International Journal of Chemical Studies

**P-ISSN: 2349–8528**
**E-ISSN: 2321–4902**
IJCS 2017; 5(6): 2004-2009

Received: 02-09-2017
Accepted: 04-10-2017

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# Efficacy of Different Rooting Media and Wrapping material on Air-Layers in Litchi (*Litchi chinensis* Sonn.) *cv*. 'Rose Scented'

**DS Mishra, Kundan Singh Thapa, PK Nimbolkar, Arunima Tripathi and Saurabh K Singh**

**Abstract**
Raising good quality planting material at nursery stage is a very important aspect for success of any orchard. Intensive applied research is needed for standardization of nursery techniques in respect of optimization of rooting media for quality planting material production. Layering is a method of vegetative propagation in which a branch is induced to grow roots before it is separated from the parent plant. Moreover, the success of layers is governed by various factors *viz*, Availability of moisture, quality of rooting media, position of branches, season and wrapping material polythene sheet. The objective of this study was to determine the effect of different rooting media *viz*., Sphagnum moss, Vermicompost, Vermicompost + VAM, Vermicompost + *Azotobacter*, Vermicompost + VAM + *Azotobacter* and wrapping material (White transparent polythene, Black polythene and Aluminium foil) air-layers in litchi. Among these different rooting media Vermicompost + VAM + *Azotobacter* treated air layers produced maximum rooting percentage (86.88), maximum number of primary (20.66) and secondary roots (18.96), Maximum length (8.13 cm) of primary and secondary roots (11.06 cm) and minimum thickness of primary roots at tip (0.74 mm) and base (0.44 mm). The same rooting media produced highest fresh and dry weight of roots and shoots. Among the different wrapping material, White polythene found as an effective for most of the rooting characters and survival percentage.

**Keywords:** Air layering, litchi, rooting behaviour, vermicompost, VAM, azotobacter, survival percentage

## Introduction

Litchi (*Litchi Chinensis Sonn.*), is one of the most important subtropical evergreen fruit crop belongs to family *Sapindaaceae;* having about 125 genera and more than 1000 species. It is believed to be originated in southern china and northern vietnam (Menzel, 2001) [17]. Litchi crop is highly specific to climatic requirements and this is probably due to its cultivation which is why it is restricted to few countries includes China, India, Thailand, Madagascar, USA, South Africa, Israel, Australia and Vietnam (Menzel, 2001) [17]. Among the above mentioned countries India is the second largest producer of litchi next to China, with an annual production 580.1 thousand metric tonnes from an area of 82.7 thousand hectares. In Uttarakhand, annual production of litchi is 19.16 thousand metric tonnes from an area of 9.49 thousand hectares (Anonymous, 2013) [2]. In India Litchi cultivation is mainly confined to sub-tropical and sub mountainous district of Uttarakhand, Uttar Pradesh, Himanchal Pradesh and Bihar especially in Muzaffarpur (Brahmachari and Rani, 2000)[6]. Litchi fruit is a rich source of vitamin C (Wall, 2006) [29] and phenolic compounds that have antioxidant activities (Hu *et al*., 2010)[11]. For centuries, litchi has been commercially propagated by air layering but still, the results are not optimum due to the production of thick and brittle roots by air layers, which are sometimes difficult to establish in the nursery and field as well (Rawat *et al*., 2013) [23]. The success of air layers with the use of different rooting media has been found to be quite varying. However, more information regarding effect of rooting media, ways to overcome higher mortality rate and improving the survival rate of litchi air layers needs to be generated. The use of suitable rooting medium will help in the production of quality planting material with better roots system of air-layers. So, use of different rooting media such as VAM fungi, sphagnum moss, vermicompost, azotobacter and wrapping material (white transparent polythene, black polythene and aluminium foil) would be helpful in production of quality planting material with improved rooting of air layers and final survival of litchi air layers in the nursery.

Litchi fruits gained popularity as an exotic fruit reason behind demand of planting material of litchi is increasing tremendously. So, keeping the above point in mind, standardization of faster multiplication technology in litchi is need of the hour.

