Effect of Plant Growth Regulators on Rooting of Avocado (*Persea americana* Mill.) Cuttings in Sikkim

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ABSTRACT

Background: Avocado (*Persea americana* Mill.) family, Lauraceae, sub-tropical evergreen tree, which is very nutritious fruit having large oil fraction which is one of the unique features and has good medicinal properties. The vegetative propagation of avocado has become increasingly important to produce a large amount of planting material.

Methods: The present study was conducted in the research field at the Department of Horticulture, Sikkim University, Gangtok during 2016-2017 to evaluate the effect of different concentration plant growth regulators on the rooting of two cultivars. Hass and Fuerte Avocado (*Persea americana* Mill.) cuttings were investigated at the mist chamber. The experiment was laid in a completely randomized design for avocado cuttings of cvs. Hass and Fuerte with eighteen treatments comprising of different concentrations of IBA (control, 200 ppm, 400 ppm, 800 ppm, 1000 ppm) and NAA (control, 200 ppm, 400 ppm, 800 ppm, 1000 ppm). In all the treatments the cuttings were dipped in the plant growth regulators for 10 seconds. Rooting medium for planting the avocado cutting used was fine coarse vermiculite 80%, soil 10% and well rotten cow dung manure 10% in the ratio of 8:1:1 respectively for all the treatments.

Result: In general, the results showed a significant increase for root initiation under treatment (IBA 800 ppm + Fuerte) followed by (IBA 400 ppm + Fuerte) which took 105.67 days for root initiation as compared to control at 5% level of significance. The avocado cuttings exhibited significant results for root initiation was 99.33 days which was recorded under treatment IBA 800 ppm + Fuerte as compared to treatment Fuerte (control) which was 121 days observed in root initiation. The maximum number of 14.05 roots at the time of transplanting in cuttings under treatment IBA 400 ppm + Fuerte and minimum was 2.00, 2.11, 2.22, 2.66 and 2.89 observed in treatment control + Hass, NAA 200 ppm + Hass, IBA 1000 ppm + Hass, IBA 200 ppm + Hass and IBA 400 ppm + Hass respectively. The maximum length of 1.53 cm root at the time of transplanting was found with treatment IBA 400 ppm + Fuerte and the minimum was 0.17 cm observed in treatment Hass (control). The rooting 72.22 percentage at the time of transplanting in cuttings was observed treatment IBA 400 ppm + Fuerte and minimum was 11.11 percentage observed in Hass (control). Fuerte with IBA 400 ppm was better in rooting capacity as compared to others.

Key words: Avocado, Cuttings, Fuerte, Hass, Plant growth regulator, Rooting.

INTRODUCTION

India is second largest producer of fruits in the world with 97.35 Million Tonnes of fruits production and Andhra Pradesh and Maharashtra are two leading states in fruit production in the country (NHB, 2018). Avocado (*Persea americana* Mill.) family, Lauraceae, sub-tropical evergreen tree, which is very nutritious fruit having large oil fraction which is one of the unique features and has good medicinal properties (Chanderbali *et al*., 2016). Food security has been mentioned as one of the challenges for growth of Indian economy by Selvan *et al*. (2021), so we should also focus on production increase and popularization of nutritionally rich fruits like avocado. The people like more native fruit like mangoes, oranges, watermelons, *etc* which are extremely sweet to taste as compared to avocado in general. Avocado is one of the most nutritive among fruits. Avocado is high yielder and nutrition value of avocado is recommendable for nutrition deficient people in developing countries (Jalata, 2021). It is regarded as most important contribution of New World to human diet. Per 100 g fruit generates 245 calories and contains protein 1.7 g, fat 26.6 g, carbohydrate 5.1 g, crude fibre 1.8 g, minerals (Ca, Cl, Cu, Fe, Mg, Mn, P, K, Na, S), Vitamins A and B. The pulp has buttery consistency, looks very much like cow's butter and blend in taste with nutty flavour resembling kernel of tender coconut. As sugar content is low, it is recommended as high energy food for diabetes. It has number of processed products and used in cosmetic industry too (Jana,1998). However, as health awareness is increasing among the educated people and they are getting informed about the great nutritive value of avocado, it is now finding the right place in the Indian market. In India, propagation is commonly done through

