Vegetative propagation of *Kusum* [*Schleicheraoleosa*(Lour.) Oken]through air layering for the mass multiplication of quality planting stock

Abstract

Schleicheraoleosa(Lour.)Oken, locally known as *kusum* (family Sapindaceae), is an important lac host tree, on which the lac insect (*Kerrialacca*), produces better quality lac, the kusmi lac Study on vegetative propagation of *kusum*was undertaken during 2014-17to generate quality planting stock through air layering in the Research Farm of the ICAR-Indian Institute of Natural Resins and Gums, Ranchi, Jharkhand. Sixteen phytohormone-medium combinations were taken for air layering, plus one already standardized for *litchi* as control, on *kusum* with 20 air layerings under each combination; 10 each with black polythene and 10 with transparent each year. The overall results revealed better rooting percentage during the pre-monsoon season (66 %) as compared to just 38 per cent during the monsoons, with black polythene in both seasons. During the pre-monsoon season, treatment combination with phyto-hormones in higher concentrations (IBA: NAA: Kinetin as 3000:1500:150) with media (sand: silt: clay: vermi compost: Sphagnum moss = 2:1:1:1:1) resulted in 100 per cent rooting. This was followed by combination with IBA: NAA: Kinetin as 2000:1000:100 and Sphagnum moss (90 %), which also resulted in highest rooting percentage (90 %) during the monsoon season. The detached air layeringwere hardened in the tree shade. Overall survival percentage of air layerings was 32.76 per cent. The technique can be helpful in mass propagation of true to type planting stock from plus trees or elite trees identified for lac production thereby increasing its productivity, germplasm conservation and management. The survival rate can be enhanced by providing better microclimate under hi-tech Poly houses at the early stages.

Keywords: Air layering, clonal multiplication, *kusum*, lac productivity, tribal upliftment

Introduction

Schleicheraoleosa(Lour.)Oken, locally known as *kusum*belongs to the family Sapindaceae, is widely distributed across the globe, locally known as *pongro* in Combodia and France, gum lac tree in Filipino, *kasambi* in Indonesia and Sudan, *kusambi* in Malaysia, *takhro* in Thailand and cy-van-rao in Vietnam. It is a multipurpose species, chiefly used for lac cultivation, besides providing timber, small durable wood for minor implements, fuelwood, tannins and dyes from bark, fodder from leaves (with crude protein 10.5%, nitrogen free extract 49% and crude fibre 32.5%), medicines from seeds (anti-ulcer) and bark (astringent) and oil from seedcalled*kusum* oil (constituting 59-72 % of the seed kernel, which is having multiple uses) (Bhattacharya and Anees, 2013).

There are more than 113 species of lac insect host plants but *Kusum*is an important major lac host tree grown in India (Kumar and Kumar, 2013). The other major lac hosts include *palas* (*Buteamonosperma*) and ber (*Zizyphusmauritiana*)among trees, *Flemingiasemialata, F.macrophylla* and *Cajanuscajan* (pigeon pea) among shrubs. The *kusmi* strain of the lac insect, *Kerrialacca,* which produces the best quality lac in the world, thrives on the fresh twigs of the branches, settles there and secretes a covering of lac resin over itself, with two crops in a year, each of 6 months.

Genetic Improvement and mass multiplication of the improved planting stock (true to type) of lac hosts can prove a vital enhancing role for increased lac productivity, which in turn can have significant effect on the lac production and socioeconomic conditions of the lac cultivators. In *kusum*, there are two types of trees, *kariya* and *charka*, of which *kariya* is better suitable for lac production (Kumar and Kumar, 2013)and at early stages, the two are not easy to differentiate. The tree being slow growing in nature becomes suitable for lac cultivation after 15-20 years of plantation.The tree is usually propagated by seed and to some extent by vegetative propagation. The seedlings propagated through seed are not true to type, thus vegetative propagation is the most important approach for production of true-to-type and better quality *kariya*seedlings for lac cultivation. The institute has selected plus trees across the state and neighboring states especially Odisha, West Bengal Madhya Pradesh and Chattisgarh, with higher lac insect survival and lac productivity.