**Materials and Methods**

The present study was carried out during the period July 2014 to April 2015 at Horticulture Research Centre, Pattharchatta, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, district- Udham Singh Nagar, Uttarakhand. The healthy mother plants of Litchi cv. 'Rose Scented' was selected for this experiment. Sphagnum moss grass was collected from HRC, Pattarchatta. Sphagnum moss grass was thoroughly cleaned and sundried. After sun drying, moss grass was filled in autoclave polythene bag and kept in an autoclave (Model No. YSU- 405, Horizontal Cylindrical Autoclave) at 121˚C with 15 pound force per square inch (PSI) for 15 minutes. Soil was being inoculated with Arbuscular Mycorrhizal Fungi (AMF), *Azotobacter* and other rooting media. The different rooting media were being used *viz*., Sphagnum moss, Vermicompost, Vermicompost + VAM, Vermicompost + *Azotobacter* and Vermicompost + VAM + *Azotobacter*. The combination of Vermicompost + VAM (1:1), Vermicompost + *Azotobacter* (1:1) and Vermicompost + VAM + *Azotobacter* (1:1:1) were prepared by mixing of them in given proportion. The layering technique was followed by removing a ring of bark, about 2-3 cm wide just below a bud from a healthy and vigorous twig of one year old and 2.5 to 4.0 cm in diameter. After removing the bark, layer of combination of different rooting media was applied on the upper portion of the girdle followed by wrapping with white transparent polythene, black polythene and aluminium foil and firmly tied using sutli rope. The observations were recorded as percent of rooting of air layers (%), average length (cm) of primary roots, average number of secondary roots, length (cm) of secondary roots, thickness (mm) of primary roots at the tip/air layer, thickness of primary roots at the base/air layer (mm), fresh weight (g) of roots, dry weight (g) of roots, fresh weight (g) of shoot, dry weight (g) of shoot and survival percentage (%). In the present investigation, number of treatment combination were 15 resulting from different wrapping material and different rooting media were laid out in factorial randomized block design (FRBD) with respective litchi plants. Mean differences were tested by 'F' test at (5%) level of significance (LOS). Critical difference (CD) at 5% level of significance was used for comparison among the treatments.

**Results and Discussion**

**1. Rooting percentage**

The data shown in table 1. Confirms that rooting media and wrapping materials, had significant effect on percentage of air layer. However, interaction between them was non-significant. Maximum rooting percentage of air layer (86.88%) was obtained with Vermicompost + VAM + *Azotobacter* and minimum (80.99%) was with vermicompost treated layers. Maximum rooting percentage of air layer (87.12%) was obtained with black polythene followed by white transparent polythene (82.76%), while minimum rooting percentage of air layer (79.08%) was recorded with aluminium foil. The increased in rooting might have been due to better initiation of roots, decreased amount of inhibitors and increased amount of rooting co-factors at the time of roots initiation. Similar result was also found by Patel *et al*. (1989) [22] where they observed that black polythene as wrapping material and IBA treatment at 3000 ppm gave 100% rooting percentage increased in litchi. Oosthuyse (1991) [19] also found that black plastic gave more rooting percentage than clear plastic in mango air layers. The similar result was also obtained by Mao *et al*. (2009) [15] where they found that vermicompost and VAM increased the rooting percentage in wild jujube. The same result was also observed by Sharma *et al*. (2009) [27] where they mentioned that VAM and *Azotobacter chroococcum* enhanced the rooting percentage in litchi air layers.

**2. Number of roots**

Data on number of primary roots per layer was significantly affected by various rooting media and wrapping materials (Table 1). Maximum number of primary roots per layer (20.66) was obtained with Vermicompost + VAM + *Azotobacter* while minimum (15.40) average number of primary roots per air layer was recorded with vermicompost. Maximum average number of primary roots per layer (19.39) was obtained with white transparent polythene which was significantly *at par* with black polythene (18.88), while minimum average number of primary roots per air layer (15.75) was recorded with aluminium foil. The interaction between wrapping materials and rooting media was also found significant.

