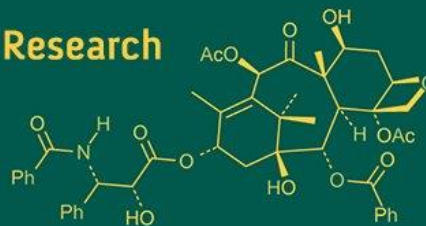
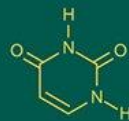
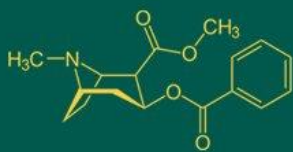


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Effect of plant growth regulators on rooting of leaf cuttings in guava (*Psidium guajava* L.) cv. Arka Kiran

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Abstract

An experiment was conducted in the Tamizh Nursery Garden, Puthukooraipeitai, Virudhachalam, Tamil Nadu, India during 2020-2022 to elucidate information on the effect of plant growth regulators on rooting of leaf cutting in guava (*Psidium guajava* L.) cv. Arka Kiran. The experiment was conducted in completely randomized block design with thirteen treatments in three replications. The treatments comprised of IBA and NAA with four different concentrations of 125, 250, 500 and 1000 ppm. The guava leaf cuttings were dipped in the growth regulators for 5 minutes and then planted in the polybags and they were kept in the mist chamber. The results of the above experiment revealed that the root parameters viz., rooting percentage (%), number of roots per cuttings, root length (cm), fresh weight of roots (g), dry weight of roots (g) and girth of roots (cm) were recorded maximum in the treatment where IBA @ 250 ppm + NAA @ 250 ppm was used. The lowest root parameters were recorded in the control. The various shoot parameters viz., days taken for shoot initiation, number of leaves per shoot, length of shoot (cm), girth of the shoot (cm) and survival percentage of rooted cuttings (%) were observed the highest in the treatment where IBA @ 250 ppm + NAA @ 250 ppm was used. The least shoot parameters were observed in the control. Hence, from the above experiment, it can be concluded that the growth regulators IBA @ 250 ppm + NAA @ 250 ppm performed best based on the root and shoot parameters when compared to other treatments.

Keywords: Guava (*Psidium guajava* L.), leaf cuttings, indole-3-butyric acid (IBA), naphthalene acetic acid (NAA), rooting and shoot growth

Introduction

Guava (*Psidium guajava* L.) is a delicious fruit that belongs to the Myrtaceae family, believed to be originated in Central America and the southern part of Mexico, known for its botanical richness and very high agro industrial potential with 121 genera and 5,800 species of aromatic fruits, classified by Farias *et al.* (2020) as one of the most important commercial families globally. There are about 150 species belongs to the genus *Psidium* and most of the cultivars are *P. guajava*. It is also called as the "Poor man's apple" and contains high vitamin C, mineral content and pectin. The pulp contains vary number and hardness of seeds and it is off white to deep pink depending on the variety (Tanishka and Vijaya, 2020).

It is one of the important species that can tolerate a wide range of soil and climatic conditions. The tree is fairly salt and drought - resistant and can be grown on a variety of soils i.e., sand, clay, loam, deep, shallow, acidic and alkaline soils with pH ranging from 4.5 to 8.5. It is cultivated in lowlands from sea level upto approximately above 1000 to 1500 m altitude. It is one of the leading fruit crops in India due to wide adaptability to varying soil and climatic conditions (Sharma *et al.*, 2013). In India, Uttar Pradesh ranks first in production with an area of 3,59,000 hectares and Andhra Pradesh ranks first in productivity (24.1 metric tonnes), 22.5 tonnes per hectare in Punjab (NHB 2023-24). In Tamil Nadu, the area under guava production is 9,700 ha with a production of 61,500 metric tonnes.

