ACTA SCIENTIARUM POLONORUM *Acta Sci. Pol., Hortorum Cultus 11(4) 2012, 179-185*

THE EFFECTS OF AVG AND GA_3 TREATMENTS ON PISTILLATE (FEMALE) FLOWER ABORTION IN „SEBIN" WALNUT CULTIVAR

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Abstract. Pistillate flower abortion (PFA) in walnuts is defined as the drop of female flowers with or without pedicles within 10–15 days after flowering. This situation is commonly observed in some walnut cultivars causes dramatic yield losses. 'Şebin' is a popular walnut cultivar among farmers in Turkey due to the quality of its fruit, yield and ease of marketability. However, in some orchards, established with this cultivar, has a fruitlessness problem. In the present study, the effects of Aminoethoxyvinylglycine (AVG, the commercial brand name is ReTain) (0, 62.5 and 125 ppm doses) and AVG plus GA_3 (45, 135 and 270 ppm doses) treatments to prevent abortion in cv. 'Şebin' were investigated. The experiments were conducted in two different ecologies. The treatments were carried out just before the receptivity period of female flowers of cv. 'Şebin'. The results showed that, the female flower abortion ratio of 'Şebin' walnut cultivar were 87.78% in Tokat ecology and 77.78% in Niksar ecology. The fruit set ratio by 125 ppm AVG treatment was determined to be 60.89% for Niksar and 57.56% for Tokat ecological conditions. The highest fruit set was obtained from 125 ppm AVG combined 270 ppm GA_3 treatment and this ratio was determined to be 93.89% for Niksar ecological conditions whereas it was determined to be 83.33% for Tokat ecological conditions. As a result, it was found that AVG alone or in combination with GA_3 is effective treatments in reducing female flower abortion for 'Şebin' walnut cultivar.

Keywords: walnut, flower abortion, ethylene, gibberellic acid

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INTRODUCTION

Fruitlessness in walnut trees is becoming more common. The main reason is pistillate flower abortion (PFA) because of excess or lack of pollen in walnut trees [Hendricks et al. 1985; McGranahan et al. 1994; Polito et al. 1998; Lemus 2005]. Female flower abortion in walnut first time observed in 1970s on the walnut orchards in California, USA established with "Serr" cultivar and abortion ratio were observed up to 90%. The problem was further observed in 'Hartley" and "Chandler" walnut cultivars [Catlin et al. 1987; Catlin et al. 1990; Lemus 2005; González 2006] and in some the other genotypes as well [Por and Por 1990] though these were not as dramatic as that in "Serr". The results obtained from studies regarding the physiological, cultural, pathological and entomological factors that might causes abortion revealed that there are no direct relationships between these factors and abortion [Polito et al. 1998]. Previous studies on this topic showed that female flower abortion might be result of high pollen load [Por and Por 1990; McGranahan et al. 1994, Gonzales et al. 2008] and a yield increase was observed when the male flower catkins were taken away thus decreasing pollen load [Robert et al. 2008].

In walnut trees, female flower abortion occurs about 2–3 weeks after flowering. Polito et al [1998] found that over 85 dead or live pollens that come onto a stigma surface produce high amounts of ethylene and this causes an aging increase in plants thereby causing abortions. Studies regarding the chemical inhibition of ethylene synthesis due to high pollen load have started in 2003 with the use of Aminoethoxyvinylglycine, AVG (commercial brand ReTain) and it has been determined that as a result of the applications a significant decrease in female flower abortion and an increase in yield has been observed [Beede and Polito 2003; Beede and Grant 2006; Lemus et al. 2007; Beede et al. 2008].

Konze and Kwiatkowski [1981] reported the appearance of ACC-synthase and it's product ACC at the beginning of ethylene biosynthesis in plant tissue. They also showed that ACC-synthase, ACC-accumulation and ethylene formation were strongly inhibited by AVG.

Growth regulator hormones such as auxin, cytokinin and gibberellic acid are found in low levels in organs where abortion occurs in plants [Vivian-Smith and Koltunow 1999]. It has been observed that with the increase in the content of these hormones via external applications, flower and fruit drops decrease [Wertheim 1973]. Successful results have been obtained with gibberellins applications for the prevention of fruit drop in pears [Wertheim 1973], citrus [Ben-Cheikh et al. 1997] and roses [Kumar et al. 2008]. Applied auxins, ethylene and ABA all act as promoters whereas, cytokinins and GA_3 act as inhibitors in the climacteric ethylene production. Little attention has been given to the effect of the gibberellins. In all floral parts of carnation, endogenous levels of ACC were reduced with GA_3 treatment [Saks and Staden 1993].

