Table 2. Interaction effect of IBA concentrations and time of layering on rooting and root parameters in guava air layering.

Factor	Rooting (%)	Primary roots	Secondary roots	Length of longest root (cm)	Roots weight (g)	
					Fresh	Dry
$I_0 M_1$	60.00	1.71	2.97	1.02	0.262	0.046
$I_0 M_2$	64.44	3.00	5.20	1.88	0.491	0.089
$I_0 M_3$	66.65	3.70	6.13	2.36	0.583	0.107
$I_1 M_1$	71.11	4.33	9.50	3.63	1.116	0.200
$I_1 M_2$	73.37	5.10	11.07	5.11	1.304	0.236
$I_1 M_3$	78.87	5.70	11.90	5.87	1.409	0.255
$I_2 M_1$	75.55	6.20	14.47	5.58	1.596	0.280
$I_2 M_2$	78.87	6.83	18.20	7.23	1.852	0.342
$I_2 M_3$	81.00	7.33	19.92	8.04	2.046	0.383
$I_3 M_1$	81.11	7.73	21.23	7.91	2.147	0.397
$I_3 M_2$	83.11	9.37	22.73	9.02	2.364	0.441
$I_3 M_3$	85.22	10.33	24.48	9.83	2.528	0.462
CD (0.05)	0.58	0.03	0.07	0.09	0.009	0.002

I_0= Control, I_1= IBA 2000ppm, I_2= IBA 3000 ppm, I_3= IBA 4000 ppm, M_1= 15th June, M_2= 15th July , M3= 15th August

Table 3. Interaction effect of IBA concentrations and rooting media on rooting and root parameters in guava air.

Factor	Rooting (%)	Primary roots	Secondary roots	Length of longest root (cm)	Roots weight (g)	
					Fresh	Dry
I_0S	65.92	3.07	5.22	1.96	0.473	0.087
I_0C	61.48	2.53	4.31	1.55	0.418	0.074
I_1S	76.28	5.31	11.33	5.12	1.344	0.243
I_1C	72.62	4.78	10.31	4.62	1.209	0.218
I_2S	79.92	6.98	18.16	7.23	1.344	0.348
I_2C	77.04	6.60	16.90	6.66	1.766	0.321
I_3S	84.07	9.53	23.65	9.33	2.420	0.444
I_3C	82.22	8.76	21.98	8.52	2.272	0.423
CD (0.05)	0.50	0.04	0.06	0.08	0.008	0.002

I_0= Control, I_1= IBA 2000ppm, I_2= IBA 3000 ppm, I_3= IBA 4000 ppm, S= Sphagnum moss and C= Coco peat

root fresh and dry weight.

Incase of time of layering, 15th August recorded maximum rooting (77.94%), number of primary (6.77) and secondary (15.61) roots, mean length of longest root (6.53) and highest fresh (1.64 gm) and dry weight (0.30 gm) of root layer^{-1}. While, 15th June recorded the minimum of these characters. This may be due to climatic and environmental factors variation and differences in varietal responses as reported by Changrappa and Gowda (3) in guava. It is evident from the results obtained that root characters had progressively improved in layer from 15th June to 15th August. The fact that August had recorded maximum rooting percentage, suggesting that the rooting in the other months was affected due to environmental conditions in the shape of steady increasing in relative humidity from June to August and with temperature approaching down from high temperature of summer to moderate temperature of rainy and autumn season.

The data pertaining to rooting media showed that Wet sphagnum moss produced maximum rooting (76.55%), number of primary (6.22) and secondary (14.59) roots, mean length of longest roots (5.91 cm) and highest fresh (1.53 gm) and dry weight (0.28 gm) of roots. However cocopeat recorded the minimum of these characters. Sphagnum moss has more success perhaps due to it capacity to retain higher moisture retention with high porosity for better aeration. This finding was also

Table 4. Interaction effect of time of layering and rooting media on rooting and root parameters in guava air layering.

Factor	Rooting (%)	Primary roots	Secondary roots	Length of longest root (cm)	Roots weight (g)	
					Fresh	Dry
M_1S	73.88	5.27	12.78	4.78	1.341	0.242
M_1C	70.00	4.72	11.30	4.29	1.219	0.219
M_2S	76.55	6.33	14.80	6.13	1.575	0.286
M_2C	73.35	5.82	13.80	5.49	1.430	0.267
M_3S	79.21	7.07	16.19	6.82	1.684	0.314
M_3C	76.66	6.47	15.02	6.24	1.599	0.290
CD (0.05)	0.71	0.05	0.08	0.11	0.011	0.002

M_1= 15th June, M_2= 15th July , M_3= 15th August , S= Sphagnum moss and C= Coco peat

Table 5. Interaction effect of IBA concentrations, time of layering and rooting media on rooting , root parameters in air layering.

