	4.03	30.00 (33.21)	3.00	3.50
$T_3C_2D_1$	46.67(43.07)	5.13	5.01	40.00 (39.23)	4.16	5.06
$T_4C_2D_1$	73.33(59.00)	7.30	6.03	63.33 (52.77)	6.33	6.08
$T_5C_2D_1$	66.67(54.79)	6.53	5.80	53.33 (46.93)	5.33	5.84
$T_1C_2D_2$	20.00(26.57)	2.60	2.11	16.67 (23.85)	2.10	2.03
$T_2C_2D_2$	26.67(30.99)	3.60	3.71	23.33 (28.78)	2.67	3.00
$T_3C_2D_2$	40.00(39.23)	4.53	4.63	36.67 (37.22)	3.67	4.33
$T_4C_2D_2$	66.67(54.79)	6.16	5.67	53.33 (46.93)	5.84	5.56
$T_5C_2D_2$	63.33(52.78)	6.00	5.00	43.33 (41.15)	4.84	5.16
SE(d)	2.82	0.32	0.26	2.96	0.38	0.25
$CD_{0.05}$	5.72	NS	NS	5.99	0.78	NS

* Figures in parentheses are arc sine transformed values

including auxins in initiating rooting in the cuttings of forest species.

Pre-sowing treatment and seedling growth

The data in Table 4 reveals the effect of various growth regulators and salt solutions on germination (Fig1) and seedling growth of *Sapindus mukorossi* under nursery condition. It was evident that seeds soaked for 24 hrs produced better results in all attributes irrespective of the treatments. The significantly highest germination (46.2%) was recorded when seeds were pretreated with 1% KNO_3 for 24 hrs. This was however closely followed by 1% KCl (44.0%) and 50 ppm IBA and 50 ppm GA_3 (39.6% each) giving high germination in 24 hrs soak. The high germination for 12 hrs soak was noticed in 100 ppm IAA (44.0%) followed by control (39.6%) treatment. The result of highest germination is in accordance with the findings of Manonmani and Varangamudi (2003) who reported that acid scarified drupes of *Tectona grandis* soaked in 2% KNO_3 improved the germination success in the species upto 54.5 per cent. The effect of pre-treatments was found to be non-significant for shoot height growth in both the durations (12 hrs

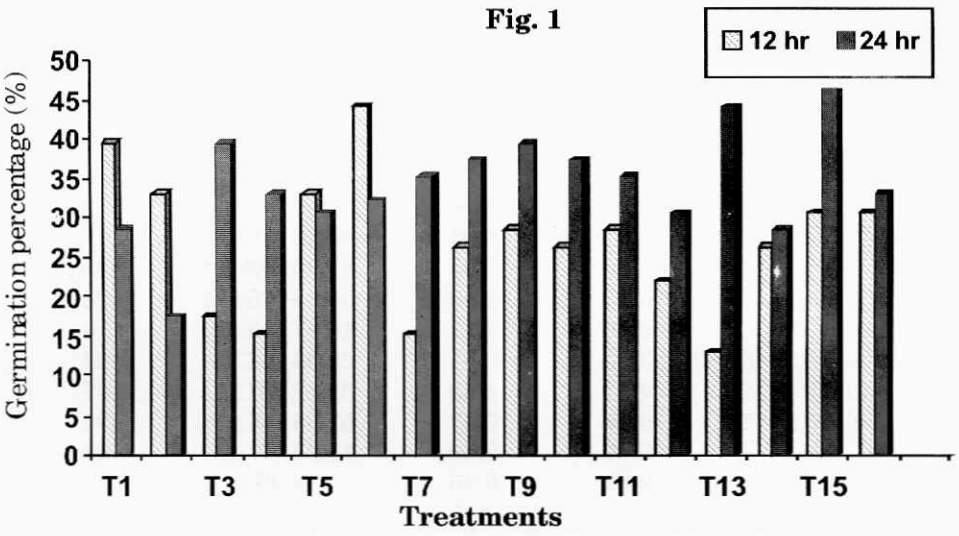
Table 4

Effect of growth regulators and salt solutions on germination and seedling growth of Sapindus mukorossi.

