Effect of different concentration of IBA on the success of hardwood and softwood cuttings of water apple

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ABSTRACT

Considering the nutritional, commercial potentiality and popularity there is an increasing tendency to grow water apple in different parts of West Bengal. However, due to the unavailability of genuine quality planting material, area under the cultivation of this crop is limited. Till date growers are raising this crop mostly through seed propagation. Asexual means of propagation reduces the long gestation period. Considering the above facts, an experiment was conducted to assess the effect of various concentrations of IBA on different types of cuttings of water apple. According to the results obtained, IBA concentration at 3000 ppm showed better response in terms of days taken for sprouting (8.66 days), number of leaves (54.23), sprouting (88.25 %), success (86.75) and survival rate (93.23 %) with least mortality rate (17.75 %) IBA at 3000 ppm performed better in terms of number of roots (23.70) and rooting per cent (91.75 %).

Keywords: Cuttings, IBA, propagation, water apple,

INTRODUCTION

Water apple [*Syzygium aqueum* (Brum. F. Alston)] is a tropical minor fruit crop under the Myrtaceace family. It is considered as potential minor fruit crop of India has believed to be primary centers of origin in Southern India and Malaysia. With passage of time, this crop successfully expanded its geographical presence to the whole Indian subcontinent, South America, the warmer regions of North America as well as in sub-Saharan Africa (Djipa *et al*., 2000). The fruit crop is commonly known as *Jamrul* in West Bengal and basically popular for its refreshing thirst-quenching property. Mainly the fruit is consumed as fresh although various post-harvest preparation like jam, jellies etc can be made through it. This minor fruit is getting attention for its medicinal values (Tripathi, 2021). Due to its high-water content it is regarded to as low-calorie fruit. Besides its unique property, water apple is also considered as one of the rich sources of essential minerals and antioxidants (Hartati, 2022; Lim *et al*., 2007).

Understanding the future potential of nutritive crops, the farmers are now a days interested in the commercial cultivation of nutrient rich fruits. Water apple is a genuine candidate to meet the farmers' interest specific to this purpose. Its cultivation has already been accelerated in various parts of India. It fetches good price during summer months and due to the increasing demands in day by day and the off-season cultivation has been started in the southern parts of West Bengal particularly in South-24 Parganas district. However, the lack of genuine, quality planting materials is one of the main constraints regarding area expansion of this crop. Traditionally, water apple is propagated by seed, but its recalcitrant seeds quickly lose viability. Besides, seed propagation leads to the significant genetic variation in fruit colour, shape, and size. Therefore, asexual means of propagation are required to produce uniform plants as well as to preserve genetic purity. In light of these considerations, the present study was designed to standardize propagation techniques through cuttings by using different concentrations of IBA.

MATERIALS AND METHODS

The present study was conducted at the Instructional Farm, Department of Pomology and Post-Harvest Technology, Faculty of Horticulture, Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal, India during 2021 under poly-house condition. Geographically the district lies in the foothills of eastern Himalayas and is located at 28º58'86'' N latitude, 81º66''73'' E longitude at an elevation of 42 m above mean sea level. The experiment was laid out in Complete Randomized Design with six treatments consisting of T_1 (control), T_2 (IBA @1000 ppm), T_3 (IBA @ 2000 ppm), T_4 (IBA @ 3000 ppm), T_5 (IBA @ 4000 ppm) and T_6 (IBA @ 5000 ppm). A total of sixty stem cuttings were taken in each treatment and replicated four times. Softwood and hardwood cuttings (15 cm long) of water apple were taken from 8-year-old tree with a 3-4 nodes in each during the month of June. The small portions from both the ends of the cuttings slightly above and below the nodes were removed in order to separate the new shoots from the cuttings and trimmed up to necessary length. A slant cut was made at the basal end of the cutting to promote the most absorbent area possible for successful rooting. Cuttings were treated by dissolving on required IBA solution through rapid dip method as mentioned above. After that the cuttings were planted in poly bags containing 1:1:1 FYM+ Soil+ Sand as the rooting media and kept in poly-house condition for 120 days. Five cuttings form each replication were selected randomly for recording observations under this experiment. For statistical interpretation, analysis of variance for each parameter was performed using Proc Glm of Statistical Analysis System (SAS) Software (Version 9.3). Means separations for different accessions under different parameter were performed using Least Significant Difference (LSD) test ($P \leq 0.05$). Normality of residuals under the assumptions of ANOVA was tested using Kolmogrov-Smirnov test using Proc-Univariate procedure of SAS (Version 9.3).