Factor	Rooting (%)	Primary roots	Secondary roots	Length of longest root (cm)	Roots weight (g)	
					Fresh	Dry
I_0SM_1	62.22	2.08	2.20	1.21	0.320	0.058
I_0SM_2	66.66	3.20	3.53	2.18	0.512	0.092
I_0SM_3	68.88	3.93	4.47	2.48	0.586	0.112
I_1SM_1	73.33	4.53	8.73	3.81	1.200	0.215
I_1SM_2	75.55	5.33	9.93	5.37	1.366	0.248
I_1SM_3	79.97	6.07	10.67	6.17	1.466	0.267
I_2SM_1	77.78	6.33	11.73	5.86	1.631	0.286
I_2SM_2	79.96	7.13	14.67	7.55	1.956	0.357
I_2SM_3	82.00	7.47	16.40	8.29	2.102	0.402
I_3SM_1	82.22	8.13	17.73	8.23	2.212	0.410
I_3SM_2	84.00	9.67	19.13	9.45	2.466	0.448
I_3SM_3	86.00	10.80	20.67	10.32	2.582	0.473
I_0CM_1	57.78	1.33	1.40	0.82	0.204	0.035
I_0CM_2	62.22	2.80	3.27	1.59	0.470	0.085
I_0CM_3	64.42	3.47	3.87	2.45	0.580	0.102
I_1CM_1	68.88	4.13	7.47	3.45	1.032	0.185
I_1CM_2	71.18	4.87	9.07	4.85	1.243	0.225
I_1CM_3	77.78	5.33	9.73	5.57	1.352	0.243
I_2CM_1	73.33	6.07	10.67	5.29	1.561	0.270
I_2CM_2	77.78	6.53	13.13	6.91	1.747	0.326
I_2CM_3	80.00	7.20	14.93	7.79	1.990	0.364
I_3CM_1	80.00	7.33	16.47	7.59	2.081	0.383
I_3CM_2	82.22	9.07	18.13	8.61	2.261	0.434
I_3CM_3	84.00	9.87	19.20	9.35	2.474	0.451
CD (0.05)	1.01	0.07	0.12	0.15	0.015	0.003

I_0= Control, I_1= IBA 2000ppm, I_2= IBA 3000 ppm, I_3= IBA 4000 ppm, M_1= 15th June, M_2= 15th July , M_3= 15th August , S= Sphagnum moss and C= Coco peat

similar with that of Singh and Jawanda (7).

Results indicated that combined effect of IBA concentrations and Time of layering was significantly influenced rooting and root characters presented in Table 2. IBA at 4000 ppm + 15th August recorded maximum rooting (85.22 %), number of primary (10.33) and secondary (24.48) roots, mean length of longest roots (9.83 cm) and root fresh (2.53 gm) and dry weight (0.46 gm).

Interaction between IBA concentrations and rooting media also significantly influence on rooting and roots characters presented in Table 3. IBA at 4000 ppm + 15th August produced maximum rooting (84.07 %), %), number of primary (9.53) and secondary (23.65) roots, mean length of longest roots (9.33 cm) and root fresh (2.42 gm) and dry weight (0.44 gm). The minimum value of these characters was observed by control + coco peat.

The interaction effect of time of layering and rooting media on rooting and root parameters in guava air layering was also significant presented in Table 4. 15th August + Wet sphagnum moss produced maximum rooting (79.21 %), number of primary roots (7.07), secondary roots (16.19), mean length of longest roots (6.82 cm), root fresh (1.68 gm) and dry (0.31 g) weight.

The combined effect of IBA concentrations, time of layering and rooting media was also significant on rooting and root characters presented in Table 5). IBA at 4000 ppm + 15th August + wet sphagnum moss recorded the maximum rooting percentage (86.00%), maximum number of primary (10.8) and secondary (20.67) roots, mean length of longest roots (10.32) and root fresh (2.58 g) and dry (0.47 g) weight. Westwood (1973) reported that the balance between auxins and other constituents in the plants tissues control organs formation and is the basis for rooting and root characters. This balance may be achieved by various combinations of genetics, environmental and chemical factors.

