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A Break Through in Guava (*Psidium guajava* L.) Propagation from Cutting

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Abstract: An investigation was conducted to find out the "effect of hormones on the rooting of guava (*Psidium guajava* L.) Cv Allaabadi cuttings at Agricultural Research Institute, Tarnab, Peshawar during the year 2001-2002. The experiment was laid out in Complete Randomized Design. There were two factors that are three different growth regulators and three types of cuttings. Growth regulators for instance, indole butyric acid (IBA), napthalene acetic acid (NAA) and Paclobutrazol each with 1000 ppm in aqueous solution were applied to hardwood, semi hardwood and softwood cuttings. The basal ends of the cuttings were immersed in the desired strength of the growth regulators for 5 min. After treatment the cutting were planted in plastic bags and covered with plastic sheets in order to maintain the humidity in the experimental area. Growth regulator and types of cuttings have non significantly affected the days to bud sprouting. While sprouting percentage, number of branches, shoot length, root length, root weight, number of roots and survival percentage was significantly affected by various growth regulators and types of cuttings ($p \leq 0.05$). The results had shown that maximum sprouting (71.22%), more number of branches (3.44), maximum root weight (1.46 g) and better survival (57.22%) were noted in softwood cuttings treated with paclobutrazol at 1000 ppm solution. Maximum number of roots (59.66) and lengthy shoot (8.24 cm) were recorded in soft wood cuttings treated with IBA at 1000 ppm. Early sprouting (17.68 days) and maximum root length 12.81cm were observed in semi hardwood and softwood cuttings respectively, treated with 1000 ppm NAA. In general, the response of growth regulators on hardwood cuttings were completely failed to manifest their superiority in the trial.

Key words: Guava (*Psidium guajava* L.), propagation, cutting, growth regulators

INTRODUCTION

Guava (*Psidium guajava* L.), also known as apple of the tropics, belongs to the family Myrataceae. It is indigenous to tropical America i.e. Peru, Mexico and Cuba, where it is grown as wild bush. Its cultivation dates back to early 17th century. Now it is grown all over the world for its high nutritious values and taste. In Indo Pak subcontinent it is one of the most common fruit, grown for its wider adaptability, its prolific bearing and high remunerating values even without much care. It ranked fourth among the fruits of Pakistan and is growing over an area of 57.4 thousand ha and producing 461.4 thousand tones of fruit per annum. While it is the fifth major fruit of NWFP and covering over an area of 3200 ha in the province producing 30800 tones of fruit per annum[1]. It can withstand minimum temperature as low as -6.5°C[2]. It can be grown right from the sea level to an altitude of 5000 feet on all type of soil having pH ranging from 4.2 to 8.2[3].

Guava is the rich source of vitamin C, containing 10 times more than tomatoes, while its juice has 2 to 5 times more vitamin C than the fresh orange juice. Guava fruit are used mostly for squashes and juices[2].

Guava can be hardly exported to other countries. Its juice and caned products are however, gaining much popularity, which may lead to a cottage industry. Guava fresh production has increased over the years, which led to comparatively high market demands for the fruit. It bears two crops a year that is summer and winter.

Guava is usually propagated from seed. The usual method is to sow the seed immediately after extraction; seedlings to tree is generally long lived but are not true to type, which bear fruit of variable size and quality. It can

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also be propagated through air layering, cutting and grafting with much more care and with very minimum result. Air layering in guava is laborious and time consuming but such technique is recommended by Ahmed[4] uneconomical. While grafting and budding in guava need suitable rootstocks beside taking long time and requiring much more care with very little success.

Plant hormones are natural substances produced by plant tissues in small quantities, especially at the apical points and transported to other regions acropetally and basipetally where they perform various physiological activities in plant. Plant growth regulators are synthetic products, which when applied to plants produce reactions almost identical to those caused by natural hormones. Therefore, in general both plant hormones and plant growth regulators are classified together in five categories i.e. auxins, gibberellins, ethylenes, cytokinins and abscisic acids. Auxins are formed in abundance in growing regions such as terminal and lateral buds, elongating internodes and the young embryo in its developing stage inside the seed. There are numerous natural and synthetic auxins: indoleacetic acid (IAA), indolebutyric acid (IBA), naphthaleneacetic acid (NAA) and 2,4-diclorophenoxyacetic acid (2,4-D). Synthetic auxins are utilized for several purposes in horticulture and agriculture such as the formation of adventitious roots from stem cuttings of various plants, micropropagation of plant species, setting of fruit etc[5].