RESULTS AND DISCUSSION

The perusal of data from the experiment showed several growth benefits across both softwood and hardwood cuttings of water apple when treated in different concentration of IBA than control. Both hardwood and softwood cuttings of the plant showed maximum sprouting percentage (Table 1) when they were treated with 3000ppm of IBA (79.75% and 88.00% respectively). The result was statistically similar with the treatments where 2000 ppm IBA was used. 3000 ppm IBA also showed the quickest sprouting (13.77 and 9.21 days respectively) and also produce highest sprout length (31.97 and 31.65 cm respectively) followed by highest number of leaves (42.64 and 31.75 respectively) after 120 days of the treatment in the respective type of cuttings (Table 1 and 2). The number of leaves produced by *Acalypha hispida* were also high in hardwood cuttings (Rifnas *et al.*, 2021). The significant effect of various concentrations of IBA on cuttings for sprouting might be due to a high concentration of stored carbohydrates and low to moderate concentrations of nitrogen were used to develop shoot systems by hydrolyzing, mobilizing, and using nutritional reserves in the area of shoot development. Adequate concentration of IBA enhanced the nutrient uptake and resulted in more photosynthetic provide required energy for cell division and cell elongation which ultimately helps to improve the sprouting on the cuttings (Singh *et al.*, 2020; Almedia *et al.*, 2010; Henrique *et al.*, 2006). The use of different concentrations of IBA may have increased leaf count due to induced robust root, allowing cuttings to absorb more nutrients in order to produce more leaves as well as the activation shoot growth which probably increased the number of nodes that lead to development of a greater number of leaves (Srihari *et al.,* 2018).

The treatment with 3000 ppm IBA also results in maximum number of roots (19.03 and 23.70 cm respectively) with fastest root induction behavior (24.20 and 19.61 days respectively) over the other treatments in both softwood and hardwood cuttings respectively (Table 2). The probable cause behind least number of days taken for rooting might due to the use of IBA which promotes the development and division of the first root initial cells. The mechanisms by which IBA stimulates root formation in stem cuttings are through its conversion to IAA, enhancement of endogenous IAA synthesis, or the action of IAA synergistically, preventing IAA degradation and increasing its activity (Hartmann *et al*., 2010). Induction of maximum numbers of roots is due to stimulation of cambial activity involved in root initiation by growth regulators. IBA promote adventitious root formation by their ability to promote the initiation of lateral roots and also enhanced the transport of carbohydrates to basal portion of cuttings and due to its cell wall plasticity, which accelerates cell division stimulates callus development and root growth (Shao *et al*., 2018; Malik *et al*., 2013).

Observation recorded on rooting percentage showed that the cuttings when treated with IBA 3000 ppm exhibited highest rooting percentage in softwood cuttings (85.50%) and hardwood cuttings (91.75 %). The maximum fresh (30.55 and 27.65g) and dry weight (12.68 and 13.64g) of roots were recorded also with the same treatment in softwood and hardwood cuttings respectively (Table 3). The application of IBA might had an indirect influence by enhancing the speed of transformation of rooting primordia and movement of sugars to the base of cuttings and consequently formation of young active root and increase in rooting percentage (Srihari *et al.,* 2018; Paul and Aditi 2009). The increase in weight of roots might be due to of increased root number, length of roots, photosynthesis, relative growth rate, and lateral branching of the shoots brought about by the IBA applied cuttings. The increment might be due to the cuttings contained higher amount of stored carbohydrate, when comes to contact with IBA increased the number of roots resulting a higher root dry matter accumulation the promoting effect of IBA on shoot parameters can be attributed to the reason that the better rooting coupled with better leaf growth and at the same time sustained the root strength to continue vigour and vitality in taking up nutrients as well as moisture as similar results were observed in the cuttings treated with IBA 3000 ppm (Abdullah *et al*., 2006).