But vegetative propagation of *kusum*has not yet yielded satisfactory results. Air layering is an important vegetation propagation technique, which can be helpful in elite host multiplication. In this technique, adventitious roots are induced from the aerial portions of the stem while it is still attached to the mother plant.Besides the generation of true-to-type quality planting material, it shall lead us a step ahead in germplasm conservation and the establishment of clonal banks, vegetative multiplication garden and clonal seed orchards for the species in the long run.Keeping in view the need of the hour, the study was conducted at ICAR-Indian Institute of Natural Resins and Gums, Ranchi, Jharkhand for three years with the objective of ‘standardization of air layering technique for mass multiplication of quality planting stock in *kusum* (*Schleicheraoleosa*)’.

Materials and Methods

For the standardization of the protocol, four different factors were considered, which included phytohormone to be applied, growing media to be used for wrapping over the exposed cambium layer, colour of polythene to be wrapped over the growing media and season of doing

the air layering procedure.Four phytohormone combinations comprising ofIndole Butyric Acid (IBA), NaphthaleneAcetic Acid (NAA) and Kinetin, four types of growing media (constituting sand, silt, clay,vermi-compost, sphagnum moss, decomposed farm yard manure), two colors of polythene: Black (B) and Transparent (T) and two seasons: Pre-monsoon and during Monsoon season were used. The details are given in the Table 1. So, in total 16 phytohormone-growingmedia combinations(T1M1, T1M2, T1M3, T1M4,T2M1, T2M2, T2M3, T2M4,T3M1, T3M2, T3M3, T3M4, T4M1, T4M2, T4M3, T4M4 besides control (already standardized for *litchi*) were used and under each treatment ten air layerings were done for both the seasons over the period. The air layerings were cut after 60 days and hardening of planting stock was done in the nursery before establishment in the field.

Table 1. Details of different phyto-hormone treatments and media used for air layering

Labels	**:**	**Treatment component**
T1	:	IBA: NAA: Kinetin @ 500:250:25
T2	:	IBA: NAA: Kinetin @ 1000: 500:50
T3	:	IBA: NAA: Kinetin @ 2000:1000:100
T4	:	IBA: NAA: Kinetin @ 3000: 1500: 150
M1	:	Sand: Silt: Clay: Cocopeat = 2: 1:1:1
M2	:	Sand: Silt: Clay: Vermicompost : Sphagnum moss = 2:1:1:1:1
M3	:	Sand: Silt: Clay: FYM= 2:1:1:1
M4	:	Sphagnum moss
Control	:	Pond silt, rotten jute bags/ leaf mould, neem cake, Farm Yard Manure(FYM), diammonium phosphate (DAP), bone meal

The procedure involved removal of a ring of bark 2-3 cm width from a branch of 2-3 cm diameter until the white cambium layer was clear. Then applied hormonal treatment with a brush, covered it with the rooting media and wrapped with polythene. Then the rooted airlayerings were detached after 60 days, and 3/4thfoliage was removed for hardening and planted in pots till the onset of next planting season under shade.

Experimental Results

The results (Table 2) revealed that overall rooting percentage during the pre-monsoon season was 66 per cent as compared to38 per cent during the monsoons. During the pre-monsoon season, treatment combination T4M2 with phyto-hormones in higher concentration (IBA: NAA: Kinetin as 3000:1500:150 ppm) with media (sand: silt: clay: vermi compost: Sphagnum moss as

2:1:1:1:1) resulted in 100 per cent rooting. This was followed by T3M4 combination with IBA: NAA: Kinetin as 2000:1000:100 ppm and Sphagnum moss with 90 per cent rooting, which also resulted in highest rooting percentage (90 %) during the monsoon season. Better rooting was observed while using black polythene (71%) over the transparent (55%) during the pre-monsoon and 42 % versus 31% (in transparent) during the monsoon season. During the pre-monsoon season, 100 per cent callus formation was observed in T1M4, T3M2, T4M1, T4M2, besides control wherein rooting was very less unlike others. During the monsoon season, more callus formation was observed but less rooting resulted (Fig. 1-5)

Table 2: Pooled data for the percentage of callus formation and successful rooting from different treatment combinations through air layering (B=Black; T = Transparent)

