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Effect of Naphthalene Acetic Acid Treatment on The Prevention of Trunk Sprout Formation in Plum (cv. Black Amber)

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Abstract: Trunk sprouts are removed from plants due to the long juvenile period and lengthy internodes. In addition, pruning costs are increased significantly, especially in the form of bush cultivation. In this study, the effects of naphthalene acetic acid (NAA) treatments at different levels on trunk sprout formation was investigated in 'Black Amber' plum cultivar were investigated in 2015 and 2016 years. As a result of the study, it was determined that NAA application had a preventive effect on the formation of trunk sprout. However, no difference was detected between NAA application doses. Analyzing the averages of two-year data, the number of trunk sprout per plant was approximately 9 in the control group while this value decreased to 2 in the NAA application groups. High NAA doses led to blighted branches and gummosis in the second year. As a result, biennial low NAA dose applications, have been found promising in terms of decreasing the trunk sprout formation.

Keywords: Auxin, branching, gummosis

Erikte (cv. Black Amber) Naftalen Asetik Asit Uygulamasının Gövde Sürgünü oluşumunu Engelleme Üzerine Etkisi

Özet: Gövde sürgünleri boğum aralarının uzun ve gençlik kısırlığının uzun olması sebepleriyle, ticari meyve yetiştiriciliğinde mecbur kalınmadıkça bitkilerden uzaklaştırılmaktadır. Ayrıca özellikle ocak şeklinde yetiştiriciliği yapılan türlerde, budama maliyetlerinin ciddi oranda artmasına sebep olmaktadır. Bu çalışmada, birbirini takip eden 2015 ve 2016 yıllarında, farklı seviyelerde naftalen asetik asit (NAA) uygulamalarının, 'Black Amber' erik çeşidinde, dip sürgünü oluşumu üzerine olan etkileri incelenmiştir. Çalışma sonucunda, NAA uygulamasının dip sürgünü oluşumunu engelleyici etkide bulunduğu tespit edilmiştir. Ancak dozlar arasında herhangi bir farklılık tespit edilmemiştir. İki yıllık verilerin ortalamaları incelendiğinde, kontrol grubunda bitki başına düşen gövde sürgünü sayısı 9 iken, NAA uygulanan gruplarda bu değer 2'ye kadar düşmüştür. Yüksek dozda uygulanan NAA, çalışmanın ikinci yılında, dal yanıklıkları ve gummosise sebep olmuştur. Sonuç olarak, düşük dozda NAA uygulamasının iki yılda bir uygulanması, dip sürgünü oluşumunun azaltılması bakımından ümitvar bulunmuştur.

Anahtar kelimeler: Oksin, dallanma, gummosis

Introduction

Plum is cultivated almost in every region in Turkey except uplands of East Anatolia that have long winter with cold climate and South East Anatolia's hot and arid regions. Due to the rich ecological conditions of Turkey, plum could be supplied to the consumers freshly for 6-7 months. In April, plum harvest begins with *Prunus cerasifera* L. species as early ripening in the Mediterranean region and continues at the uplands and high altitude regions with late ripening varieties of *Prunus salicina* L. and *Prunus domestica* L. groups until October. According to FAO (2017), 11.758.135 tonnes of plum fruit were produced from 2.619.471 hectare areas in the world. Turkey provided 2.5 % of world plum production with 291.934 tones and ranks as 6th in the world.

In modern fruit cultivation, the fact that the trees reach yield age as early as possible and the long yield periods are important for a profitable of cultivation. Therefore, cultivation should be planned and carried out accordingly from onset of the cultivation process.

