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Effect of type of cuttings and growth regulators on sprouting and growth parameters of wax apple (*Syzygium samarangense* L.)

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Abstract
The study was conducted during 2015-16 at Agriculture Experimental Station (AES), Navsari Agricultural University, Paria, Dist- Valsad. An experiment comprised with two factors (1) Types of cutting [Hardwood cutting (P_1) and Semi-hardwood cutting (P_2)] and (2) Growth regulators [IBA 5000 mg/lit.(G_1), IBA 7500 mg/lit. (G_2), NAA 5000 mg/lit. (G_3), NAA 7500 mg/lit. (G_4), IBA 5000 + NAA 5000 mg/lit. (G_5), IBA 5000 + NAA 7500 mg/lit. (G_6), IBA 7500 + NAA 5000 mg/lit. (G_7), IBA 7500 + NAA 7500 mg/lit. (G_8) and Control (G_9)] in Completely Randomized Design with Factorial Concept and repeated thrice under Net house conditions. Results showed that among the different cutting types and growth regulators, hardwood cutting and IBA 5000 mg/lit. + NAA 5000 mg/lit. were individually as well as in their combination found to be the most beneficial for early sprouting. Similar trend was observed on the growth parameters such as number of shoots, leaves and leaf area, length and diameter of longest shoot, fresh and dry weight of plant and survival percentage.

Keywords: Wax apple, IBA, NAA, Hardwood cutting, Semi- hardwood cutting

Introduction
Wax apple (*Syzygium samarangense*) belongs to the family Myrtaceae. *Syzygium samarangense* is medium tree, 8-12 m height, has a short 25-30 cm thick pinkish grey, flaking bark and open, wide spreading crown (Bose *et al*., 2002) [2]. Wax apple fruits are crispy, juicy and tasty with apple aroma. Fruits are used as stomatitis aphtosa, diuretic, emmenagogue, abortifacient and febrifuge. Leaves and barks of wax apple are used for various ailments like cough, cold and amenorrhoea (Peter *et al*., 2011) [11]. Any living vegetative plant tissue, cambium, epidermis, parenchyma of bark, *etc*. can form roots if there are fulfilled appropriate environment conditions and if there is a certain level of hormonal contents. The higher hormonal concentrations provoke the cambium and pericycle cell division from where the process of root formation starts. Roots originated from vegetative plants parts under the hormone effect are similar to roots formed naturally. In India, air layering is most commonly used methods to multiply wax apple, but air layering can be done only in rainy season and limited number of plants can be produced from the mother plants. Cuttings are very difficult to rooting. Moreover, it is easy to do, rapid, simple and cheaper than other asexual methods and large number of plants can be obtained within short time. Demand may be increased in future for good quality planting material. The most commonly used plant growth regulators for better rooting of cuttings are IAA, IBA and NAA. Among those auxins, IBA and NAA have proved to be the best for proper root growth and are widely used for successful rooting of cuttings. Thus the investigation was carried out to find out the best performance of different cutting types under the different IBA and NAA concentrations.

Materials and Methods
Experiment entitle effect of type of cuttings and growth regulators on sprouting and growth parameters of wax apple (*Syzygium samarangense* L.) was conducted during 2015-16 at Agriculture Experimental Station (AES), Navsari Agricultural University, Paria, Dist- Valsad with a view to study the effect of different growth regulators and cutting types on sprouting and growth parameters of wax apple with two factors consisted of type of cuttings and growth regulators. First factor of type of cutting, Hardwood cutting (P_1) and Semi-hardwood cutting (P_2). Second factor comprised of growth regulators, IBA 5000 ppm (G_1), IBA 7500 ppm(G_2)

NAA 5000 ppm(G_3), NAA 7500 ppm(G_4), IBA 5000 + NAA 5000 ppm(G_5), IBA 5000 + NAA 7500 ppm(G_6), IBA 7500 + NAA 5000 ppm(G_7), IBA 7500 + NAA 7500 ppm (G_8) and Control (G_9) under Net house conditions. The cuttings were taken from 10-15 year old healthy mother plants of the local cultivar during June. 15 to 20 cm long cuttings were generally taken from the matured branches. The cuttings are dipped in pre-prepared different IBA and NAA solutions by quick dip method for 10 seconds. After that the cuttings were planted immediately in a polythene bags containing media. Each replication contains 20 cuttings per treatment. Different growth observations of shoot were recorded number of day taken to first sprouting, number of shoots and leaves, length of longest shoot and diameter of longest shoot at 30,60,90 and 120 days after planting. Fresh and dry weight of plant and leaf area at 120 days after planting. The data collected were subjected to statistical analysis suggested by Panse and Sukhatme (1967) [10].

