10.7251/AGSY1303671D

CHEMICAL CONTROL OF *CURCULIO NUCUM* L. (COLEOPTERA: CURCULIONIDAE) WITH KNAPSACK SPRAYERS EQUIPPED WITH AIR-ASSISTED ROTARY DISC NOZZLES

Hüseyin DURAN[1], İbrahim ÇİLİNGİR[2], Kibar AK[1]

[1]Black Sea Agricultural Research Institute, Samsun
[2] University of Ankara Faculty of Agriculture, Ankara
*(Corresponding author: husduran@yahoo.com)

Abstract

The hazelnut (*Corylus avellena* L) is a hard-shelled fruit that is extensively cultivated in The Black Sea Region, Turkey. Turkey is the main producer of hazelnuts in the world, with an average annual production of 600-650 thousand tons, which represents nearly 70% of worldwide production. The hazelnut is one of Turkey's most important agricultural exports.

The nut weevil *Curculio nucum* L. is the most dangerous pest of hazelnut trees. If unchecked, the nut weevil can significantly and adversely affect hazelnut yields. In this study, we used knapsack sprayers with air-assisted rotary disc nozzles for the chemical control of the nut weevil in hazelnut orchards. The study was conducted in the province of Samsun between 2008 and 2009, in an orchard with planting distances of 4 x 4.5 m between the trees, and an average tree height of 4.5-5 m. During the study, insecticide applications were performed at different doses. Important pulverization characteristics (volume median diameter, residue etc.) were determined by performing trace residue studies. The food dye, tartrazine, was used in trace residue studies. Biological effectiveness studies were also performed by using Carbosulfan insecticide.

During the studies, the hazelnut trees were divided horizontally (lower, middle, upper) and vertically (external, middle, central) into different zones, and the consistency of insecticide distribution, insecticide penetration, residue and pesticide loss were determined. It was observed that the residue varied depending on different zones of the hazelnut trees. Based on the trace residue studies, the highest quantities of residue were identified in the middle and lower zones of trees. Biological effectiveness studies were conducted by performing cage and parcel tests. Based on these tests, the number of dead, alive, and paralyzed mature nut weevils was determined. During the study, the insecticide was applied at 1/1 dose, ¾ dose, ½ dose, and at a standard dose of 20 l/da. The biological effectiveness value in the cage studies was 97.34% at full dose, 93.55% at ¾ dose, and 90.67% at ½ dose. The biological effectiveness value in the parcel studies was 97.25% at 1/1 dose, 91.03% at ¾ dose, and 80.27% at ½ dose.

Based on the results of the study, it can be concluded that effective chemical control against nut weevils can be achieved with insecticide applications performed at 1/1 dose, at ¾ dose, and at a standard dose of 20 l/da.

Keywords: Hazelnut, *Curculio nucum,* sprayer, residue, biological effectiveness

Introduction

It is known from historical records that the cultivation and production of hazelnuts in northern Turkey on the shores of the Black Sea began 2300 years ago. It is also known that Turkey has exported hazelnut for the past six centuries (Duran, 2007).

The hazelnut is one of Turkey's most important agricultural exports. Hazelnut cultivation in Turkey is currently performed over an area of 640,000 hectares and provides an annual yield of 600-650 thousand tons; this represents 70% of worldwide production (Anonymous, 2010a). Turkey exports nearly 90% of the hazelnut that it produces.

In Turkey, the most preferred method for the control of diseases, pests and weeds in hazelnut orchards is chemical control. Depending on the size and structure of their orchards, farmers in Turkey generally use knapsack sprayers for chemical control.

In all stages of production, any disease, pests and weeds that affect the hazelnut tree can decrease the yield and quality of hazelnuts. Among 150 species of insects that are found in hazelnut orchards, the most important is the nut weevil (Tuncer et al., 2002a). In the absence of control measures, the loss of yield caused by *C. nucum* can reach up 30 to 40% (Ali Niazee, 1998).