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seeds, though the climatic requirement and soil condition in different regions are ideal for successful large cultivation but yet there is no commercial nursery involved in the vegetative propagation of avocado (Ghosh, 2000). The vegetative propagation of avocado has become increasingly important to produce a large amount of planting material (Hiti-Bandaralage *et al.,* 2017). The use of Plant Growth Regulators is a promising technique for seed germination, rooting and vegetative growth of different crops by evoking changes in hormones in metabolism and distribution within the plant (Suman *et al.,* 2017). In the state of Sikkim, avocado cultivars like Hass and Fuerte are successfully growing in hill ranges with an altitude of 800 to 1600 m and growing area temperature range from 12°C to 30°C with an average annual rainfall of 2000 mm. So, there is hope and scope for large scale nursery propagation through cuttings of avocado.

The agro-climatic requirement of this crop in a different region of our state is more favourable for the cultivation of more areas under avocado. Presently, nursery as well as an orchard is not well structured in a systematic way and they are scattered. Besides, with a selected good number of improved varieties having high yield potential and standard vegetative propagation techniques we can increase a large number of high quality nursery plants of selected varieties and their systematic planting in different humid subtropical areas of the north-eastern region of our country comprising eight states *i.e.* Arunachal Pradesh, Assam, Meghalaya, Manipur, Mizoram, Nagaland, Tripura and Sikkim.

The support for this crop is still in growing phase but the available information from Sikkim shows that the size, color and quality of fruits present in India are similar to those of avocado fruits grown in other countries or places. With proper varietal selection, it would be possible to have large scale production, thus enhancing the availability of fruits in different places which can be marketed without much difficulty, particularly to provide the requirement of high nutrition. Keeping farmer's point of view and economic point of view it would be very much beneficial for farmers to fetch more returns from crop if they could produce avocado at commercial scale. Therefore, the present research focused on successful large scale production of avocado planting material and the main aim was to evaluate the rooting duration, rooting percentage, root length and root numbers of Fuerte and Hass Avocado cv. cuttings treated with plant growth regulators *i.e.* IBA and NAA.

MATERIALS AND METHODS

The research work entitled "Effect of plant growth regulators on rooting of avocado (*Persea americana* Mill.) cuttings under Sikkim conditions" was carried during 2016-2017 at Department of Horticulture, Sikkim University, Gangtok, Sikkim, India. The planting materials of avocado cutting used in the study were semi-hardwood cuttings collected from two places Tokal Bermiok, Today and Denchung, Nandugoan, South Sikkim (Sikkim).

Preparation of cuttings

The length of cuttings was kept as 15-20 cm and breadth of pencil size having 2-3 buds from two cultivars namely Hass and Fuerte. The top of the cutting was kept round and the bottoms were cut in slanting way.

Preparation of solution of plant growth regulators

The stock solution of IBA and NAA were prepared by dissolving plant growth regulators into ethanol and the volume was made up by adding double distilled water with different concentration of Plant Growth Regulators which are mentioned in Table 1.

Treatment of cuttings

In all the treatments the cuttings were dipped in the plant growth regulators for 10 seconds. Rooting medium for planting the avocado cutting used were fine coarse vermiculite 80%, soil 10% and well rotten cow dung manure 10% in the ratio of 8:1:1 respectively same for all treatments.

Time of planting and observation

After treatment with IBA and NAA as per different treatment combinations, the prepared cutting was planted into rooting media and placed in the mist chamber in required humidity maintained. The time of planting of Fuerte was first week of January, 2017 (7th January) and Hass was second week of January, 2017 (14th January) and after planting cuttings were placed in the mist chamber. The observations of Fuerte were recorded from 19th March 2017 to 25th April 2017 and for Hass observations were recorded from 23rd March 2017 to 9th May 2017.

