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The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(6): 2011-2014

www.thepharmajournal.com
Received: 16-03-2022
Accepted: 30-05-2022

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Studies on the effect of PGR and maturity of cuttings on the propagation in guava (*Psidium guajava* L.)

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Abstract
Presented study was conducted at Horticulture farm of Lovely Professional University under department of Lovely Professional University, Phagwara, Jalandhar, Punjab during the year 2021-22 to evaluate the effect of plant growth regulators and maturity level of cuttings on vegetative and rooting parameters of guava cuttings. It was observed that semi hardwood cuttings of guava treated with IBA@4000 ppm showed minimum days taken for bud emergence, days taken for sprouting, days taken for first leaf emergence, maximum number of leaves at 30 and 60 DAP, number of branches at 30 and 60 DAP and maximum number of roots per cutting. Fresh weight of roots was recorded in IBA@ 4000 ppm with semi-hardwood cuttings, with semi-hardwood cuttings, the dry weight of roots was observed in IBA@ 4000 ppm, rooting percentage was found in IBA@ 4000 ppm with semi-hardwood cuttings. Maximum root length and highest survival percentage was observed in IBA @ 3000 ppm with hardwood cuttings. Overall semi-hardwood cuttings gave superior results for most of the characters recorded.

Keywords: Guava, Semi-hardwood cutting, Hardwood cutting, Indole-3-Butyric Acid, Naphthalene Acetic Acid

Introduction
Guava (*Psidium guajava* L.), often known as the "Poor Man's Fruit" or "Apple of the Tropics," is a tropical and subtropical fruit that belongs to the Myrtaceae family. Guava was originated in Tropical America. Guava contains 150 species and most of them are fruit bearing. The basic chromosome number is 2n=11 and the diploids have 2n=22 and some of the species are triploid (2n=33) naturally or artificially which produces seedless fruits. Guava has a creamy texture and with a flowery essence and sweet flavour. Seeds inside are small in size and gives a crunchy texture while eating. Guava is a climacteric fruit and its shelf life is poor as after harvesting it goes under quick ripening which reduces its shelf life within a week and becomes squishy. It is rich in fibre, vitamin C and vitamin A and also contains potassium, manganese and copper. Guava fruit is available year-round at reasonable costs. It is in high demand as a table fruit as well as a raw material for value-added goods like as jam, jelly, candy, cheese, ice cream, canned fruit, RTS (Ready to Serve), and squash. At an estimated production volume of 6.5 million tonnes in 2017, guava is the largest of the minor tropical fruits in terms of production volume. India is ranks 1st as the major guava producing country which accounts for the estimated 56% of total global output (FAO 2017). Area under production of guava is 264.9 thousand ha and its production and productivity is 4053.5 thousand MT and 15.3 MT/ha respectively. (NHB 2017-18).

Guava can be grown by both vegetative and seedling techniques, however on a commercial scale, vegetative propagation is more effective. Guava can be vegetatively propagated through different methods such as budding, stooling, air layering and inarching. Clonal propagation of guava is recommended to maintain the quality of fruit and to produce true-to-type planting material. Considering air layering is a time-consuming mode of propagation in guava, researchers looked for other viable options for vegetative growth. Use of terminal cuttings of several woody perennials is a successful method of vegetative propagation in many fruit plants. So this study was taken up to evaluate the effect of PGR and maturity level of cuttings on rooting success of guava cuttings.

Materials and Methods
This study was conducted at Horticulture farm of Lovely Professional University under department of Lovely Professional University, Phagwara, Jalandhar, Punjab during the year 2021-22. For the experiment two types of cuttings were taken *viz.*

semi-hardwood and hardwood cuttings from guava plant. The cuttings were taken from a healthy and disease free plants semi-hardwood and hardwood cuttings were taken 20-25 cm in length with 3-4 buds. Basal ends of cuttings were dipped in different concentrations ofIndole-3-Butyric Acid (IBA) and Naphthalene Acetic Acid (NAA) for about 5 seconds using quick dip method. The treated cuttings were planted in rooting media consisting vermicompost, sand and soil in the ratio of 2:2:1 and kept under greenhouse conditions.