The reason of increased number of primary roots per layer might be due to better increase in carbohydrate and metabolic activities by rooting media. Similar result was depicted by Ananthakrishnan *et al.* (2004) [1] where they observed that *G. fasciculatum* significantly increased roots number in cashew nut. Likewise Sharma *et al*. (2009) [27] also noted that the dual inoculation of *G. fasciculatum* and *Azotobacter* strain-I significantly increased total number of roots of air-layers in litchi. Data on number of secondary roots per layer was significantly affected by various rooting media (Table 1). Maximum number of secondary roots per layer (18.96) was recorded with Vermicompost + VAM + *Azotobacter* followed by Vermicompost + *Azotobacter* (14.23), while minimum average number of secondary roots per air layer (11.33) was recorded with vermicompost. Wrapping material showed significant effect on number of secondary roots per layer. Maximum number of secondary roots per layer (14.83) was obtained with white transparent polythene followed by black polythene (13.99), while minimum average number of secondary roots per air layer (12.94) was recorded with aluminium foil. The interaction between wrapping materials and rooting media was found non-significant (Table 1). Jaizme-Vega *et al*. (2005)[12] where they conducted a trial on the banana and concluded that the rhizosphere microorganisms (AMF and PGPBs) promoted positively banana roots system development that leads to an improvement in plant nutrition and health. The AMF inoculated plants showed denser adventitious roots, significantly higher adventitious root numbers.

**3. Length of roots**

Data on length of primary roots per layer was significantly affected by various rooting media and wrapping materials (Table 1). Maximum average length of primary roots per layer (8.13 cm) was obtained with Vermicompost + VAM + *Azotobacter* followed by Vermicompost + *Azotobacter* (6.96 cm), while minimum (4.77 cm) was in sphagnum moss. More average length of primary roots per layer (6.77 cm) was obtained with black polythene followed by aluminium foil

(6.08 cm), whereas minimum average length of primary roots (6.08 cm) was recorded in white transparent polythene. The interaction between rooting media and wrapping materials significantly affected the average length of primary roots. Lucy *et al*. (2004) [14] had shown that IAA- producing PGPR increased the roots growth and roots length in plants. A combined inoculation of AMF and PGPR significantly enhanced roots length in red pepper (Kim *et al*., 2010) [13]. Fan *et al.* (2011)[10] also reported that the presence of AMF significantly changed roots morphology and increased roots length percentage in strawberry. Data presented in table 1. indicates that length of secondary roots per layer was significantly affected by various rooting media and wrapping material. Maximum average length (11.06 cm) of secondary roots per layer was obtained with Vermicompost + VAM + *Azotobacter* followed by sphagnum moss (9.80 cm), while minimum (8.85 cm) was in vermicompost. Maximum average length of secondary roots per layer (10.46 cm) was obtained with white transparent polythene while minimum average length of secondary roots per air layer (8.85 cm) was recorded with aluminium foil.

The interaction between wrapping material and rooting media was found non-significant (Table 1). The result is better in white transparent polythene followed by black polythene and aluminium foil. Air layers treated with Vermicompost + VAM + *Azotobacter* shows better result than other rooting media. The increase in roots length might be due to promotive effect of rooting media on growth. The increase in roots length might be due to promotive effect of rooting media on growth. In this regard our findings are also match with those of Singh *et al.* (2012) [28] who mentioned that the *Glomus mosseae* inoculated plantlets of pomegranate produce prominent length of roots.