Guava is one of the richest sources of vitamin C, containing 2 to 5 times more than in oranges. It is a very good source of pectin, flavonoids like beta carotene, lycopene, lutein and cryptoxanthin. These compounds have antioxidant properties for good health. Compared to other fruits, the whole fruit is a good source of calcium, a fair source of phosphorus and a good source of iron. In recent years, guava is getting more popularity in the international trade due to its nutritional value and various processing products like jelly, jam, sherbet, ice cream, cheese, canned fruit, RTS, nectar, squash and powders (Singh *et al.*, 2005) [6, 26, 28].

To maximize the production and keeping in mind about its good demand, production of genuine and quality planting material is a pre-requisite. Guava is propagated sexually by seeds and asexually by budding, grafting, layering and cutting (Chandra *et al.*, 2004) [5]. Vegetative propagation of guava is widely practiced to ensure true to type and early bearing of fruits. But these methods are often associated with genetic variability, inconsistent fruit quality, and susceptibility to soil-borne pests such as nematodes. Among the various vegetative propagation methods, the cuttings (softwood, semi-hardwood, hardwood, leaf cuttings and leaf bud cuttings) are widely practiced, because it is observed as one of the simplest methods to deal with Formation of roots 'Rhizogenesis' is an important criterion which takes place only when several influencing factors are taken into consideration. Hence, nodal cuttings are being explored as a promising alternative for true-to-type propagation and reduced pest-related risks.

Leaf cuttings have shown limited but promising success in certain fruit crops like guava, fig, and mulberry when treated with plant growth regulators like IBA and rooted under controlled conditions such as mist chambers. This method enables clonal propagation, especially where stem cuttings or seeds are less effective. Plant growth regulators, particularly auxins like IBA and NAA, significantly stimulate rooting in cuttings by enhancing root initiation, increasing root number, and ensuring uniformity. Auxins influence physiological processes such as protein synthesis, enzyme activity, and membrane permeability. Their application is crucial for the division of root initial cells. A proper rooting medium-loose, porous, and moisture-retentive-is equally important, as it affects root quality. For example, sand yields coarse roots, while a mix of soil, sand, and peat promotes fine, healthy root development. Therefore, it is imperative to step towards this experiment to study the effect of plant growth regulators on rooting of leaf cuttings in guava. The aim is to evaluate the individual and combined effects of IBA and NAA on rooting

of leaf cuttings in guava to identify the most effective treatment.

Materials and methods: The experiment was conducted in a Tamizh nursery at Puthukoorai, Cuddalore district of Tamil Nadu. The single leaf cutting was taken from one-year old shoots of 6 years old mother plant. These cuttings have one leaf and leaf petiole. The rooting environment is under mist chamber. The cuttings were treated with the respective concentrations of different growth regulators for soaking method (5 minutes). The experiment was laid out in Completely randomized Design (Poly bag experiment) with thirteen treatments which replicated thrice. The present investigation was carried out on guava (*Psidium guajava* L.) using the variety 'Arka Kiran' to evaluate the rooting response under different treatment conditions. Leaf cuttings were used as the planting material, and the rooting environment was maintained under a mist chamber to ensure optimal humidity and temperature for root induction.

A unit of 20 cuttings comprised of one replication, hence total 60 cuttings were used in each treatment including control and 780 cuttings were planted for conducting the present experiment. Polythene bags of 200-gauge thicknesses and of size 10 cm × 9 cm were used for raising the leaf cuttings. The pot mixture used for potting comprises of sand, soil, FYM, red earth mixture and coir dust in equal proportion. The cuttings were inserted including leaf petiole and ¼th leaf as well. IBA and NAA were weighed with the help of electronic balance. The requisite quantity 0.125g, 0.25g, 0.5g and 1g (125 ppm, 250 ppm, 500 ppm and 1000 ppm) were weighed separately and transferred in to flask and then initially the IBA sample were dissolved in 10 ml ethyl alcohol (90%) and volume was made to 1000 ml with mixing of 990 ml distilled water. By this process we prepared the 125 ppm, 250 ppm, 500 ppm and 1000 ppm of IBA and NAA solution.

