Environment & Ecology 35 (2) : 712—716, April—June 2017
Website: environmentandecology.com ISSN 0970-0420

Effect of Etiolation and Plant Growth Substances on Success, Survival and Growth Behavior of Air Layers of Guava (*Psidium guajava* L.)

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Received 4 June 2016; Accepted 2 July 2016; Published online 30 July 2016

Abstract The experiment was conducted in the horticulture garden in 2011-12. The design of experiment was randomized block design with three replications. The experiment comprised twelve treatments including control. The symbol and treatment detail is are as follows : T_1 – Control, T_2 – Etiolation, T_3 – NAA @ 3000 ppm, T_4 – NAA @ 6000 ppm, T_5 – NAA @ 3000 ppm + etiolation, T_6 – IBA @ 3000 ppm, T_7 – IBA @ 6000 ppm, T_8 – IBA @ 3000 ppm + etiolation, T_9 – NAA @ 3000 ppm + IBA @ 3000 ppm, T_{10} – NAA @ 3000 ppm + IBA @ 6000 ppm, T_{11} – NAA @ 6000 ppm + IBA @ 3000 ppm and T_{12} – NAA @ 6000 ppm + IBA @ 6000 ppm. Maximum success (94.66%) was obtained with etiolation followed by application of IBA @ 3000 ppm concentration, which was statistically at par with T_5 (91.33%) and T_7 (88.33%). Whereas, control i.e., T_1 showed 54.33% success in air-layers. Etiolation followed by application of growth regulators i.e., IBA @ 3000 ppm showed the maximum number and length of primary roots i.e., 15.75 and 11.62 cm. However, the lowest length of primary roots was measured in control (T_1) i.e., 4.00 and 6.69 cm respectively. The best treatment in respect of survivability was T_8 (etiolation + IBA @ 3000 ppm) which showed maximum survival (78.33%). Next effective treatment was T_5 (etiolation + NAA @ 3000 ppm) with 75.90% survival of air-layers in nursery.

Keywords Etiolation, IBA, NAA, Success, Survival.

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Introduction

Guava (*Psidium guajava* L.) is the fourth most common and popular fruit of India in area and production after mango, citrus and banana. It has been in cultivation in India since 17th century and gradually became a crop of commercial importance. Guava belongs to the family Myrtaceae and native of tropical America. It is most important, highly productive, delicious and nutritious fruit of tropical and sub-tropical region. It is said to be the "apple of tropics". It is good source of calcium, iron, fair source of phosphorus and a rich source of vitamin C and pectin. Guava is available at cheaper rate and is popularly known as "Poor man apple". The vitamin 'C' content of the fresh ripe fruit varies from 100 to 260 mg per 100g of fruit pulp. Beside this, it is also a good source of vitamin A,vitamin B and minerals.Guava has an important place in the fruit industries because it provides a good raw material for making jelly and many kinds of other preserves and does not loss the vitamin C content in preserved form. It is also reputed for its medicinal properties and almost all the parts of plants are used in medicines.

Guava can be propagated by air-layering, inarching, stooling, root cutting and budding. Air-layering is the most popular commercial method of vegetative propagation of guava in Bihar. The success and survival of the plants are poor. Air-layering was evaluated as a commercial method of vegetative propagation of guava [1]. The success of air-layering depends on factors like varying conditions of climate, species and varieties of the plant and environmental factors like air, temperature, humidity and mechanical treatments. Physiological condition of mother plant, age of wood and season during which cutting are taken also affect the rooting of cuttings. Internal and structural factors like stored food material in the layerage, maturity of the tissues, etiolation and callusing. With the advancement of horticultural science, the technology of air-layering has also been improved.

In the recent past the use of plant growth regulators have played a key role in various phases of plant growth and development. It has also influenced in early root initiation and in producing fibrous roots. These two are limiting factors which effects on the success of propagated layers. A number of plant growth substances have been used successfully, in rooting of cuttings and layering. The most commonly used plant growth regulators are IBA, NAA and IAA. However, the selection of growth regulators and their concentrations varies with fruit plants.

While using growth regulators, use of proper concentration is also important factor because growth regulators used in excessive concentration may results in injury and cause yellowing and dropping of leaves, blackening of stem and eventual death of cutting and layering usually a concentration just below the toxic point is considered the most favofrable for root formation, while lower concentration may inhibit the growth, higher concentration may become toxic and this range of action is very narrow. Therefore, from standardization point of view, it is essential to determine the suitable concentration with etiolation in plant physiology by way of experimentation.

Keeping all the facts under consideration and visualizing the paucity of information on these aspects, the present investigation was undertaken with objective to find out the success and survival percentage of air-layers of guava and the efficiency of etiolation and plant growth regulators in inducing roots in air layers of guava.