Until now, no methods other than chemical control have been utilized in Turkey for the control of nut weevils. In addition, producers tend to use excessive doses of insecticides to achieve biological effectiveness with this control method (Tuncer et al., 2001 and 2002b).

Due to the small size of orchards and their location in areas that are generally inclined, various problems are encountered in hazelnut orchards during the application of chemical control methods. These problems include insecticides not reaching target surfaces, and low biological effectiveness. The fact that 91% of the area within the Ordu province in the Black Sea region has more than 12% incline underlines the necessity and importance of developing different insecticide application techniques for hazelnut cultivation.

Materials and Methods

Cage and plot studies for trace residues and biological effectiveness were organized in the Terme and Atakum counties of the Samsun province in 2008 and 2009. The study was performed in orchards with a planting distance of 4 x 4.5 m between the trees, and an average tree height of 4.5-5 m. The study materials that were used during the study period included knapsack sprayers with air-assisted rotary disc nozzles (Fig. 1), hazelnut orchards, nut weevils, net cages, spectrophotometers, anemometer, tartrazine, laser droplet size measurement device, water sensitive papers (WSP), insecticide Carbosulfan, leaf area meter, water distillation device, blankets, pallets and fixers.

This study was conducted by using knapsack sprayers, cold fogging machines and knapsack sprayers with air-assisted rotary disc nozzles.

Volumetric Mean Diameter (VMD) value was measured by using a Malvern brand Spraytec model device.

Figure 1. Air-assisted rotary disc nozzle

Trace residue studies

Testing for trace residues was performed by using the food dye tartrazine instead of an insecticide. In this study, the amount of trace residues obtained from the hazelnut trees, the penetration within the hazelnut trees, and the insecticide loss were investigated. The colorimetric method was used in this study (Çilingir, 1983; Özmerzi and Çilingir, 1992). For this purpose the hazelnut trees were divided into three vertical (height) zones and three horizontal (crown width) zones, thus yielding a total of nine sampling zones (Dursun et al., 2008) (Fig. 2). Application at standard value of 20 l/da was performed with knapsack sprayer equipped with an air-assisted rotary disc nozzle.

