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The Effect of Hazelnut Husk Compost and Some Organic and Inorganic Media on Root Growth of Kiwifruit (*Actinidia deliciosa*)

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Abstract: In this study, the effects of different concentrations of Indol Butyric Acid (IBA) and growing media on root growth of kiwifruit cutting were investigated. Organic materials such as hazelnut husk compost, farmyard manure, peat and inorganic materials such as perlite and pumice were used as rooting medium, with 2000, 4000 and 6000 mg kg^{-1} IBA concentration. The experiment was arranged in a completely randomized design with five media, four IBA doses with ten replicates under mist propagation in heated greenhouse conditions. After a growing period of 45 days, some root parameters were measured. Inorganic materials were found to be suitable based on the rooting ratio, dry matter weight and root size. While the IBA-2000 mg kg^{-1} dose on rooting ratio and root dry weight was found to be sufficient, IBA-6000mg kg^{-1} dose on rooting size was effective dose. Organic materials affected root length and root area. The best effect on these parameters was obtained from husk compost medium with IBA-6000 concentration and followed with peat medium with IBA-2000 concentration.

Key words: Hazelnut husk compost, farmyard manure, peat, perlite, pumice, indol butyric acid, kiwifruit

INTRODUCTION

Today, a lot of organic origin wastes after composting are widely used as organic material in growing. These materials have been using in different field depending on its properties (Duke *et al*., 2003; Kahtz and Gawel, 2003; Özenç, 2005; Benito *et al*., 2005; Perez-Murcia *et al*., 2006). Recently, many different materials have been used in propagation techniques. Especially, nurseries prefer to use less costly potting media. Kiwifruit is a recent introduction in Turkey, becoming increasingly popular among growers in the Black Sea region. The kiwifruit may be propagated by various methods such as stem cuttings, leaf cuttings, leaf-bud cuttings and root cuttings (Hartmann *et al*., 1990). Propagation with cutting is the cheapest and the quickest method in easily rooting fruit varieties (Poincelot, 1980; Kaska and Yilmaz, 1987). Previous researchers have reported that rooting ability of kiwifruit cuttings are related to ecology, nutrient condition of plant, rooting media and cultural applications (Martyn and Hopping, 1990; Özcan, 1993; Tu *et al*., 1991; Ercisli *et al*., 2002; Merino *et al*., 2006). Perlite is the most widespread medium for propagation of kiwifruit cuttings. In addition, vermiculite, turf, peat and sawdust were also used by some researcher (Karadeniz, 2000; Ono *et al*., 2002; Özcan, 1993; Ercisli *et al*., 2002; Kumar and Sharma, 2002). Kiwifruit plants have a high water requirement. For this reason, water content and aeration capacity of media are extremely important with any types of cutting propagation. In propagation, the air content of media should be between 20 and 45% to promote root formation and growth. This level in media should not drop below 15 volumes percent (Gislerod, 1983). Keep the soil moist enough to promote root growth, but don't over-water, which can cause anaerobic conditions that promote root rot. Several methods of cuttings propagating are used to optimize growth of the fastest and healthiest cutting. Mist propagation is such an efficient and economical system to produce large quantities of rooted cuttings, it is one of the most widely used means of cuttings propagating in nurseries since 1950 (Hartmann *et al*., 1990). On the other hand, the other factors affecting cutting propagation are growth regulators. Kiwifruit cuttings are dipped stimulant hormones such as IBA, NAA for increasing rooting. Cuttings of some species root readily without an auxin treatment, while cuttings of other species benefit from auxin treatment through enhanced promotion of rooting; benefits may be dependent upon the species and cultivar, condition of the cutting wood, time of year and other factors (Hartmann *et al*., 2002). IBA is widely applied in general use because it is non-toxic to most plants over a

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wide range and promotes root growth in a large number of plant species. Root development shows differences depending on hormone concentrations, rooting media and improper time (Lawes, 1990; Anvari *et al*., 1991; Blythe *et al*., 2004). Although the dosages of IBA-4000 and IBA-6000 mg kg^{-1} are suggested in some research (Samanci, 1990), the studies done on Hayward, Bruno and Matua species at Giresun Nut Research Center with perlite media and dosage of IBA-2000 mg kg^{-1} have indicated that rooting can reach up to 90%, though this percentage may vary with years (Çaliskan, 1997).

In this study, organic materials such as hazelnut husk compost, peat and farmyard manure for rich in organic matter and plant nutrient element content were preferred and the materials like perlite and pumice with inorganic origins were chosen for their porosity. The objective of this study was to investigate the effect of organic and inorganic media and the most suitable IBA concentrations on root development of semi-hardwood cutting of kiwifruit cv. Hayward.