Treatment schedule

Treatments	Growth Regulators / Dipping Time
T ₁	IBA @ 125 ppm - 5 minutes
T ₂	IBA @ 250 ppm - 5 minutes
T ₃	IBA @ 500 ppm - 5 minutes
T ₄	IBA @ 1000 ppm - 5 minutes
T ₅	NAA @ 125 ppm - 5 minutes
T ₆	NAA @ 250 ppm - 5 minutes
T ₇	NAA @ 500 ppm - 5 minutes
T ₈	NAA @ 1000 ppm - 5 minutes
T ₉	IBA @ 62.5 ppm + NAA @ 62.5 ppm - 5 minutes
T ₁₀	IBA @ 125 ppm + NAA @ 125 ppm - 5 minutes
T ₁₁	IBA @ 250 ppm + NAA @ 250 ppm - 5 minutes
T ₁₂	IBA @ 500 ppm + NAA @ 500 ppm - 5 minutes
T ₁₃	Control - Distilled water

The various observation like days to sprouting, number of sprouts per cutting, length of root, number of roots per cutting, length of longest root, girth of the root, percentage of rooted cuttings, survival percentage of cuttings were recorded with proceeding of experiment.

Result and discussion

Root parameters

The percentage of rooting was maximum (86.45%) in cuttings treated with IBA @ 250 ppm + NAA @ 250 ppm. Rooting of cuttings is intensified by IBA through polysaccharide hydrolysis which provides energy for

meristematic tissues and thereby for root primordial formation (Husen and pal, 2007).

The enhanced hydrolytic activity in presence of applied IBA might be responsible for the increased percentage of rooted cuttings. High carbohydrate and low nitrogen have been reported to favors root formation (Singh and Tomar, 2015). Exogenous application of auxin breaks starch into simple sugars, which is needed to a greater extent for the production of new cells and for increased respiratory activity in the regeneration tissue at the time of initiation of new root primordia (Nanda, 1975). Presence of leaves on cuttings also

could have helped in the initiation of roots Newton *et al.* (1992). Kriekenet *et al.* (1993) reported that IBA have enhanced the rooting by increase of internal auxins ^[11, 29, 16, 17].

Higher percentage of rooting with higher concentration of auxins maybe attributed to the higher partitioning of photosynthesis towards the root development.

Table 1: Root parametters

Treatment	Root Percentage	No of roots / cutting	Root length (cm)	Fresh weight (g)	Dry weight (g)	Girth of root (cm)
T ₁ - IBA 125 ppm	57.25	15.62	11.34	0.87	0.10	0.19
T ₂ - IBA 250 ppm	61.30	16.19	12.41	0.94	0.12	0.20
T ₃ - IBA 500 ppm	65.08	16.84	13.48	1.01	0.13	0.21
T ₄ - IBA 1000 ppm	68.99	17.34	14.55	1.08	0.15	0.22
T ₅ - NAA 125 ppm	40.83	13.39	7.09	0.58	0.06	0.16
T ₆ - NAA 250 ppm	45.09	14.07	8.16	0.65	0.07	0.17
T ₇ - NAA 500 ppm	49.07	14.59	9.23	0.72	0.08	0.18
T ₈ - NAA 1000 ppm	53.07	15.09	10.30	0.80	0.09	0.18
T ₉ - IBA 62.5 ppm + NAA 62.5 ppm	72.81	17.95	15.62	1.15	0.16	0.23
T ₁₀ - IBA 125 ppm + NAA 125 ppm	76.62	18.43	16.69	1.21	0.18	0.24
T ₁₁ - IBA 250 ppm + NAA 250 ppm	86.45	19.72	18.83	1.36	0.21	0.26
T ₁₂ - IBA 500 ppm + NAA 500 ppm	85.29	19.51	18.76	1.32	0.21	0.26
T ₁₃ - Control (Distilled water)	36.47	12.86	6.01	0.51	0.05	0.15
S.Ed	1.06	0.25	0.46	0.03	0.005	0.005
C.D(P=0.05)	2.12	0.52	0.94	0.06	0.01	0.01

The improvement in the rooting of cutting with the aid of IBA may be due to enhanced hydrolysis of nutritional reserves under the influences of auxin. Furthermore, it appears the phenol auxin complex influence root formation through the production of ethylene (Gregory and Samantarai, 1950). The probable reason for the better rooting cutting by IBA treatments is due to its greater stability, low mobility and its

slow degradation by enzymes (Hartman *et al.*, 2002). Treatment of cuttings with increasing concentrations of IBA coupled with endogenous auxins improves the percentage of rooting in cuttings as reported by Melgarejo *et al.* (2000). Similar findings were observed by Rahman *et al.* (2004) in guava ^[9, 20, 35].

