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Change of Arthropod Communities in A Wheat Field After Application of Wood Vinegar Produced from Nutshells

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ABSTRACT

This study was conducted to evaluate the biological effects of wood vinegar obtained from nutshells on arthropods. The study was conducted randomized as a block design with four replications in a wheat field in Muş province. Wood vinegar was applied at 0.5%, 1%, 2%, 3%, 4% and 5% ml concentrations via backpack sprayer. Pitfall-traps were used to determine the effect of wood vinegars. Results indicated that the mean number of arthropods varied based on the years and vinegar applications at different concentrations (compared to the control). In addition, it is thought that all wood vinegar treatments compared to the control lead to a decrease in the average number of Opiliones and an increase in the average number of Arachnids.

Research Article

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Fındık Kabuklarından Üretilen Odun Sirkesi Uygulamalarından Sonra Buğday Tarlasındaki Arthropod Komünitelerinin Değişimi

ÖZET

Bu çalışma, fındık kabuklarından elde edilmiş odun sirkesinin arthropodlar üzerindeki biyolojik etkilerini değerlendirmek için yapılmıştır. Çalışma, Muş ili iklim şartlarında buğday tarlasında rastgele bloklar deneme desenine göre dört tekerrürlü olarak yürütülmüştür. Odun sirkesi, sırt pülverizatörü yardımıyla % 0.5, %1.0, % 2.0, % 3.0, % 4.0 ve % 5.0 ml'lik konsantrasyonlarda uygulanmıştır. Sirkenin etkisinin belirlenmesinde çukur tuzaklar kullanılmıştır. Sonuç olarak; kontrole kıyasla, ortalama arthropod sayısının yıllara ve farklı konsantrasyonlardaki sirke uygulamalarına göre farklılık gösterdiği bulunmuştur. Ek olarak, kontrole göre tüm odun sirkesi muamelelerinin ortalama Opilionid (ot biçen) sayısında azalmaya ve ortalama Araknid sayısında artışa sebep olduğu düşünülmektedir.

Araştırma Makalesi

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Anahtar Kelimeler
Araknidler
Biyopestisit
Çukur tuzak
Bitki koruma
Odun sirkesi

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INTRODUCTION

Because of the negative effects of chemicals, the bio-control has become more popular among other alternative methods (Demirci et al., 2002). The primary purpose of agricultural practices is to obtain high quality and more harvest per unit of land, without disturbing ecological balance (Topal, 2011). For instance, *Spodoptera frugiperda* (J.E.Smith) (Lepidoptera: Noctuidae), causes significant amount of losses by reducing the agricultural yield due to its resistance to pesticides over the year across the world. Recently, alternative (natural) methods such as Neem oil and wood vinegar applications (WV) have become more popular for the control of *S. frugiperda* (Ferreira et al., 2013). WV is a type of product that was used in the Neanderthal's Era and produced as the result of heat treatment (pyrolysis liquids) (Tiilikkala et al., 2010). Jang (2004) and Kim et al. (2008) reported that a WV consists of approximately 80-90% water and 10-20% organic components include 200 different types of organic components (mostly acetic acid). Further, annual WV production can be as high as 14.000 tons (Kim et al., 2008). WV can also be used as natural organic pesticide (Ying, 2008; Tsuzuki et al., 1989). Jothityangkoon et al. (2008), Rakmai (2009) and Hagner (2013) reported that WVs can be used effectively against arthropod pests. Moreover, Yatagai et al. (2002) stated that WV can be used in order to control termites. Diba et al. (2009) observed that WV

