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Effect of rooting media and indole-3-butyric acid on rooting of cuttings in persimmon (*Diospyros kaki* L.) cv. Fuyu

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Abstract
Two factors of different rooting medium *i.e.* SOIL + FYM, with ratio of 1:1, 1:2 and 2:1 with three different IBA concentration i.e. untreated IBA, 1500 ppm, 3000 ppm, 4500 ppm and 6000 ppm were tried to investigate their effects on Rooting of Cuttings in Persimmon (*Diospyros kaki* L.) cv. Fuyu, in polyhouse condition at Fruit Nursery, Department of Fruit science, VCSG Uttarakhand University of Horticulture and Forestry, Bharsar, Pauri Garhwal, Uttarakhand, India. The results showed significant effects on number of days taken for sprouting, number of sprout per cutting, shoot length (cm), shoot diameter (mm), number of leaves, leaf area (cm^2), length of longest root, percent of rooted cuttings, percent survival cuttings and cost benefit (C:B) ratio. Minimum number of days taken to sprouting (8.07 days) was recorded on and maximum number of sprout (7.57), length of shoot (11.27 cm), diameter of sprout (4.85 mm), number of leaves (11.80), leaf area (8.86 cm^2), rooted cutting (61.10 %), survival cutting (64.40%), length of root (8.00 cm) and cost benefit (C:B) ratio (1:1.37) were recorded on 1:2 soil and FYM + 6000 ppm IBA. 1: 2 soil and FYM showed significant results among most of the parameters observed. Hence for better cutting success of Persimmon (*Diospyros kaki* L.) cv. Fuyu in 1:2 soil + FYM with 6000 ppm IBA is recommended.

Keywords: Persimmon, soil, FYM, cutting Survival, cost benefit ratio

Introduction
Persimmon (*Diospyros kaki* L.), is the edible fruit in the genus *Diospyros*, with family Ebenaceae, having chromosome number 2n=90 and a number of persimmon species of the genus are grown for ebony timber. The word *Diospyros*, comes from the ancient Greek words "dios" and "pyron" meaning dio-being an affix attached to plant names and pyron- referred to the fruit of the nettle tree. A popular etymology construed this as "divine fruit", or as meaning "Wheat of Zeus"or God's pear" and "Joves fire". The word persimmon itself is derived from putchamin, pasiminan, or pessamin from Powhatan, an Algonquian language of the Eastern United States, meaning "a dry fruit". The tree *Diospyros kaki*, is the most widely cultivated species of persimmon. Typically the tree reaches have a willowy appearance (Morton JF, 1987) [7]. The leaves alternate, are oblong with brown hairy petioles that are 2.0 centimeters in length. The leaves are deciduous and bluish green in colour. Persimmon trees are typically dioecious meaning male and female flowers and in rare cases also bear the 'perfect flower'. Persimmon fruit matures late in the fall and can stay on the tree until winter. The ripe fruit has a high glucose content and is sweet in taste. Like the tomato, persimmons are not typically considered to be barriers, but in terms of botanical morphology, the fruit is in fact a berry.
The total worldwide production of persimmon in 2013 was 4.6 million tonnes (Faostat), with china accounting for 43% of this total. Other major producers include the Republic of Korea, Japan, Brazil and Azerbaijan. Major growing countries of persimmon production are China (2.0 million tons), South Korea (0.3 million tons), Japan (0.26 million tons) followed by Brazil and Azerbaijan. In India, persimmon is grown in the states like Himachal Pradesh, Jammu and Kashmir, Uttarakhand and Tamil Nadu. Japani phal is the local name of this fruit in India. As per horticulture department estimates, more than 10,000 farmers grow the fruit over 420 hectares. The commercial cultivation of persimmon as an alternative commercial fruit crop was picking up in the temperate regions of the state. The monoecious trees of persimmon could tolerate even hostile weather and its production would least hit apples. The trees starts bearing fruit four to five years after planting. On an average, a full grown persimmon tree yields more than 200 kg of fruit per year. In Kullu, the astringent varieties Hachiya, Fuyu and Hyakuma are growing prominently. The fruits are deep orange red with glossy skin. Trade representative say one kilogram of persimmon sells at about Rs.50-60 in the Azadpur wholesale fruit market in Delhi.

In the retail market, it sells at Rs.100-120 per kg in Chandigarh and Delhi. The state horticulture department estimates, say this year's persimmon production will be around 480 tonnes alone in Kullu district, where it is cultivated on 148 hectares, last year yield was 380 tons. Besides Kullu, it is also grown in Shimla, Mandi, Chamba and Solan districts but in small pockets.