Statistical analysis

The result presented in this experiment are on rooting percentage, number of roots, roots length and days taken for root initiation. The experimental design used was completely randomized design with 18 no. of treatments and three replications and treatment combinations have been mentioned in Table 1.

RESULTS AND DISCUSSION

The results of the study on the above mentioned aspects have been achieved during the investigation and being presented under various subheads as follows:

Number of days taken for root initiation in cuttings

The observation regarding different treatments showed that the number of days taken for root initiation was significant at 5% level of significance (Fig 1) showed that a minimum of 99.33 days taken for root initiation under treatment T_{12} (IBA 800 ppm + Fuerte) and the maximum 121 days taken was by treatment T_9 (Control + Fuerte). Treatment T_{12} was the best treatment for the number of days taken for root initiation. The treatment T_{12} showed significant difference

followed by T_{11} (IBA 400 ppm + Fuerte) which took 105.67 days for root initiation. Remaining all the treatments were found to be significantly at par at 5% level of significance.

Gustafson and Kadman (1969) suggested use of plant growth regulator as a possible way to increase the rooting capacity of avocado cuttings. The results of the present experiments indicate that in most cases the Fuerte roots faster than Hass which is in agreement with results obtained in experiments and here we found minimum days taken by the cuttings of Fuerte with PGRs concentration IBA 800 ppm. Different effects of IBA treatment was found among the different types of cuttings and according to the various concentrations used. Generally, it seems that the optimal concentration of IBA is between 400 and 800 ppm but Hass responded better to the intermediate IBA concentration used 800 ppm and the Fuerte responded better to the intermediate concentration 400 ppm. The highest concentration tested 1000 ppm is too high since in

Table 1: Effect of plant growth regulators on rooting of avocado cuttings of cvs. Hass and Fuerte.

Treatment	Number of days taken for root initiation in cuttings	No. of roots	Length of root at time of transplanting (cm)	Rooting percentage (%)
T_0: Hass-control	118.33	2	0.17	11.11
T_1: Hass+IBA 200 ppm	118	2.66	0.27	16.66
T_2: Hass+IBA 400 ppm	114.33	2.89	0.3	16.66
T_3: Hass+IBA 800 ppm	112.33	4.17	0.53	22.22
T_4: Hass+IBA 1000 ppm	108.33	5.22	0.73	27.77
T_5: Hass+NAA 200 ppm	109.67	2.22	0.2	11.11
T_6: Hass+NAA 400 ppm	111.67	2.11	0.3	11.11
T_7: Hass+NAA 800 ppm	112.33	2.55	0.33	22.22
T_8: Hass+NAA 1000 ppm	118.33	4.5	0.63	33.33
T_9: Fuerte-control	121	7.37	0.63	27.77
T_{10}: Fuerte+IBA 200 ppm	112.67	9.55	0.9	33.33
T_{11}: Fuerte+IBA 400 ppm	105.67	14.05	1.53	72.22
T_{12}: Fuerte+IBA 800 ppm	99.33	11.67	1.03	61.11
T_{13}: Fuerte+IBA 1000 ppm	106	11.94	1.23	55.55
T_{14}: Fuerte+NAA 200 ppm	107.67	6.67	0.63	16.66
T_{15}: Fuerte+NAA 400 ppm	108	8.17	0.8	27.77
T_{16}: Fuerte+NAA 800 ppm	104	5.67	0.83	33.33
T_{17}: Fuerte+NAA 1000 ppm	109	6.61	1	38.89
GM	110.93	6.11	0.67	29.93
SEm±	1.995	0.88	0.098	6.636
CD (5%)	5.746	2.535	0.283	19.11

