Science Arena Publications
Specialty Journal of Agricultural Sciences
ISSN: 2412-737X
Available online at www.sciarena.com
2019, Vol 5 (1): 25-33

Effect of Auxin Treatments on the Striking of Vegetative Pear Rootstocks Using Trench Layering and Cutting Methods

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Abstract: *Pear producers are in search for earlier returns on their capital, a goal which is readily achieved with the cultivation of pear orchards in densely populated gardens. To investigate the effect of auxin treatments on the striking of vegetative pear rootstocks using methods of cutting and trench layering, a completely randomized experiment with three replications was conducted at the Agricultural College, University of Ilam in 2016. For the striking of the cuttings, hormonal treatments including Indole Butyric Acid hormones at 4 levels of zero (as the control treatment), 10, 100 and 500 mg/lit were employed. As for the methodology, the ends of the cuttings were placed in each of the hormonal treatments for 15 minutes. For the cultivation of cuttings, cocopeat and sand were mixed and used with a ratio of 1 to 2. The seedbed was disinfected in an autoclave for 30 minutes at a temperature of 120 ° C. The variables studied in this study included root length, root count, rooting percentage, and changes in root length. The results showed that the effect of the propagation method and the levels of auxin hormone were significant at 1% p-value on rooting percentage, frequency and root length. Still, regarding the variable of changes in the length of the branch, only hormone levels proved statistically significant. The results showed that the level of 100 mg/L of hormone is the optimal dose for using on rootstocks. Also, as for the type of propagation method, trench layering yielded better results than cuttings.*

Keywords: Indole Butyric Acid, Vegetative, Rootstocks, Trench Layering, Cuttings, Pear

INTRODUCTION

Pear is one the most important fruits in the temperate regions including Iran. It belongs to the family of Rosaceae and sub-family of Pomoideae (Vatandoost et al., 2011). The taste, scent and digestibility of pear fruit has made it very popular among different consumers (Bakhtiari et al., 2016). Pear producers all over the globe are in search for earlier returns on their capital and lowering labor costs, a goal which is readily achieved with the cultivation of pear orchards in densely populated gardens. For creating denser gardens, orchards and shrubs are of utmost importance. Various details on the interaction between the base and the scion have been reported. Such associations are significant in terms of gardening point of view. Having more than 10 genus of pear, Iran is considered as one the most diverse genetic pools. The species cultivated in pear-cultivatable areas of Iran include native cultivars of Concorde, Forelle, Seckel, Bosc, Bartlett, Sabri, Anjou, Beirut, Ghoschi, and Palestine Pear among others, the variation of which has changed significantly in recent years. (Abdullahi, 2015). As most pear-cultivable regions of Iran bear alkaline soils, pear production in Iran is faced with even more challenges. Symptoms of irregularities observed in various saplings include barque discontinuity and cambium disorders and accumulation of starch in the grafting site (Davari-Nezhad et al., 2007), which leads to a delay in the tree's fruiting. In addition, due to the general weakness of the tree, the resulting fruits are not of pleasant quality. The use of other asexual reproduction methods that lead to the production of saplings from the rootstocks can be a proper solution to aforementioned challenges. The major methods that lead to the production of their self-rooted trees are cutting, layering and tissue culture. In scientific literature, it has been proven that the self-rooted saplings are far healthier than the grafted trees and yield better fruits (Steffens et al., 1993).