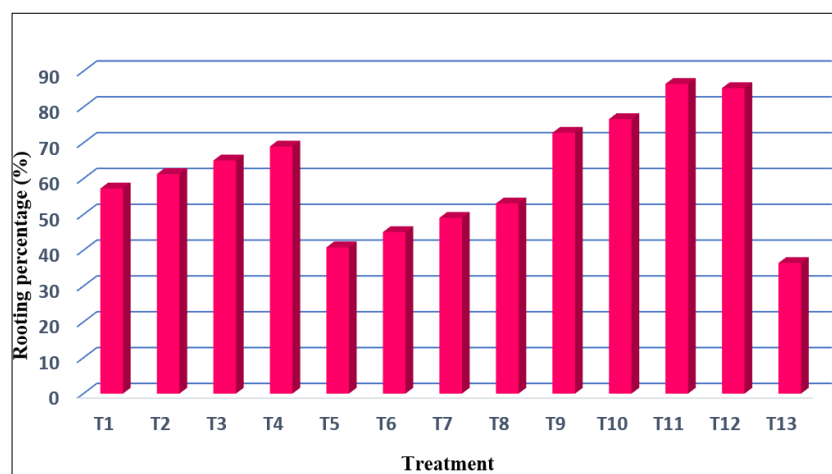


Fig 1: Effect of PGR's on rooting percentage (%) in guava (*Psidium guajava* L.)

The Number of roots per cutting was maximum (19.72) in cuttings treated with IBA @ 250 ppm + NAA @ 250 ppm.

The reason for the better rooting and increase in root growth with various auxins treatment might be due to maximum

utilization of sugar and starch after hydrolysis (Singh, 2001). (Preece *et al.*, 2003) reported that application of IBA would be more effective to increase the rooting ability of guava cuttings. The results are in conformity with the findings of Celik *et al.* (1993) in olive and Abdul Kareem *et al.* (2013) in guava [27, 18, 4].

The root length was maximum (18.83 cm) in cuttings treated with IBA @ 250 ppm + NAA @ 250 ppm. The increased size of roots may be due to auxin which plays an important role in

metabolic activity and cell division process of cuttings, resulting into increased growth of roots. The increase in root length may also be due to the effect of growth regulators IBA on the metabolites translocation and carbohydrates metabolism which may be involved in the role of hormones on root length. The difference in root system due to different hormones might have been due to their varying molecular structure and configuration.

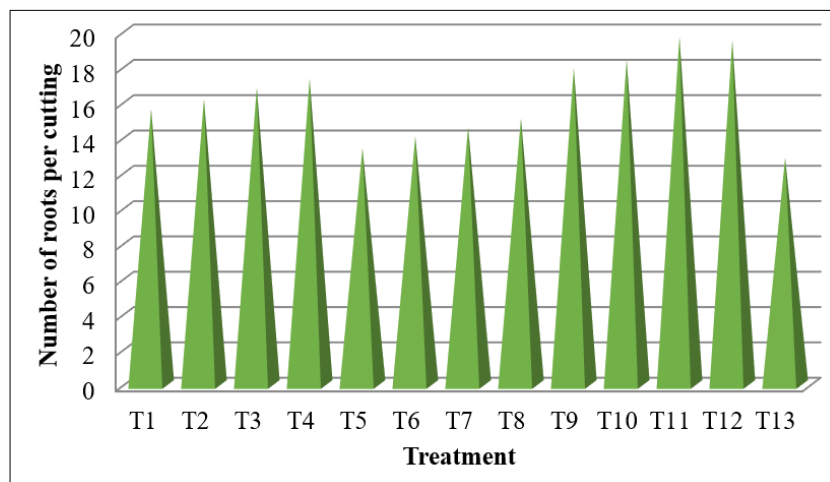


Fig 2: Effect of PGR's on number of roots per cutting in guava (*Psidium guajava* L.)