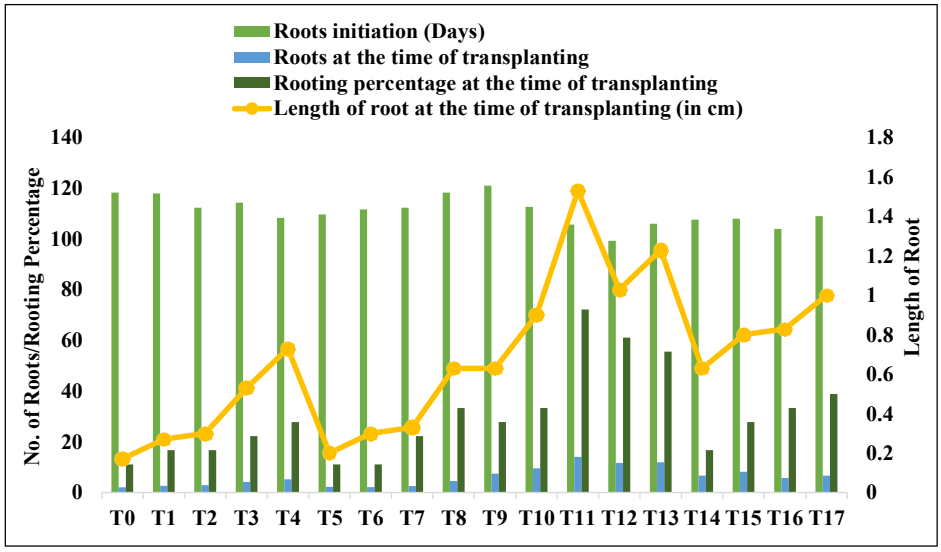

Fig 1: Effect of plant growth regulators on rooting of avocado cuttings.

most cases the number of days taken following this treatment was the lowest. Young (2000) explained that when using cuttings from mature trees, such as varieties Zutano and Scott often give 100% rooting. Fuerte, however, roots poorly, while Hass does not root at all. The result was shown in the present finding that PGRs IBA 800 ppm root faster in both cultivars Hass and Fuerte.

Number of roots at the time of transplanting

The data presented in Table 1 showed a significant difference at a 5% level of significance on the number of roots at the time of transplanting. The treatment IBA 400 ppm + Fuerte showed the highest 14.05 number of roots. Minimum 2.00, 2.11, 2.22, 2.66 and 2.89 number of roots was found in Control + Hass, NAA 200 ppm + Hass, IBA 1000 ppm + Hass, IBA 200 ppm + Hass and IBA 400 ppm + Hass. All the treatments were found to be at par statistically.

In the present finding, good rooting was enhanced with the treatment of IBA 400 ppm (Table 1) and similar results were found by Daoud *et al.,* (1989) where treatment of olive cutting *i.e.* dipping with the concentration of 2000, 3000 and 4000 ppm IBA increased in the number of roots. Sedaghathoor *et al.,* (2016) had also studied the effect of planting substrate and concentrations of IBA and NAA hormones on the rooting of mugo pine cuttings in which both hormones IBA and NAA were applied at four concentrations of 0, 1000, 2000 and 4000 mg/l and highest rooting 55% was obtained under the treatment 4000 mg/l NAA+ 1000 mg/l IBA was found to be the best. So, we can say that IBA and NAA might be the good plant growth regulators for root initiation. The result of earlier workers showed some differences with the present study which is possible due to the difference in present species grown and growing conditions. IBA is an important hormone for root initiation of cuttings of avocado.

Plate 1: Leaf initiation in cutting of Avocado cv. Fuerte.

Plate 2: Leaf initiation in cutting of Avocado cv. Hass.

Length of the root at the time of transplanting (in cm)

The observation regarding the length of roots at the time of transplanting in cuttings have been presented in Table 1, Fig 1 and Plate 1, 2, 3 and 4. The treatment IBA 400 ppm + Fuerte was found to be the best with the longest length of 1.53 cm roots and the shortest length was 0.17 cm roots were in Control + Hass. The present study revealed that treatment IBA 1000 ppm + Fuerte had a significant difference with 1.23 cm length of roots at the time of transplanting. Remaining all treatments were found to be significantly at par at 5% level of significance.