In fruit cultivation, giving the desired crown shape to the trees is possible by removing the unwanted branches from the plant (Macit et al., 2017). Accordingly, unnecessary branches and trunk sprouts on the plant should be removed. Although trunk sprouts considerably absorb the nutrients for plants, they should not be left on the plant as much as possible due to long juvenile period and lengthy internodes. Since trunk sprouts develop quickly, if the pruning is delayed or not done, it becomes difficult to remove them. Especially, in the species that are cultivated by bush cultivation methods, trunk sprout elimination constitutes a significant amount of labor, economic cost and time loss. Harvesting becomes difficult and harvest loss increases. Quality loss can be seen as well as yield loss (Salama and Elsherbeny, 2016). Also, mechanical injuries caused by pruning lead to the formation of areas where primary and secondary infections can easily penetrate (Tucker and Talbot, 2001). The control of vegetative growth in plants can be achieved by the use of chemicals and prohexadium calcium, alar, cycocel, ethephon, Trinexapac-ethyl, paclobutrazol are the chemicals commonly used accordingly (Kumar and Sharma, 2016; Cline and Bakker, 2016; Atay and Koyuncu, 2017; Raja et al., 2018; Pakkish et al., 2019).

Auxine is mainly produced in terminal buds and carried basipetally. It suppresses other shoots during transport and prevents them from shooting (Barbier et al., 2017; Luo et al., 2018). In this study, the effects of auxine group hormone NAA, which has important physiological effects on the shoot formation in plants, on trunk sprout formation was investigated using different levels of naphthalene acetic acid.

Material and Method

'Black Amber' plum cultivar (*Prunus salicina* Lindell), was used as the material. The plants were planted in 2011 after grafting onto seedling rootstocks.

Stock solution of naphthalene acetic acid was prepared with ethanol. Ethanol-distilled water solution (1/1) was used for the preparation of final concentrations (1000 ppm, 2000 ppm, 3000 ppm and 4000 ppm). Solutions were sprayed to trunk (from ground level to the first section of branching) of plants using a knapsack pulverizator on the 1st of March when the daylight temperature reached approximately 8-10 ºC (Dolci et al., 2004a; Dolci et al., 2004b).

The experimental area has a typical continental climate with cold-moist winter and hot-dry summer. The weather was warmer than long-term average during the experimental periods in both years. The first year was carried out under cooler climatic conditions and the number of frosty days were higher in February, March and April when the bud burst, blooming and shooting periods were seen (Table 1).

The study was carried out between 2015 and 2016 with three replications. In the statistical model of the study, years and naphthalene acetic acid were regarded as independent factors. The SPSS 18 (SPSS 18 Inc.,) statistical package program was used in the statistical analyses of the effects of the treatments on the investigated property. Before the application of the ANOVA, normal distribution of data and homogeneity of variance were examined. The differences between the levels and interactions of the factors were revealed using the Duncan multiple comparison test at a significance level of 5 % (Duzgunes et al., 1987).

Table 1. Climatic conditions for the related months in Eskisehir in 2015 and 2016
Çizelge 1. 2015 ve 2016 yıllarında deneme dönemini kapsayan aylara ait iklimsel veriler

	Number of Frosty Days	Mean weather Temperature (°C)	Mean Monthly 50 cm soil temperature (°C)	Total Rainfall (mm)	Mean Humidity (%)
2015					
February		2,7		44,8	77,8
March	10	5.7	7.3	38.9	78.6
April	13	7.8	9.8	26.6	68.2
May	0	15.8	17.1	47.8	68.1
June	0	17.1	18.2	151.1	81.0
July	0	22.0	21.3	0	63.3
August	0	22.8	22.9	37.2	66.1
September	0	21.0	22.6	3.1	64.9
2016					
February		6,6		33,6	76,3
March	9	7.5	8.6	41.2	70.3
April	2	12.9	12.4	36.7	64.5
May	0	14.1	15.6	44.7	74.2
June	0	21.0	21.0	6.3	62.1
July	0	22.8	24.5	14.5	58.3
August	0	22.8	24.2	27.7	66.0
September	0	17.8	21.1	31.7	64.9

Long term average temperature (1970-2011) (°C): February (0,9); March (4,9); April (9,6); May (14,9); June (19,1); July (22,1); August (21,8); September (16,7)

Results and Discussion

The effects of naphthalene acetic acid on the formation of the trunk sprout is given in Table 2. It is found that, NAA application significantly reduced the occurrence of trunk sprout. However, no statistically significant difference was found between the different NAA levels applied.