**4. Roots thickness**

The data presented in fig. 1. indicated that thickness of roots at the tip was not significantly affected by various treatments. However, data on thickness of roots at the tip was significantly affected by various rooting media. Maximum thickness of roots (1.14 mm) at the tip was obtained with vermicompost while minimum thickness (0.74 mm) at the tip was noticed with Vermicompost + VAM + *Azotobacter*. The interaction between wrapping material and rooting media was found non-significant. The results are comparatively good in white transparent polythene. Air layers treated with vermicompost showed maximum thickness than other rooting media, while Vermicompost + VAM + *Azotobacter* results in minimum thickness which is generally beneficial for the development of air layers. Similar findings were reported by Yao *et al*. (2005) [30] where they inoculated the trifoliate orange (*Poncirus trifoliate*) seedling with four AM fungal species in rhizoboxes, with non- inoculated seedling as control. Result indicates that the AMF colonization did not affect the average roots diameter. The basal roots growth in spite of that four AM fungal species exerted differential influence on the plant growth. In addition to this AMF colonization induced more fine roots and less coarse roots and also reported that AMF colonization did not affect the basal roots growth. The fig. 2. revealed that thickness of roots at the base was significantly affected by various wrapping materials. Maximum thickness of roots (0.48 mm) at the base was recorded in aluminium foil followed by black polythene (0.46 mm), while minimum thickness of roots (0.44 mm) at the base was noticed with white transparent polythene. However, data on thickness of roots at the base was significantly affected by various rooting media. Maximum thickness of roots (0.57 mm) at the base was obtained with vermicompost while minimum (0.30 mm) was noticed with VAM + *Azotobacter*. The interaction between wrapping material and rooting media was found non-significant. It is clear from data that minimum thickness of roots at the tip and base was found with white transparent polythene + Vermicompost + VAM + *Azotobacter*.

**5. Fresh and dry weight of roots**

The data presented in table 2. showed that average fresh weight of roots was significantly affected by various wrapping materials. Maximum average fresh weight of roots (0.91 g) was obtained with black polythene which was statistically *at par* with white transparent polythene (0.89 g), while minimum fresh weight of roots (0.85 g) was noticed in aluminium foil. However, data presented on fresh weight of roots was significantly affected by various rooting media. Maximum average fresh weight of roots (1.02 g) was obtained with sphagnum moss whereas minimum fresh weight of roots (0.77 g) was noticed with vermicompost. The interaction between wrapping material and rooting media was found non-significant. Findings of present investigation were similar to Rymbai and Reddy (2010)[25] in pomegranate where sphagnum moss increased the fresh weight of roots of pomegranate. Maurya *et al*. (2012) [16] also found that fresh weight of roots is affected by sphagnum moss in guava. Same results were found by Patel *et al*. (2012)[21] in pomegranate is also correlating with our current study results. Ozdemir *et al*. (2010)[20] found *Glomus intraradices* appears to have a greater effect on roots growth of grape cuttings. have a greater effect on roots growth of grape cuttings. The data presented in table 2. indicates that average dry weight of roots was not significantly affected by various wrapping materials and interaction of wrapping materials and rooting media. However, data on dry weight of roots was significantly affected by various rooting media. Maximum average dry weight of roots (0.11 g) was obtained with sphagnum moss while minimum dry weight of roots (0.07 g) was noticed with vermicompost. Chatzistathis *et al*. (2013)[7] reported that olive rooted leafy cuttings of inoculated with AMF (*Glomus sp.* and *Gigaspora sp*.) had higher roots dry weight. Similar result was found by Rymbai *et al*. (2012)[26] where he found that sphagnum moss increased the dry weight in guava air layers. Similar findings were obtained by Bhosale *et al*. (2014)[5] in pomegranate air layers.