MATERIALS AND METHODS

Semi-hardwood cuttings of kiwifruit cv. Hayward were prepared from vigorous shoots of 12-year-old plants on 2 August 2004. Perlite, pumice, peat, Farmyard Manure (FM) and Hazelnut Husk Compost (HHC) was used as pure. Peat was taken from Bolu-Yeniçağa, located in the Western part of Black Sea region of Turkey. Hazelnut husk was taken from Giresun, located in the Eastern part of Black Sea region of Turkey. It was composted according to Indore method as described by Çaliskan *et al*. (1996). Using materials in media have medium and coarse size.

Setting up experiment: The study was carried out under greenhouse conditions. The design was a completely randomized design with ten replicates. At first, cuttings were dipped into IBA solutions at 0, 2000, 4000 and 6000 mg kg^{-1} for 10 sec. After treatment, they were planted to 3300 cm^3 of different rooting media in mist propagation system in heated greenhouse for 45 days. At the end of experiment, cuttings were cleaned and dry weights of roots and root parameters were determined.

Media analyses: Bulk Density (BD), Aeration Capacity (AC), Easily Available Water (EAW), Water Buffering Capacity (WBC) (De Boodt *et al*., 1973), Organic Matter (OM) (DIN 11542, 1978), Total Nitrogen (TN) (Bremner, 1982), pH and Electrical Conductivity (EC) (Gabriels and Verdonck, 1992) were determined. Root parameters were determined as described by Böhm (1979) and dry matter weight by Kacar (1984). Statistical analyses were evaluated by ANOVA and differences among the groups were separated by LSD ($p<0.01$).

RESULTS AND DISCUSSION

The main physical properties of the different media are related to water retention characteristics. De Boodt and Verdonck (1972) defined the requirements of an ideal substrate this should exhibit 20-30% AC, 20-25% EAW content and WBC between 5-7%. Accordingly, while the highest AC level was HHC media (33.21%), the most suitable AC was found in pumice (24.52%) and perlite (20.40%). EAW was ideal range in organic substrates and the highest EAW was found in peat (27.81%). WBC of all substrates was found adequate. At the same time, the lowest BD was also found in HHC media. 5.5-7.6 pH values recommended for healthy rooting (Samanci, 1990). pH of media was found adequate, except for perlite and FM media (pH 7.70 and 7.72). Especially, HHC has most suitable pH and EC for rooting. While HHC has the highest organic matter content, farmyard manure has the highest total nitrogen, available phosphorus and potassium contents (Table 1).

There is an interaction between the rooting media and IBA doses with respect to rooting percentage ($p<0.01$), root length ($p<0.01$) and root size ($p<0.05$) (Table 2). These parameters were significantly affected by rooting media and IBA doses. Changes in rooting ratio of different rooting media and IBA doses are shown in Table 2. When compared with the control, treatment of IBA enhanced rooting. Rooting was significantly higher in cuttings in 2000 and 4000 mg kg^{-1} IBA treatments of perlite and pumice media and 2000 and 6000 mg kg^{-1} IBA treatments of peat media. As expected, perlite and pumiceled to increases rooting percentage because of suitable aeration capacity

Table1: Some physical and chemical properties of growing media used in the experiment

Media	AC (%)	EAW (%)	WBC (%)	BD (g cm^{-3})	pH	EC (dSm^{-1})	OM (%)	TN (%)	P (mg kg^{-1})	K (mg kg^{-1})
Perlite	20.40	9.50	5.10	0.13	7.70	0.18	-	-	-	-
Pumice	24.52	7.71	5.29	0.17	6.87	0.25	-	-	-	-
Peat	16.26	27.81	5.04	0.25	7.33	1.81	65.85	1.10	125.00	155.50
FM	13.02	25.05	7.12	0.22	7.72	4.72	75.18	1.60	2750.0	4384.0
HHC	33.21	21.97	6.84	0.11	6.12	1.85	84.90	0.83	370.02	871.88

AC: Aeration Capacity; EAW: Easily Available Water; WBC: Water Balance Capacity; BD: Bulk Density; EC: Electrical Conductivity; OM: Organic Matter Content; TN: Total Nitrogen; P: Available Phosphoms; K: Available Potassium

Table 2: The effect of rooting media and different IBA concentration on rooting ratio, root dry matter weight, root length, root area and root size