	Pre-monsoon season						During Monsoon season					
Treatment	Callus (%)			Rooting (%)			Callus (%)			Rooting (%)		
	B	T	Overall	B	T	Overall	B	T	Overall	B	T	Overall
T1M1	90	80	85	80	30	55	100	80	90	60	70	65
T1M2	100	90	95	90	80	85	100	100	100	0	0	0
T1M3	100	90	95	60	10	35	100	100	100	0	40	20
T1M4	100	100	100	70	80	75	100	100	100	20	0	10
T2M1	100	70	85	100	70	85	100	90	95	60	60	60
T2M2	90	50	70	90	40	65	100	100	100	0	0	0
T2M3	100	90	95	20	50	35	90	70	80	40	0	20
T2M4	90	10	50	80	10	45	70	90	80	50	40	45
T3M1	100	60	80	80	60	70	90	50	70	60	40	50
T3M2	100	100	100	100	50	75	100	100	100	90	30	60
T3M3	60	50	55	60	40	50	100	100	100	10	10	10
T3M4	100	80	90	100	80	90	100	100	100	90	90	90
T4M1	100	100	100	60	90	75	90	100	95	80	60	70
T4M2	100	100	100	100	100	100	90	40	65	80	40	60
T4M3	100	70	85	70	20	45	100	100	100	0	0	0
T4M4	80	100	90	50	90	70	100	100	100	40	50	45
Control	100	100	100	0	40	20	100	100	100	30	0	15
Average	95	79	87	71	55	66	96	89	93	42	31	38
$CD_{0.05}$	NS	8.71	8.95	9.66	9.97	7.79	NS	3.61	6.95	8.94	7.38	9.03

Differential effect of different phyto-hormonal treatments and media used was also studied (Table 3). It was observed that higher rooting was observed for media with higher concentration T4 (IBA: NAA: Kinetin as 3000:1500:150 ppm) and M2 (sand: silt: clay:

vermicompost: Sphagnum moss as 2:1:1:1:1) during the pre-monsoon season. However, during the monsoons, T3 (IBA: NAA: Kinetin as2000:1000:100) and M1 (Sand : Silt: Clay: Cocopeat as 2: 1:1:1) resulted in more rooting. Desired combinations can be used for more successful air layering generation. The air layering seedlings raised were hardened in the tree shade with survival percentage 32.76 per cent (Fig. 6).

Table 3: Differential effect of different phyto-hormonal treatments and media used in successful air layering

	Pre-monsoon season		**During Monsoons**	
Treatment	Rooting (%)	Callus (%)	Rooting (%)	Callus (%)
T1…	63	94	24	98
T2…	58	75	31	89
T3…	70	81	53	93
T4…	73	94	44	90
…M1	71	88	61	88
…M2	80	91	30	91
…M3	41	83	13	95
…M4	70	83	48	95

Discussion

Air layering has been used as a vegetative propagation technique to produce true to type planting stock from long. The success of rooting through air layering depends on the species, rooting media, phyto-hormones, time of the year, and thickness of branch among others. So the different factors were considered for evaluating the success of air layering in *kusum*. For the accumulation of the nutritive substances and sap flow, bark plays an important role, which subsequently effects the cellular differentiation towards the rhizogenesis (Harivel et al., 2006). So, optimum sized branch 2-3 cm diameter was selected for both the years and both the seasons.