The only mentionable downside to these trees is their high vegetative growth rate, which is likely to be less than those on the seedling base. Despite the fact that cuttings are one of the most convenient and cost-effective methods for propagating fruit trees, no significant achievement have been reported on the pear tree. In general, the increase in the number of soft and semi-hardwood cuttings has not yet resulted in much success in pears. Propagation through soft wood cuttings has been carried out with little success in the case of Old Home rootstock and Polish Quince, and hence this method has yet to withhold any economic justification at commercial level. Moreover, root cuttings have also had little to no success (Hansen and Eggers, 1951). Several studies have been conducted on the pear tree vegetation. For example, Ermel et al. (1999) showed that newly planted pear trees have the highest rooting rates in cuttings. Davari-Nezhad and colleagues (2007) showed that the length and duration of cuttings and, callus induction temperature, hormone concentrations used and the duration of cuttings being soaked therein, as well as the temperature of the rooting medium are among the factors influencing the rooting of pear cuttings. Reed et al. (1998) argued that hormonal theory suggests that branch growth is the result of hormones produced by the root and root growth is influenced by hormones produced by the branch. In another study, the influence of type and concentration of cytokinin along with pectin on the conference pear cultivar was studied and it was shown that 0.5% of pectin increased the number and survival of micro-shoots and their leaf development in various pear cultivars (Nourmohammadi et al., 2015). Nosrati (2010) did not notice any significant differences between imported and indigenous cultivars in terms of stem length and rooting when comparing the growth rate of three indigenous pear cultivars namely Dargazi, Shahi fruit and Tashkandy genotypes and six imported Pearl cultivars. In his research, Pyrodwarf imported cultivar had the highest increase in stem length and rooting percentage.

Materials and Methods

Preparation of plant samples

The required plant samples from this research were collected from the Agricultural Garden of the College of Agriculture, University of Ilam. Grafted pear trees on seedling base as parent plant were used to provide the cuttings. To this end, five healthy trees in almost identical circumstances from each cultivar were selected in different areas of the garden. Samples were taken from branches with approximate diameter of 0.7 cm from the outer parts of the crown. In preparing cuttings, sugary pear cultivars samples from march 2016 were collected. After transferring the species to the greenhouse, preliminary cleansing and disinfecting of the branches was carried out with Captain Fungicide at a concentration of 2 mg / l. From each branch, cuttings of twigs and stems with length of 17 to 20 cm and three to four buds were collected. 3% sodium hypochlorite solution was used for 15 minutes to disinfect the samples.

Preparation the cutting culture bed

For cultivating the cuttings, coco peat and sand were used in a ratio of 1 to 2. The culture bed was disinfected for an hour in autoclave at a temperature of 120 °C for 30 minutes.

Rooting treatments in cuttings

To strike the cuttings, hormonal treatments including indole butyric acid hormones in 4 levels of zero as control, 10, 100 and 500 mg / lit were employed. As for the methodology, the ends of the prepared cuttings were placed in each of the hormonal treatments for 15 minutes and then were cultivated in the pots, such that about the 2/3 of the cuttings were buried in the bed. Trench layering was carried out similarly. The difference between cutting and trench layering was only in the manner of connection with the parent plant. The remaining circumstances were identical for both methods.

Requirements for keeping the cuttings

This research was carried out at the Research Greenhouse of the Faculty of Agriculture, University of Ilam. The greenhouse temperature was about 20-25 ° C while its relative humidity was adjusted to about 70% using temperature and humidity sensor. irrigation was carried out daily and manually. samples were set in sufficient light and were kept away from direct sunlight.

The experimental design and the variables examined

This experiment was carried out in a factorial completely randomized design with three iterations. The variables studied in this research included root length, root number, rooting percentage, and branch length increase. The results of the study were analyzed using SAS and Excel software. The averages were compared with Duncan's method at a probability level of 5%. Samples were taken out of the pot after 45 days and the variables were then measured.

Results and Discussion

Rooting percentage

The results from the table of analysis of variance (Table 1) indicate that the effect of repetition on root percentage is significant at 0.05 significance level. The effect of vegetative rootstock propagation, the levels of indole butyric acid hormones, as well as the mutual effect of these two factors is significant on rooting percent at 0.01 p-value level; in other words, it can be stated with a 99% CI of that the type of vegetative rootstock propagation and hormone levels, along with the interaction of these two, positively influence the rooting percentage in the pear rootstock. According to the average values calculated for each treatment (Tables 2 and 3), the highest percentage of rooting is witnessed in trench layering (43.91%), which has a statistically significant difference with that of the cutting method. Also, among the various treatments of indole butyric acid hormones, the highest rooting percentage was witnessed in the 100 mg / l hormone treatment (79.5%), while the lowest rooting percentage was obtained in control treatment (10.5%). As for the highest percentage of rooting in mutual effect of treatments (Figure 1), the highest and lowest percentage of rooting were respectively related to treatments of trench layering in 100 mg / L of indole butyric acid hormones with a staggering 84.33% and cutting in control levels of hormone, with 33.31%. Based on the obtained values, it can be stated that the effect of auxin hormone on rooting percentage of pear rootstock is far more significant than that of the propagation method. Safarnejad and colleagues (2016) showed that by increasing the rooting hormones to an optimal level, the percentage of rooting increases, then decreases. Vatan Doost et al. (2011) reported similar results. MacDonald (2000) has also reported on the better effect of the type of auxin used in this study on hard rootstocks than other types of auxin.