**6. Fresh and dry weight of shoot**

The data presented in table 2. showed that average fresh weight of shoot per layer was not significantly affected by various wrapping materials and interaction of wrapping materials and rooting media. However, data reported on fresh weight of shoot was significantly affected by various rooting media. Maximum average fresh weight of shoot per air layer (41.01 g) was obtained with Vermicompost + VAM + *Azotobacter*. David *et al*. (2001)[8] noticed similar result where shoot growth enhancement in air-layered litchi trees inoculated with indigenous arbuscular mycorrhizal fungal species. Similar findings were recorded by Ojha *et al*. (2008)[18] where they found that fresh weight of the shoots were observed to be significantly high in *Glomus fasciculatum* treated custard-apple plants compared to the respective controls**.** Data on dry weight of shoot was significantly affected by various rooting media. Maximum average dry weight of shoot per air layer (22.50 g) was obtained with Vermicompost + VAM + *Azotobacter* whereas minimum average fresh weight of shoot per layer (19.35 g) was noticed with sphagnum moss. VAM appears to have effect on fresh and dry weight of shoots in apple seedlings (Runjin and Xinshu, 1990)[24]. Chatzistathis *et al*. (2013)[7] reported that olive rooted leafy cutting inoculated with AMF (*Glomus sp.* and *Gigaspora sp*.) had higher shoot dry weight. Similar findings were found by Dutta *et al*. (2013)[9] where they studied the influence of indigenous arbuscular mycorrhizal fungi (AMF) on growth, biochemical characteristics , mineral nutrient content and its uptake by leaves of apricot seedlings cv. *New Castle*. The results also inferred that the inoculation of *G. fasciculatum* was the most effective to maximise shoot dry weight than control.

### 7. Survival percentage

The data presented in table 3. showed that survival percentage of air layer after transplanting was significantly affected by various rooting media and wrapping materials. Maximum survival percentage of air layers (72.94%) was obtained with Vermicompost + VAM + *Azotobacter* and minimum (65.90%) was noticed in vermicompost. Maximum survival percentage of air layer (72.45%) was obtained with white transparent polythene while minimum survival percentage of air layers (62.98%) was noticed with aluminium foil. The interaction between wrapping materials and rooting media was also found significant. Maximum survival percentage of air layer (78.22%) was obtained with Black polythene + Vermicompost + VAM + *Azotobacter* whereas; minimum survival percentage of air layer (55.48) was noticed with Aluminium foil + Vermicompost. It might be due to the fact that bio-inoculants exudates plant growth hormones which are vital for roots initiation and healthy growth of roots. The results were similar with the finding of Baghel (1999)[4] where he found that black polythene had better effect on survival percentage than white transparent polythene. Patel *et al*. (1989)[22] also found similar result where they observed that black polythene as wrapping material and IBA treatment at 3000 ppm gave 100% rooting and survival percentage is also increased in litchi. Our results are also support the findings of Aseri *et al.* (2008)[3] who observed that combined treatment of *Azotobacter chroococcum* and *Glomus mossseae* was found to be the most effective in pomegranate.

### Conclusion

The current investigation revealed that Litchi *cv*. Rose scented can effectively be propagated through air layering with use of wrapping materials (white transparent polythene) and rooting media (Vermicompost + VAM + *Azotobacter*) which produces better rooting as well as highest survival percentage of air layers, compared to other wrapping materials and rooting media.

**Table 1:** Effect of rooting media and wrapping materials on rooting percentage (%), number of primary roots, length (cm) of primary roots, number of secondary roots and length (cm) of secondary roots of air layers of litchi