Plant species and cultivars vary markedly in their ability to develop adventitious roots. Cutting from some kinds of plants root easy even when the simplest procedures are used. Cuttings of other roots only influencing root factors are observed. Cuttings of still other kinds of plants have never been rooted, or rooted only rarely and meagre amounts, despite great efforts and much research. Guava is hardy to root. However, there is convincing evidence that auxins, one of the natural growth hormones, are essential for root development[2]. The accumulation of auxins at the base of the cutting trigger normal rooting. To overcome some of the inherent difficulties encountered by the cuttings to the root, synthetic auxin application may be helpful as reported by Bleasdale[6]. Mitra and Bose[7] reported the studies of many researchers on the subject with diverge findings. Mukhopadhaya and Sen[8] also covered the efforts of many scientists on the effects of various concentrations of auxins like IAA, IBA and NAA on rooting of the guava cuttings.

There is great of demand for true to type plants of guava. Propagation through cutting has got the attention of many workers. Although guava cuttings are hard to roots[9] results of recent investigation indicate that it can be successfully propagated from cuttings[10]. It is quick, easy and economical method of vegetative propagation. To avoid segregating progeny in the orchard with diversified fruiting behavior and quality, quest for true to type guava plants has increased. Therefore, a research project was envisaged at Agriculture Research Institute, Tarnab, Peshawar with a view: To find out the rooting ability of guava cuttings by the application of different growth regulators and types of cutting. To find out the easy, quick and economical method of guava propagation in order to enhance the nursery operation of the species.

MATERIALS AND METHODS

The experiment was conducted at the Lathe House of Horticulture Section, Agriculture Research Institute, Tarnab, Peshawar during 2001-2002.

Preparation of cutting: Hardwood, semi hardwood and softwood cuttings of guava Cv. Allaabadi were taken from farmer orchard of Bahadar Kot Kohat. The Cuttings were made of uniform size 25 cm long, having four buds and two cut leaves.

Application of hormones: Indole butyric acid (IBA), naphthalene acetic acid (NAA) was prepared according to the formula i.e., 1 mg of growth regulator in 1 L of distilled water to make 1 ppm solution[11]. These two chemicals are available in crystal form.

These were dissolved initially in 90% ethanol before adding distilled water to make the required strength. However, paclobutrazol is available in liquid (emulsion) form so 1 μL of paclobutrazol was dissolved in 1 L of distill water to make 1 ppm of solution. Paclobutrazol is available in 25% w/v which means that it contains 25% active ingredient. The volume was taken for various treatments and multiplied by a factor of 4 to get the required paclobutrazol strength. The basal ends of the cuttings (5 cm) were immersed in the required strength of the hormone for 5 min. The cuttings for the experiment were taken during the month of August 2001.

Plantation of cuttings: After treatment with specified growth regulator, the treated cuttings were planted in well prepared polyethylene bags at a depth of 6-8 cm. The polyethylene bags contain mixture of sand and well rotten farm yard manure at ratio of 1:1. The bags were covered properly with polyethylene sheets, in order to arrest proper humidity inside the plastic. Immediately after planting of the cuttings, the experimental plots were irrigated. Second irrigation was applied one week after plantation of the cuttings. All the cultural practices like hoeing, weeding and irrigation were kept uniformly as usual during the research work.

Experiment design and lay out: The experiment was laid out in CRD design with two factors. The total number of treatments amounting to 9. In factor one three different growth regulators i.e. IBA, NAA and Paclobutrazol were used each with concentration of 1000 ppm. In factor two different types of stem cutting i.e. hardwood, semi hardwood and soft wood was studied. So as to make a total of 9 combinations. The number of cutting per treatment was 40. Each treatment was replicated three times. The set up was done in the following ways:

Growth regulators	=	3
Types of cuttings	=	3
Replications	=	3
Number of cuttings per treatment	=	40
Total number of cuttings	=	3×3×3×40 = 1080

Data regarding growth parameters were recorded and was subject to statistical analysis. Means for various treatments were compared by LSD Multiple Range Test.

RESULTS

Number of days to bud sprouting: Growth regulators and types of cutting had no significant effects on number of days to bud sprouting. The interaction between various growth regulators and types of cutting had significant ($p \leq 0.05$) effect on days to bud sprouting. Maximum days were taken by the semi hardwood cuttings, treated with IBA (27.33), while minimum days (17.68) was taken by semi hardwood cuttings treated with NAA (Table 1).