Turkey is one of the leading walnut producing countries in the world with 185.000 tons annual fruit production [FAO 2011]. The country is also rich for walnut germplasm [Ercisli 2004]. "Şebin" is the one of the most common walnut cultivar used in orchards in Turkey due to its high fruit quality and yield. Its fruit weight is about 9.40 g, kernel weight 6.60 g, kernel percentage 63% and fat content is average 69%. A lot of walnut

orchards have been established with this cultivar since 1990 along with cv. "Bilecik" used as pollinator with a ratio of 1:1. Currently there are about a total 1.5 millions 'Şebin' and "Bilecik" walnut trees in Turkey. However, because of infertility problems that have started when trees reached their yield periods, flower drop took place later even though the trees formed female flowers [Akça et al unpublished data].

Therefore this study was aimed in order to determine the effects of the AVG and GA_3 applications in the prevention of pistillate flower abortion in walnut cv. 'Şebin'.

MATERIAL AND METHOD

The research has been carried out in 2010 in Tokat (Longitude 36°43' E, Latitude 40°19' N) and Niksar provinces (Longitude 36°58'E, Latitude 40°35'N). One orchard for each provinces selected and mature 'Şebin' walnut trees was used as material with a planting space of 10×10 m. The orchards in both provinces contain 1:1 ratio of "Bilecik" cultivar as pollinator. The pest management programs have been carried out regularly on all trees. In this study, IPM compatible Aminoethoxyvinylglycine (AVG, the commercial brand name is ReTain) has been used in order to inhibit the synthesis of ethylene. Also, two chemicals, AVG and Gibberellic acid (GA_3), were combined to determine the effect of interactions on flower abortion. In the trial, AVG alone (0, 62.5 and 125 ppm) and combination with GA_3 doses as 45, 135 and 270 ppm have been applied on trees (tab. 1). AVG and AVG + GA_3 combinations were applied via a pulverizer on all of the trees before the female flowers became receptive. The applications were made in the morning between 7 and 8 am. 100 female flowers were marked on the 20 branches located at the outer part of the tree canopy on the southern side of each tree. Fruits were counted on the marked female flowers 15 days after the receptive period. The trial was setup as 3 replications including 3 trees per replicate arranged in a completely randomized block. The data were analyzed using the analysis of variance (ANOVA) method to assess differences with SAS version 8.1 (SAS Institute, Cary, NC) and significance between means was tested by LSD test at probability of 0.05.

Table 1. AVG and AVG + GA_3 treatments
Tabela 1. Zabiegi AVG i AVG + GA_3

	Treatment – Zabieg
1	Water – Woda
2	0 ppm (Control – Kontrola)
3	62,5 ppm AVG
4	125 ppm AVG
5	62.5 ppm AVG + 45 ppm GA_3
6	62.5 ppm AVG +135 ppm GA_3
7	62.5 ppm AVG + 270 ppm GA_3
8	125 ppm AVG + 45 ppm GA_3
9	125 ppm AVG + 135 pm GA_3
10	125 ppm AVG + 270 ppm GA_3

RESULTS AND DISCUSSION

The results of the treatments on the prevention of female flower abortion in 'Şebin' walnut cultivars at two different locations are given in Table 2. As indicated in Table 2, AVG and AVG + GA_3 applications have substantially increased fruit set compared to control treatment in walnut cv. 'Şebin'. There were no statistically significant differences between Tokat and Niksar locations for 62.5 ppm and 125 ppm AVG treatments, however the highest fruit set (54.56% and 60.89%, respectively) was observed in the 125 ppm AVG treatments in both locations. Although Gun et al [2011] obtained 27.9% fruit set for 'Şebin' cultivar with a 125 ppm AVG treatment, we found higher ratio of fruit set. In the studies carried out with "Serr" cultivar, it was determined that 62.5, 125 and 250 ppm AVG treatments, especially the 125 ppm treatment increased fruit set as 80% [Lemus et al. 2007]. Beede et al. [2008] reported that AVG treatment decreased female flower abortion of walnuts at three different locations of USA. They found that female flower abortion ratio was between 40.60–73.30% for the control treatment based on locations whereas these ratios varied between 14.0–36.30% by 125 ppm AVG treatment. In another study carried out to prevent female flower abortion in „Serr" walnut cultivar, the fruit set ratio was obtained as 81,70% in 62.5 ppm AVG treatment while this ratio determined to be 89.70% in the 125 ppm AVG treatment. However no statistically significant differences were observed between these treatments [Beede 2004].

In our study, GA_3 treatments carried out in different doses combined with AVG doses (62.5 ppm and 125 ppm) and these treatments in general increased the fruit set ratio compared to alone AVG treatments. In particular, fruit set ratio has increased in the AVG + GA_3 treatment when GA_3 doses increased (tab. 2). We found that 125 ppm AVG + 270 ppm GA_3 treatment has resulted in the highest fruit set ratio at both locations (Tokat 83.33%; Niksar 93.89%). According to the obtained results, the role of Gibberellic acid treatment combined with AVG increases effectiveness by assisting the ethylene synthesis inhibition by Gibberellic acid. Even though Gibberellic acid treatments prevent flower abortion in some plants [Saks et al. 1992; Ben-Cheikh 1997; Kumar et al. 2008], Gibberellic acid treatments were not sufficient to prevent abortion in walnuts [Tadeo et al. 1994]. However, we found in this study that Giberrellic acid combined with AVG is the most effective treatment against flower abortion in walnuts. Abortion prevention effects of Giberrellic acid are well known because it decreases the sensitivity of the plants against ethylene and thus helping to decrease abortions [Saks et al. 1992].