has a termiticidal effect on *Coptotermes curvignathu* Holmgren (Isoptera: Rhinotermitidae). Oramahi and Yoshimura (2013) found that WV obtained from *Acacia mangium* Willd. (Fabaceae) and *Vitex pubescens* L. (Lamiaceae) has an antitermite effect and can be used as crop protector. Additionally, Inoue et al. (2000) reported that WV produced from bamboo can be used to control termites and arthropods. Pangnakom et al. (2011) reported that mosquito larvae can be controlled using WV. In addition to these observations, Wititsiri (2011) stated that WV from various raw materials have termiticidal (*Odontotermes* sp., Isoptera: Termitidae) and pesticidal (*Ferrisia virgate* Cockerell, Hemiptera: Pseudococcidae) effects. Kiarie-Makara et al. (2010) reported that WV had a repellant effect against *Culex pipiens pallens* Coquillete and *Aedes togoi* Theobald (Diptera: Culucidae). However, Hashemi et al. (2014) alleged that WV has no significant insecticide impact on *Lasioderma serricorne* (F.) (Coleoptera: Ptinidae); Kim et al. (2008) found that WV has no insecticidal influence on rice brown planthoppers (*Nilaparvata lugens* (Stal) and *Laodelphax striatellus* (Fallen) (Hemiptera: Delphacidae) but has a synergistic effect on the insecticidal activity of Carbosulfan®. Consequently, as Tiilikkala et al. (2010) stated, it can be anticipated that these liquids obtained by heat treatment will substitute chemical pesticides in upcoming years. The purpose of this research was to determine the effects of WV obtained from nutshells on the arthropods as a bio-pesticide in wheat agro-ecosystem using pitfall-traps.

MATERIAL and METHOD

This study was conducted in a winter wheat field belongs to Berce Alparslan in Agricultural Enterprise (lat.: 38^0 47' 33. 1577", long.: 41^0 32' 45. 8119", 1276 m), during the period of growth of 2014 to 2016. The application field was divided into 5m×5m squares (25m^2 in total) and with at least 2-m intervals between blocks or parcels (Figure 1a) (Anonymous, 2016a).

Figure 1. Application field (a), an installed pitfall-trap in the field (b), and a photo of arthropodes captured by a pitfall-trap (c)
Şekil 1. Deneme alanı (a), deneme alanında kurulmuş bir çukur tuzak (b) ve çukur tuzak ile yakalanmış arthropodlardan görüntü (c)

The wood vinegar (WV) (Figure 2a) used in the experiment was supplied from a bio-coal and wood vinegar products manufacturer, further the WV used in this study was produced through gasifier of nutshells (Namlı et al., 2014). WV were applied in six different doses including 0.5%, 1.0%, 2.0%, 3.0%, 4.0% and 5.0% ml, and a control group (with only water). For WV, Berce's schedule for fertilizer application and agricultural spraying was followed and practiced. WV was applied using a 16 L backpack sprayer (AnadoluPower APW-16) (Figure 2) once from 2014 to 2015 and four times from 2015 to 2016. Climatic data for the application field, including average temperature, total rainfall, and average relative humidity are presented in Table 1 (Anonymous, 2016b).

Figure 2. A photo of WV produced from hazelnut shells (a) and application of WV using a backpack sprayer (b)
Şekil 2. Fındık kabuklarından üretilmiş odun sirkesi (a) ve sırt pülverizatörü ile odun sirkesi muamelesinden görüntü (b)

Table 1. Climate data for last ten years (LTY), 2014-15, and 2015-16 years in Muş province
Tablo 1. Muş ilinde 2014-2015, 2015-2016 ve uzun yıllar (son on yıl) iklim verileri

Mean temperature (°C) *Ortalama sıcaklık (°C)*			Total rainfall (mm) *Toplam yağış (mm)*			Mean relative humidity (%) *Ortalama nispi nem (%)*		
LTY	2014-15	2015-16	LTY	2014-15	2015-16	LTY	2014-15	2015-16
10.62	11.55	11.48	740.5	740.4	790.1	60.79	55.02	54.00
Min / Max (*En az / En çok*)			Min / Max (*En az / En çok*)			Min / Max (*En az / En çok*)		
-7.7/26.3	-5.7/27.4	-6.2/26.7	3.5/105.8	0.6/117.7	0.3/191.3	34.3/82.3	20.8/83.3	24.1/81.9