The Fresh weight of the root per cutting was maximum (1.36 g) in cuttings treated with IBA @ 250 ppm + NAA @ 250 ppm. IBA concentration increases the fresh weight of the rooting is observed by Sardoei (2014). The fresh weight of the root is directly proportional to number of roots in each cutting. The increase in number of roots per cutting might have directly influenced the fresh weight of the roots as reported by Milind (2008) in stevia and Singh and Tomar (2015) in Phalsa. The results are in conformity with the finding of Zamir *et al.* (2003) in guava.

The dry weight of the root per cutting was maximum (0.21 g)

in cuttings treated with IBA @ 250 ppm + NAA @ 250 ppm. The higher dry weight of the roots might be attributed to higher root length which accumulates more stored carbohydrates and more number of roots increased their volume per cutting of the roots in hardwood cuttings were observed than semi hardwood cuttings as stated by Hartman (2002). The present finding is in conformity with the report of Bacarin *et al.* (1994) in guava and Giriet *et al.* (2004) in guava, Rhymbai and Reddy (2010) in guava, Chawla *et al.* (2012) in litchi, Ramketeet *et al.* (2016) in guava, Kumari *et al.* (2017) in guava [24, 14, 29, 2, 8, 23, 33, 22, 13, 21].

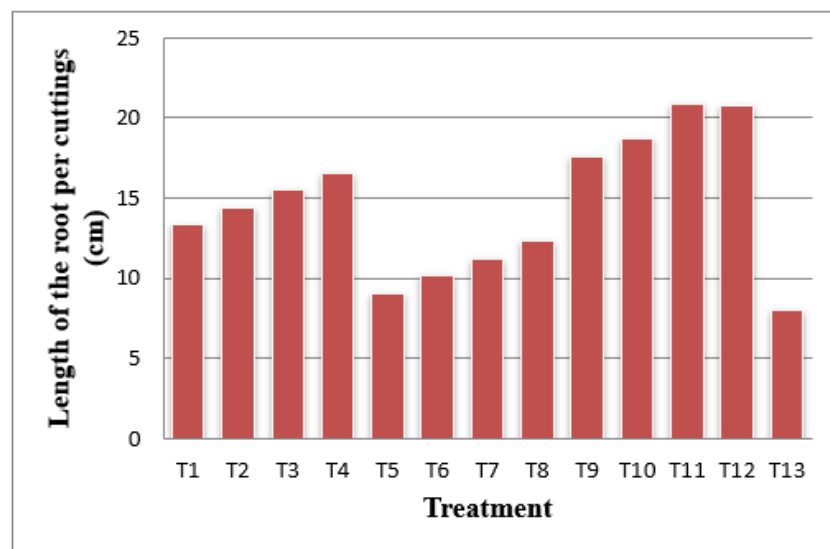


Fig 3: Effect of PGR's on length of the root per cutting (cm) in guava (*Psidium guajava* L.)

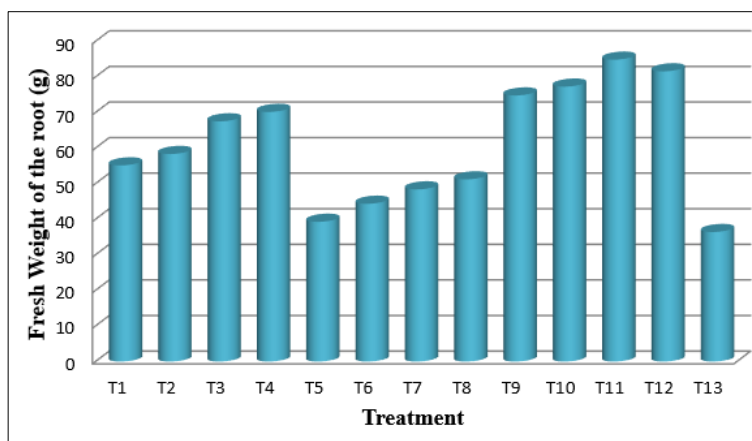


Fig 4: Effect of PGR's on fresh weight of the root per cutting (g) in guava (*Psidium guajava* L.)