Treatments	Soaking time							
	12 hrs				24 hrs			
	Germination percentage (%)	Shoot height (cm)	Collar diameter (mm)	Root shoot ratio	Germination percentage (%)	Shoot height (cm)	Collar diameter (mm)	Root shoot ratio
Control	39.6 (38.96)	17.18	2.74	0.38	28.6 (31.44)	29.97	3.61	0.77
Cold water(2-3^{O}c)	33.0 (34.99)	24.66	2.99	0.39	17.6 (24.07)	23.78	3.72	0.48
IBA 50 ppm	17.6 (23.75)	19.33	3.57	0.60	39.6 (38.96)	24.63	3.32	0.52
100 ppm	15.4 (19.21)	15.35	2.00	0.20	33.0 (34.77)	23.20	3.20	0.53
IAA 50 ppm	33.0 (34.81)	24.83	3.32	0.34	30.8 (33.61)	25.20	3.03	0.47
100 ppm	44.0 (41.49)	28.73	3.16	0.32	32.3 (34.26)	21.11	3.51	0.54
NAA 50 ppm	15.4 (23.01)	13.99	3.05	0.32	35.2 (36.37)	28.20	3.38	0.43
100 ppm	26.4 (30.92)	24.65	3.45	0.53	37.4 (37.65)	26.36	3.63	0.48
GA_3 50 ppm	28.6 (32.18)	20.84	2.73	0.37	39.6 (38.85)	29.20	4.14	0.51
100 ppm	26.4 (30.80)	21.87	2.93	0.45	37.4 (37.34)	35.52	3.34	0.46
Kinetin 50 ppm	28.6 (32.18)	25.68	3.38	0.44	35.2 (36.37)	26.85	3.12	0.31
100 ppm	22.0 (27.60)	18.98	3.00	0.33	30.8 (33.06)	29.25	3.66	0.44
KCl 1%	13.2 (20.87)	19.54	2.30	0.27	44.0 (41.49)	28.98	3.68	0.59
$FeSO_4$ 1%	26.4 (30.80)	21.44	2.81	0.30	28.6 (32.30)	27.72	3.38	0.44
KNO_3 1%	30.8 (33.09)	25.15	3.21	0.43	46.2 (42.65)	29.33	3.73	0.42
$MgSO_4$ 1%	30.8 (33.49)	24.97	3.61	0.44	33.0 (33.45)	25.26	2.99	0.40
Mean	26.95	21.70	3.01	0.38	34.33	23.80	3.46	0.48
SE	6.47	4.72	0.40	0.09	6.47	4.72	0.40	0.09
$Cd_{0.05}$	12.93	NS	0.80	0.18	12.93	NS	0.80	0.18

Figures in parentheses are arc sine transformed values

Fig. 1



Comparative germination percentage in *Sapindus mukorossi* as affected by different soaking times

and 24 hrs).The maximum shoot height of 35.52 cm was however, observed in 100 ppm GA_3 treatment when soaked for 24 hrs. The minimum height growth (13.99 cm) was recorded in 100 ppm NAA given as 24 hrs soaking. The superiority of GA_3 in germination and seedling height finds support from Singh *et al.* (2004) who reported maximum 80.83 cm seedling height in *Ziziphus mauritiana* when soaked in GA_3. The pre-treatment exerted significant effect on collar diameter and root-shoot ratio. The significantly maximum collar diameter (4.14 mm) was seen when seeds were soaked in 50 ppm GA_3 for 24 hrs. This was followed by 1% KNO_3 (3.73 mm) and cold water (3.72 mm) treatments giving values in descending order. Treatment with salt and growth regulators probably scarify hard seed coat and antagonizes inhibitory substances within the seed enabling higher and uniform germination in the species. Gibberellic acid (GA_3) is known to control mobilization of starch to increase somatic pressure of cell leading to enhancement in cell elongation (Nanda and Dhindsa, 1967). The minimum collar diameter of 2.00 mm was observed in 100 ppm IBA given as 12 hrs soaking. The higher

collar diameter growth in GA_3 treatment is in accordance with the Masilamani and Dharmalingam (2002) who reported that pre-sowing seed treatment with 250 ppm GA_3 greatly enhanced collar diameter, root dry weight and shoot dry weight in *Grevilea robusta*. As far as root-shoot ratio was concerned, the maximum ratio (0.77) was noticed in control i.e. seed soaked at ambient room temperature. This was however, at par with 1% KCl (24 hrs) giving root- shoot ratio of 0.59. The minimum root-shoot ratio (0.20) was noticed when seeds were soaked in 100 ppm IBA for 12 hrs.