Pitfall-traps, after the experimental area reached dry conditions which is required for practicing, were placed into each parcel and as three pitfall traps (plastic glasses 7 cm in diameter and 10 cm in depth) as to be inter-rowed at random (Figure 1b). Until the harvest, after each WV application (on a weekly basis), traps remained stable for 2 or 3 days, and then they were labeled and collected (Figure 1c). All the collected traps were analyzed, identified, and categorized in the laboratory (Yardim, 1996; 2002). During 2014-2015, 504 pitfall-traps were installed (repeated six times) while 756 pitfall-traps were installed between 2015 to 2016 (repeated nine times). For statistical analyses, Minitab (Ver. 17) and IBM SPSS (Ver. 24) statistical packages were used. For the purpose of determining the effects of applications performed on arthropods, simple correspondence analysis was employed (Winer et al., 1971).

RESEARCH FINDINGS and DISCUSSION

Effects of WV treatments at different doses on arthropods

It was seen from the WV treatments in different doses for the year of 2014-2015 that the 2% and 3% ml, 0.5% ml and control, 1% and 5% ml treatments were almost similar. Moreover, it was observed that 4% ml WV have no significant relation with dosage. Moreover, 0.5% ml and control are in a relation with the Gryllidae (Orthoptera) and 4% ml WV is related to the Carabidae (Coleoptera) (Figure 3).

It was observed from the WV treatments in different doses for the year 2015-2016 that 2% and 3% ml, 0.5% ml and 4% ml, 1% and 5% ml were in a relation. Also, it was observed that control does not have a significant relation with any of the doses statistically. In addition, it was realized that 2% and 3% ml were related to Arachnida and 0.5% and 4% ml WV were related to the Gryllidae and Carabidae, additionally control is in a relation with Opiliones (Arachnida). The concentration of 5% and 1% ml WV are related to other arthropods (Figure 4).

When the simple correspondence analysis results given in Figure 3 and Figure 4 are considered, it can be concluded that the effects of applied doses on the number of arthropods vary by periods. At the same time, those significant differences also exist among doses draws attention as well.

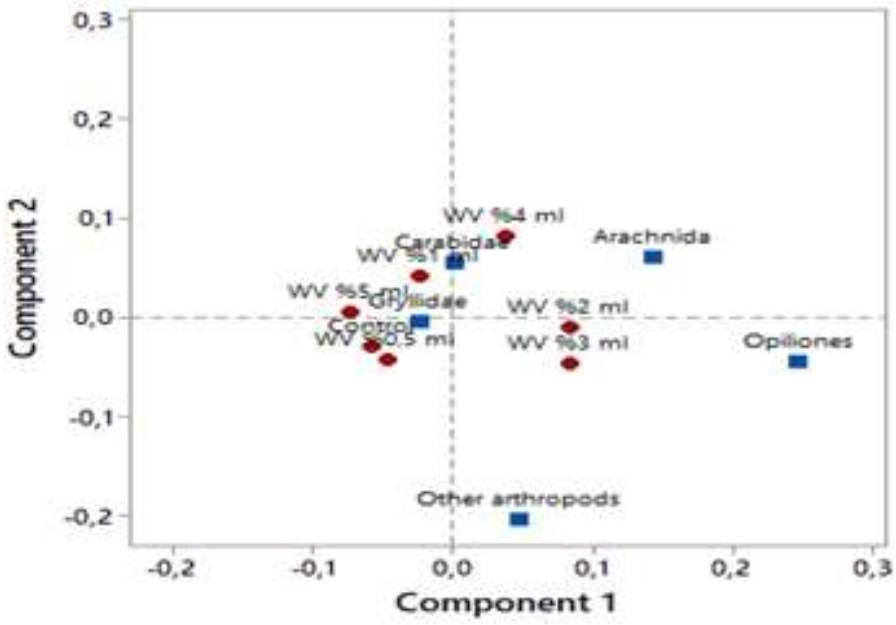

Figure 3. The effects of WV doses applied in the period of 2014-2015 on the change in the numbers of arthropods
Şekil 3. 2014-2015 yılında uygulanan odun sirkesi dozlarının arthropod sayılarındaki değişime etkileri