Experiment was laid out in randomized block design having 10 treatments replicated thrice. Each treatment consisted of 10 cuttings which were replicated thrice and a total of 300 cuttings were used. Here the treatments applied were T_1 (IBA @ 3000ppm + Semi-hardwood cutting), T_2 (IBA @ 4000 ppm + Semi-hardwood cutting), T_3 (NAA@ 500ppm + Semi-hardwood cutting), T_4 (NAA @ 1000ppm + Semi-hardwood cutting), T_5 (IBA @ 3000ppm + Hardwood cutting), T_6 (IBA @ 4000 ppm + Hardwood cutting), T_7 (NAA@ 500 ppm + Hardwood cutting), T_8 (NAA@ 1000 ppm + Hardwood cutting), T_9 (Semi-hardwood cutting), T_{10} (Hardwood cutting). Data was collected from the date of planting. The parameters evaluated were emergence of bud, sprout and first leaf, number of leaves and branches, root length, number of roots per cutting, fresh and dry weight of roots, rooting percentage and survival percentage were recorded and the collected data of different parameters was statistically analyzed using SPSS V21. software.

Results

Emergence of bud, sprout and first leaf

Application of plant growth regulators and maturity level of cuttings had significant effect on the emergence of bud, sprout and first leaf. Least number of days (13.43 days) for emergence of bud was observed in semi-hardwood cuttings treated with IBA@4000 ppm and maximum (20.43 days) was noted in control (Semi-hardwood cutting). In case of sprouting minimum days (16.13 days) was observed in IBA@4000 ppm with semi-hardwood cuttings and maximum was in control (Semi-hardwood cuttings). For emergence of first leaf minimum number (17.13 days) of days was recorded in IBA@4000 ppm with semi-hardwood cuttings and maximum (24.10 days) number of days was noted under control (Semi-hardwood cuttings).

Number of leaves and branches (30, 60 DAP)

Significant effect was observed under number of leaves and branches 30 and 60 DAP. Maximum number of leaves (6.70) 30 DAP was found in hardwood cuttings that have been treated with IBA@4000 ppm and least count of leaves (3.60) was observed under control (Semi-hardwood cuttings). As for count of leaves 60 DAP most number of leaves (20.23) was found in hardwood cuttings treated with IBA@4000 ppm and least count of leaves (10.06) was under control (Hardwood cuttings). For number of branches 30 DAP utmost count of branches (6.26) was noted in hardwood cuttings treated with IBA@4000 ppm and least count of branches (3.23) was noted in control (Semi-hardwood cuttings). In case of number of branches 60 DAP maximum number of branches (7.56) was recoded in semi-hardwood cuttings treated with IBA @4000 ppm and least count of branches (3.50) was observed in control (Semi-hardwood cuttings).

Roots per cutting and root length (cm)

Application of PGR and maturity of cuttings exhibited a significant effect on roots per cutting and root length (Table 1). Maximum number of roots per cutting (23.56) was observed in semi-hardwood cuttings treated with IBA@4000ppm and minimum per cutting root (5.33) was observed in control (Hardwood cuttings). In case of root length maximum (13.46 cm) was found in hardwood cuttings treated with IBA@3000 ppm and minimum (2.13 cm) was found in semi-hardwood cuttings treated with NAA@500 ppm.

Table 1: Effect of PGR and maturity of cuttings on emergence of bud, sprout, first leaf and number of leaves and branches (30, 60 DAP) in guava