	Rooting media					
IBA Application	Perlite	Pumice	Peat	FM	HHC	Means
Rooting ratio (%)						
0 mg kg^{-1}	0.00e	30.00d	30.00d	0.00e	0.00e	30.00
2000 mg kg^{-1}	100.00a	100.00a	100.00a	80.00b	0.00e	95.00
4000 mg kg^{-1}	100.00a	100.00a	90.00ab	60.00c	10.00e	72.00
6000 mg kg^{-1}	90.00ab	90.00ab	100.00a	80.00b	30.00d	78.00
Means	96.67	80.00	80.00	73.33	20.00	
LSD ($p<0.01$): 16.51						
Root dry matter weight (g)						
0 mg kg^{-1}	0.00	0.072	0.129	0.00	0.00	0.100c
2000 mg kg^{-1}	0.497	0.276	0.343	0.160	0.00	0.319a
4000 mg kg^{-1}	0.238	0.305	0.192	0.094	0.096	0.185bc
6000 mg kg^{-1}	0.397	0.430	0.376	0.131	0.045	0.276ab
Means	0.377a	0.271ab	0.260b	0.128c	0.071c	
LSD for media ($p<0.01$): 0.1009						
LSD for IBA ($p<0.01$): 0.09025						
Root length (cm)						
0 mg kg^{-1}	0.00f	661ef	2992b-d	0.00f	0.00f	1827
2000 mg kg^{-1}	2438de	2659cd	4512b	3030b-d	0.00f	3159
4000 mg kg^{-1}	3895b-d	2835b-d	4476bc	4253b-d	2948b-d	3681
6000 mg kg^{-1}	3076b-d	4108b-d	3608b-d	3182b-d	6358a	4067
Means	3136	2566	3897	3488	4653	
LSD ($p<0.01$): 1819						
Root area (cm^2)						
0 mg kg^{-1}	0.00	992	1296	0.00	0.00	1144b
2000 mg kg^{-1}	3033	3882	6974	4609	0.00	4625a
4000 mg kg^{-1}	5323	4931	6001	6862	3659	5355a
6000 mg kg^{-1}	4284	5329	7503	5181	7234	5906a
Means	4213b	3784b	5444a	5551a	5447a	
LSD for media ($p<0.05$): 1140.						
LSD for IBA ($p<0.01$): 1375.						
Root size (cm^3)						
0 mg kg^{-1}	0.00h	2.00gh	0.33gh	0.00h	0.00 h	1.17
2000 mg kg^{-1}	11.60b	8.17c-e	10.50bc	6.83de	0.00h	9.28
4000 mg kg^{-1}	10.67bc	8.50cd	5.67ef	1.33gh	1.50gh	5.53
6000 mg kg^{-1}	14.33a	5.67ef	10.00bc	3.00fg	2.63gh	7.13
Means	12.20	6.08	6.62	3.72	2.07	
LSD ($p<0.05$): 2.701						

IBA: Indol Butyric Acid; FM: Farmyard Manure; HHC: Hazelnut Husk Compost

(Table 1). Peat and the other organic materials support the formation of good root due to their special properties. Biasi *et al.* (1990) found that doses of IBA (2000, 4000 and 6000 mg kg^{-1}) as well as the time of preparing cuttings are important for rooting of Hayward cuttings. The effect of various phytoregulator treatments (IBA, NAA) on rooting with cuttings of *Actinidia deliciosa* (A. Chev) was searched by Bartolini and Ianni (1990). The rooting percentage and the quality of formed roots were strongly influenced by specie, variety, cutting period, substrate type used (Kumar and Sharma, 2002; Davidescu *et al.*, 2003; Dumitrascu *et al.*, 2003; Stanica *et al.*, 2003). Generally, all of the IBA doses increased the rooting, but it has been determined that rooting would be achieved without hormone when peat and pumice present. Fasolo Fabbri Malavasi and Predieri (1988) reported that rooting could be formed without hormone presence for plum, peach and kiwi variety Hayward. The similar findings were obtained from Ono *et al.* (2003). These results indicated that rooting media was more important than IBA concentration for rooting of this kiwifruit cultivar.