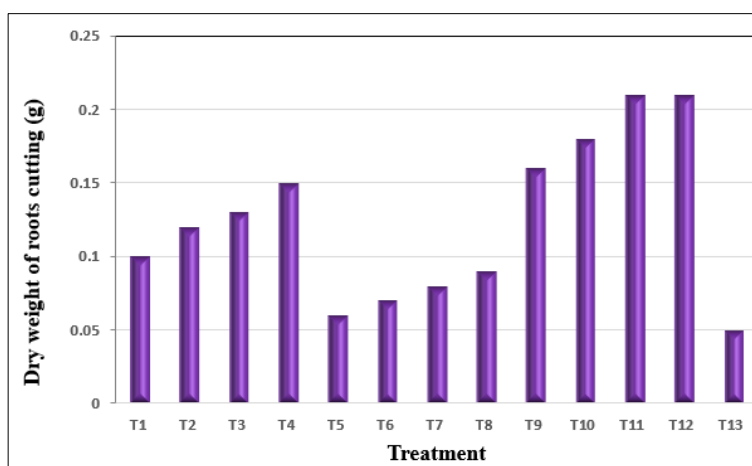


Fig 5: Effect of PGR's on dry weight of the root per cutting (g) in guava (*Psidium guajava* L.)

The girth of the root per cutting was maximum (0.26 g) in cuttings treated with IBA @ 250 ppm + NAA @ 250 ppm. The increase in root girth might be because of the best favorable increase in the endogenous auxins level in lower portion of ringed branch. This is probably because of the fact that higher concentration of IBA promoted the cell division which increased the diameter of primary root. Similar observation was also obtained by Kumar *et al.* (2004)

Shoot parameters: The earliest shoot initiation (46.41 days) was noticed in cuttings treated with IBA @ 250 ppm + NAA

@ 250 ppm. In control the guava cuttings took the maximum number of day (58.38 days) for shoot initiation to appear. The early shoot initiation of cutting may occur because of the prevention of downward translocation of carbohydrate and accumulation of higher level of endogenous auxins in the ringed at lower portion of cutting during the observation period of root initiation which might have resulted earliest completion of physiological process involved in rooting and sprouting. Similar results were also reported by Kumar *et al.* (1995) in lemon, Awasthi *et al.* (2008) in guava [21, 19, 36].

Table 2: Shoot parameters

Treatment	Days taken for shoot initiation	No of leaves / cutting	Shoot length (cm)	Girth of shoot (cm)	Survival Percentage (%)
T ₁ - IBA 125 ppm	50.70	3.54	8.98	0.14	55.13
T ₂ - IBA 250 ppm	49.78	3.79	9.39	0.15	58.33
T ₃ - IBA 500 ppm	48.80	4.02	9.78	0.16	67.51
T ₄ - IBA 1000 ppm	47.06	4.26	10.17	0.18	70.16
T ₅ - NAA 125 ppm	54.41	2.38	7.47	0.11	39.28
T ₆ - NAA 250 ppm	53.51	2.60	7.84	0.12	44.35
T ₇ - NAA 500 ppm	54.54	3.08	8.21	0.13	48.39
T ₈ - NAA 1000 ppm	51.60	3.31	8.61	0.14	51.21