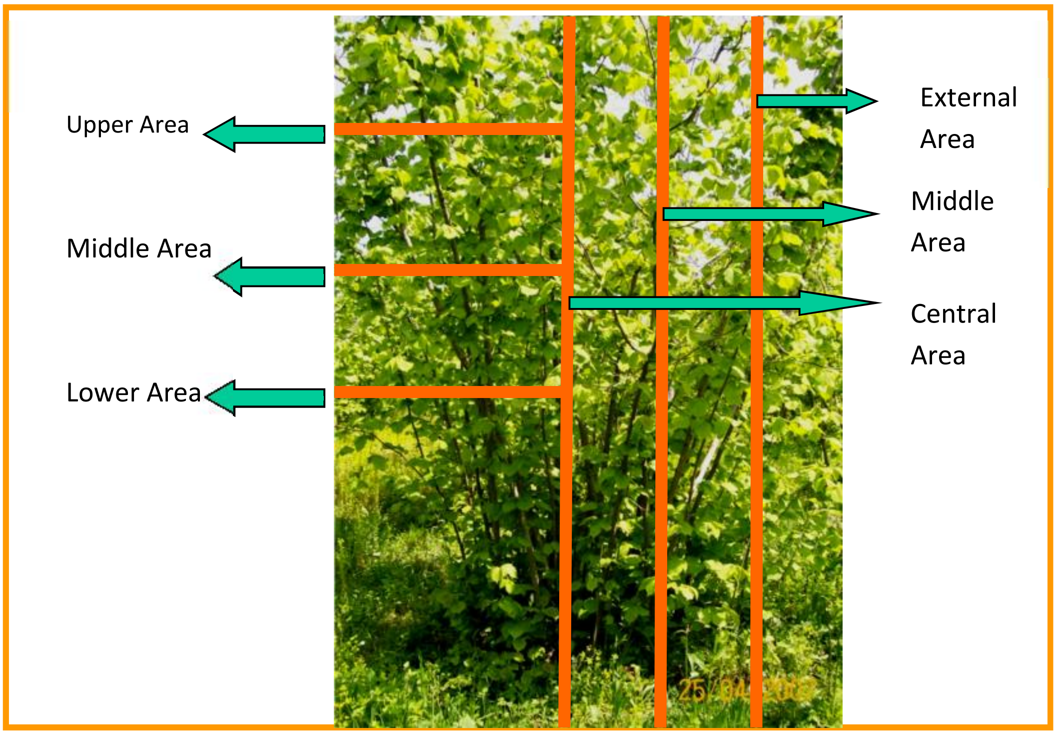

Figure 2. Sampling zones

Biological effectiveness studies

Biological effectiveness of insecticide studies was conducted between 2008 and 2009 within the context of the cage and parcel studies. The insecticide was applied after most of fruits reached the size of a lentil (3-4 mm). Based on the number of mature nut weevils counted on Day 7 (after insecticide application) during the cage studies performed in 2008 and 2009. Counting paralyzed, dead or alive insects was performed according to Anonymous (1995).

Prior to spraying, mature nut weevils were collected for the cage studies. In order to collect mature adults, 3x4 m blankets made of white cloth were used. The data obtained from the cage studies were evaluated by using the Abbott formula (Karman, 1971). All data were analyzed by analysis of variance JMP Analysis Programme.

Results and discussion

The D_v (50) Volumetric Mean Diameter (VMD) value was measured as 64.68 µm by using a Malvern brand Spraytec model device.

The highest quantity of residue was found in the middle external zone with a value of 1.427 $\mu g/cm^2$, while the lowest in the upper central zone with a value of 0.578 $\mu g/cm^2$. The quantity of residue found in the middle and central zones gradually decreased from the lower to the upper zones. The lowest quantities of residue were found in the upper zones. Residue quantities in the upper external, middle, and central zones were 1.163 µg/cm^2, 0.849 µg/cm^2 and 0.578 µg/cm^2, respectively.

Because the trees that had more leaves on them during the time/season in which droplets of smaller diameters were sprayed by using the knapsack sprayer equipped with an air-assisted rotary disc nozzle, the highest quantities of residue were observed in the lower zones of hazelnut trees.

Hazelnut trees were divided horizontally into external, middle and central zones (from the exterior to the center). The amount of residue was determined for each one of these different zones. The highest quantity of residue was found in the middle external zone with a value of 1.427 µg/cm^2, while the lowest quantity was found in the upper central zone with a value of 0.578 µg/cm^2. Penetration from the exterior to the center in the lower and middle zones of hazelnut trees was higher in comparison to the upper zone. This was due to the higher amount of dye residue that was sprayed on the lower and middle zones. In the middle area, the amount of residue on the external, middle and central zones was 1.427 µg/cm^2, 1.003 µg/cm^2 and 0.666 µg/cm^2, respectively. In the upper area, the amount of residue on the external, middle and central zones was 1.163 µg/cm^2, 0.849 µg/cm^2 and 0.578 µg/cm^2, respectively.

As droplets of insecticide settle on the first target surface they touch when being sprayed the number of droplets gradually decreased towards the center of the hazelnut trees. For this reason, the amount of residue that accumulated in the center was also lower according to the other surfaces of tree. Cross et all. (2001b) found that zones of hazelnut trees whichwere closer to the pulverizer during insecticide application had higher levels of residue than zones that were more distant. Results of the study Balsari et al. (2002) showed that the amount of residue which accumulated in leaves of the outer tree canopy was higher than the amount which accumulated in leaves of the inner zones.