Among different concentration of IBA, 3000ppm IBA resulted in maximum success (77.25% and 86.00% respectively) in both softwood and hardwood cuttings followed by with IBA 2000ppm treatment with statistically similar results (Table 4). The same treatments also showed statistically similar results for survival across the type of cuttings. Among the different methods of propagation, hardwood cuttings performed well (80.60% survival rate) in *Acalypha hispida* (Rifnas *et al*., 2021). Root and shoot formation as well as growth, which is well recorded to be influenced by a number of factors, including genotypes, physiological and ontogenetic age of cuttings, endogenous hormone contents, type of wood, carbohydrate contents, preconditioning treatment of cuttings, and external factors like cuttings micro-environment and the use of root-promoting substances may be the possible reasons for the present experimental results (Sharma *et al*., 2009).

CONCLUSION

The study reflects that the application of IBA significantly influences the propagation potential of water apple through stem cuttings. Hardwood cuttings treated with IBA at 3000 ppm exhibited superior performance across all parameters, including sprouting percentage, rooting percentage, number of leaves, number of roots, and success rate. These cuttings also showed reduced time to sprouting and rooting, with enhanced root and shoot growth, ensuring a higher survival rate and lower mortality. Softwood cuttings also responded better with 3000 ppm IBA, although hardwood cuttings showed overall superior results.

CONFLICT OF INTEREST STATEMENT

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Table 1. Effect of IBA on sprouting percentage, sprouting days and sprout length of water apple cuttings

Treatments	Sprouting percentage of cuttings		Days taken for sprouting		Sprout length (cm)	
	SWC	**HWC**	**SWC**	**HWC**	**SWC**	**HWC**
T_1 (Control)	50.25^d (45.13)	56.25^d (48.60)	17.38 ^{a}	13.49 ^{a}	15.62^e	16.73^e
T_2 (IBA@1000 ppm)	65.25^{bc} (53.88)	78.25^{bc} (62.19)	14.35 ^{e}	10.44 ^{c}	26.76^b	26.68^c
T_3 (IBA @2000 ppm)	73.50^{ab} (59.45)	84.75 ^{a} (67.26)	14.69 ^{d}	9.84 ^{e}	27.04^b	28.01^b
T_4 (IBA @3000 ppm)	79.75^a (63.35)	88.00 ^{a} (70.05)	13.77 ^{f}	9.21^f	31.97^a	31.65^a
T_5 (IBA @4000 ppm)	59.50^{cd} (50.54)	70.50 ^{c} (57.48)	15.85 ^{c}	12.79 ^{b}	24.08^c	21.94^d
T_6 (IBA @1000 ppm)	53.00^d (46.71)	66.50 ^{c} (54.72)	16.67 ^{b}	12.81^b	21.74^d	20.94^d
S.Em.(±)	2.22	2.56	0.02	0.02	0.51	0.43
CD at ≤ 5%	6.65	7.66	0.07	0.05	1.53	1.29

* SWC- Softwood cutting; HWC; Hardwood cutting; DAC- Days after Cutting. ** Means with same letter are not significantly different, Values in the parenthesis are the angular transform values

Table 2. Effect of IBA on number of leaves, days taken for rooting and root numbers of water apple cuttings