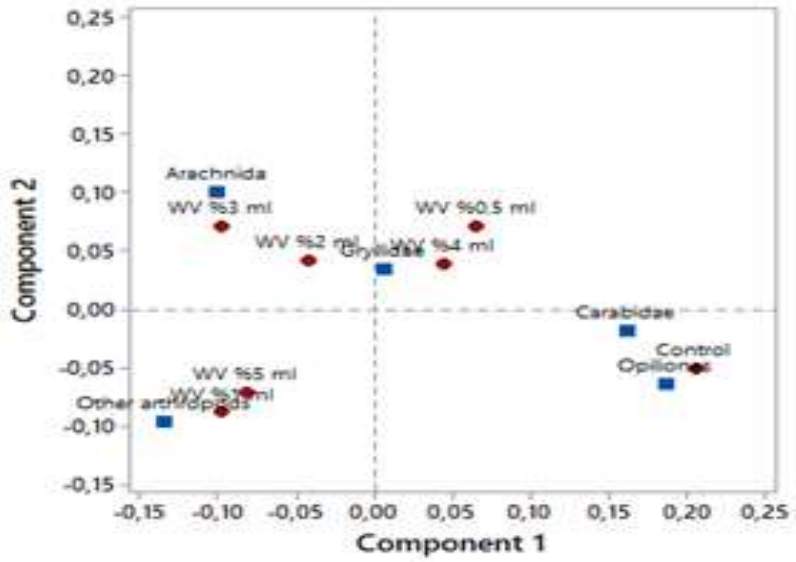

Figure 4. The effects of WV doses applied in the period of 2015-2016 on the change in the numbers of arthropods
Şekil 4. 2015-2016 yılında uygulanan odun sirkesi dozlarının arthropod sayılarındaki değişime etkileri

Effects of WV treatments at different doses on the number of Carabidae (Coleoptera)

Considering the control, it was detected that the number of Carabidae was found minimum at 2% ml WV (18.09) and maximum at 4% ml WV (34.64), (Figure 5).

Effects of WV treatments at different doses on the number of Gryllidae (Orthoptera)

Compared to the control, the average number of Gryllidae was minimum in 4% ml WV (131.5) and was maximum at 1% ml WV (165.72) (Figure 6).

Effects of WV treatments at different doses on the number of Arachnida

It was detected that the applied WV treatment, compared to the control, led an increase in the average number of Arachnida at all doses (Figure 7).

Effects of WV treatments at different doses on the number of Opiliones (Arachnida)

Compared to the control, all WVs caused a decrease in the average number of Opiliones (Figure 8).