Results and Discussion

Two type of cutting (hardwood and semi hardwood) and different growth regulators concentration (IBA and NAA, 5000 and 7500 mg/lit.) individual and combinations were used. The interaction effect between type of cutting and growth regulators concentrations were significant in all the characters the best results was found in hardwood cuttings with IBA 5000mg/lit + NAA 500 mg/lit. (P_1G_5) treatment.

The minimum number of days (7.23 days) required for sprouting were found in P_1G_5 treatment which at par with P_2G_5 treatment and maximum number of days (21.24 days) for sprouting were found in control treatment (P_2G_9)mentioned in Table-1. This might be due to level of maturity of the wood, the chemical composition of the wood from base to tip and presence of active buds on stem. Similar results finding with Kochhar *et al*.,2008 [7]; Kracikova, 1996 [8], Purohit and Shekharappa (1985) [12]. Increased level of auxins resulted in earlier completion of physiological processes in rooting and sprouting of cuttings. Hardwood cuttings having high amount of stored carbohydrate and low to moderate amount of nitrogen which was utilized by cutting to produce shoot system with the help of IBA by hydrolysis, mobilization and utilization of nutritional reserves in region of shoot formation (Canli and Bozkurt, 2009) [3].

Maximum number of shoots at 30, 60, 90 and 120 DAP (4.74, 7.14, 9.00 and 11.03, respectively) were found in P_1G_5 treatment while minimum number of shoots at 30, 60, 90 and 120 DAP (1.02, 2.00, 2.78 and 3.04, respectively) were found in P2G_9 treatment mentioned in Table-2. Maximum number of shoot was noted because of planting material was taken from the base portion of the branch and the minimum shoots were recorded in middle portion of the cutting because of presence of apical portion which results in creation of apical dominance. The portion of branch used and the mobilization and utilization of the carbohydrate due to increase in the indigenous auxin had significant effect on the maximum number of shoots recorded (Alam *et al.*,2007; Saroj *et al.*, 2011; Singh *et al*., 2014) [1, 15].

The maximum shoot length (13.40 cm) and diameter of longest shoot (0.41 cm) were observed in P_1G_5 treatment at 120 DAP (table-3 and 4). While minimum shoot length (5.09 cm) and diameter of longest shoot (0.20 cm) were observed in P_2G_9 treatment. This might be due to auxin cause increased linear growth of stem by way of cell elongation (Saroj *et al*., 2008) [14]. Exogenous IBA application affected significantly on shoot parameters because it enhance hydrolysis of nutritional reserves under the influence of exogenous auxin (Kochhar *et al*., 2008) [7].

Maximum number of leaves (34.00) and leaf area (71.51 cm^2) at 120 DAP were found in P_1G_5 treatment which was at par with P_2G_5 and minimum number of leaves (13.07) and leaf area (43.99 cm^2) were found in P_2G_9 treatment (table-5 and 6). As the numbers of sprouts are higher in hardwood cuttings the numbers of leaves are also high. Increase in leaf number due to application at higher concentrations of auxin might induced vigorous root thus enabling the cuttings to absorb more nutrients and produced more number of leaves. More or less similar results were also reported by Thakur *et al*., (2014) [16] in olive; Rafael, (2006) [13] in fig.

Maximum plant fresh weight (40.41 g) and plant dry weight (21.89 g) at 120 DAP were recorded in P_1G_5 treatment and minimum fresh weight (23.96 g) and plant dry weight (10.30 g) were found in P_2G_9 treatment (Table-6 and 7). This might be due to increase in the production of the leaves and leaf area ultimately increased the photosynthesis, relative growth rate and growth of lateral branching of shoots which were increased fresh and dry biomass of the shoots and root: shoot ratio (Khapare *et al*., 2012) [6].