Table 1. Analysis of variance of traits

Source of Variation	Degree of Freedom	Average of squares			
		Rooting Percentage	Root Count	Root length	Branch length
Replication	2	14.29*	3.1 ns	65.2**	0.006 ns
Propagation Type	2	73.5**	26.04**	737**	0.02 ns
Hormone Level	4	4884**	550**	31427**	3.07**
Mutual effect of Propagation type and Hormone Level	3	27.27**	1.04 ns	162**	0.1 ns
Error	14	2.81	1.92	4.19	0.03
Variation Coefficient		3.97	9.71	1.68	6.7
ns not significant; * 0.05 p-value; ** 0.01 p-value					

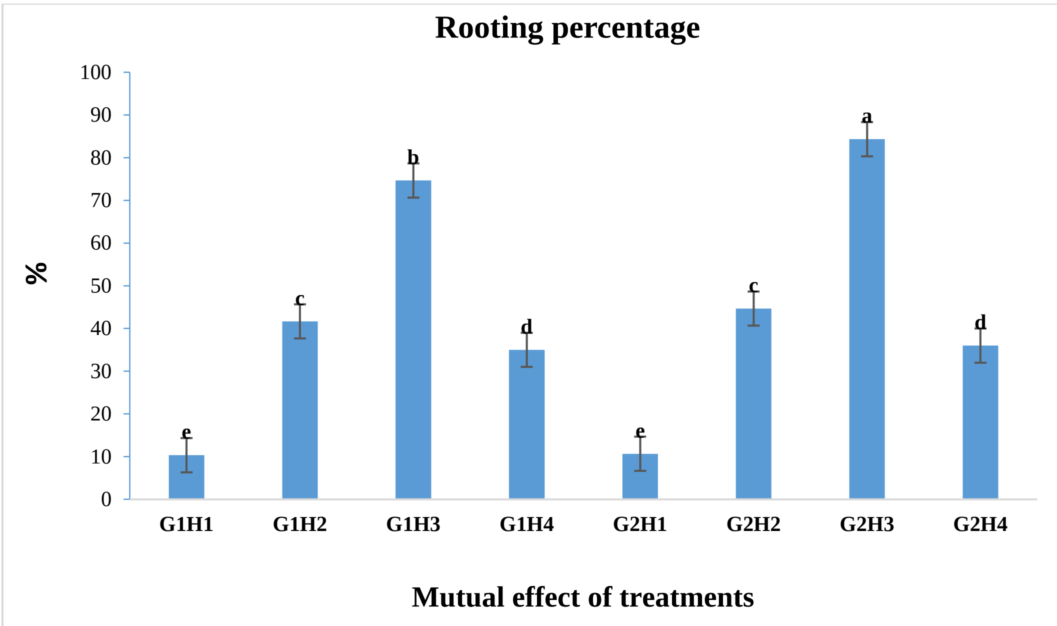

Figure 1. Diagram of rooting percentage changes in the interaction effects of treatments