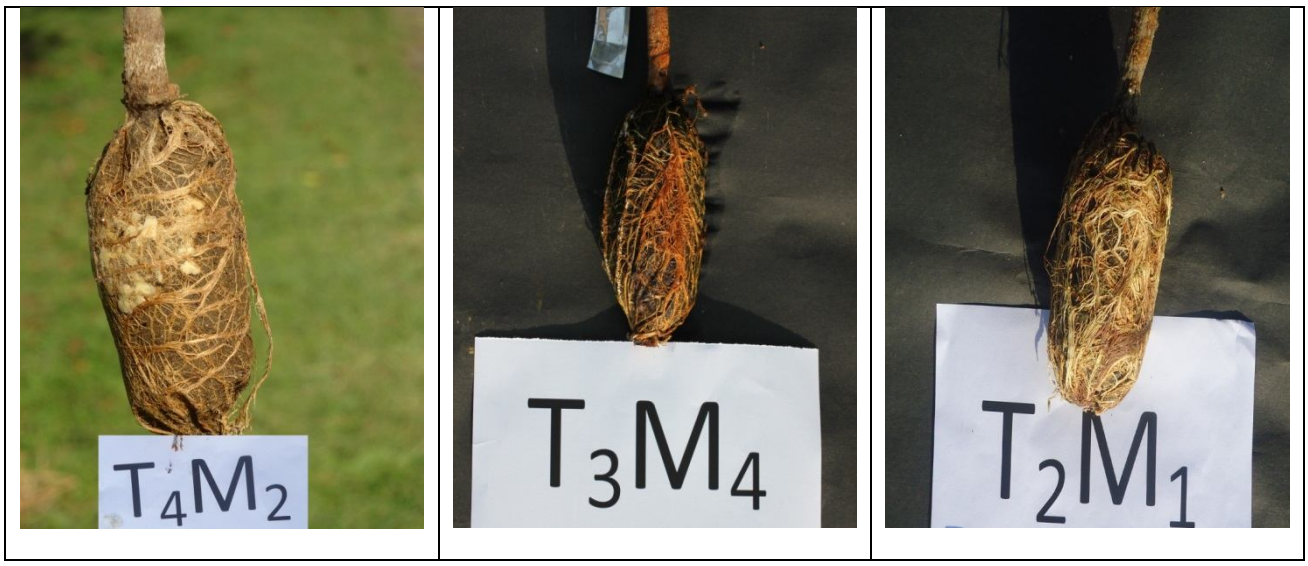

Fig. 1	Fig. 2	Fig. 3
		
Fig. 4	**Fig. 5**	**Fig. 6**

Fig. 1-5: Rooting under different treatment combinations

Fig. 6: A seedling raised through air layering technique

Rabiou*et al* (2017), while attempting the aerial layering of *Pterocarpuserinaceus*also considered multiple factors for the standardization of the technique in the species. Rymbai and Reddy (2010) also considered different factors like the effect of plant hormones, time of layering and rooting media on air-layers and plantlets survival under different growing nursery conditions in guava.

From our study on the vegetative propagation through air layering of *kusum*, significantly better rooting percentage(66 %) was obtained during the pre-monsoon season. Using black polythene, the rooting percentage and callus formation was significantly better during both the years and both the seasons, which may be the due to no light penetration inside the rooted air layering. During the pre-monsoon season, treatment combination with phyto-hormones in higher concentration (IBA: NAA: Kinetin as 3000:1500:150) with media (sand: silt: clay: vermi compost: Sphagnum moss = 2:1:1:1:1) resulted in 100 per cent rooting. This was followed by combination with IBA: NAA: Kinetin as 2000:1000:100 and Sphagnum moss (90 %), which also resulted in highest rooting percentage (90 %) during the monsoon season.This could be due to better root initiation, higher amounts of rooting co-factors and reduced inhibitors. Higher phytohormone concentration and black polythene has also been reported by Patel et al. (1989) in guavaand Misra et al. (2017) in *litchi*. The application of a rooting hormone for vegetative propagation is widely recognized, examples include (Husen and Pal (2006) in teak, Kumar

(2012) in litchi, Jannat et al. (2016) in *kusum*, Ansari and Gupta (2000) for their role in different tropical species. Different rooting media and time of air layering has responded differently in other species also like in guava where IBA concentrations of 2000 ppm, 3000 ppm and 4000 ppm were used in three time of layering viz., 15th June, 15th July and 15th August with two rooting media viz., sphagnum moss and coco peat (Rymbai and Reddy, 2010).The differential effect of different phyto-hormonal treatments and media used in successful air layering revealed that higher concentrations of the phyto-hormones. The media with better water retension provided better results in callus formation and rooting. Subsequently, the suitable factors may be considered for successful air layering in a species.

The air layering seedlings raised were hardened in the tree shade with survival percentage 32.76 per cent. The survival percentage can further be improved provided poly house or mist chamber conditions, due to congenial environmental conditions as compared to uncontrolled environmental conditions of open nursery. This finding is in agreement with the results obtained by Ahmad et al. (2007) in patch budding of walnut, Singh et al. (2007) on Wedge method of grafting in guava (*Psidiumguajava*) and Rymbai and Reddy (2010) in air layering of guava (*Psidium guajava*). Production of elite planting material through this technique shall be helpful in increasing lac productivity per tree and thereby increasing income of the farming community.

Conclusions

Keeping in view the importance of *kusum* as a premiere lac host, production of elite genetic stock is important, which requires true-to-type production and mass multiplication of genotypes with higher productivity potential. Though many vegetative methods have been tried in the species, but air layering offers the best option for the same. During the experimentation for the three years, we concluded that phyto-hormone combinations constituting IBA, NAA and kinetin in higher concentration resulted in better rooting and production of seedlings, significantly higher in the pre-monsoon season with black polythene used to wrap the growing media. Growing media with higher water holding capacity resulted in better rooting; especially the sphagnum moss.The technique can be helpful in mass propagation of true to type planting stock from plus trees or elite trees identified for lac production thereby increasing its productivity, germplasm conservation and management. The survival rate can be enhanced by providing better microclimate under hi-tech Poly houses at the early stages.