The findings of the present study show that the length of roots at the time of transplanting (in cm) in avocado cuttings was 1.53 cm. Borys, (Borys 1986) worked on rooting of avocado cuttings *Persea americana* Mill. cultivars Fuerte and Colin V-33. The length of roots at the time of transplanting in the present study was slightly lower than the earlier reported study in which the length of roots (Fuerte)

Plate 3: Avocado cv. Fuerte callus, root and shoot initiation under different concentrations of PGRs (IBA/NAA).

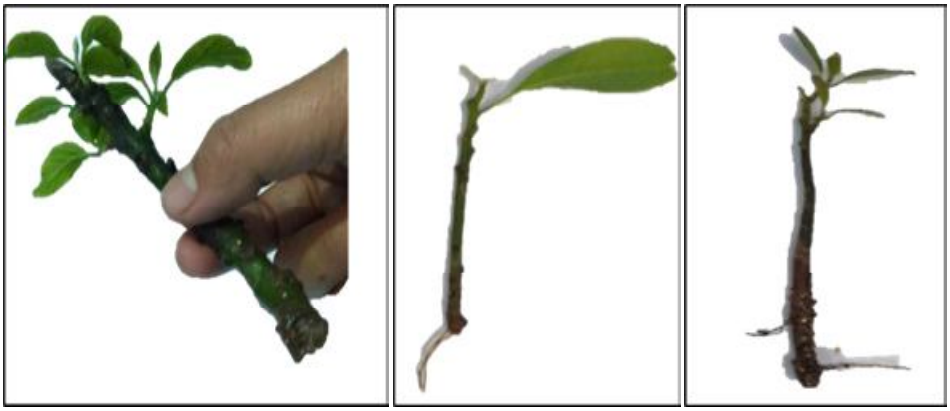

Plate 4: Avocado cv. Hass callus, root and shoot initiation under different concentrations of PGRs (IBA/NAA).

was 2.8 cm. The reported study was used on etiolation + ring barking + auxins, were as the present study was on semi-hardwood cuttings. The reported study showed the application of IBA at 10,000 ppm and 300 ppm of NAA (Salazar and Borys, 1983) which were incrusted in the cuttings before they were placed in a propagating bed with bottom heat at 27°C under intermittent mist were as the present study used IBA 400 ppm dipping for 20 seconds in the cuttings before they were placed in a propagating bed without bottom heat and intermittent mist.

Rooting percentage at the time of transplanting

The data presented in Table 1 showed significant difference at 5% level of significance on rooting percentage of cuttings. The treatment (IBA 400 ppm + Fuerte) showed the highest rooting 72.22 percentage and lowest rooting 11.11, 11.11 and 11.11 percentages were Control + Hass, NAA 200 ppm + Hass and NAA 400 ppm + Hass. All the treatments were found to be statistically at par.

In the present finding, the good rooting percentage was enhanced with treatment IBA 400 ppm + Fuerte (Table 1) similar results were found by Gustafson and Kadman (1969) worked on the effect of some plant hormones on the rooting capacity of avocado cuttings which was an individual difference between variety and treatment were using KIBA at a concentration of 500 ppm on Gvar-Am 13, a 70% rooting occurred and the Fuchs 20 variety, a 60% rooting took place with KIBA at 10 ppm concentration were as 500 ppm concentration of KIBA on Fuchs 20 resulted in only 5% rooting, while 10 ppm KIBA Gvar-Am 13 gave a 20% rooting. Gvar-Am 13 variety rooted with a similar percentage when treated with IAA, NAA and KIBA. Borys (1986) also worked on vegetative propagation of avocado cuttings were the treatment etiolation + ring barking + auxins gave the best in the percentage of rooted cutting in both avocado cultivars Fuerte and Colin V-33 followed by etiolation + ring barking.

CONCLUSION

The positive effect of plant growth regulators was observed on rooting of cuttings of both avocado cultivars Hass and Fuerte under study in Sikkim. Indole Butyric acid (IBA) performed better in both the cultivars in terms of rooting percentage, length of roots, days for root initiation *etc*. The use of plant growth regulators (IBA 400-800 ppm) may be done on commercial scale for large scale production and propagation of avocado cuttings.

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