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Araştırma
(Research)

Effectiveness of Some Environmentally Friendly Products on Hazelnut Powdery Mildew Caused by *Erysiphe corylacearum**

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Abstract

Objective: Powdery mildew disease caused by *Erysiphe corylacearum* is one of the main diseases affecting the yield and quality of hazelnut (*Corylus avellana* L.), one of the most important agricultural products of Türkiye. The study was conducted in Giresun in 2017 to determine the effect of some environmentally fiendly products (one biological fungicide, one fungicides containing plant extract and one plant activator) against the disease.

Materials and Methods: As environmentally fiendly products against to disease, commercial products including AQ 10 (*Ampelomyces quisqualis* M-10 isolate), Regalia (*Reynoutria* spp. extract) and ISR 2000 (*Lactobacillus acidophilus* fermentation product) were used. For comparison Quadris Maxx (Azoxystrobin 200 g/l+Difenoconazole 125 g/l), a chemical fungicide known to be effective against this disease, was also used in the study. A total of five spraying applications beginning at the fruit setting time, prior to appearance of disease symptoms were performed. Disease severity values on hazelnut leaves and fruits were calculated according to the Townsend-Heuberger formula using the 0-4 scale. The efficacy of fungicides was determined using Abbott's formula.

Results: The effectiveness of AQ 10 (*Ampelomyces quisqualis* M-10 isolate) was 21.07% on leaves and 21.29% on clusters; for Regalia (*Reynoutria* spp. extract) 19.13% and 28.09% anf for ISR 2000 (*Lactobacillus acidophilus* fermentation product) 19.23% and 10.80% on leaves and fruits respectively. Regarding chemical fungicide, Quadris Maxx (Azoxystrobin 200 g/l+Difenoconazole 125 g/l), the effectiveness was 91.98% on leaves and 73.63% on clusters.

Conclusion: The chemical fungicide Quadris Maxx (Azoxystrobin 200 g/l+Difenoconazole 125 g/l), used in this study provided sufficient efficacy for the disease control, while the efficacy of environmentally friendly products used was found to be quite low. However, it is very important to use of environmentally friendly products for the disease control and the further studies should be conducted.

Keywords: Hazelnut, Powdery mildew, Control, Environmentally fiendly products

Bazı Çevre Dostu Ürünlerin *Erysiphe corylacearum*'un Neden Olduğu Fındıkta Külleme Hastalığı Üzerindeki Etkinliği

Öz

Amaç: *Erysiphe corylacearum*'un neden olduğu külleme hastalığı, Türkiye'nin en önemli tarımsal ürünlerinden biri olan fındığın (*Corylus avellana* L.) verim ve kalitesini etkileyen başlıca hastalıklarından biridir. Çalışma 2017 yılında hastalığa karşı çevre dostu bazı ürünlerin (bir biyolojik fungisit, bir bitki ekstraktı içeren fungisit ve bir bitki aktivatörü) etkisini belirlemek amacıyla Giresun'da yürütülmüştür.

Matertal ve Yöntem: Ticari ürünler AQ 10 (*Ampelomyces quisqualis* M-10 izolatı), Regalia (*Reynoutria* spp. ekstraktı) ve ISR 2000 (*Lactobacillus acidophilus* fermantasyon ürünü) hastalığa karşı

çevre dostu ürünler olarak kullanılmıştır. Karşılaştırma amacıyla bu hastalığa karşı etkili olduğu bilinen kimyasal bir fungisit olan Quadris Maxx (Azoxystrobin 200 g/l + Difenoconazole 125 g/l) da çalışmada ele alınmıştır. Hastalık belirtileri ortaya çıkmadan önce, meyve bağlama döneminde başlayarak toplam 5 ilaçlama uygulaması yapılmıştır. Fındık yaprak ve çotanaklarındaki hastalık şiddeti değerleri 0-4 skalası kullanılarak Townsend-Heuberger formülüne göre hesaplanmıştır. Fungisitlerin etkinliği ise Abbott formülü kullanılarak belirlenmiştir.

Araştırma Bulguları AQ 10 (*Ampelomyces quisqualis* M-10 izolatı) için etkinlik yapraklarda %21.07, çotanaklarda %21.29; yaprak ve çotanaklarda sırasıyla Regalia (*Reynoutria* spp. ekstraktı) için %19.13 ve %28.09; ISR 2000 (*Lactobacillus acidophilus* fermantasyon ürünü) için %19.23 ve %10.80 olarak belirlenmiştir. Kimyasal fungisidin yapraklarda etkinliği %91.98, çotanaklarda ise %73.63 olarak belirlenmiştir.

Sonuç: Bu çalışmada kullanılan kimyasal fungisit Quadris Maxx (Azoxystrobin 200 g/l+Difenoconazole 125 g/l) hastalık kontrolü için yeterli etkinlik sağlarken, kullanılan çevre dostu ürünlerin etkinliği oldukça düşük bulunmuştur. Ancak hastalığın kontrolü için çevre dostu ürünlerin kullanılması çok önemli olup gelecekte yeni çalışmalar yapılmalıdır.