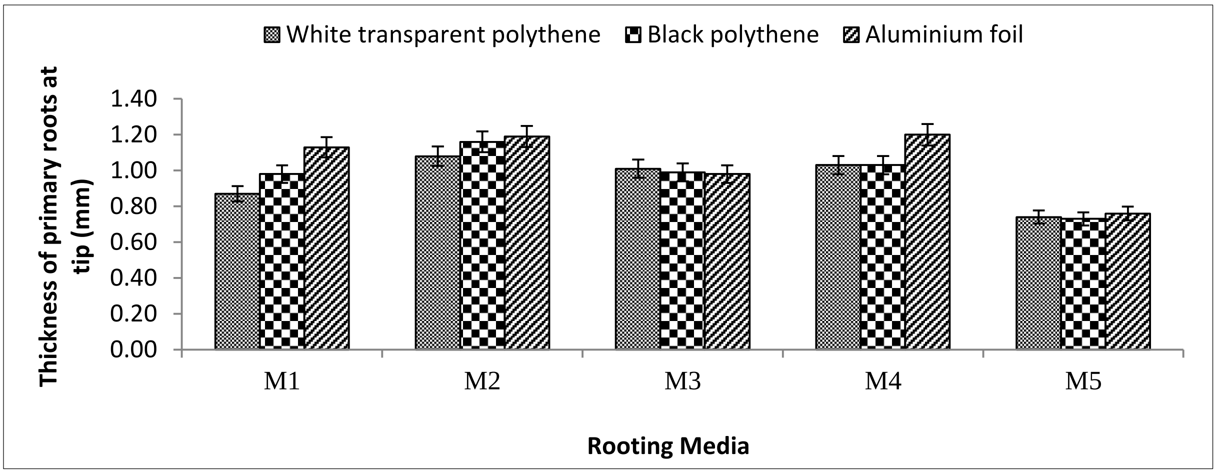
| Rooting media (R) | | Rooting percentage | Number of primary roots | Length (cm) of primary roots | Number of secondary roots | Length (cm) of secondary roots |
|---|---|---|---|---|---|---|
| Sphagnum moss | | 81.26 | 16.77 | 4.77 | 12.43 | 9.80 |
| Vermicompost | | 80.99 | 15.40 | 5.54 | 11.33 | 8.85 |
| Vermicompost+VAM | | 81.95 | 17.96 | 6.31 | 12.65 | 9.29 |
| Vermicompost+*Azotobacter* | | 83.85 | 19.25 | 6.96 | 14.23 | 9.65 |
| Vermicompost+VAM+*Azotobacter* | | 86.88 | 20.66 | 8.13 | 18.96 | 11.06 |
| Wrapping materials (W) | | | | | | |
| White transparent polythene | | 82.76 | 19.39 | 6.08 | 14.83 | 10.46 |
| Black polythene | | 87.12 | 18.88 | 6.77 | 13.99 | 9.88 |
| Aluminium foil | | 79.08 | 15.75 | 6.18 | 12.94 | 8.85 |
| Sem± and C.D. (at 5%) | | | | | | |
| R | Sem± | 0.84 | 0.34 | 0.20 | 0.43 | 0.29 |
| | C.D. | 2.43 | 0.99 | 0.59 | 1.27 | 0.84 |
| W | Sem± | 0.65 | 0.26 | 0.15 | 0.34 | 0.22 |
| | C.D. | 1.88 | 0.77 | 0.46 | 0.98 | 0.65 |
| R × W | Sem± | 1.45 | 0.59 | 0.35 | 0.76 | 0.50 |
| | C.D. | NS | 1.72 | 1.03 | NS | NS |

**Table 2:** Effect of rooting media and wrapping materials on fresh weight (g) of roots, dry weight (g) of roots, fresh weight (g) of shoots and dry weight (g) of shoots of air layers of litchi

| Rooting media (R) | | Fresh weight (g) of roots | Dry weight (g) of roots | Fresh weight (g) of shoots | Dry weight (g) of shoots |
|---|---|---|---|---|---|
| Sphagnum moss | | 1.02 | 0.11 | 37.62 | 19.35 |
| Vermicompost | | 0.77 | 0.07 | 37.24 | 19.73 |
| Vermicompost+VAM | | 0.80 | 0.08 | 37.65 | 20.88 |
| Vermicompost+*Azotobacter* | | 0.85 | 0.09 | 37.99 | 20.49 |
| Vermicompost+VAM+*Azotobacter* | | 0.98 | 0.09 | 41.01 | 22.50 |
| Wrapping materials (W) | | | | | |
| White transparent polythene | | 0.89 | 0.09 | 38.56 | 21.30 |
| Black polythene | | 0.91 | 0.09 | 38.03 | 20.01 |
| Aluminium foil | | 0.85 | 0.08 | 38.30 | 20.45 |
| Sem± and C.D. (at 5%) | | | | | |
| R | Sem± | 0.01 | 0.01 | 0.64 | 0.50 |
| | C.D. | 0.05 | 0.01 | 1.87 | 1.46 |
| W | Sem± | 0.01 | 0.00 | 0.50 | 0.39 |
| | C.D. | 0.04 | NS | NS | NS |
| R×W | Sem± | 0.03 | 0.01 | 1.12 | 0.87 |
| | C.D. | NS | NS | NS | NS |