Materials and Methods

The present investigation was carried out during the year 2011-12 to study the effect of etiolation and growth regulators i.e., IBA and NAA on survival, regeneration of roots, rooting ability, growth and development of layers in the nursery to air-layering of guava. The experiment was conducted with twelve treatment replicated thrice in the monsoon season of 2011. The experiment was conducted in the Horticulture Garden of Bihar Agricultural College, Sabour (Bhagalpur). For the present investigation seven years old guava plant of uniform growth was selected as experimental plant. The plants were healthy, free from pests and diseases and were grown under similar agro-climatic condition. Similar cultural and manurial schedules were adopted. One or two years old shoots having the pencil thickness (i.e., approximately 0.8 to 1.0 cm) were selected for air-layering. Twenty shoots were selected for each treatment. The selected shoots, which have to be ringed, the 4-6 cm long shoot portion wrapped with a band of black polythene film. The etiolation was done before one month of layering.

Results and Discussion

The results of different characters i.e. rooting characters in relation to the percentage of rooted air-layers, the number of primary roots, and the average length of new roots of air-layers were recorded at 70 days of layering. Establishment of air-layers in the nursery, survival percentage of air-layers, average number of new shoots per layer and length of new shoots were recorded after 180 days of detachment from the mother plants and finally the data were analyzed and interpreted. Observation on rooting percentage of air-layers revealed that success in air layering induced by all etiolation followed by application of growth regulators, varied from 54.33 to 94.66%. The maximum rooting percentage was recorded in T_8 (94.66%) which was statistically at par with the treatments T_5 (91.33%) and T_7 (88.33%). Whereas, the minimum rooting per-

Table 1. Average success of air-layers in per cent (70 days after layering).

Treatments	Chemicals and concentrations	Rooting (%)	Number of primary roots	Length of primary roots
T_1	Control	54.33	4.00	6.69
T_2	Etiolation	66.33	6.66	7.68
T_3	NAA @ 3000 ppm	78.33	8.33	8.95
T_4	NAA @ 6000 ppm	71.66	7.00	8.25
T_5	NAA @ 3000 ppm + Etiolation	91.33	13.33	10.99
T_6	IBA @ 3000 ppm	84.66	8.00	10.66
T_7	IBA @ 6000 ppm	88.33	9.66	9.79
T_8	IBA @ 3000 ppm + Etiolation	94.66	15.00	11.62
T_9	NAA @ 3000 ppm + IBA @ 3000 ppm	85.00	11.66	10.76
T_{10}	NAA @ 3000 ppm + IBA @ 6000 ppm	82.66	10.33	9.28
T_{11}	NAA @ 6000 ppm + IBA @ 3000 ppm	79.33	9.33	8.89
T_{12}	NAA @ 6000 ppm + IBA @ 6000 ppm	86.66	13.00	10.83
SEm±		2.78	0.38	0.3644
CD at 5%		8.17	1.11	1.0685

Table 2. Average survial of air-layers (%) (180 days after detachment).

Treatments	Chemicals and concentrations	Survival (%)	Avg. of new shoots/ layer	Length of new shoots (cm)
T_1	Control	50.33	2.33	19.48
T_2	Etiolation	61.00	2.66	20.40
T_3	NAA @ 3000 ppm	64.75	3.00	20.43
T_4	NAA @ 6000 ppm	62.27	3.33	22.82
T_5	NAA @ 3000 ppm+Etiolation	75.90	3.66	29.25
T_6	IBA @ 3000 ppm	74.30	3.33	24.35
T_7	IBA @ 6000 ppm	71.42	3.66	26.70
T_8	IBA @ 3000 ppm + Etiolation	78.33	4.00	31.50
T_9	NAA @ 3000 ppm + IBA @ 3000 ppm	68.15	3.33	25.79
T_{10}	NAA @ 3000 ppm + IBA @ 6000 ppm	66.38	3.66	27.28
T_{11}	NAA @ 6000 ppm + IBA@ 3000 ppm	64.25	3.33	26.36
T_{12}	NAA @ 6000 ppm + IBA @ 6000 ppm	69.82	3.66	28.63
SEm ±		1.82	0.12	0.97
CD at 5%		5.35	0.35	2.86

centage was found in T_1(54.33%) followed by treatment T_2 which was statistically at par with T_4. Among all the treatments, etiolation followed by application of IBA @ 3000 ppm was found most effective, followed by etiolation with application of NAA @ 3000 ppm concentration. While, with growth regulators NAA @ 6000 ppm concentration showed minimum effect on the success of rooted layers (71.66%). In respect of the number of primary roots per layer, IBA @ 3000 ppm with etiolation was found significantly superior to other treatments. Etiolation followed by application of NAA @ 3000 ppm concentration was the second best and NAA @ 6000 ppm + IBA @ 6000 ppm stood third. Treatments T_1 (Control) without etiolation and growth regulator showed minimum number of root per layer.