Table 2. The effects of different NAA dose applications on the number of trunk sprout
Çizelge 2. Farklı seviyelerde NAA uygulamalarının gövde sürgün sayısı üzerine etkileri

	First year (2015)	Second year (2016)	Mean of treatments±SE
Control	12.33±2.03	6.33±2.03	9.33±1.86^{b}
1000 ppm	2.33±0.67	2.00±1.00	2.17±0.54^{a}
2000 ppm	2.67±1.76	1.00±1.00	1.83±0.98^{a}
3000 ppm	4.00±1.53	0.67±0.33	2.33±1.02^{a}
4000 ppm	1.67±1.20	1.33±1.33	1.50±0.81^{a}
Mean of years±SE	4.60±1.20^{b}	2.27±0.73^{a}	

In addition to the systemic transmission, auxin passes long distance by moving from one cell to another (Zhang et al., 2018). In both cases, auxin limits vegetative development of plants by preventing lateral bud burst (Barbier et al., 2017). Examining the averages of two-year data, the number of trunk sprout per plant was approximately 9 in the control while this value decreased to 2 in the NAA applied groups (Table 2). NAA applications were reported to reduce the number of trunk sprout in grapevine, pomegranate, hazelnut, avocado and peach species (Dolci et al., 2004a; Dolci et al., 2004b; Fare et al., 2005; Arpaia et al., 2007; Salama and Elsherbeny, 2016). Growth differences between auxin-mutant and normal plants revealed that auxin has important effects on trunk sprout and plant growth (Li et al., 2016; Luo et al., 2018).

No difference was observed between the applied NAA doses (Table 2). The fact that the lowest NAA concentration applied was high might have yielded statistically not significant results. No significant differences were found between the high doses of NAA applications in terms of trunk sprouts presence (Keever et al., 1998). Also, in second year there were blight and gummosis in plants due to high doses (3000 ppm and 4000 ppm) of NAA application (Figure 1). It has been reported that high doses of auxin caused damage to plant tissues (Trueman, 2018). Some auxins are used as herbicide at high doses (Epp et al., 2016).

A (Control) B (1000 ppm NAA)

C (2000 ppm NAA) D (4000 ppm NAA)

Figure 1. Trunk sprouts in control and NAA applications (A, B, C) and physical damage of high NAA application (D)

Şekil 1. Kontrol ve NAA uygulanan bitkilerde gövde sürgünleri (A, B, C) ve yüksek doz NAA uygulanan bitkilerde fiziksel zararlanma (D)

Experiment was carried out in 2015 and 2016 consecutively. The difference between the years in terms of sprout number per plant was found to be significant. In the first year, number of the trunk sprout per plant was 4.6, while it was 2.27 in the second year (Table 2). In all groups, the number of trunk sprouts decreased in the second year. This decrease might be caused by the reduction in bud development after the application of NAA. The excess of auxin causes senescence by increasing ethylene biosynthesis (El-Sharkawy et al., 2016; Farcuh., 2019). However, the decrease in sprout number in control where no application was made, showed that different conditions were also effective, such as late spring frost. There were more frosty days in 2015. In addition, high humidity triggered the cold damage during this period (Table 1). So, there was a strong vegetative development in 2015. The presence and management of buds is one of the important factors affecting plant growth (Macit et al., 2017). Vegetative development was reported to increase as a result of the decrease in generative development (Richardson et al., 2018). The decrease in the number of trunk sprout allows to increase in assimilate content in plants. Thus, fruit branches develop stronger and this increases the yield per plant (Salama and Elserbeny, 2016). Increase in leaf area and number occurs in parallel with the increase in assimilate content (Rimpika et al., 2017). Increase in leaf/fruit ratio yields in heavier fruits on plants (Sebek, 2016). Also, with the reduction of trunk sprout number, light and air into the plant becomes easier and more. This means an increase in disease control and yield efficiency.

Conclusion

As a result, biennial low NAA dose applications, have been found promising in terms of decreasing the trunk sprout formation in Plum (cv. Black Amber). High NAA doses led to blighted branches and gummosis in the second year.

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