The application of root promoting growth regulatory substances, especially auxins is the most common treatment to enhance rooting in stem cuttings. Before the auxins many chemicals were tried with limited success. The discovery that auxins such as Indole-3Butyric Acid(IBA), Indole-3-Acetic Acid(IAA) and Napthalene Acetic Acid(NAA) stimulated the production of adventitious roots in cuttings. Typically, cuttings treated with auxins root more rapidly and produce more roots with a higher percentage of rooted cuttings. Indole-3-Butyric Acid (IBA) is the best auxin for general use because it is nontoxic to plants over a wide concentration range and is effective in root promotion of a large number of plant species. It is relatively a stable compound. It is also probably the single most effective treatment to achieve successful propagation.

The propagation techniques for persimmon do not greatly vary from other fruit trees and are reproduced from seeds, propagation by grafting, cutting etc. The early history of asexual propagation was essentially the history of grafting. It was not until the 17th century that detailed information on the propagation of plants by means of layers and cuttings was available. Probably no other single operation in asexual propagation is more important than cutting because the average nurseryman depends very largely upon this type of propagation. Cutting may be described as a method of propagating plants by the use of detached vegetative plant parts which, when placed under conditions favorable for regeneration, will develop into a complete plant. Propagation of Japanese persimmon cultivars by cuttings has so far proved to be very difficult (Kitagawa *et al*, 1984) [5] and few scientists tried it and succeeded in softwood cutting propagation (Machida and Fuji, 1969) [6]. In all cases, etiolation of stock plants and blanching of cutting bases were necessary to obtain good rooting. These operations requires a lot of time. These propagation methods have never been used commercially, and there has been no report of field performance of the own-rooted trees are propagated by cutting, although there are many advantages in hardwood cuttings propagation. They are more difficult to root than softwood cuttings (Gemma *et al*, 1983) [3].

With the view of above facts the present study entitled "Effect of Rooting Media and Indole-3-Butyric Acid on Rooting of Cuttings in Persimmon (*Diospyros kaki*) cv. Fuyu" will therefore be conducted at College of Horticulture, Bharsar has to be carried out with the following objectives:

- To study the effect of different rooting media and Indole-3–Butyric Acid on rooting and growth in persimmon cuttings.
- To work out economics based on cost benefit ratio.

Materials and methods

The material used in this experiment were uniform sized of Hard wood cutting of Persimmon (*Diospyros kaki* L.) cv. 'Fuyu' from one year old plant prepared about 0.8 to 1.2 cm in diameter and 15 to 20 cm length with 5 to 8 nodes each. The basal end of cutting was given a slant cut to expose maximum absorbing surface for maximum rooting. For preparing the rooting media, sandy soil and farm yard manure (FYM) in ratio of 1:1, 1:2 and 2:1 were mixed thoroughly, cleaned for stones and grasses, then the mixture was filled in polythene bags. The basal ends of cutting were dipped in dilute solutions, 1500 ppm, 3000 ppm, 4500 ppm and 6000 ppm indole -3- butyric acid respectively along with control by soaking method for 10 seconds and were allowed to dry for 15 minutes under shade, and planted carefully in the polythene bags. The experiment was replicated thrice with 10 cuttings in each treatment and a total 450 cuttings were tested. Number of days taken for sprouting, number of sprout per cutting, shoot length (cm), shoot diameter(mm), number of leaves, leaf area(cm^2), fresh weight and dry weight of roots and shoots, number of primary and secondary root, length of longest root, percent of rooted cuttings, percent survival cuttings and cost benefit ratio, recorded 90 days after cuttings were planted. The data recorded were subjected to statistical analysis for least significance difference factorial randomized block design (FRBD) as described by (Cochran and Cox, 1992).

Results and discussions

The rooting response of Persimmon (*Diospyros kaki* L.) cv. 'Fuyu' cuttings treated with various concentrations of IBA and different rooting media ratio in showed (Table 1).

Days taken sprouting (Number of days)

The statistical analysis of data showed (Table.1) significantly influenced by IBA, rooting media and their interaction that treatment combination M_1I_3 (1:1 soil and FYM +3000ppm IBA) recorded minimum days to sprouting (8.07 days). The earliness in sprouting of shoots under 1:2 soil and FYM media which might be due to decomposition of lignins present in rooting media resulting in the formation of humic fractions and treated with IBA 3000ppm recorded greater number of sprouts per cutting which could be attributed to the enhancement of physiological functions in the cuttings. These results are in close conformity with those obtained in Ratnakumari, (2014) [11] in pomegranate.