During insecticide applications performed by using knapsack sprayers with air-assisted rotary disc nozzles, the average amount of residue loss was 0.146 µg/cm^2. The loss observed on surfaces closer to the hazelnut trees was greater than the loss observed on surfaces in more distant locations.

Filter papers indicated that the amount of loss to the air was 0.22 µg/cm^2. Low volume applications may lead to greater drift losses (Salyani and Cromwell, 1992).

Following the application of the insecticide, a net cage was placed on each hazelnut-yielding branch, and 10 mature nut weevils were placed within each one of these net cages (Figure 3). One cage was formed for each one of the three different doses. Counts were then performed on the first, third, and seventh days following insecticide application (Anonymous, 1996). During these counts, the number of dead, living, and paralyzed mature nut weevils was determined.

Figure 3. Cage studies for assessing biological effectiveness, and the counting of mature nut weevils that was performed after insecticide application.

Statistically significant difference was found between doses that were used in the studies (P<0.01) (Table 1). It was determined that the applied doses had an effect on the results of the cage studies.

Table 1. Biological effectiveness values calculated according to the combined Day 7 counting results of the cage studies

Sprayer type	Doses	Analysis results	Biological effectiveness %
Knapsack sprayer with air-assisted rotary disk nozzle	1/1 dose	9.91	97.34
	¾ dose	9.70	93.35
	½ dose	9.56	90.67
Mean		9.73	
		9.77	
Doses			
1/1 dose		9.96 A	
¾ dose		9.77 B	
½ dose		9.54 C	
Doses		**	
Sprayer		N.S.	
Year		N.S.	
Dose x Sprayer		N.S.	
Year x Dose		N.S.	
Year x Sprayer		N.S.	
Year x Dose x Sprayer		N.S.	
CV		4.32	

** Significant (P<0.01). There are no differences between values indicated with the same letters.
N.S. Difference between the relevant items was not statistically significant

The biological effectiveness values obtained by combining results of parcel studies performed over two years are presented in Table 2. It can be seen that a statistically significant difference was found between the doses used in the study (P<0.01).

According to the two-year plot study results, 1/1dose applications were found as statistically very significant. The biological effectiveness was determined at 1/1dose applications.

Table 2. Biological effectiveness values calculated according to the combined counting results of the parcel studies

Sprayer type	Doses	Analysis results	Biological effectiveness %
Knapsack sprayer with air-assisted rotary disk nozzle	1/1 dose	9.91	97.25
	¾ dose	9.60	91.03
	½ dose	9.01	80.27
Mean		**9.50 B**	
Doses			
Full dose		9.97 A	
¾ dose		9.68 B	
½ dose		9.20 C	
Doses		**	
Sprayer		N.S.	
Year		N.S.	
Dose x Sprayer		N.S.	
Year x Dose		N.S.	
Year x Sprayer		N.S.	
Year x Dose X Sprayer		N.S.	
VK		3.69	

Conclusions

In the studies performed by using the knapsack sprayer with an air-assisted rotary disc nozzle, the D_v (50) value was measured as 64.68 µm under study conditions.

Regarding the distribution of residue quantities from the upper to the lower zones of hazelnut trees, the highest quantity of residue was found in the middle external zone of the tree with a value of 1.427 µg/cm^2, while the lowest quantity was found in the upper central zone with a value of 0.578 µg/cm^2.

The amount of loss to the soil was 0.146 µg/cm^2, while the amount lost to drift was 0.22 µg/cm^2.

In the parcel studies for biological effectiveness, the effectiveness value was determined as 97.25% for full dose applications, 91.03% for ¾ dose applications, and 80.27% for ½ dose applications. During the parcel studies, the ½ dose application provided the lowest biological effectiveness value.

In the cage and parcel zones, an average biological effectiveness of 97.3% was obtained. Based on these values, it was determined that standard 20 l/da applications for chemical control can be performed with the sprayer used within the context of this study.