Treatments	Days taken for emergence of bud	Days to sprouting	Emergence of first leaf	Number of leaves at 30 DAP	Number of leaves at 60 DAP	Number of branches at 30 DAP	Number of branches at 60 DAP
T_1 IBA @ 3000ppm Semi-hardwood cutting	14.16^{b}	17.63^{b}	18.66^{b}	5.60^{e}	13.66^{e}	5.16^{d}	7.20^{h}
T_2 IBA @ 4000 ppm + Semi-hardwood cutting	13.43^{a}	16.13^{a}	17.13^{a}	6.03^{f}	13.76^{e}	5.83^{e}	7.56^{i}
T_3 NAA@ 500ppm + Semi-hardwood cutting	15.56^{c}	18.16^{c}	19.53^{c}	4.23^{b}	10.63^{b}	3.96^{b}	4.36^{cd}
T_4 NAA @ 1000ppm + Semi-hardwood cutting	15.63^{c}	18.60^{d}	19.53^{c}	4.86^{d}	11.06^{c}	4.53^{c}	5.26^{e}
T_5 IBA @ 3000ppm + Hardwood cutting	17.73^{de}	20.33^{e}	21.33^{d}	5.86^{f}	16.80^{f}	5.50^{de}	5.66^{f}
T_6 IBA @ 4000 ppm + Hardwood cutting	15.43^{c}	18.60^{d}	19.96^{c}	6.70^{g}	20.23^{g}	6.26^{f}	6.26^{g}
T_7 NAA@ 500 ppm + Hardwood cutting	18.06^{e}	20.90^{f}	21.86e	4.20^{b}	10.86^{c}	3.93^{b}	3.90^{b}
T_8 NAA@ 1000 ppm + Hardwood cutting	17.56^{d}	20.43^{e}	21.43^{de}	4.56^{c}	13.20^{d}	4.16^{bc}	4.56^{d}
T_9Semi-hardwood cutting	20.43^{g}	23.13^{h}	24.10^{g}	3.60^{a}	10.86^{c}	3.23^{a}	3.50^{a}
T_{10} Hardwood cutting	19.30^{f}	22.20^{g}	23.26^{f}	3.76^{a}	10.06^{a}	3.43^{a}	4.16^{bc}

Table 2: Effect of PGR and maturity of cuttings on roots per cutting, root length, fresh and dry weight of roots and rooting and survival percentage in guava

Treatments	Roots per cutting	Roots length (cm)	Fresh weight of roots (g)	Dry weight of roots (g)	Rooting percentage (%)	Survival percentage (%)
T_1 IBA @ 3000ppm Semi-hardwood cutting	10.70^{e}	2.43^{b}	34.10^{e}	1.80^{f}	73.33^{h}	87.33^{f}
T_2 IBA @ 4000 ppm + Semi-hardwood cutting	23.56^{i}	2.76^{d}	43.20^{i}	2.46^{j}	74.66^{h}	80.33^{d}
T_3 NAA@ 500ppm + Semi-hardwood cutting	16.03^{g}	2.13^{a}	37.50^{g}	2.30^{h}	66.33^{f}	68.33^{b}
T_4 NAA @ 1000ppm + Semi-hardwood cutting	19.16^{h}	2.56^{c}	39.23^{h}	2.40^{i}	69.33^{g}	73.66^{c}
T_5 IBA @ 3000ppm + Hardwood cutting	12.56^{f}	13.46^{j}	35.46^{f}	2.00^{g}	62.33^{e}	90.33^{g}
T_6 IBA @ 4000 ppm + Hardwood cutting	10.16^{d}	10.76^{i}	35.56^{d}	1.56^{d}	63.66^{e}	84.33^{e}

T_7 NAA@ 500 ppm + Hardwood cutting	9.10[b]	8.66[g]	28.36[b]	1.40[b]	54.66[c]	72.66[c]
T_8 NAA@ 1000 ppm + Hardwood cutting	9.46[c]	8.96[h]	30.66[c]	1.50[c]	57.33[d]	74.33[c]
T_9 Semi-hardwood cutting	10.40[de]	3.26[e]	32.53[d]	1.70[e]	33.33[b]	36.33[a]
T_{10} Hardwood cutting	5.33[a]	5.86[f]	17.70[a]	1.26[a]	30.33[a]	38.33[a]

Fresh and dry weight of roots (g)

Utmost fresh weight of roots (43.20 g) was found in IBA@ 4000 ppm + Semi-hardwood cuttings and least fresh weight of roots (17.70 g) was recorded in control (Hardwood cuttings). As in dry weight of roots maximum weight (2.46 g) was noted in semi-hardwood cuttings treated with IBA@4000 ppm and least weight (1.26 g) was observed in control (Hardwood cuttings).

Rooting and survival percentage

Application of PGR and maturity of cuttings positively influenced the rooting and survival percentage. Maximum rooting percentage (74.66%) was observed in semi-hardwood cuttings treated with IBA @ 4000 ppm and minimum rooting percentage (30.33%) was noted in control (Hardwood cuttings). As of survival percentage maximum survival percentage (90.33%) was recorded in hardwood cuttings treated with IBA @ 3000 ppm and minimum survival percentage (36.33%) was recorded in control (Semi-hardwood cuttings).

