



## Short communication

## Rooting response of shoot cuttings from three peach growth habits

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**Abstract**

Current year shoot cuttings were collected in October and August from three growth habits of peach (Compact, Pillar, and Standard) and treated with one of four concentrations of indole butyric acid (0, 250, 1250, and 2500 mg L<sup>-1</sup> IBA). Rooting response was measured after 5 weeks in the greenhouse. Little or no rooting occurred with cuttings from any growth habit that was collected in October or in August when treated with 0 and 2500 mg L<sup>-1</sup> IBA. In August, the number of shoots that rooted was greater in cuttings from Pillar (79 and 45%) than Compact (13 and 3%) treated with 250 and 1250 mg L<sup>-1</sup> IBA, respectively. Cuttings from Standard trees had intermediate rooting of 56 and 6% at 250 and 1250 mg L<sup>-1</sup> IBA, respectively. Pillar trees consistently grew more roots with greater root length per cutting than the other growth habits. It is proposed that differences in rooting response among the growth habits may be associated with differences in endogenous auxin concentration that had been found in previous studies. Within peach and possibly other fruit trees, the capacity of shoot cuttings to develop adventitious roots can vary by cultivar and successful root induction with exogenous plant growth regulators may depend, in part, on endogenous hormone levels.

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**Keywords:** *Prunus persica*; Adventitious root development; Endogenous hormone; Exogenous plant growth regulator; Indole butyric acid

**1. Introduction**

Peach trees (*Prunus persica* (L.) Batch) are generally grown for commercial production as two genetically different components consisting of a scion either budded or grafted to a rootstock. Fruit tree rootstocks can provide to the scion desired growth traits, disease resistance, and abiotic stress tolerance. Rootstocks are reproduced asexually by inducing adventitious root development on rootstock shoots or sexually from seed. One criterion used in selection of vegetatively propagated peach rootstocks is how readily cuttings produce roots (Cambra, 1990). Producing own-rooted peach trees have potential benefits compared with trees that are scion budded to a rootstock. Own-rooted trees may have greater capacity to absorb soil resources, be more uniform in shoot growth, and eliminate chances of tree death due to graft incompatibility (Couvillon, 1985).

Rooting of cuttings is not always successful and the reasons for rooting failure are not clearly understood. Factors such as cultivar and age of the source tree; the collection date, length,

diameter, and degree of hardening of the cuttings; injury and heat treatments of the cuttings; and the treatment concentrations of auxin-like compounds can affect rooting (de Oliveira et al., 2003; Tsipouridis et al., 2003, 2005, 2006). The plant growth regulator indole butyric acid (IBA), a synthetic auxin, induces rooting in peach cuttings, but its effect can vary with the type of cutting used (Couvillon, 1985). Tsipouridis et al. (2003) found that IBA concentrations of 2000 mg L<sup>-1</sup> stimulated rooting of hardwood and semi-hardwood cuttings but rooting success varied with peach cultivar. In contrast, softwood cuttings treated for 24 h with 25 mg L<sup>-1</sup> solutions of IBA rooted (Gur et al., 1986).

In several species, rooting success has been related to endogenous auxin concentrations (Haissig, 1970; Eliasson and Areblad, 1984; Guerrero et al., 1999). Differences in auxin have been measured among growth habits of peach (Tworkoski et al., 2006). Auxin concentrations were greater in peach trees with a Pillar (upright branches) than a Standard (spreading branches) growth habit (Tworkoski et al., 2006). In addition, Pillar trees had higher shoot-to-root dry weight ratios (2.4) than Compact and Standard trees (1.7 for both) (Tworkoski and Scorza, 2001). In their experiment, Compact trees had more fibrous roots than Pillar or Standard trees. For this study, we hypothesized that the differences in auxin concentrations could effect a difference in

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rooting ability that may occur among peach growth habits and other plant species. The objective was to compare the effects of four IBA concentrations on rooting of shoots from three different peach growth habits, specifically, comparing Pillar trees, shown to have higher auxin concentration, with Standard and Compact trees.

## 2. Materials and methods

### 2.1. Plants

Shoots used in this experiment came from Standard Redhaven, ComPact Redhaven, and Pillar (KV930454) trees that were described previously (Scorza et al., 1986, 1989). Trees were planted in 1995 and grown in the field at the Appalachian Fruit Research Station, Kearneysville, WV, USA, on Hagerstown silt loam (fine, mixed, mesic Typic Hapludalf). Insect and disease pressure was managed following Pfeiffer (1998). One hundred and twenty current-year shoots (30 cm) were cut from three trees of each growth habit. Shoots from the three trees were a single genotype of one growth habit and were pooled.

### 2.2. Shoot cutting and treatment

Shoots were stored for less than 18 h and were kept cold and in high humidity until treated. At the time of treatment the proximal portion of the shoot was cut and approximately 5 cm of the proximal portion of the remaining shoot received two tangential cuts on opposite sides to expose cambium. The newly cut tissue was then dipped in an aqueous solution of indole-3-butyric acid (IBA) for 60 s. Concentrations of 0, 250, 1250, and 2500 mg L<sup>-1</sup> IBA were prepared by dissolving IBA in a drop of 1N KOH and then dissolving with water.