The establishment of rooted air layering was also significantly influenced by nursery and treatment combinations of IBA concentrations, time of layering and rooting media presented Table 6. Of the two nursery, Polyhouse recorded higher establishment (67.43%) than open nursery conditions (60.30%). Among the treatment combinations, I_3SM_3 (IBA at 4000 ppm + 15th August + moist sphagnum moss) recorded the highest establishment (87.50%). In the interaction effect of treatment combinations and nursery, I_3SM_3 under polyhouse nursery recorded the highest establishment (91.67%). This might be due to more number of primary and secondary roots and root length at this combination for better absorption of nutrients and moisture from the soil and ultimately resulted in higher establishment percentage (Tyagi and Patel, 8). Establishment under poly-house nursery conditions always higher than that of open nursery conditions irrespective of IBA concentrations, time of layering and media and their interactions. This might be due to congenial environmental conditions under poly-house conditions when compared to uncontrolled environmental conditions of open nursery. This finding is in agreement with the results obtained by Ahmad *et al.* (1) in patch budding of walnut, Singh *et al.* (6) on Wedge method of grafting in guava (*Psidium guajava*) cultivars Allahabad Safeda and Sardar under greenhouse obtained higher successes than in an opened conditions .

Table 6. Effect of IBA concentrations, time of layering, rooting media and nursery on survival of plantlets.

Treatments (T)	Nursery (N)		
	Open	Polyhouse	Mean
I_0SM_1	33.33	50.00	41.67
I_0SM_2	50.00	55.55	52.78
I_0SM_3	55.55	61.10	58.33
I_1SM_1	61.10	61.11	61.10
I_1SM_2	63.89	66.66	65.27
I_1SM_3	66.66	69.44	68.06
I_2SM_1	66.66	69.44	68.22
I_2SM_2	69.44	77.77	73.60
I_2SM_3	72.22	82.00	77.11
I_3SM_1	75.00	83.33	79.17
I_3SM_2	78.33	88.88	83.33
I_3SM_3	83.33	91.67	87.50
I_0CM_1	16.66	33.33	25.00
I_0CM_2	33.33	50.00	41.67
I_0CM_3	50.00	55.55	52.78
I_1CM_1	49.99	58.34	54.17
I_1CM_2	55.55	61.10	58.33
I_1CM_3	61.10	63.88	62.49
I_2CM_1	61.10	66.66	65.27
I_2CM_2	63.89	69.44	65.27
I_2CM_3	66.66	72.22	69.44
I_3CM_1	66.66	72.22	69.44
I_3CM_2	72.22	75.00	72.22
I_3CM_3	75.00	83.33	80.55
Mean	60.30	67.43	
$CD_{0.05}$	N	1.28	
	T	4.44	
	N x T	6.28	

I_0= Control, I_1= IBA 2000ppm, I_2= IBA 3000 ppm, I_3= IBA 4000 ppm M_1= 15th June, M_2= 15th July , M_3= 15th August, S= Sphagnum moss and C= Coco peat

Based on the above result it was concluded that rooting could be enhanced in air layer by exogenous

application of IBA at 4000 ppm with moist sphagnum moss as rooting media layering during 15th August. Besides it also improved root characters like number of roots, root length and root weight and also recorded highest establishment.Comparatively, establishment under polyhouse conditions always higher than that of open nursery conditions irrespective of IBA concentrations, time of layering and rooting media.

REFERENCES

1. Ahmad, M.F., Iqbal, U. and Khan, A.A. 2007. Response of different environments and dates of patch budding on success in walnut. *Indian J. Hort*. **64**: 286-89.
2. Bhagat, B.K., Singh, C. and Chaudhary, B.B. 1999. Effect of growth substances on rooting and survival of airlayers of guava (*Psidium guajava* L.) cv. Sardar. *Orissa J. Hort.* **27**: 72-75.
3. Chandrappa and Gowda, V.N. 1998. Influence of auxin and 1,2,3 Acid on rooting of guava air layers. *Mysore J. Agric. Sci.* **32**: 59-66.
4. Panse, V.G. and Sukhatme, P.V. 1978. *Statistical Methods for Agricultural Workers*. Indian Council of Agricultural Research, New Delhi. pp. 125-28.
5. Singh, D.K. 1998. Regeneration of guava (*Psidium guajava* L.) cultivars by stooling with the aid of paclobutrazol. *Ann. Agric. Res.* **19**: 317-20.
6. Singh, G. Gupta, S., Mishra, R. and Singh, A. 2007. Technique for rapid multiplication of guava (*Psidium guajava* L.). *Acta Hort.* **735**: 177-83.
7. Singh, S. and Jawanda, J.S. 1981. Propagation studies in litchi. *Punjab Hort. J.* **21**: 184-87.
8. Tyagi, S.K. and Patel, R.M. 2004. Effect of growth regulators on rooting of air-layering of guava (*Psidium guajava* L.) cv. Sardar. *Orissa J. Hort.* **32**: 58-62.

Received: February, 2010; Revised: April, 2010
Accepted: August, 2010