Number of sprouts per cutting

The data presented (Table.1) it is evident from the data that number of sprouts per cutting was significantly influenced with respect to rooting media and IBA concentrations and their interaction. The result on interaction effect of IBA concentrations and rooting media indicated that maximum number of sprouts per cutting (7.57) was recorded in treatment combination M_1I_3 (1:1 soil and FYM + 3000 ppm IBA). This might be due to the cuttings treated with IBA 3000ppm recorded greater number of sprouts per cutting which could be attributed to the enhancement of physiological functions in the cuttings favorably (Iqbal, *et al*. 1999) [4] at this concentration and FYM + soil had a property of retaining more nutrients and also helpful in increasing the number of shoots per cutting. Earliness to sprouting, increase in the number of sprouts and sprout length might be due to better utilization of stored carbohydrates, nitrogen and other factors with the aid of growth regulators (Chandramouli, 2001) [2].

Table 1: Effect of different concentration of IBA and rooting DIA on various characters.

Treatment combinations	Days taken to sprouting (no. of days)	No of Sprouted cutting	Shoot Length (cm)	Shoot diameter (mm)	No of leaves	Leaf area (cm^2)	Rooted cutting (%)	Survival cutting (%)	Length of Longest root(cm)	Cost benefit ratio (C:B)
M_1I_1	16.20	4.40	7.76	1.53	4.83	4.30	22.21	22.20	2.93	1:0.07
M_2I_1	20.60	3.47	8.98	2.76	5.07	2.53	28.89	26.66	3.18	1:0.34
M_3I_1	17.10	4.33	4.79	2.97	3.80	3.67	25.51	25.50	3.07	1:0.25
M_1I_2	12.93	5.47	10.19	3.03	7.83	4.81	33.30	28.87	3.76	1:0.11
M_2I_2	12.70	4.87	9.32	4.51	7.40	4.30	32.19	29.97	4.98	1:0.09
M_3I_2	13.60	5.70	9.02	4.32	9.00	4.41	32.20	32.20	4.69	1:0.25
M_1I_3	8.07	7.57	8.86	4.15	11.80	6.50	44.43	39.99	8.00	1:0.47
M_2I_3	10.07	5.53	9.89	4.85	8.20	8.86	42.19	39.99	7.78	1:0.44
M_3I_3	11.60	5.27	10.41	3.07	7.17	6.30	48.89	44.42	7.57	1:0.74
M_1I_4	13.73	4.80	10.57	2.85	7.40	5.75	44.40	43.32	6.22	1:0.71
M_2I_4	13.67	5.87	10.12	3.90	7.87	5.30	55.51	52.20	6.52	1:0.90
M_3I_4	12.80	4.77	10.07	4.19	8.20	6.12	56.63	54.40	6.20	1:0.98
M_1I_5	13.60	5.86	9.97	3.92	8.60	5.39	61.10	58.85	6.46	1:1.18
M_2I_5	13.97	5.07	11.27	4.68	8.53	6.00	44.40	64.40	7.24	1:1.37
M_3I_5	13.23	4.93	9.56	4.19	9.43	5.37	61.10	58.89	6.19	1:1.21
C.D $_{0.05}$	2.19	1.18	1.70	0.73	0.99	0.60	5.04	4.39	0.53	-

M_1= SOIL+ FYM (1:1), M_2 = SOIL+ FYM (1:2), M_3 = SOIL+ FYM (2:1),
I_1= Control (Untreated IBA), I_2=1500 ppm (IBA), I_3 = 3000 ppm (IBA), I_4 = 4500 ppm (IBA), I_5=6000 ppm (IBA).

Shoot length (cm)

Data of (Table.1) indicate the effect of rooting media, IBA concentrations and their interaction on shoot length. Data showed that the shoot length exhibit significant differences among the different concentrations of IBA, rooting media and their interaction. The maximum length of shoot (11.27 cm) was recorded in treatment combination M_2I_5 (1:2 soil and FYM + 6000ppm IBA). This may be attributed to nutritionally better mixture, high water and nutrient holding capacity, good drainage and high porosity of the media combination, which helped in the development of excellent root system, which in turn supported better shoot system. In addition, such media enhanced apical meristematic activity and also triggered cambial division. Similar findings have been reported by Sharma (1993) [12] in mulberry, Singh *et al.* (2003) [13].