Root number

The results of the analysis of variance (Table 1) demonstrate that the effect of repetition has no significant effect the root number. However, the effect of type of propagation of vegetative rootstocks and indole butyric acid hormone levels is significant at 1% probability level, yet the interaction of these two factors on the root number is not significant. As a result, it can be stated with a 99% CI that the type of propagation and hormone levels influence the number of roots in the pear rootstock. Considering the mean values calculated for each treatment (Tables 2 and 3), it is safe to say that the highest number of roots was observed in trench layering (n=15), which has a significant different with that of the cutting method. Furthermore, the highest number of roots was obtained during the application of 100 mg/L indole butyric acid (n=26.5). The lowest root number was also obtained in control treatment (n=5). As for the highest number of roots in the interactions of the treatments (Figure 2), the highest and lowest root numbers were respectively related to the treatments of trench layering in 100 mg / L of indole butyric acid hormone (n=28) and cutting in control hormone (n=4.33). Considering the obtained values, it can be stated that the effect of auxin hormone on the number of vegetative rootstocks of pear is far more pronounced than that of propagation. Likewise, increasing the concentration of hormone, first, increases the number of roots while decreases it after that, which is due to inactivity of the root in high concentrations and phenomena such as osmotic pressure. These results are consistent with those of Khodaei et al. (2011), who have also suggested the use of auxin hormone to increase the amount of root in pear. Also, Modares et al. (2012) also advocate the use of auxin hormone in increasing the number of roots in the plant. The results of this research are also in line with the results of Safarnejad and his colleagues (2016) and Vatan Doost et al. (2011).

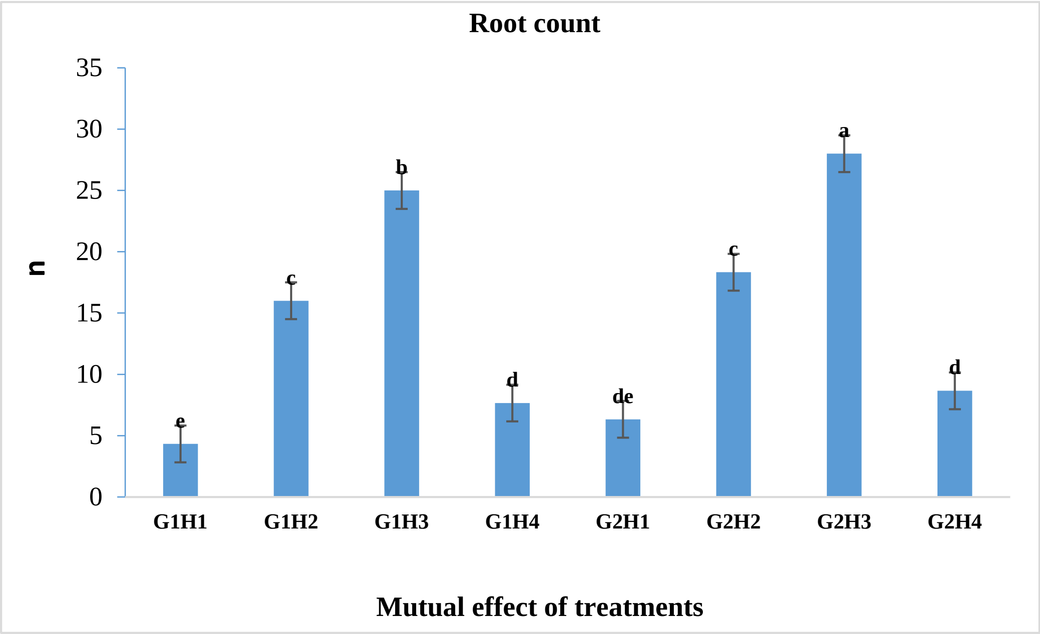

Figure 2. Diagram of Root Number Changes in Mutual Effects of Treatments

Root Length

The results of the analysis of variance (Table 1) indicate that the effect of replication, the type of propagation of vegetative rootstock and the levels of indole butyric acid hormones, as well as the interaction of these two factors is statistically significant on root length at 1% probability level. In other words, it can be concluded with a confidence level of 99% that the type of vegetative rootstock propagation and hormone levels influences root length in pear rootstocks. According to the mean values calculated for each treatment (Tables 2 and 3), it can be established that the maximum root length in trench layering is 127.3 cm, which is, statistically speaking, significantly different with that in cutting method. As for the cuttings method, the root length was 116.5 cm. Also, the highest root length, 192.3 cm, was obtained in 100 mg/L of indole butyric acid hormone treatment. The lowest number of roots was witnessed in control treatment with the length of 23.3 cm. Regarding the highest number of roots in the interaction of treatments (Fig. 3), the highest and lowest root lengths were respectively related to 100 mg/L indole butyric acid hormones with a length of 199.3 cm, and the treatment of trench layering in control hormone with a meagre length of 22 cm. Given the mathematical results, it can be stated that the impact of auxin hormone on the root length of the pear rootstock is far more pronounced than that of the propagation method. Moreover, increasing the concentration of hormone increases the root length initially, while decreases the aforementioned index thereafter. The results of this research are consistent with Karami et al. (2013), Safarnezhad et al. (2016) and Vatan-Doust et al. (2011).