The maximum survival percentage (88.02 %) was recorded when hardwood cuttings were treated with IBA 5000 mg/lit. + NAA 5000 mg/lit. (P_1G_5) while minimum survival percentage (28.49 %) in control treatment P_2G_9 (Table-5). This might be due to overall performance in relation to growth parameters of root and also shoots were significantly better in this treatment which ultimately increased the survival percentage. These observations are in close conformity with finding of Faghihi *et al*., (2013) in apple; Kumar *et al*., (2008) [9] in passion fruits; Das *et al*.,(2006) [4] in olive.

Table 1: Effect of type of cutting and growth regulators on number of days taken to first sprouting of wax apple

PGR(G)/ Type of cutting(P)	P_1	P_2	Mean
G_1	11.02	12.45	11.74
G_2	11.37	12.67	12.02
G_3	14.00	15.02	14.51
G_4	14.58	16.11	15.35
G_5	7.23	9.35	8.29
G_6	12.02	14.20	13.11
G_7	10.32	12.00	11.16
G_8	13.03	14.87	13.95
G_9	19.35	21.24	20.30
Mean	12.55	14.21	
	S.Em.±	CD at 5 %	CV %
P	0.06	0.16	2.16
G	0.12	0.34	
P x G	0.17	0.48	

Table 2: Effect of type of cuttings and growth regulators on number of shoots per cutting (30, 60, 90 and 120 DAP)

Type of cuttings (P) / PGR (G)	30 DAP			60 DAP			90 DAP			120 DAP		
	P_1	P_2	Mean	P_1	P_2	Mean	P_1	P_2	Mean	P_1	P_2	Mean
G_1	3.12	2.47	2.80	5.65	4.54	5.10	6.74	5.86	6.30	8.78	6.48	7.63
G_2	2.87	2.41	2.64	5.11	4.12	4.62	6.70	5.78	6.24	7.89	6.40	7.15
G_3	2.31	2.14	2.23	3.67	3.24	3.46	4.81	4.27	4.54	6.00	5.28	5.64
G_4	2.21	2.07	2.14	3.45	3.00	3.23	4.51	4.01	4.26	5.63	5.02	5.33

G_5	4.74	4.03	4.39	7.14	6.48	6.81	9.00	8.12	8.56	11.03	10.01	10.52
G_6	2.55	2.27	2.41	4.72	3.54	4.13	5.94	4.58	5.26	6.87	5.81	6.34
G_7	3.64	2.67	3.16	6.03	4.87	5.45	7.75	6.10	6.93	8.92	7.54	8.23
G_8	2.37	2.17	2.27	4.00	3.31	3.66	5.34	4.32	4.83	6.32	5.38	5.85
G_9	1.09	1.02	1.06	2.23	2.00	2.12	2.98	2.78	2.88	3.48	3.04	3.26
Mean	2.77	2.36		4.67	3.90		5.97	5.09		7.21	6.11	
	S.Em.±	CD at 5 %	CV %	S.Em.±	CD at 5 %	CV %	S.Em.±	CD at 5 %	CV %	S.Em.±	CD at 5 %	CV %
P	0.023	0.065		0.04	0.11		0.04	0.11		0.029	0.082	
G	0.048	0.137	4.57	0.08	0.24	4.72	0.08	0.24	3.66	0.061	0.175	2.24
P x G	0.068	0.194		0.12	0.33		0.12	0.33		0.086	0.247	

Table 3: Effect of type of cuttings and growth regulators on length of longest shoot (cm) of wax apple (120 DAP)

PGR(G)/ Type of cutting(P)	P_1	P_2	Mean
G_1	11.67	9.56	10.61
G_2	10.53	9.21	9.87
G_3	9.02	7.65	8.34
G_4	8.22	7.45	7.83
G_5	13.40	12.65	13.02
G_6	9.79	8.34	9.06
G_7	12.03	10.12	11.08
G_8	9.09	7.96	8.53
G_9	5.41	5.09	5.25
Mean	9.91	8.67	
	S.Em.±	CD at 5 %	CV %
P	0.03	0.10	
G	0.07	0.21	1.95
P x G	0.10	0.30	