Sprouting percentage: Sprouting percentage was significantly ($p \leq 0.05$) affected by different growth regulators and types of cuttings. The interaction between various growth regulators and types of cutting had no significant effect to sprouting percentage in guava cutting at 5% level of significance. Among the growth regulators paclobutrazol at 1000 ppm dominated (61.22%) over other hormones. Although no significance difference was noted among them. They are statistically alike with each other. While maximum sprouting percentage was notice in softwood cutting (62.42%) then hardwood cuttings (48.92%) (Table 2).

Number of leaves/plant: Number of leaves per plant was significantly ($p \leq 0.05$) affected by different types of guava cuttings and the interaction between different types of guava cuttings ($p \leq 0.05$) and growth regulators ($p \leq 0.05$). Various growth regulators had no significant effect on number of leaves. Maximum number of leaves (11.43) was observed in softwood cuttings in control while minimum number of leaves (7.33) was noted in softwood cuttings treated with NAA. (Table 3).

Table 1: Effect of various growth regulators and types of cuttings on number of days to bud sprouting in guava (*Psidium guajava* L.)

Growth regulators (ppm)	Types of cuttings: Hardwood	Semi hardwood	Softwood	Mean
IBA (1000)	25.67a	27.33a	24.33a	25.78
NAA(1000)	27.00a	17.68b	23.00a	22.56
Paclobutrazol (1000)	23.33a	24.00a	23.67a	23.67
Control	23.00a	23.00a	26.33a	24.11
Mean	24.75	23.00	24.33	

Table 2: Effect of various growth regulators and different types stem cuttings on the Sprouting percentage of guava (*Psidium guajava* L.)

Growth regulators (ppm)	Types of cuttings: Hardwood	Semi hardwood	Softwood	Mean
IBA (1000)	56.67	58.33	61.67	58.89a
NAA (1000)	48.33	59.33	63.67	57.11a
Paclobutrazol(1000)	57.33	55.33	71.00	61.22a
Control	33.33	46.67	53.33	44.44b
Mean	48.92b	54.92ab	62.42a	

Means followed by the same letters are not statistically different from each other at 5%level of probability

Table 3: Effect of various growth regulators and types of cuttings on the number of leaves/plant in guava (Psidium *guajav* L.)

Growth regulators (ppm)	Types of cuttings: Hardwood	Semi hardwood	Softwood	Mean
IBA (1000)	0.00	0.00	10.22a	3.41
NAA (1000)	0.00	0.00	7.33b	2.45
Paclobutrazol(1000)	0.00	0.00	11.00a	3.67
Control	0.00	0.00	11.43a	3.81
Mean	0.00	0.00	10.00a	

Table 4: Effect of various growth regulators and types of cuttings on the number of branches/plant in guava (*Psidium guajava* L.)

Growth regulators (ppm)	Types of cuttings: Hardwood	Semi hardwood	Softwood	Mean
IBA (1000)	0.00	0.00	3.00ab	1.00a
NAA (1000)	0.00	0.00	2.88b	0.96a
Paclobutrazol (1000)	0.00	0.00	3.44a	1.15a
Control	0.00	0.00	1.68c	0.56b
Mean	0.00	0.00	2.75a	

Means followed by the same letters are not statistically different from each other at 5%level of probability

Number of branches/plant: Number of branches was significantly ($p \leq 0.05$) affected by different types of cutting of guava, various growth regulators ($p \leq 0.05$) and interactions between various growth regulators and types of cuttings.

Maximum number of branches (3.44) was observed in softwood cutting with paclobutrazol while minimum number of branches (1.68) was observed in control (Table 4).

Shoot length: Shoot length was significantly ($p \leq 0.05$) affected by various types of guava cuttings, different growth regulators ($p \leq 0.05$) and the interaction between types of cuttings and different growth regulators at 5% level of significance.

Table 5: Effect of various growth regulators and different types of stem cuttings of guava on shoot length

Growth regulators (ppm)	Types of cuttings			
	Hardwood	Semi hardwood	Softwood	Mean
IBA (1000)	0.00	0.00	8.24	2.75
NAA (1000)	0.00	0.00	6.33	2.11
Paclobutrazol (1000)	0.00	0.00	4.88	1.63
Control	0.00	0.00	3.83	1.29
Mean	0.00	0.00	5.82	

Table 6: Effect of various growth regulators and types of cuttings on the root length (cm) in guava (*Psidium guajava* L.)