Literature

Anonim. 1995. Zirai Mücadele Teknik Talimatları. Cilt-3, Tarım ve Köyişleri Bakanlığı, Koruma Kontrol Genel Müdürlüğü, 444 s., Ankara.

Anonim. 1996. Zirai Mücadele Standart İlaç Deneme Metodları. Cilt 1. Tarım ve Köyişleri Bakanlığı, Ankara.

Anonim. 2003. Ordu Tarım İl Müdürlüğü Çalışma Raporu.

Anonim. 2010a. Ülkelere Göre Dünya Kabuklu Fındık Üretim Alanları. Fiskobirlik Verileri 2010. Erişim tarihi: 21.04.2010

AliNiazee, M. T. 1998. Ecolology and Management of Hazelnut Pests. Annu. Rev. Entomol.,vol. 43: pp. 395-419.

Balsari, P., Marucco, P. and Oggero, G. 2002. Spray applications in Italian apple orchards: Target coverage, ground losses and drift. ASAE paper No: 021002. USA. pp. 1-12.

Cross, J.V., Walklate, P.J., Murray, R.A. and Richardson, G. M. 2001b. Spray deposits and losses in different sized apple trees from an axial fan orchard sprayer: 2.Effects of spray ouality, Crop Protection, voll. 20 pp. 333-343.

Çilingir, İ. 1983. Şeker pancarı tarımsal savaşında turbo atömizörlerin ilaçlama karakteristikleri ve iş başarıları üzerinde bir araştırma. Yayınlanmamış Doktora Tezi, Ankara Üniversitesi Fen Bilimleri Enstitüsü, Ankara, 172 s.

Duran, H. 2007. Fındık Bahçelerinde Pestisit Uygulama Teknikleri. A.Ü. Fen Bilimleri Enstitüsü, Doktora Semineri (yayımlanmamış), Ankara.

Dursun, E., Çilingir, İ., Aydar, A., Sabahoğlu, Y., Zeki, C. ve Şenöz, B. 2008. Elma içkurdu (*Cydia pomonella* L.) mücadelesinde yardımcı hava akımlı iki bahçe pülverizatörünün ilaç uygulama etkinliğinin belirlenmesi. TÜBİTAK Proje No: 104O412. Sonuç Raporu, 178 s., Ankara.

Karman, M. 1971. Bitki koruma araştırmalarında genele bilgiler denemelerin kuruluşu ve değerlendirme esasları. Tarım Bakanlığı Zirai Mücadele ve Zirai Karantina Genel Müdürlüğü Yayınları, Bornova Bölge Zirai Mücadele Araştırma Enstitüsü, 279 s., İzmir.

Özmerzi, A and Çilingir, İ. 1992. Use of colorimetric technique in determining surface coverage in spraying. Agricultural Mechanization in Asia, Africa And Latin America. vol 23. number: 1. pp. 37-38.

Salyani, M. and Cromwell, R.P. 1992. Spray drift from ground and aerial applications. Transactions of ASAE, Vol.35(4), pp.1113-1120.

Tuncer, C., Akça, İ. and Saruhan İ. 2001. Integrated Pest Management in Turkish Hazelnut Orchards. Proc. V. Int. Congress on Hazelnut. Ed. S.A. Mehlenbacher. Acta Hort. 556. I SHS 2001. 419-429.

Tuncer C., Saruhan İ. ve Akça İ. 2002a. Karadeniz Bölgesi Fındık Üretim Alanlarındaki Önemli Zararlılar. Samsun Ticaret Borsası Yayın Organı. Yıl:2, Sayı:2, 43-54.

Tuncer C., Saruhan İ. ve Akça İ. 2002b. Fındıkta Zararlı Olan Bazı Emici Böceklerin (heteroptera:pentatomidae, coreidea ve acanthhosomatidae) Kimyasal Mücadelesi Üzerine Araştırmalar OMÜ Ziraat Fakültesi Dergisi, 17(3):17-26.