Anahtar kelimeler: Fındık, Külleme, Mücadele, Çevre dostu ürünler

Introduction

Hazelnut (*Corylus avellana* L.) is one of the most important agricultural products in Türkiye, the first in production and export in the world (FAOSTAT, 2022). Growing hazelnut is the main economical activity for about 400000 households in the Black Sea Region of Türkiye (Tanrıvermiş et al., 2006). Powdery mildew disease is usually caused by *Phyllactinia guttata* (Wallr.: Fr) Lév. infection on hazelnut worldwide and control of the disease is often neglected as the fungus does not directly affect the fruits. In 2013 a much more destructive disease symptoms was observed on hazelnut in Giresun province and in the following years disease has become epidemic for hazelnut production areas in Turkiye. In 2017, the causal agent of this disease was reported as *Erysiphe corylacearum* U.Braun & S.Takam. which has not been observed on *C. avellana* before and stated that in addition to its negative effect on Turkey's hazelnut production, for other parts of Asia and in Europe that disease is a latent threat to wild and cultivated hazelnut plants (Sezer et al., 2017). In accordance with this view, at later years *E. corylacearum* was also reported in Iran (Arzanlou et al., 2018), Azerbaijan (Abasova et al., 2018), Ukraine (Heluta et al., 2019), Georgia (Meparishvili et al., 2019), Switzerland (Beeken et al., 2020) Austria (EPPO, 2021), Spain (Mazzaglia et al., 2021), Italy (Mezzalama et al., 2021), Romania (Rosati et al., (2021), Germany (Beenken et al., 2022) Macaristan (Kalmár et al., 2023), Slovenia (Zajc et al., 2023) and Bulgaria (Boneva et al., 2023). After emerging destructive powdery mildew agent, several studies on the control of disease either with some chemicals or environmentally friendly products were conducted in Türkiye (Türkkan et al., 2018; Sezer et al., 2019; Tuğlu and Coşkuntuna, 2019; Gulcu 2022; Yıldırım, 2022; Özsoy, 2023).

Disease control efforts which started with temporary recommendations of some fungicides at first, it continues using many registered ones today (Sezer, 2016; Anonymous, 2023). Regarding the management of this emerging and destructive disease, the repeated application of some fungicides during the growing season is necessary. However these applications may cause some adverse effects on humans and the environment. Regarding these adverse effect it is very important to use of environmentally friendly products for management the disease. This study was conducted to determine the effects of one biological fungicide, one botanical fungicide and one plant defence activator on powdery mildew on hazelnut in Giresun in 2017.

Materials and Methods

The study were carried out in a hazelnut orchards on 'Tombul' hazelnut cultivar in Espiye of Giresun province on the Black Sea coast. A randomized block design was used with four blocks including five experimental plots per block according to four treatments and one control. Each plot consisted of three "ocak". Commercial products active ingredient with *Ampelomyces quisqualis* M-10 isolate (AQ 10), *Reynoutria* spp. extract (Regalia) and *Lactobacillus acidophilus* fermentation product (ISR 2000) were used as environmentally friendly products. One chemical fungicide determined as effective to this disease in previous years studies with active ingredient Azoxystrobin 200 g/l + Difenoconazole 125 g/l (Quadris Maxx) was used for comparison (Table 1).

Table 1. Information about the products used in the study

Active Ingredient	Trade Name	Formulation	Doses
Ampelomyces quisqualis M-10 isolate	AQ 10	WG	5 g/100 l
Reynoutria spp. extract	Regalia	SC	100 ml/100 l
Lactobacillus acidophilus fermentation product	ISR 2000	SL	100 ml/100 l
Azoxystrobin 200 g/l + Difenoconazole 125 g/l	Quadris Maxx	SC	80 ml/100 l

Products applications were carried out at least fifteen days intervals beginning at the fruit setting time, prior to appearance of disease symptoms, using 25 L backpack sprayer. A total of five spraying applications (on April 26, May 12, June 7 and 23, July 10) were performed. For severity of infection 21 days after the last application 120 leaves and 90 fruit clusters from each plots were selected at random and scored using the 0-4 scale where 0 indicates no sign of infection, 4 indicates powdery mildew visible on >60% of tissue of leaves or fruits (Sezer et al., 2019). These scores were then converted into estimated overall percentages of diseased foliage/nut clusters using the Townsend-Heuberger formula (Townsend and Heuberger 1943). The effectiveness of fungicides was calculated using Abbott's formula.

Results were evaluated statistically using the JMP statistical software. Variance analysis was applied to the results and the differences between the applications were determined with LSMeans Differences Student's t test.