Table 2 shows that organic materials affected root length. Root length was the highest in IBA-6000 mg kg^{-1} treatment of HHC media (6358cm). IBA-2000 mg kg^{-1} (4512 cm) in peat media was followed as the best effective treatments. Changes in root length are shown Table 2. Hazelnut husk compost is a rich material for organic content (Çaliskan *et al.*, 1996) and also, this media has high EAW and WBC (Özenç, 2005). For this reason, IBA-6000 mg kg^{-1} treatment of husk compost has found the most effective media for root length. The interaction between the rooting medium and auxin treatment could affect rooting response, since increased water uptake could be expected to increase auxin uptake. Peat and farmyard manure with organic content can be following media for that purpose. The least effective media on root length are perlite and pumice. Seven different rooting medias have been used to study the effect of substrates on the rooting of cuttings of *BegoniaXLucerna* by Marahrens and Top (1986), the shortest and thinnest roots are formed only on vermiculite and perlite medias. It has been reported that the best rooting

system was developed on mixture of peat+perlite and peat+vermiculite. The properties of these media caused different effectiveness by varying hormone levels. On the other hand, Ercisli *et al.* (2002) reported that cuttings in perlite medium had longer roots than the others. The growth of root on the hardwood cuttings of 13 *Actinidia arguta* species were examined on a media containing 0.3% IBA within chopped foam cubes by Beyl *et al.* (1995). Besides, count of root wasn't achieved in applied without IBA of perlite, farmyard manure and husk compost because of only callus formation. Souad (1994) has taken buds from grafted stalks of kiwi *in vitro* media, if at the beginning 2 mg L^{-1} BA applied for 4 weeks, it has been reported that no buds form but instead callus form. When planting out, the plants should be put to the ground at the same level they used to grow in a pot, into a hole dressed with compost or well-rotted manure (Kumar and Sharma, 2002).

Hughes *et al.* (1992) reported that kiwi roots have clumping structure; rooting size is above 20% and has no root under soil conditions. In this, they differ from other trees and vines. In this study, the highest root size on kiwi cuttings (14.33 cm^3) was also achieved on highest rooting formation which was perlite media containing IBA-6000 dose. IBA-2000 mg kg^{-1} dose on perlite media, IBA-2000 mg kg^{-1} and 6000 mg kg^{-1} doses on peat media were followed as the best effective treatments, respectively (Table 2).

Both rooting media and IBA concentrations significantly affected root dry matter weight ($p<0.01$) and root area ($p<0.05$) in cuttings. As seen on Table 2, cuttings in perlite medium (0.377 g) are heavier than the others. The pumice (0.271 g) and peat media (0.260 g) are the following best media. As expected, root length increased in these media depending on theirs higher rooting ratio. Thick roots were higher in inorganic media; on the contrary, fine roots were higher in organic media. Besides, thick root amount was higher in perlite media so root dry weight was increased. Pumice was found the second most effective media for root weight because of its origin similar to perlite. Peat among the organic media has the greatest effect, farmyard manure and hazelnut husk compost follows that. Besides, IBA treated cuttings gave higher root weight than control cuttings in all media types. The highest root dry matter weight was obtained with the application of IBA-2000 mg kg^{-1}, which is followed by IBA-6000 and IBA-4000 mg kg^{-1}, respectively (Table 2).

According to root area, although organic materials doesn't have significant difference from each other, but order of effect has lined up as farmyard manure, husk compost, peat media, respectively (Table 2). It is an expected result that these mediums have given highest root area as same media is causing longest root length (Table 2). This finding is harmonious with other media and criterions. As the media like perlite and pumice supply the most effective media for root formation, it causes less spreading of roots. Tonutti and Giulivo (1990) in their study on the effect of available soil volume on growth of young kiwi plants reported that growth of root is negatively affected by reduction of soil volume and the increase of planting density, distribution of root system is inhibited and fresh and dry weight of root is decreased. Piccotino *et al.* (1992) have used propagated kiwifruit vines (Hayward) by micropropagation from hardwood cuttings. It has been explained that fine roots (<1 mm) were represented 90-93% of root length and 50% of the total root surface area.

CONCLUSIONS

In conclusion, one of the most important criteria for the successful rooting of cuttings is suitable rooting medium. The application of IBA at a concentration of 2000 mg kg^{-1} seemed to be enough for rooting of semi-hardwood cuttings of kiwifruit cv. 'Hayward'. Inorganic materials were founded more suitable for rooting for this kiwifruit cultivar. However, organic materials were more affected in root growth. For this reason, cuttings rooted in an inorganic medium should be taken in an organic medium.

Hazelnut husk compost appeared to be a good rooting medium based on its some physical (such as EAW and WBC) and chemical (such as pH, EC, OM, P and K) properties. However, this medium didn't suitable based on some physical properties.

Therefore, further studies should be carried to find out how its desired or undesired properties would be affected when it is mixed with the other media.

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