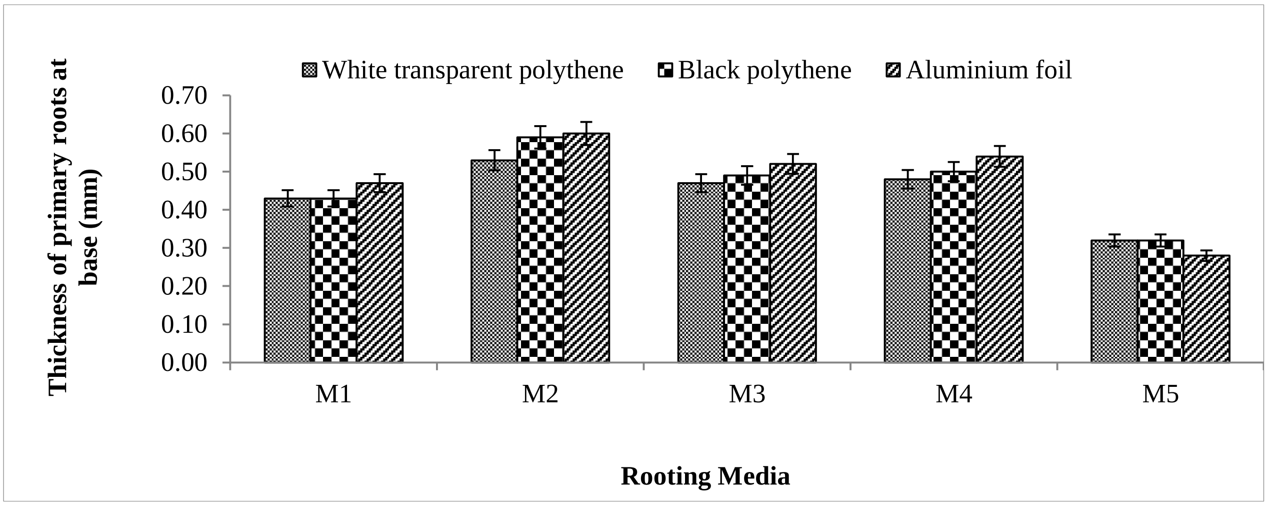
**Table 3:** Effect of rooting media and wrapping materials on survival percentage (%) of air layers of litchi

| Rooting media | Wrapping materials | | | |
|---|---|---|---|---|
| | **White transparent polythene** | **Black polythene** | **Aluminium foil** | **Mean** |
| Sphagnum moss | 72.42 | 74.18 | 68.32 | 71.64 |
| Vermicompost | 76.40 | 65.50 | 55.48 | 65.90 |
| Vermicompost+VAM | 66.38 | 70.56 | 62.04 | 66.33 |
| Vermicompost+Azotobacter | 71.51 | 73.40 | 63.69 | 69.53 |
| Vermicompost+VAM+Azotobacter | 75.21 | 78.22 | 65.38 | 72.94 |
| Mean | 72.45 | 72.37 | 62.98 | 69.27 |
| | Sem± | C.D. | | |
| Wrapping materials | 0.89 | 2.60 | | |
| Rooting media | 1.15 | 3.35 | | |
| Wrapping materials × Rooting media | 2.00 | 5.81 | | |




($M_1$- Sphagnum moss, $M_2$- Vermicompost, $M_3$- Vermicompost+VAM, $M_4$- Vermicompost+*Azotobacter*, $M_5$- Vermicompost+VAM+*Azotobacter*)

**Fig 1:** Effect of rooting media and wrapping materials on rooting thickness (mm) of primary roots at tip of air layers of litchi




($M_1$- Sphagnum moss, $M_2$- Vermicompost, $M_3$- Vermicompost+VAM, $M_4$- Vermicompost+*Azotobacter*, $M_5$- Vermicompost+VAM+*Azotobacter*)

**Fig 2:** Effect of rooting media and wrapping materials on rooting thickness (mm) of primary roots at the base of air layers of litchi

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