Shoot diameter (mm)

The data obtained for effect of rooting media and Indole-3-Butyric Acid on shoot diameter of cutting depicted in (Table 1). The diameter of shoots exhibit significant difference among the different concentrations of IBA, rooting media and their interaction. The interaction among the various concentrations of IBA and media indicated that maximum shoot diameter (4.85 mm) was recorded in M_2I_3 (1:2 soil and FYM + 3000ppm IBA). Because of the earliest and good growth of cutting have stem maximum thickness due to more photosynthesis.

Number of leaves

The data recorded to the effect of IBA concentrations and rooting media on number of leaves per cutting furnished in (Table 1). It was evident that, there was a significant difference among the different concentrations of IBA, rooting media and their interaction in term of increasing number of leaves per cutting. Data also showed the treatment combinations M_1I_3 (1:1 soil and FYM + 3000ppm IBA) recorded the maximum number of leaves (11.80). Better nutrient absorption could have encouraged production of more number of leaves by the cuttings. The increase in number of leaves with IBA 3000 ppm might be due to more number of roots, plant height and branches per cutting (Ismail and Asghar, 2007). The above results are in accordance with by Wahab, *et al.* (2001) [14], Malik, *et al.* (2013) [8] in guava.

Leaf area (cm^2)

The interaction among various concentrations of IBA and rooting media on leaf area of cuttings depicted in Table 1. Data also showed that the treatment combination M_2I_3 (1:2 soil and FYM + 3000ppm IBA) recorded maximum leaf area (8.86 cm^2).it is due to vigorous growth of cutting as it is capable of absorbing more nutrients and prepares more photosynthetic resulted in maximum leaf area.

Rooted cuttings (%)

The data showed significant interaction existed between rooting media and IBA for per cent rooted cuttings of persimmon cv. Fuyu, at 90 days after planting. Significantly maximum per cent rooted cutting with the maximum per cent of (64.40 %) was observed in 1:2 Soil and FYM + 6000ppm IBA (M_2I_5). %). The superiority of soil + FYM (1:1) rooting medium might due to its unique ability to enhance rooting and root development as compared to other rooting media. FYM plays vital role in maintenance of physical and biological condition of soil and supplies nutrients to crop beside maintenance of humic substances in soil.

Survival of rooted cuttings (%)

Statistically data for the effect of interaction between IBA and rooting media on survival per cent of rooted cuttings of persimmon cv. Fuyu, are given in Table 1. Data also showed that treatment combination M_2I_5 (1:2 soil and FYM + 6000ppm IBA) recorded maximum percent of rooted cuttings (64.40%). The highest survival percent was recorded in the cuttings treated with IBA solution @ 6000ppm, which might due to development of effective root system and increase in number and length of roots per cutting as influenced by the uptake of nutrients and water (Reddy *et al*, 2008) [10].

Length of the longest root (cm)

The data recorded for the effect of rooting media and IBA on the length of longest root per cutting. It is evident from the Table. 1, that the length of the longest root varied significant under different concentrations of IBA concentration and rooting media. Among the interactions, the treatment combination M_1I_3 (1:1 soil and FYM + 3000ppm IBA) was recorded to gave the maximum length of the root (8.00 cm). These media might be attributed to their better physical,

chemical and biological properties, which in turn supported better root growth and hence, increased its root length. The increase in length of the roots is might be due to the amount of food reserves in cuttings. Similar findings have been previously reported by Ozenc, (2007) [9] in kiwifruit.

Cost of cultivation

Data depicted in Table.1 summarizes the effect of rooting media and IBA on cost of cultivation of cuttings. It is evident from the data that rooting media and different concentrations of IBA significantly increased cost benefit ratio. The treatment combination M_2I_5 (1:2 soil and FYM + 6000ppm IBA) showed maximum gross return (Rs.1600).

Conclusions

Conclusion Based on Experimental Results are as

- Among the rooting media the cuttings planted in 1: 2 soil and FYM was found better than other media used.
- In the present study cuttings planted under 6000ppm IBA were found the best for many of the root and shoot parameters.
- Interaction of IBA treatments and rooting media, were also found significant for many of the parameters. The treatment combination M_2I_5 (1:2 soil and FYM + 6000ppm IBA) was found to be significantly superior for many of the root and shoot parameters.
- The maximum cost benefit ratio (1:1.37) was observed in M_2I_5 (1:2 soil and FYM + 6000ppm IBA).

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