Treatments	Number of leaves		Days taken for rooting		Number of roots	
	SWC	HWC	SWC	HWC	SWC	HWC
T_1 (Control)	21.93^e	16.73^e	28.04^a	23.21^a	11.13^e	11.60^e
T_2 (IBA @1000 ppm)	29.35^c	26.68^c	25.32^d	20.35^d	13.88^{bc}	17.88^c
T_3 (IBA @2000 ppm)	38.18^b	28.01^b	24.79^e	19.84^e	15.98^b	20.90^b
T_4 (IBA @3000 ppm)	42.75^a	31.65^a	24.20^f	19.61^e	19.03^a	23.70^a
T_5 (IBA @4000 ppm)	27.68^{cd}	21.94^d	25.50^c	22.26^c	13.35^{cd}	14.65^d
T_6 (IBA @5000 ppm)	25.13^d	20.94^d	27.04^b	22.78^b	11.73^{de}	13.68^d
S.Em.(±)	0.90	0.43	0.08	0.11	0.71	0.70
CD at ≤ 5%	2.71	1.29	0.03	0.32	2.14	2.09

* SWC- Softwood cutting; HWC; Hardwood cutting; DAC- Days after Cutting. ** Means with same letter are not significantly different

Table 3. Effect of IBA on rooting percentage, fresh and dry weight roots of water apple cuttings

Treatments	Rooting percentage at 120 DAC		Fresh weight of root (g)		Dry weight of root (g)	
	SWC	HWC	SWC	HWC	SWC	HWC
T_1 (Control)	48.00 ^{e} (43.83)	60.75 ^{d} (51.20)	19.24^{f}	12.77^{f}	5.99^{d}	6.74^{b}
T_2 (IBA @ 1000 ppm)	68.25 ^{c} (55.74)	78.75 ^{c} (62.54)	25.79^{c}	20.13^{c}	10.80^{b}	11.98^{a}
T_3 (IBA @ 2000 ppm)	79.25 ^{b} (62.94)	87.00 ^{b} (68.88)	27.24^{b}	26.04^{b}	10.94^{b}	13.52^{a}
T_4 (IBA @ 3000 ppm)	85.50 ^{a} (67.67)	91.75 ^{a} (73.28)	30.55^{a}	27.65^{a}	12.68^{a}	13.64^{a}
T_5 (IBA @ 4000 ppm)	67.00 ^{c} (54.94)	83.25 ^{bc}(65.83)	23.42^{d}	17.37^{d}	9.35^{c}	8.37^{b}
T_6 (IBA @5000 ppm)	57.75 ^{d} (49.44)	82.50 ^{bc}(65.51)	22.61^{e}	13.87^{e}	9.33^{c}	7.24^{b}
S.Em.(±)	1.21	1.19	0.22	1.65	0.46	0.63
CD at ≤ 5%	3.61	3.57	0.66	0.55	1.38	1.88

* SWC- Softwood cutting; HWC; Hardwood cutting; DAC- Days after Cutting. ** Means with same letter are not significantly different, Values in the parenthesis are the angular transform values

Table 4. Effect of IBA on success rate and survival percentage of water apple cuttings

Treatments	Success rate (%)		Survival percentage	
	SWC	**HWC**	**SWC**	**HWC**
T_1 (Control)	45.75^{d} (42.53)	54.00^{c} (47.30)	73.56^{c} (59.21)	71.22^{a} (57.62)
T_2 (IBA @1000 ppm)	63.75^{bc} (52.98)	76.25^{ab} (60.840)	84.52^{ab} (66.93)	80.66^{abc} (64.04)
T_3 (IBA @2000 ppm)	73.00^{ab} (59.08)	82.50^{a} (65.48)	87.35^{a} (69.20)	82.26 ^{ab} (65.21)
T_4 (IBA @3000 ppm)	77.25 ^{a} (61.65)	86.00^{a} (68.27)	90.24^{a} (72.04)	87.41^{a} (69.28)
T_5 (IBA @4000 ppm)	55.50^{cd} (48.21)	68.50^{b} (56.21)	80.16^{bc} (63.60)	77.39^{bcd} (61.69)
T_6 (IBA @5000 ppm)	51.50^{cd} (45.84)	65.25^{bc} (53.94)	76.44^{c} (61.11)	74.27^{cd} (59.58)
S.Em.(±)	2.43	2.57	1.85	1.77
CD at ≤ 5%	7.28	7.70	5.53	5.30

* SWC- Softwood cutting; HWC; Hardwood cutting; ** Means with same letter are not significantly different, Values in the parenthesis are the angular transform values