In walnuts, the high pollen load on the stigma surface increases ethylene synthesis which is also known as aging hormone, thus making the plants age rapidly and causing abortion. According to the studies carried out, it has been determined that the loss of yield in walnuts due to high pollen load is between 40–90% and that the loss of yield due to insufficient pollen amount is only 5% [Rovira and Aletá 1997; Lemus 2005].

Table 2. Fruit set ratios of 'Şebin' walnut cultivar after AVG and AVG + GA_3 treatments on two locations

Tabela 2. Współczynnik zawiązanych owoców orzecha odmiany 'Şebin' po zabiegach AVG i AVG + GA_3 z dwóch stanowisk

Treatment Zabieg	Locations – Stanowisko Tokat Niksar	
	Fruit Set – Zawiązki owoców (%)	
Control – Kontrola	12.22 d	22.22 d
Water – Woda	11.55d	21.66 d
62.5 ppm AVG	49.33c	57.78 bc
125 ppm AVG	54.56bc	60.89 bc
62.5 ppm AVG + 45 ppm GA_3	55.55bc	63.33 cd
62.5 ppm AVG +135 ppm GA_3	59.44bc	65.00 bc
62.5 ppm AVG + 270 ppm GA_3	75.56ab	76.11 ab
125 ppm AVG + 45 ppm GA_3	56.67bc	63.33 cd
125 ppm AVG +135 pm GA_3	60.00bc	67.78 bc
125 ppm AVG +270 ppm GA_3	83.33a	93.89 a
LSD	22.66	26.40

According to the results obtained from this study, AVG treatments increased fruit set drastically in comparison to the control group in 'Şebin' cultivar, however this effect was observed more in AVG + GA_3 combinations due to the increased GA_3 dose and the 125 ppm AVG + 270 ppm GA_3 application has given the highest fruit set in both locations (Tokat 83.33%; Niksar 93.89%). The different fruit set ratio in both locations may have results of different environment temperature, rainfall regime during pollination period etc. in both regions.

CONCLUSIONS

We can concluded that the AVG treatments decreased female flower abortion. AVG plus GA_3 increased fruit set compared to alone AVG treatment. As a result, AVG + GA_3 treatments found useful to decrease PFA (pistillate flower abortion) in walnut cultivars tends female flower abortion due to excess pollen load. However treatments did not completely prevent PFA, but reduced it.

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EFEKTY ZABIEGÓW AVG I GA_3 NA PROCES OPADANIA KWIATÓW ŻEŃSKICH U ORZECHA ODMIANY 'SEBIN'

Streszczenie. Opadanie kwiatów żeńskich u orzechów określa się jako spadanie żeńskich kwiatów z szypułkami lub bez, w ciągu 10–15 dni po kwitnieniu. Zjawisko to, powszechnie obserwowane u pewnych odmian orzecha, powoduje znaczne straty w plonie. 'Şebin' jest popularną odmianą orzecha wśród farmerów w Turcji ze względu na jej owoce, plon oraz łatwość sprzedaży. Jednak niektóre sady założone z tą odmianą mają problem braku owoców. Niniejsze badanie określa wpływ zabiegów aminoetoksywinyloglicyną (AVG, nazwa handlowa ReTain) (w dawkach 0, 62,5 i 125 ppm) oraz AVG plus GA_3 (dawki 45, 135 oraz 270 ppm) stosowanych, aby zapobiec opadaniu. Doświadczenia przeprowadzono w dwóch różnych lokalizacjach. Zabiegi przeprowadzono tuż przed okresem receptywności żeńskich kwiatów odmiany 'Şebin'. Wyniki pokazały, że wskaźnik opadania kwiatów odmiany 'Şebin' wynosił 87,78% w uprawie w Tokat oraz 77,78% w uprawie w Niksar. Współczynnik zawiązanych kwiatów pod wpływem zabiegu 125 ppm AVG określono jako 60,89% dla Niksar oraz 57,56% dla ekologicznych warunków Tokat. Najwięcej zawiązanych kwiatów osiągnięto przy zabiegu 125 ppm AVG w połączeniu z 270 ppm GA_3: 93,89% dla warunków ekologicznych Niksar oraz 83,33% dla warunków ekologicznych Tokat. W rezultacie stwierdzono, że sam AVG lub w kombinacji z GA_3 jest efektywnych zabiegiem ograniczającym spadanie kwiatów dla odmiany orzecha 'Şebin'.

Słowa kluczowe: orzech, opadanie kwiatów, etylen, kwas giberelinowy

Accepted for print – Zaakceptowano do druku: 3.07.2012