Growth regulators (ppm)	Types of cuttings			
	Hardwood	Semi hardwood	Softwood	Mean
IBA (1000)	0.00	0.00	6.26c	2.08bc
NAA (1000)	0.00	0.00	12.81a	4.27a
Paclobutrazol(1000)	0.00	0.00	9.54b	3.18ab
Control	0.00	0.00	4.97c	1.66c
Mean	0.00	0.00	8.39a	

Table 7: Effect of various growth regulators and different types of cuttings on root weight of guava (*Psidium guajava*)

Growth regulators (ppm)	Types of cuttings			
	Hardwood	Semi hardwood	Softwood	Mean
IBA (1000)	0.00	0.00	1.34a	0.45a
NAA (1000)	0.00	0.00	1.30a	0.43ab
Paclobutrazol (1000)	0.00	0.00	1.46a	0.49a
Control	0.00	0.00	0.57b	0.19b
Mean	0.00	0.00	1.17a	

Table 8: Effect of various growth regulators and different types of cuttings on number of roots of guava (*Psidium guajava* L.)

Growth regulators (ppm)	Types of cuttings			
	Hardwood	Semi hardwood	Softwood	Mean
IBA (1000)	0.00	0.00	59.66d	19.89a
NAA (1000)	0.00	0.00	40.66d	13.55ab
Paclobutrazol (1000)	0.00	0.00	36.11d	12.04b
Control	0.00	0.00	15.67e	5.220c
Mean	0.00	0.00	38.03a	

Table 9: Effect of various growth regulators and different types of stem cuttings of guava on Survival percentage

Growth regulators (ppm)	Types of cuttings			
	Hardwood	Semi hardwood	Softwood	Mean
IBA (1000)	0.00	0.00	54.97	18.32
NAA (1000)	0.00	0.00	15.83	5.28
Paclobutrazol (1000)	0.00	0.00	57.22	19.07
Control	0.00	0.00	37.58	12.53
Mean		0.00	0.00	41.40

Means followed by the same letters are not statistically different from each other at 5%level of probability

Maximum shoot length (8.24 cm) was observed in softwood cuttings treated with IBA while minimum (3.83 cm) was notice in control (Table 5).

Root length (cm): Root length was significantly ($p \leq 0.05$) affected by different growth regulators, types of guava cuttings ($p \leq 0.05$) and the interaction between various growth regulators and types of cutting.

Maximum root length (12.81 cm) was observed in softwood cuttings treated with NAA at 1000 ppm while minimum root length (4.97 cm) was observed in control (Table 6).

Root weight (g): Roots weight was significantly ($p \leq 0.05$) affected by different types of guava cuttings, various growth regulators ($p \leq 0.05$) and the interaction ($p \leq 0.05$) between different growth regulators and types of cuttings.

Maximum weight of 1.46 g was found in softwood cuttings treated with paclobutrazol at 1000 ppm. While minimum of 0.57 g was observed in control (Table 7).

Number of roots: Number of roots was significantly ($p \leq 0.05$) affected by various types of growth regulators, different types of guava cuttings ($p \leq 0.05$) and the interaction between various types of growth regulators and different types of cuttings.

Maximum number of root (59.66) was found in softwood cutting treated with IBA at 1000 ppm while minimum number of (15.67) roots were noticed in control (Table 8).

Survival percentage: The survival percentage was significantly ($p \leq 0.05$) affected by various types of growth regulators, different types of cutting ($p \leq 0.05$) and the interaction between various types of growth regulators and different types of cuttings.

The highest survival of 57.22% was observed in softwood cuttings treated with paclobutrazol, followed by 54.97% in softwood cutting treated with IBA. While softwood cuttings with NAA showed minimum (15.83%) survival (Table 9).

DISCUSSION

Number of days to bud sprouting: It is evident from the results that different growth regulators and types of cutting had no effects on days to sprouting while the interaction between the various growth regulators and types of cuttings had significant effect on number of days to sprouting (Table 1). Early sprouting of (17.68) was noted in the semi hardwood treated with NAA at 1000 ppm. While late sprouting (27.33) days were recorded in semi hardwood treated with NAA at 1000 ppm.

The reason for non significant effect of different growth regulators and types of cuttings may be, first that the applied growth regulators may not have direct effect on the shoot development as it is described by Mukhtar[12], Hartman[13], Bleasdale[6], Mitra and Bose[7] as

responsible for inducing roots and secondly, the stored food materials (carbohydrates) in the cutting provide sufficient amount of food for bud sprouting.

Sprouting percentage: Sprouting percentage was significantly affected by different growth regulators, types of cuttings. The interaction between growth regulators and types of cuttings had no significant effect on days to sprouting (Table 2). Better sprouting of (62.42%) was recorded in softwood cutting than hard wood (48.92%). Paclobutrazol at 1000 ppm was found effective at chemical to give maximum sprouting (61.22%). In the present case softwood cuttings resulted better sprouting of bud after treatment with Paclobutrazol. Better sprouting by the soft wood cuttings may be on account of an accumulation of endogenous growth promoters in the tissue of the materials. Paclobutrazol was found to act a synergist with endogenous hormones and hence better sprouting was observed.