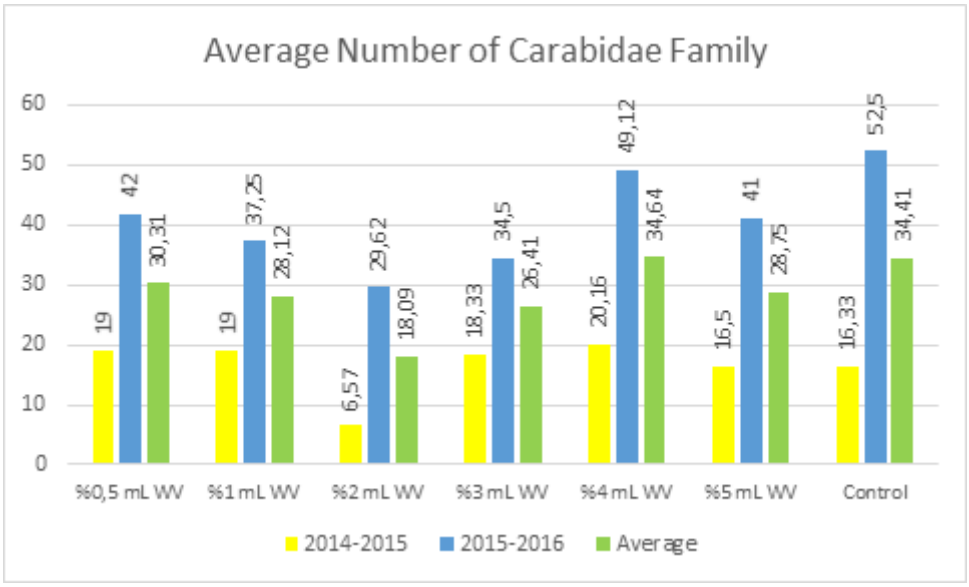

Figure 5. The effects of applied WV doses on the average number of Carabidae (Coleoptera)
Şekil 5. Uygulanan odun sirkesi dozlarının ortalama Carabidae (Coleoptera) sayısına etkileri

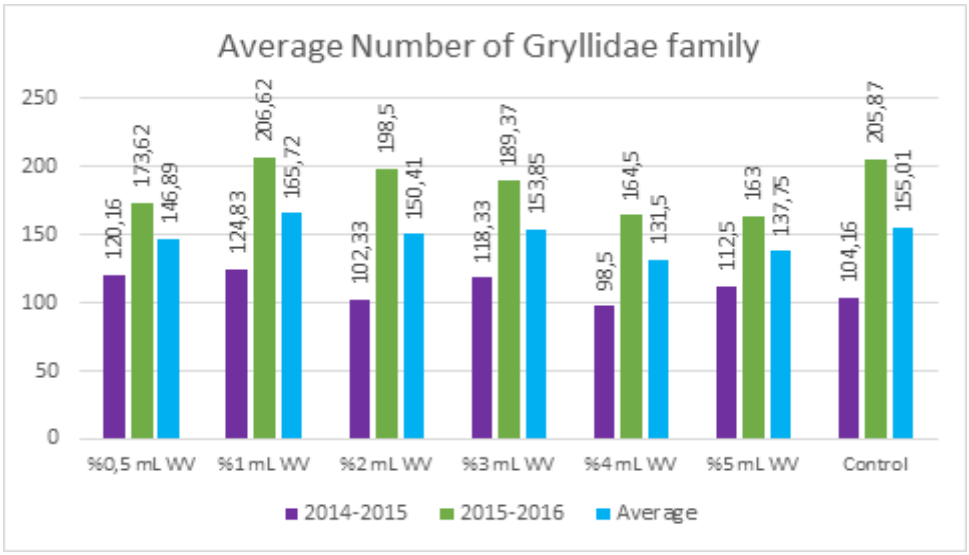

Figure 6. The effects of applied WV doses on the average number of Gryllidae (Orthoptera)
Şekil 6. Uygulanan odun sirkesi dozlarının ortalama Gryllidae (Orthoptera) sayısına etkileri