T ₉ - IBA 62.5 ppm + NAA 62.5 ppm	46.14	4.48	10.58	0.19	74.79
T ₁₀ - IBA 125 ppm + NAA 125 ppm	45.17	4.69	10.96	0.20	77.27
T ₁₁ - IBA 250 ppm + NAA 250 ppm	43.41	4.92	11.76	0.22	84.85
T ₁₂ - IBA 500 ppm + NAA 500 ppm	44.26	4.88	11.64	0.22	81.57
T ₁₃ - Control (Distilled water)	55.38	2.15	7.02	0.10	36.40
S.Ed	0.15	0.10	0.19	0.005	1.08
C.D(P=0.05)	0.31	0.21	0.36	0.01	2.18

The number of leaves per shoot was maximum (4.92) in cuttings treated with IBA @ 250 ppm + NAA @ 250 ppm. Auxins application may have necessitated the increased activity of photosynthesis and other activities carried out in the leaves, which in turn may have resulted in the increase of leaves in the cuttings. The increase in number of leaves per cutting might be due to the reason that the plant might have diverted maximum assimilate quantities to the leaf buds, since the leaves are one of the production sites of natural auxins in them besides being very important for vital processes like photosynthesis and respiration (Fazli *et al.*, 2001). This might be attributed the auxins in increases plasticity of cell wall which in turn increases permeability of cell for moisture and nutrients and resulted in enlargement of cell causing more growth of plant parts.

The shoot length was maximum (11.76 cm) in cuttings treated with IBA @ 250 ppm + NAA @ 250 ppm. The increased shoot length obtained in cuttings treated with growth regulators due to the increase in cell division and cell elongation because of the actions of auxins. These findings are in accordance with the results reported by Ramkete *et al.* (2016) in guava and Munde *et al.* (2016) in pomegranate. The girth of the shoot per cutting was maximum (0.22 g) in cuttings treated with IBA @ 250 ppm + NAA @ 250 ppm. Alam *et al.* (2007) reported that maximum shoot diameter with the treatment of IBA 4000 ppm. Further, they stated that the increase in shoot diameter in kiwifruit cuttings might be due to more number of leaves and vigorous root system as a consequence of better carbohydrates production and assimilation [22, 15, 1].

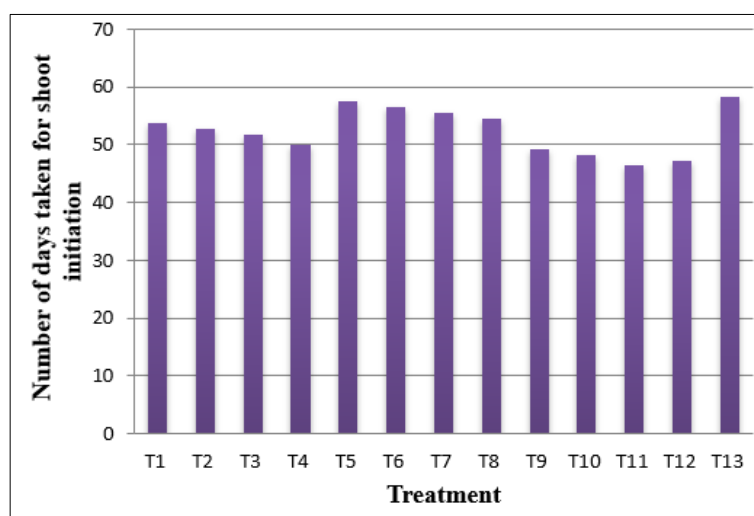


Fig 6: Effect of PGR's on number days taken for shoot initiation in guava (*Psidium guajava* L.)

There was a significant difference in the survival percentage of rooted cuttings (%) among different concentrations of growth regulator treatments is presented in fig 8. The maximum survival percentage in the rooting media was noticed in the cuttings treated with IBA @ 250 ppm + NAA @ 250 ppm (84.85%). This might be due to increased length, maximum number of primary roots and early sprouting resulted in more thickness of the roots, perhaps the ability of regenerating further new fibrous roots from main roots, which probably absorb more nutrients and water from the soil

under low transpiration losses. The effect of auxins might be due to the slow translocation property or slow destruction of auxins by auxin destroying enzyme system as reported by Debnath and Maiti (1990) and also by the early formation of roots and more utilization of reserved food materials of the treated cuttings [7].