Number of leaves per cutting: Numbers of leaves per plant were significantly affected by types of cuttings and interaction between different types of cutting and growth regulators had no significant effect on number of leaves (Table 3). Significantly more number of leaves/plant (11.43) were recorded in non-treated cutting and least number of leaves were produced by softwood cuttings treated with 1000 ppm of NAA. The more number of leaves may be satisfied with the reason that this type of cutting also produced significantly more roots as compared to other types. The more number of roots may supply more nutrients from the media for the growth of leaves.

Number of branches per cutting: The results revealed significant effect of various types of cuttings and the interaction between various growth regulators and types of cuttings on number of branches. Maximum number of branches 3.44 was observed in softwood cuttings with paclobutrazol while the minimum number of branches 1.68 was recorded in control.

The increased in the number of shoots in soft wood cutting may be that auxins are produced in abundance in growing regions[5], which may enhance the growth in the softwood as compare to hard wood and semi hardwood cuttings.

Secondly the more number of branches with paclobutrazol may be because of the fact that paclobutrazol inhibit the gibberellins biosynthesis[14] caused growth suppression. The suppression in upward growth may enhance lateral growth.

Root length: Root length was significantly increased by the application of growth regulators. The longer roots of 12.81 and 9.54 cm was observed in softwood cuttings treated with NAA and paclobutrazol each with 1000 ppm. Minimum root length was observed in control.

The results are in consistence with those of wahab[15] who reported that auxins have increasing effect on the root length.

Root weight: Root weight was significantly affected by different growth regulators and types of cutting and the interaction between the growth regulator and types of cutting. Maximum weight of 1.46 g was found in softwood cuttings treated with paclobutrazol. While minimum weight 0.57 g was recorded in control.

Increase in the root weight of softwood cuttings of guava may be primarily due to root promoting qualities of growth regulator as reported by Hafeez *et al.*[16] who obtained 94.44% rooting with paclobutrazol.

Number of roots: The results reveal that number of roots was significantly affected by various growth regulator and different types of cutting. Maximum number of root of 59.66 was recorded in softwood cuttings treated with IBA while minimum number of 15.67 roots was observed in control. These results are similar with the finding of Magherni and Sani[17]. They reported that IBA concentrations increase the rooting percentage and length of the root significantly. They further reported that cutting after treatments with 500-1000 ppm of IBA improve the rooting percentage, number of roots and length of root per cutting. Similarly Singh and Gaur[18], reported 51.25% of rooting in the cutting after treating with IBA. However, they obtained the same results with IBA at 500 ppm.

The induction of maximum number of roots in the treated cutting may be due to the fact that cambial activity involved in root initiation is stimulated by growth regulators in many species as reported by Digby and Wanerman[19] in pea.

Shoot length: Results indicate that maximum shoot length of 8.24 cm was recorded in soft wood cutting treated with IBA while minimum 3.83 cm shoot length was noticed in control. These finding are in line with the finding of Mohmand[20] who reported maximum shoot length of 11.33 cm. However, he obtained the same results at 3000 ppm concentration. The shoot length in case in IBA and NAA was superior to paclobutraxol. The reason for this may be that paclobutrazol inhibited gibberellins biosynthesis[14], where Gibberellins is a growth promoting hormone.

Survival percentage: The data regarding survival had showed better survival percentage of 57.22 and 54.97% in paclobutrazol and IBA, while minimum 15.83% was noticed in NAA treated cuttings. The increased survival percentage in paclobutrazol and IBA may be because of more number of roots observed in softwood cuttings. The results are similar to Hafeez *et al.*[16] who also reported more number of roots in tip cutting of guava with paclobutrazol at 12 ppm. While observed no rooting with in hardwood cutting at any concentration.

It is concluded from the present result that maximum sprouting (71.22%), more number of branches (3.44), maximum root weight (1.46 g) and better survival (57.22%) were noted in softwood cutting treated with paclobutrazol at the 1000 ppm solution. Maximum number of roots (59.66), lengthy shoot (8.24 cm) was recorded in softwood cuttings treated with IBA at 1000 ppm. Early sprouting (17.68 days) and maximum root length (12.81cm) was observed in semi hardwood and softwood cutting treated with NAA at concentration of 1000 ppm, respectively. In general, the response of growth regulators on hardwood cuttings were completely failed to manifest their superiority in the trial.

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