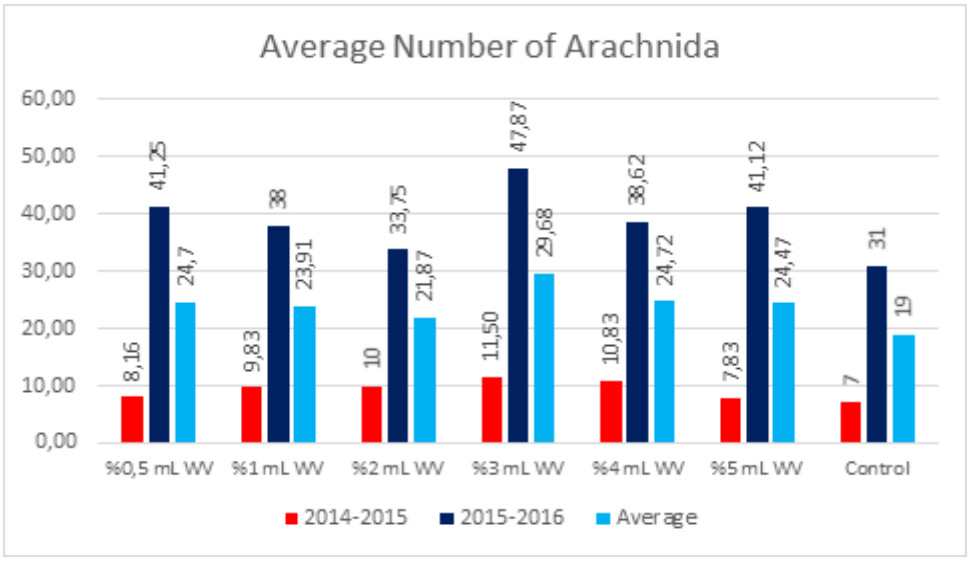

Figure 7. The effects of applied WV doses on the average number of Arachnida
Şekil 7. Uygulanan odun sirkesi dozlarının ortalama Araknid sayısına etkileri

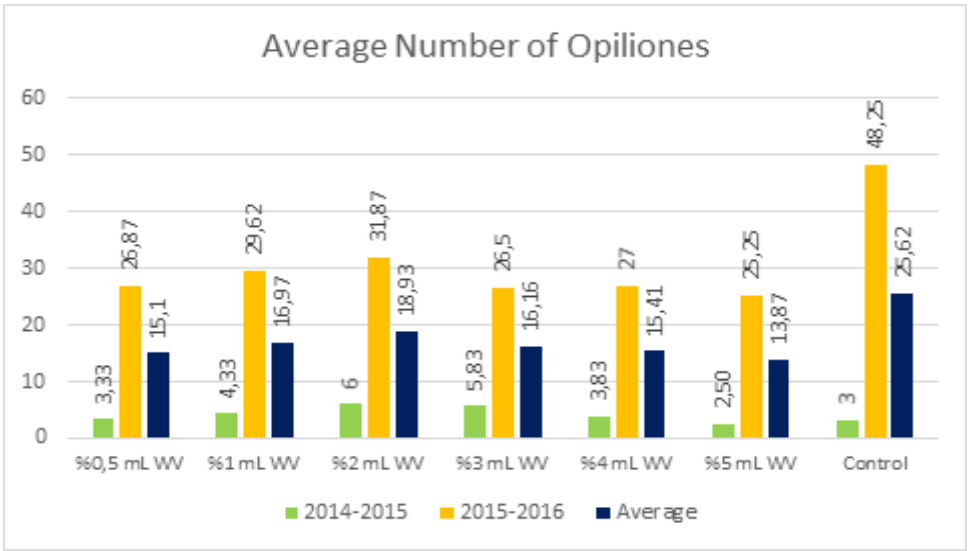

Figure 8. The effects of applied WV doses on the average number of Opiliones (Arachnida)
Şekil 8. Uygulanan odun sirkesi dozlarının ortalama Opilionid (Arachnida) sayısına etkileri

Effects of WV treatments at different doses on the number of other arthropods

Compared to the control, the average number of other arthropods was minimum for 0.5% ml WV (26.43) and was maximum for 5% ml WV (36.97) (Figure 9).

Insecticides that are used against arthropods pests in agro-ecosystems protect the crop; however, the residue on crops is a big danger for human health. Additionally, the pesticides have negative impacts on biological diversity. Furthermore, they contaminate the soil, air and water; and therefore, they adversely affect all living organisms. In this sense, it is essential to use and prefer alternative products which do not leave toxic chemical residues on crops and do not harm the bio-chain and environment.