Discussion

Shoot parameters

Early emergence of bud, sprouting and leaf in cuttings treated with IBA might be because of the effect that auxin breaks starch into simple sugars when externally applied. The breakdown of starch in to simple sugars is required to a higher extent for the production of new cells and for enhanced respiratory activity in the renewal of tissue at the time of new root primordia (Nanda, 1975) [5]. Early sprouting in cuttings containing IBA application might be because of elimination of descending translocation of carbohydrate and aggregation of higher level of external auxin which hydrolysis starch in sugars (Bhattacharjee and Thimmappa, 1993) [1].

Maximum number of leaves after 30 and 60 days of planting was recorded in cuttings treated with IBA which might be because of impact of internal and external auxin. Highest number of leaves was observed in cuttings having IBA concentration without considering the concentration of IBA due to invigorating shoot growth and lead to enhance in node count which leads to increase in number of leaves. It could be because of diversion of most of the assimilate amount of plant to the buds of leaf as they are one of the production station of natural auxin and the fact that they are crucial for processes like photosynthesis and respiration (Wahab *et al*., 2001).

The highest number of branches after 30 and 60 days of planting was recorded in cuttings treated with IBA. As the development of dormant or resting buds is directly related to the breakdown of stored food and its mobilization in to the growing area and auxin is primarily involved in this procedure. Elongation of stem and its length through division of cell leading towards more count in sprouts is due to the activation of shoot growth by auxin (Mukhtar *et al*., 1998) [9].

Rooting parameters

Auxins encourage adventitious formation of roots with its potential to encourage the commencement of sideward roots and furthermore increased the shifting of carbohydrates in cuttings at basal part. The highest root count in cuttings treated with IBA could be due to the fact that IBA affects plasticity of cell wall which resulted in acceleration in division of cells and stimulation of callus development and root growth (Weaver, 1972) [13].

Increase in length of root and number of roots per cuttings might be due to auxin which plays crucial part in the metabolic activity and division of cell process in cuttings which turns out as increase in length of roots (Edmond *et al*., 1997) [2]. Enhanced length of roots could also be due to application of IBA which affects the metabolic translocation and metabolism of carbohydrates which might be involved on root length. Familiar findings were recorded by Sujin *et al*. (2020) in guava and Sokhuma *et al*. (2018) [11] in 'Himalayan' mulberry. Maximum fresh and dry weight of roots was noted in treatment with highest concentration of IBA these results are in accordance with Reddy *et al*. (2005). These similar findings was in accordance with Sharma *et al*. (2002) [12] who observed maximum fresh weight of roots when treated with IBA in cuttings of *Gardenia lucida*.

Application of IBA have increased the rooting by rise in interior auxins (Van der Krieken *et al.*, 1993). Application of increasing concentrations of auxin in cuttings get doubled with internal auxin which gives improved rooting percentage as delineated by Melgarejo *et al.* (2000) [8]. Better result in with IBA was found might be due to the fact that more concentration of auxin involves high count of roots with percentage of survival stated by (Noor Rahman *et al*., (2004) in guava. This might also be the reason that in hardwood cuttings persistent metabolic activity and constant growth and development are the main reason for increased survival rates while applying plant growth regulators reported by Fachinello *et al*. (2005) [3]. Present study has familiar results reported by Sujin *et al.* (2020) in guava.

Conclusion

It may be inferred, based on the outcomes of this investigation, that all the cuttings treated with PGR at different concentrations with different maturity levels of cuttings exhibited significant results in vegetative and rooting parameters as compared to control. The treatments contain application of IBA and NAA at different concentrations on cuttings having varied maturity levels semi-hardwood and hardwood.

Out of all treatments regarding vegetative growth application of IBA at concentration of 4000 ppm with semi-hardwood cuttings proved to be most effective in terms of bud emergence, sprouting, first leaf emergence In case of number of leaves and branches varied results were found. As for the rooting parameters also IBA proved out to be the best PGR at both 3000 and 4000 ppm concentration and showed varied results as for parameters such as number of roots per cutting, fresh and dry weight of roots and rooting percentage IBA@ 4000ppm + Semi-hardwood cutting showed best results and for root length and survival percentage IBA@ 3000ppm + Hardwood cuttings gave best results. Therefore, the study concludes that the treatment of 4000 ppm indole-3-butyric acid with semi-hardwood cuttings is recommended for the better growth in guava cuttings.

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