Cuttings were planted in plastic tubes (3.8 cm diameter × 21 cm deep “Cone tainer”, Stuewe and Sons, Inc., Corvallis, OR, USA) filled with potting media (Sunshine Mix # 5; SunGro Horticulture Canada Ltd., Seba Beach, Canada). Approximately 15 cm shoot was exposed to the atmosphere. The average cutting diameter within 2 cm of soil level was 3.1 mm. Each planted cutting had five leaves. The media was kept moist but not saturated under mist for 10–15 s every 6 min over a 5-week period.

### 2.3. Harvest and analysis

Shoot cuttings were removed from plastic tubes 5 weeks after planting and adventitious rooting (% cuttings with roots, no. roots/cutting, and total root length/cutting) and number of leaves retained per cutting were measured. The experiment was a completely randomized design with three replications and 10 subsamples (cuttings) per replication. Following analysis of variance, means were separated by the lsmeans, pdiff procedure of SAS (2001). Cuttings were taken on 17 October 2005 and again on 10 August 2006.

## 3. Results and discussion

In August, the percent shoots that rooted were greater in cuttings from Pillar than Compact (79% vs. 13% at 250 mg L<sup>-1</sup> and 45% vs. 3% at the 1250 mg L<sup>-1</sup>, respectively) (Fig. 1). Compared with Compact trees, cuttings from Standard trees had higher rooting at 250 mg L<sup>-1</sup> (56% rooting) and the same rooting at 1250 mg L<sup>-1</sup> (6% rooting). Little or no rooting was observed at the 0 and 2500 mg L<sup>-1</sup> IBA concentrations. Rooted cuttings from Pillar growth habits had, on average, nine roots per cutting that were 81 cm in total length compared to Standard cuttings with three roots that were 25 cm in total length and Compact cuttings had two roots that were 17 cm in total length (Table 1). Several researchers obtained rooting in peach cuttings by applying IBA in concentrations from 500 to 2500 mg L<sup>-1</sup> (Testolin et al., 1988; de Oliveira et al., 2003; Tsipouridis et al., 2003, 2005). In this experiment, rooting declined at 1250–2500 mg L<sup>-1</sup> (Fig. 1). This may be associated with the IBA being applied as a 60 s dip in our experiment compared with shorter duration applications in other experiments.

Previously, we reported that endogenous auxin was higher and cytokinin was lower in Pillar than Standard shoots (Tworkoski et al., 2006). It has been reported that higher endogenous auxin concentrations improve rooting (Haissig, 1970; Eliasson and Areblad, 1984; Guerrero et al., 1999) but applications of cytokinin inhibit rooting (Drewes and Van Staden, 1989). Higher endogenous auxin and lower cytokinin concentrations may have enabled greater rooting in cuttings from Pillar trees. Cytokinin concentrations were found to be elevated in Compact compared with Pillar trees (Tworkoski, unpublished data). Cuttings from Compact growth habits retained five leaves per cutting compared with two leaves for Pillar and one leaf for Standard growth habits (Table 1). High cytokinin and sugar concentrations have been related to leaf retention in peach cuttings (Gur et al., 1986). It is possible that higher cytokinin levels in Compact shoot cuttings may have contributed to leaf retention and also to reduce rooting (Fig. 1 and Table 1).

Rooting success in peach cuttings is affected by date of collection of cuttings (Testolin et al., 1988). No rooting

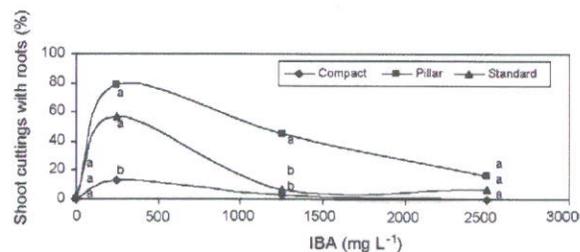


Fig. 1. Rooting response of shoot cuttings collected from three growth habits on 10 August 2006, dipped in one of four IBA concentrations, and maintained for 5 weeks under intermittent mist in a greenhouse. Effects of growth habit, IBA, and growth habit-by-IBA interactions were all significant at the 99% level of confidence. Within each IBA concentration, averages followed by the same letter do not differ at the 95% level of confidence.