Investigations on length of primary roots indicated that maximum root length (11.62 cm) was recorded in T_8 which was statistically at par with T_5 (10.99 cm), T_{12} (10.83 cm), T_9 (10.76 cm) and T_6 (10.66 cm). Whereas minimum (6.69 cm) length of primary roots observed under the treatment control. The vegetative propagation of guava by air-layering has been stressed earlier [2]. The air-layering though considered to be the most inexpensive method for vegetative propagation, which did not prove very successful in case of guava, due to production of poor quality roots as a result poor field survival. Thus, in modern technology etiolation followed by application of growth regulators had made root formation easier and has also improved the quality of roots, if applied in correct form and in accurate concentration. Satisfactory results in rooting of layers have been obtained by etiolation followed by application of growth regulators at different concentrations [2].

Etiolation of shoot cleaved before air-layering definitely have profound effect on rooting ability and root quality of air-layers. The etiolated region accumulated more sugar natural auxin and other rooting co-factors, which are known to increase adventitious root formation. Etiolation treatment of shoot further improved the regeneration capacity of layers. Etiolation may reduce the production of lignin, thus instead of forming lignin phenolic metabolites may be channelled to enhance root initiation. Different scientists observed that the application of root promoting substances (IBA, NAA and IAA) used in eti-

olated shoots gave higher percentage of success than non-etiolated shoots. Some unknown "rooting factor" normally possesses upward in the etiolated portion and accumulates just below the nodes where it reacts with auxin to form a product which is essential for root formation. Exogenous application of IBA markedly improved the regeneration of roots in comparison to NAA. The significant effect of IBA over NAA was also reported earlier [3, 4].

As regards the effective of etiolation to concentration of growth substances, IBA @ 3000 ppm was found most effective, followed by NAA @ 3000 ppm concentration. It is also observed that IBA induced higher rooting, percentage than NAA treatment and control. These results are in support of the earlier findings [5, 6] who observed that IBA was better than NAA. In the present investigation the percentage of rooting was increased significantly in IBA @ 3000 ppm to etiolated shoot as compared to other treatments and control.

Maximum number of primary roots was obtained under treatment etiolated shoot with IBA @ 3000 ppm followed by etiolated shoot + NAA @ 3000 ppm, respectively. Among IBA and NAA, IBA was found most effective in producing more number of primary and secondary roots. The increase in number of roots may be due to the accumulation of carbohydrates, enhanced protein synthesis and greater accumulation of rooting co-factors near the etiolated region. Observation of length of primary roots revealed that the length of primary roots varied from 6.69 to 11.62 cm. Thus it may be inferred from the present findings that etiolated shoots with IBA @ 3000 ppm was more effective in increasing length of primary roots. These findings are supported earlier [7].

Etiolation followed by application of IBA @ 3000 ppm was found most effective in increasing the survival of air-layers. Etiolation followed by application of NAA @ 3000 ppm concentration recorded second; whereas IBA @ 6000 ppm concentration was obtained third position. These results are in conformity with earlier report in guava [3].

The maximum number of shoots per layer was recorded in T_8 (4.00) was statistically at par with T_5 (3.66) and were found significantly differ from minimum number of shoots per layer was observed in T_1 (2.33) i.e., control. Among the treatment T_2 (2.66) showed the minimum number of shoots per layer followed by T_3 (3.00). Treatment T_8 etiolation followed by application of IBA @ 3000 ppm concentration recorded maximum number of shoots per layer which was statistically at par with T_5 i.e., etiolation followed by application of NAA @ 3000 ppm concentration.

A critical examination of data indicated that the length of new shoots varied from 19.48 cm to 31.50 cm. Maximum length of new shoots was recorded in T_8 (31.50 cm) which was statistically at par with T_5 (29.25 cm). Among all the treatment T_2 (2.40 cm) showed the minimum shoot length. However, minimum shoot length (19.48 cm) was recorded in control.

Among the treatment, etiolation followed by application of IBA @ 3000 ppm concentration exhibited best (31.50 cm) result. Treatments with etiolation, only (T_2), with application of NAA @ 3000 ppm concentration were found statistically similar with respect to the length of new shoots.

All the growth regulator produced significantly more number of leaves, maximum length and diameter of shoots over control. These results are in conformity with earlier report [1, 2] Which reported that highest percentage of rooting and survival of air-layers of litchi have been successfully achieved by improved method of exogenous application of IBA @ 3000 ppm after 60 days of etiolation. Highest success, average number of primary roots, length of primary roots and final survival were recorded with IBA @ 3000 ppm.

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