For the production year of 2014-2015, it is thought that the relation between 2% and 3% ml might be relevant to their close dose levels and similar effects. It is also estimated that 0.5% ml application was not highly effective against arthropods however, 0.5% ml and control were related. For 2015-2016, as similar to the previous year, it is seen that 2% and 3% ml were in a relation (Figure 4), and this relation was also supposed to have similar effects on arthropods. There was no clear relationship between the control treatment and the doses in 2015-2016 (compared to 2014-2015); this could be related to higher amount of pesticide and WV application and its impact on arthropods. In addition to the graphics created over the average data obtained from this research, it was realized that the results from simple correspondence analyses were also in parallel to the findings of Diba et al. (2009), Hagner (2013), Inoue et al. (2000), Jothityangkoon et al. (2008), Kiarie-Makara et al. (2010), Oramahi and Yoshimura (2013), Pangnakorn et al. (2011), Rakmai (2009), Wititsiri (2011), Yatagai et al. (2002), Koç and Yardım (2018) in the way that WV as repellant and organic-pesticide. However, the studies addressing that WV did not have an insecticidal effect on the arthropods which Hashemi et al. (2014), Kim et al. (2008) had already used in their experiments. In spite of the unstable and though climatic conditions of the application field (Muş, Turkey), it is predicted that vinegar will be able to play an effective role in increasing the number of arachnids as significant predators for the agro-ecosystem and the number of other arthropods in decreasing the number of Opiliones. It was thought that especially the increase of other arthropods (mostly winged arthropods) might be caused by the applied vinegar residue on the plants and burning smell in ambient. In conclusion, as Wititsiri (2011) stated, it was estimated that wood vinegar could be used effectively for the control of arthropods based on the their mechanisms of action of active components and/or compounds.

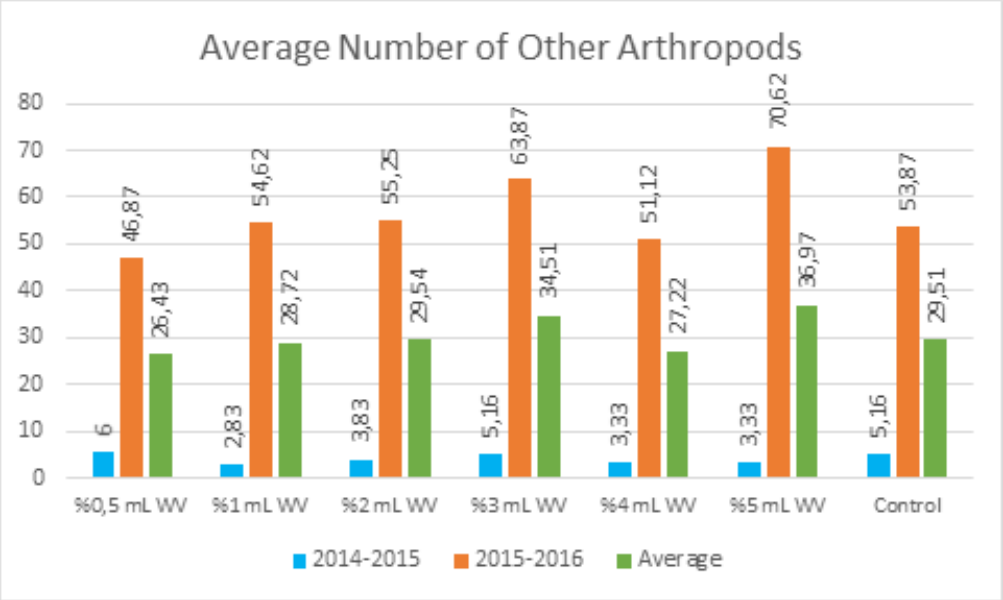

Figure 9. The effects of applied WV doses on the average number of other arthropods
Şekil 9. Uygulanan odun sirkesi dozlarının diğer arthropodlar ortalama sayısına etkileri

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Statement of Conflict of Interest

Author have declared no conflict of interest.

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