Table 1

Analysis of rooting response of shoot cuttings collected from three growth habits on 10 August 2006, dipped in one of four IBA concentrations, and maintained for 5 weeks under intermittent mist in a greenhouse

Main effect	Roots/ cutting (no.)	Root length/ cutting (cm)	Leaves/cutting after 5 weeks (no.)
Growth habit (GH)			
Compact	2 b	17 b	5 a
Pillar	9 a	81 a	2 b
Standard	3 b	25 b	1 b
<i>P</i> > <i>F</i>			
GH	0.03	0.04	0.01
IBA	0.77	0.50	0.01
GH × IBA	0.31	0.60	0.91

Within each column, means followed by the same letter do not differ at the 95% level of confidence.

occurred on the cuttings that were collected in October (data not shown), but cuttings collected in August rooted. It is possible that greater rooting could have been obtained by taking cuttings earlier in the growing season. We have found that endogenous IAA levels decline in peach stems after 104 days following bud break (Tworkoski et al., 2006). We suggest that the changes in rooting capacity may be linked, at least in part, to endogenous IAA and that cuttings should be taken in peach, and possibly in other species, before significant decline occur. The rate of IAA decline may differ between cultivars.

#### 4. Conclusion

The current experiment focused on differences among representative peach genotypes of growth habits in their capacity to produce roots. A clear difference in rooting was measured and this difference can be explained, in part, based on differences in endogenous hormones that were measured previously. However, the results do not characterize the optimum conditions for date of collection, size of cutting, state of shoot hardening, or IBA concentration. These parameters and potential interactive effects that may be related with endogenous hormones in populations of peach growth habits must be determined in future work. The current experiment indicates that adventitious rooting varies among peach genotypes with different growth habits and possibly other fruit trees, and this variability may, in part, be due to differences in endogenous hormone levels.

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#### References

- Cambra, R., 1990. 'Adafuel', an almond × peach hybrid rootstock. *HortScience* 25, 584.
- Couvillon, G.A., 1985. Propagation and performance of inexpensive peach trees from cuttings for high density peach plantings. *Acta Horticulturae* 173, 271–282.
- de Oliveira, A.P., Nienow, A., y Calvete, A., de Oliveira, E., 2003. Rooting potential capacity of peach tree cultivars of semi-hardwood and hardwood cuttings treated with IBA. *Rev. Bras. Frutic.* 25, 282–285.
- Drewes, F.E., Van Staden, J., 1989. The effect of 6-benzyladenine derivatives on the rooting of *Phaseolus vulgaris* L. primary leaf cuttings. *Plant Growth Regul.* 8, 289–296.
- Eliasson, L., Areblad, K., 1984. Auxin effects on rooting in pea cuttings. *Physiologia Plantarum* 61, 293–297.
- Guerrero, J.R., Garrido, G., Acosta, M., Sanchez-Bravo, J., 1999. Influence of 2,3,5-triiodobenzoic acid and 1-*N*-naphthylphthalamic acid on indoleacetic acid transport in carnation cuttings: relationship with rooting. *J. Plant Growth Regul.* 18, 183–190.
- Gur, A., Altman, A., Stern, R., Wolowitz, B., 1986. Improving rooting and survival of softwood peach cuttings. *Scientia Horticulturae* 30, 97–108.
- Haissig, B.E., 1970. Influence of indole-3-acetic acid on adventitious root primordia of brittle willow. *Planta* 95, 27–35.
- Pfeiffer, D.G., 1998. Bulletin coordinator. In: Virginia-West Virginia-Maryland Commercial Tree Fruit Spray Bulletin, Virginia Coop. Ext. Publ., pp. 456–419.
- SAS, 2001. Users Guide Statistics Vers. 8. 02. SAS Institution, Cary, NC.
- Scorza, R., Lightner, G.W., Liverani, A., 1989. The pillar peach tree and growth habit analysis of compact × pillar progeny. *J. Am. Soc. Hortic. Sci.* 114, 991–995.
- Scorza, R., Zailong, L., Lightner, G.W., Gilreath, L.E., 1986. Dry matter distribution and responses to pruning within a population of standard, semi-dwarf, compact, and dwarf peach [*Prunus persica* (L.) Batsch] seedlings. *J. Am. Soc. Hortic. Sci.* 111, 541–545.
- Testolin, R., Avanzato, D., Couvillon, G.A., 1988. Rooting peach by mallet cuttings. *Acta Horticulturae* 227, 224–229.
- Tsipouridis, C., Thomidis, T., Bladenopoulou, S., 2006. Seasonal variation in sprouting of GF677 peach 'almond (*Prunus persica* × *Prunus aygdalus*) hybrid root cuttings. *N.Z. J. Crop Hortic. Sci.* 34, 45–50.
- Tsipouridis, C., Thomidis, T., Isaakidis, A., 2003. Rooting of peach hardwood and semi-hardwood cuttings. *Aust. J. Exp. Agric.* 43, 1363–1368.
- Tsipouridis, C., Thomidis, T., Michailides, Z., 2005. Influence of some external factors on the rooting of GF677, peach and nectarine shoot hardwood cuttings. *Aust. J. Exp. Agric.* 45, 107–113.
- Tworkoski, T., Scorza, R., 2001. Root and shoot characteristics of peach trees with different growth habits. *J. Am. Soc. Hortic. Sci.* 126, 785–790.
- Tworkoski, T., Miller, S., Scorza, R., 2006. Relationship of pruning and growth morphology with hormone ratios in shoots of pillar and standard peach trees. *J. Plant Growth Regul.* 25, 145–155.