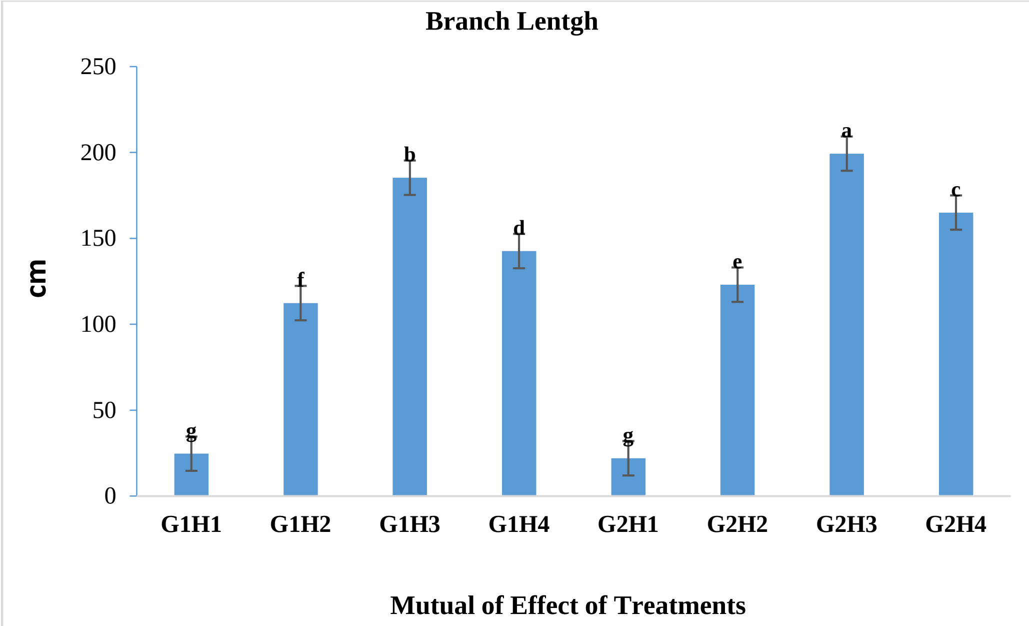

Figure 3. Diagram of Root Length Changes in Mutual Interaction Effects of Treatments

Branch length Increase

The results of the analysis of variance (Table 1) reveal that the effect of propagation and the effect of plant propagation type on the increase of branch length is not significant, but the levels of indole butyric acid hormones are significant at 1% probability level. Moreover, the mutual interaction of these two factors have no significant effect on the increase of branch length; in other words, with 99% confidence interval, it can be said that the levels of hormone increase the branch length on pear vegetative rootstocks. Bearing in mind the average means calculated for each treatment (Tables 2 and 3), it can be concluded that the highest value for increase of branch length in trench layering was 2.65 cm, which is not statistically different with that of cutting, a slightly less value of 2.59 cm. Furthermore, among the treatment of indole butyric acid hormones, the highest increase in branch length was obtained with a dose of 100 mg/L of this hormone with a value of 48.3 cm, while the lowest number of roots was obtained in control treatment (0 mg/L) with 1.73 cm. There were no significant differences between treatments of 10 mg/L and 500 mg/L. The highest number of roots in the interaction of treatments (Fig. 4), the highest growths in branch length were associated with trench layering and shooting in 100 mg / L of Indole Butyric acid hormones with lengths of 3.5 cm and 3.46 cm respectively, while the lowest growth in branch length was obtained for cutting treatment in control dosage. Considering the obtained values, it can be stated that the effect of auxin hormone on the increase of the branch length is far more pronounced than that of the propagation method, and also, by increasing the concentration of hormone, first the length of this variable maximizes and then decreases.