Table 4: Effect of type of cuttings and growth regulators on diameter of longest shoot (cm) of wax apple (120 DAP)

PGR(G)/ Type of cutting(P)	P_1	P_2	Mean
G_1	0.39	0.35	0.37
G_2	0.40	0.34	0.37
G_3	0.31	0.26	0.28
G_4	0.29	0.25	0.27
G_5	0.41	0.42	0.42
G_6	0.35	0.31	0.33
G_7	0.40	0.36	0.38
G_8	0.32	0.28	0.30
G_9	0.23	0.20	0.21
Mean	0.34	0.31	
	S.Em.±	CD at 5 %	CV %
P	0.003	0.009	
G	0.007	0.019	4.93
P x G	0.031	0.088	

Table 5: Effect of type of cuttings and growth regulators on number of leaves per cutting of wax apple (120 DAP)

PGR(G)/ Type of cutting(P)	P_1	P_2	Mean
G_1	21.00	20.14	20.57
G_2	20.00	19.12	19.56
G_3	14.24	13.01	13.63
G_4	13.12	13.00	13.06
G_5	34.00	26.00	30.00
G_6	19.00	14.14	16.57
G_7	24.00	17.00	20.50
G_8	17.12	13.07	15.10
G_9	9.00	8.67	8.84
Mean	19.05	16.02	
	S.Em.±	CD at 5 %	CV %
P	0.010	0.029	
G	0.022	0.062	0.30
P x G	0.031	0.088	

Table 6: Effect of type of cuttings and growth regulators on total leaf area (cm^2) of wax apple (120 DAP)

PGR(G)/ Type of cutting(P)	P_1	P_2	Mean
G_1	69.97	62.11	66.04
G_2	63.60	65.78	64.69
G_3	62.13	64.66	63.40
G_4	61.20	64.98	63.09
G_5	71.51	66.99	69.25
G_6	65.50	62.53	64.01
G_7	69.18	63.07	66.13
G_8	62.90	64.34	63.62
G_9	50.55	43.99	47.27
Mean	64.06	62.05	
	S.Em.±	CD at 5 %	CV %
P	0.70	2.00	
G	1.48	4.24	5.75
P x G	2.09	6.00	

Table 7: Effect of type of cuttings and growth regulators on fresh weight of plant (g) of wax apple (120 DAP)

PGR(G)/ Type of cutting(P)	P_1	P_2	Mean
G_1	36.80	33.49	35.14
G_2	34.38	34.23	34.30
G_3	32.58	32.67	32.63
G_4	32.22	32.65	32.44
G_5	40.41	37.88	39.14
G_6	33.79	33.05	33.42
G_7	36.73	34.12	35.43
G_8	33.70	32.59	33.15
G_9	27.92	23.96	25.94
Mean	34.28	32.74	
	S.Em.±	CD at 5 %	CV %
P	0.25	0.72	
G	0.53	1.53	3.91
P x G	0.76	2.17	

Table 8: Effect of type of cuttings and growth regulators on dry weight of plant (g) of wax apple (120 DAP)

PGR(G)/ Type of cutting(P)	P_1	P_2	Mean
G_1	19.83	18.93	19.38
G_2	19.72	18.32	19.02
G_3	17.73	16.81	17.27
G_4	16.93	16.17	16.55
G_5	21.89	21.35	21.62
G_6	19.25	17.11	18.18
G_7	19.79	19.81	19.80
G_8	17.97	16.92	17.44
G_9	13.50	10.30	11.90
Mean	18.51	17.30	
	S.Em.±	CD at 5 %	CV %
P	0.15	0.43	
G	0.32	0.91	4.34
P x G	0.45	1.29	

Conclusions

On the basis, obtained results of present investigation it can be concluded that among all the treatments, wax apple propagated through hardwood cutting treated with IBA 5000 mg/lit. + NAA 5000 mg/lit. (P_1G_5) individually as well as in their combination was superior in all the growth parameters and in producing healthy and vigorous plants. Therefore, use of hardwood cuttings with combination of IBA 5000 mg/lit. + NAA 5000 mg/lit. Can be utilized for producing healthy and vigorous planting material of wax apple.

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