SUMMARY

Application of 0.4 % NAA + 2% captan + 2% sucrose-talc to the lower type of sapling origin cuttings of *Sapindus mukorossi* in monsoon (July-August) resulted in the highest 73.33 per cent rooting in the species. The pre-sowing seed treatment of soaking seeds of same species in 1% KNO_3 for 24 hrs produced superior germination and seedling growth under nursery condition.

Key words: NAA, *Sapindus mukorossi*, rooting, pre-sowing, germination.

कलम और बीजों के रीठे (*सेपिण्डस मुकोरोस्सी*) का संवर्धन कराना

ए.डी. मुण्ढे व जी. एस. शामेत

सारांश

मानसून काल (जुलाई–अगस्त) में *सैपिण्डस मुकोरोस्सी* के पौधे की निचली तरफ वाली कलम में 0.4% नैप्थेलीन एसेटिक अम्ल + 2% कैप्टान + 2% सुक्रोज–खड़िया उपयोग करने पर इस जाति में सबसे ज्यादा 73.33% जड़ें निकल आई। वपन पूर्व इसी जाति के बीजों को 1% के.एन. ओ$_3$ में 24 घंटे भिगोकर रखने के उपचार से श्रेष्ठतर अंकुरण हुआ और रोपणी दशाओं में पौधे की बढ़वार भी अच्छी रही।

References

Akoumianaki, L. A., R. Fragkouli and M. Gedeon (2004). Propagation of *Bauhinia variegata* L. by cuttings and seed. *Advances in Horticultural Science,* **18** (1):26-28.

Bakshi, Meena and M. Pal (2007). Rooting of semi-hardwood cuttings of *Dalbergia sissoo* Roxb. (shisham) as influenced by stock plant fertilization and position of cuttings. *Annals of Forestry,* **15** (2): 261-272.

Bhardwaj, D. R. and V. K. Mishra (2005). Vegetative propagation of *Ulmus villosa*: effects of plant growth regulators, collection time, type of donor and position of shoot on adventitious root formation in stem cuttings. *New Forest,* **29**: 105- 116.

Dubois, M., K. Gills, J. K. Hamilton P. A. Roberts and F. Smith (1951). A colorimetric method for determination of sugars. *Nature*. 166-167.

Hamooh, B. T. (2004). Cutting types and IBA concentrations in relation to rooting of stem hardwood cuttings of fig tree (*Ficus cariaca* L.). *Annals of Agricultural Science,* **49** (2):661-669.

Husen, A. and M. Pal (2007). Seasonal changes in rooting response of hardwood cuttings of teak (*Tectona grandis* Linn. F.) in relation to drift of total soluble sugar, starch and total nitrogen. *Annals of Forestry,* **15** (1): 11-31.

Kanwar, B. S., S. D. Bhardwaj and G. S. Shamet (1996). Vegetative propagation of *Ulmus laevigata* by stem cuttings. *Journal of Tropical Forest Science,* **8** (3): 333- 338.

Masilamani, P. and C. Dharmalingam (2002). Enhancement of germination and seedling growth in Silver oak (*Grevilia robusta* A. Cunn.) seeds. *Indian J. of Forestry,* **25** (1/2): 30-33.

Manonmani, V. and K. Varangamudi (2003). Studies on enhancing seed germination and seedling vigour in teak (*Tectona grandis*). *Journal of Tropical Forest Science* **15** (1): 51-58.

Nanda, K. K. and R. S. Dhindsa (1967). Effect of gibberellic acid (GA_3) on nitrogen content of soyabean (*Glycine max L.*) and mechanism of gibberellin action. *Proc. Internat. Symp. Plant Growth Substances.* Calcutta University Calcutta, Jan. 23-28.

Shamet, G. S. and A. Kaundal (2005). Studies on the effects of species, cutting portion and auxin concentration on rooting behaviour of Seabuckthorn (*Hippophae* spp.). In: *Short Rotation Forestry for Industrial and rural Development.* (eds. Verma K S, Khurana D K and Lars Christersson). ISTS, Nauni, Solan, India: 263-267 pp.

Singh, A. K., B. G. Bagle and M. Trivedi (2004). Effect of GA_3 and sucrose on seed germination and seedling growth in ber under semi arid conditions. *Orissa J. of Hort.*, **32** (1):78-81.

Troup, R. S. (1981). *The Silviculture of Indian trees*. International Book Distributors. Dehradun, India. pp.239-242.