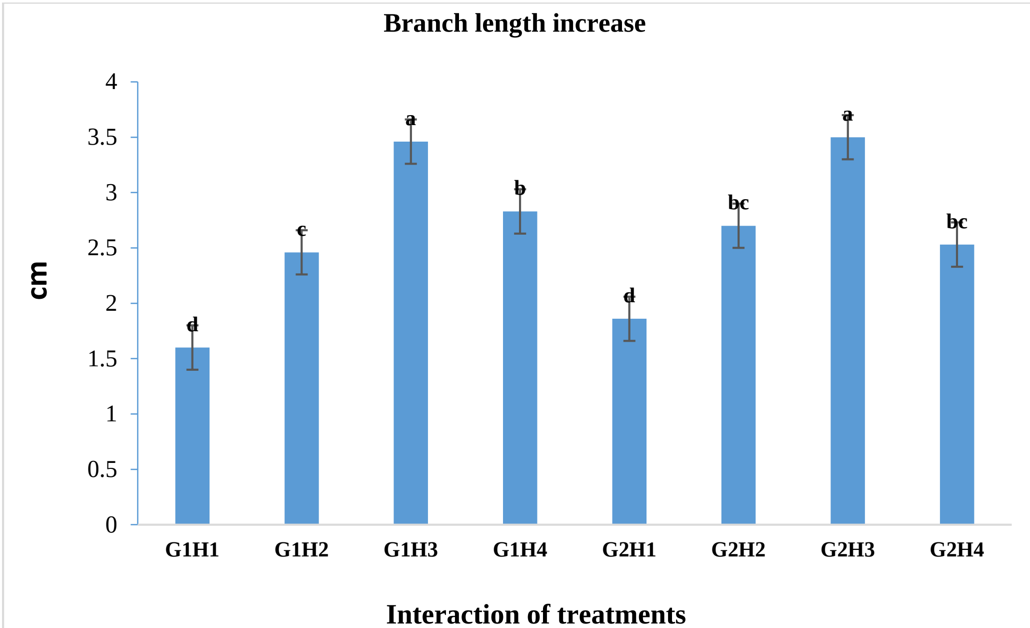

Figure 4: diagram of branch length increase changes in the interaction effects of treatments

Table 2. Comparison of mean values of traits in propagation type treatment

Type of propagation of the vegetative rootstock	Mean value			
	Rooting percentage	Root number (n)	Root length (cm)	Branch length increase (cm)
Trench Layering	43.91	15.3	127.3	2.65
Cutting	40.41	13.25	116.25	2.59
a , b significant under Duncan Multi-domain test				

Table 3: Comparison of mean values of traits in Indole Butyric Acid hormone levels

Indole Butyric Acid Hormone Treatment (mg / L)	Mean value			
	Rooting percentage	Root number (n)	Root length (cm)	Branch length increase (cm)
Control	10.5	5.3	22.3	1.73
10	43.16	17.16	117.66	2.58
100	79.5	26.5	192.3	3.48
600	35.5	8.16	153.83	2.58
a , b significant under Duncan Multi-domain test				

Correlation Between Treats

The correlation between traits can be either negative or positive. A positive correlation indicates that the higher the value of the trait, the higher the value of the correlating trait, while a negative correlation means that with the increase of a trait, the value for the other trait is decreased. It can be seen from the table that all the correlations are positive at a significance level of 1%. The highest correlation was observed between number of roots and rooting percentage

Table 4: Correlation table between traits

Correlation				
	Rooting percentage	Root number	Root length	Root length increase
Rooting percentage	1	0.942**	0.889**	0.931**
Root number	0.942**	1	0.732**	0.831**
Root length	0.889**	0.732**	1	0.912**
Root length increase	0.931**	0.831**	0.912**	1
**. Correlation is significant at the 0.01 level (2-tailed).				

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