Acknowledgements

The authors are highly thankful to Dr R Ramani and Dr KK Sharma, ex-Directors ICAR-Indian Institute of Natural Resins and Gums, Namkum, Ranchi, Jharkhand for their guidance and support in conducting the research work.

Disclaimer (Artificial intelligence)

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

Option 2:

Author(s) hereby declare that generative AI technologies such as Large Language Models, etc. have been used during the writing or editing of manuscripts. This explanation will include the name, version, model, and source of the generative AI technology and as well as all input prompts provided to the generative AI technology

Details of the AI usage are given below:

1.

2.

3.

References

Ahmad, M.F., Iqbal, U. & Khan, A.A. (2007). Response of different environments and dates of patch budding on success in walnut. *Indian J. Hort.* 64: 286-89.

Ansari, S. A., & Gupta, B. N. (2000). Tree Improvement Program at Tropical Forest Institute: A Status Report, Proceedings workshop on production of genetically improved planting materials for afforestation programs, 18-25 June, Coimbatore, India.

Bhattacharya, A, and Anees, K. (2013). Lac host plants: potential uses. Technical Bulletin No. 1/2013.ICAR-Indian Institute of Natural Resins and Gums, Ranchi. 51p.

Harivel, A., Bellefontaine, R.. &Boly, O. (2006). Aptitude for vegetative propagation of eight forest species of interest in Burkina Faso. *Woods and Forests of the Tropics*, 288 (2): 39-50.

Husen, A. & Pal, M. (2006). Variation in shoot anatomy and rooting behaviour of stem cuttings in relation to age of donor plants in teak (*Tectona grandis* Linn. f.). *New Forest*, 31: 57–73

Jannat, M., Hossain, M.K. &Kamruzzaman. (2016). Vegetative Propagation Potential of *Kusum* (*Schleicheraoleosa*Lour) By Stem Cutting from Young Stock Plants. *Imperial Journal of Interdisciplinary Research.* 2(10):106-110

Kumar, A. & Kumar, A. (2013). Lac insect host plants of India. In: Kumar A and Das R. (Eds.), Prospects of scientific lac cultivation in India. Institute of Forest productivity, Ranchi. Pp 21-26

Kumar, R. (2012). Off season air layering in *litchi* : A prudent and efficient approach. Technical Bulletin-6, NRC for Litchi Muzaffarpur, Bihar, pp.13.

Mishra, D.S, Thapa, K.S., Nimbolkar, P.K.,Tripathi, A. &Singh, S.K. (2017). Efficacy of Different Rooting Media and Wrapping material on Air-Layers in Litchi (Litchi chinensis Sonn.) cv. 'Rose Scented'. *International Journal of Chemical Studies* 5(6): 2004-2009.

Patel, R.M., Patel, R.B., & Patel, M.P. (1989). Effect of growth regulators and polythene wrappers on rooting of air layers of guava. *BhartiyaKrishiAnusandhanaPatrika*, 4(3): 145-148.

Rabiou, H., Bationo, B.A., Laouali, A., Segla, Adjonou, K.N.K., Kokutse, A.D., Mahamane, A.& Kokou, K. (2017). Vegetative propagation by aerial layering of *Pterocarpuserinaceus*: in the sudanian zone. *International Journal of Recent Advances in Multidisciplinary Research*. 4(10): 2902-2908

Rymbai, H. & Reddy,G. S. (2010). Effect of IBA, time of layering and rooting media on air-layers and plantlets survival under different growing nursery conditions in guava. *Indian J. Hort.* 67: 99-104

Singh, G., Gupta, S., Mishra, R. & Singh, A. (2007). Technique for rapid multiplication of guava (*Psidium guajava* L.). *Acta Hort*. 735: 177-83.

Verma, P.K., Das, N., Kaushik, P.K., Kumar, V. & Yadav, A. (2013). Vegetative propagation through air layering of *Guaduaangustifolia* Kunth. - a commercially important Bamboo. *Indian Forester*. 139(12): 1088-1091