Finally, it could be concluded that the higher rooting of cuttings and maximum survival percentage of cuttings could be obtained by application of IBA @ 250 ppm and NAA @ 250 ppm by quick dip method for 5 minutes in guava.

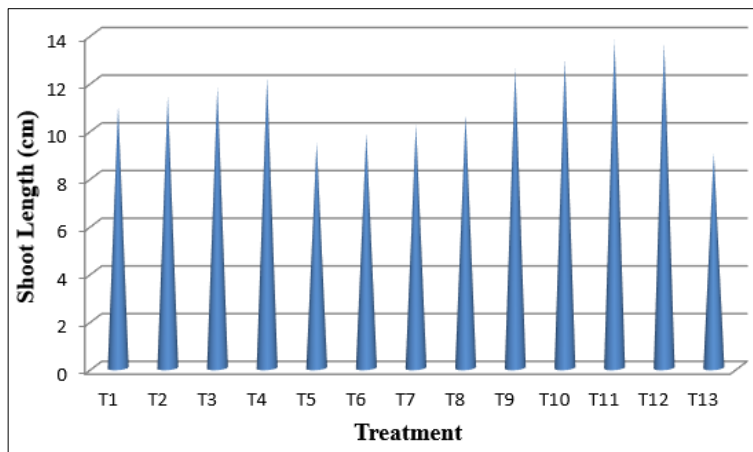


Fig 7: Effect of PGR's on shoot length of the root per cutting (cm) in guava (*Psidium guajava* L.)

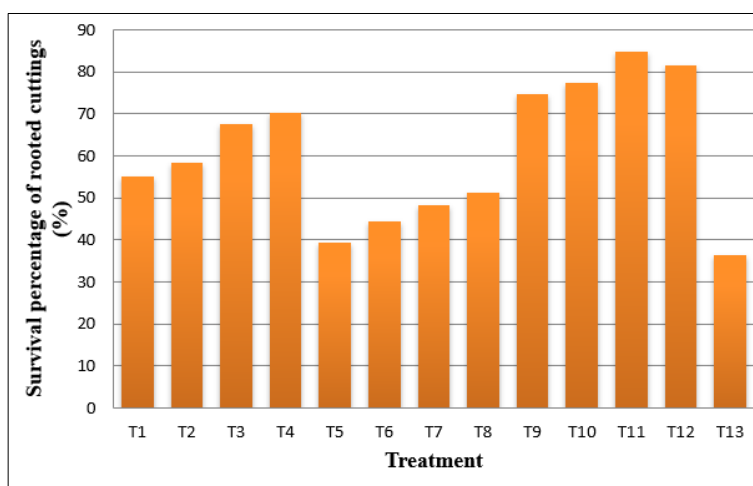


Fig 8: Effect of PGR's on survival percentage of rooted cuttings (%) in guava (*Psidium guajava* L.)



Fig 9: Comparison between best treatment and control

- T₁₁ - IBA @ 250 ppm + NAA @ 250 ppm
- T₁₂ - IBA @ 500 ppm + NAA @ 500 ppm
- T₁₃ - CONTROL

Conclusion

The present investigation clearly demonstrated that the combined application of IBA acid (IBA) at 250 ppm and α -Naphthalene acetic acid (NAA) at 250 ppm (T₁₁) significantly improved rooting and vegetative growth parameters in leaf cuttings of guava (*Psidium guajava* L.) cv. Arka Kiran. This treatment resulted in the highest rooting percentage (86.29%), root number (19.72), root length (18.83

cm), root girth (0.26 cm), as well as superior fresh and dry root weight. Additionally, it promoted earlier shoot initiation (46.41 days), enhanced shoot length (11.76 cm), greater leaf number per cutting (4.92), and increased shoot girth (0.22 cm). The highest survival rate of rooted cuttings (84.85%) was also recorded in this treatment. Based on the above results, the synergistic effect of IBA and NAA at 250 ppm each can be scientifically recommended as the most effective combination for promoting successful rooting and establishment of guava leaf cuttings under mist chamber conditions.

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