Results and Discussion

In the trial orchard powdery mildew disease severity was very high with the rate of 75.35% on leaves and 72.16% on fruit clusters. While chemical fungicide, Quadris Maxx, has achieve effective control against to disease with 91.88% and 73.63% efficacy rate, none of the environmentally fiendly products was effective. Their efficacy rates were 19.13% – 21.07% for leaves and 10.80% – 28.09% for the fruit clusters, respectively (Table 2). High disease severity may cause this situation and incorporating these products with chemical fungicides may achieve more success for the disease control.

Table 2. Effectiveness of the applications

Treatment	Disease Severity for leaves (%)	Effectiveness of applications for leaves (%)	Disease Severity for fruit clusters (%)	Effectiveness of applications for fruit clusters (%)
Quadris Maxx (Azoxystrobin + Difenoconazole)	5.48c	91.88a	19.53d	73.63a
AQ 10 (*Ampelomyces quisqualis* M-10 isolate)	59.35b	21.07b	57.16bc	21.29bc
Regalia (*Reynoutria* spp. extract)	60.39b	19.13b	51.86c	28.09b
ISR 2000 (*Lactobacillus acidophilus* fermentation product)	60.89b	19.23b	64.23ab	10.80cd
Control	75.35a		72.16a	

* The difference between the means shown with the same letter in the same column is not significant at the 5% level

In a study conducted in Sakarya province *L. acidophilus* yeast extract + bonzaic acid, Acibenzolar - S- methyl harpin protein *Ampelomyces quisqualis* M-10 and fluopyram+tebuconazole were effective in decreasing disease severity by 49.26%, 55.83%, 33.34%, 45.86% and 63,27% respectively. (Tuğlu and Coşkuntuna, 2019). The products used that study, except chemical fungicide, were more effective than ones used our current study. Yıldırım (2022) investigated efficacies of tebuconazole plus azoxystrobin/*Reynoutria* spp. extract, sulfur/*Reynoutria* spp. extract, *Reynoutria* spp. extract/ sulfur, KH_2PO_4 plus sulfur, Na_2SiO_3 (moduli m2 and m3) plus sulfur, and $NaHCO_3$ against the disease in the Akçakoca district of Düzce Province. Efficacy of treatments was 65.0%-100%. Differences in activities of product in all these studies may result from regions, varieties and products being used in different programs.

Conclusion

The effectiveness of AQ 10 (*Ampelomyces quisqualis* M-10 isolate) was 21.07% on leaves and 21.29% on clusters; for Regalia (*Reynoutria* spp. extract) it was 19.13% and 28.09% and for ISR 2000 (*Lactobacillus acidophilus* fermentation product) was 19.23%) and 10.80%, respectively. Chemical fungicide, Quadris Maxx (Azoxystrobin + Difenoconazole) was highly effective with 91.98% on leaves and 73.63% on clusters. In conclusion, the results showed that the environmentally friendly products used in the current study were not effective enough for control of powdery mildew caused by *E. corylacearum*. However, regarding environmental impact of widespread fungicides application, it is very

important to use of environmentally friendly products for the disease control and the further studies should be conducted in different ecological condition, different spraying programmes with or without incorporate some chemical fungicides for this purpose.

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References

Abasova, L.V., Aghayeva, D.N., & Takamatsu, S. (2018). Notes on powdery mildews of the genus *Erysiphe* from Azerbaijan. *Current Research in Environmental & Applied Mycology*, *8*(1), 30-53.

Arzanlou, M., Torbati, M., & Golmohammadi, H. (2018). Powdery mildew on hazelnut (*Corylus avellana*) caused by *Erysiphe corylacearum* in Iran. *Forest Pathology*, 48,e12450.

http://dx.doi.org/10.1111/efp.12450

Beenken, L., Kruse, J., Schmidt, A., & Braun, U. (2022). Epidemic spread of *Erysiphe corylacearum* in Europe–first records from Germany. *Schlechtendalia*, *39*, 112-118.

BKÜ Data Base. (2023). Access address https://bku.tarimorman.gov.tr

Boneva, D.V., Bobev, S.G., & Van Poucke, K. (2023). First report of powdery mildew caused by *Erysiphe corylacearum* on hazelnut in Bulgaria. *Plant Disease*. Electronic early view.

https://doi.org/10.1094/PDIS-05-23-0840-PDN.

EPPO, (2021). *Erysiphe corylacearum*, an emerging pathogen of hazelnut in the EPPO region. EPPO Reporting Service no. 02-2021 Num. article: 2021/042. https://gd.eppo.int/reporting/article-6981

FAOSTAT, (2022). Crops and livestock products. Food and Agriculture Organization of the United Nations. https://www.fao.org/faostat/en/#data/qcl.

Gulcu, B. (2022). Field efficacy of trans-Cinnamic Acid against powdery mildew disease, *Erysiphe corylacearum*, in hazelnut fields. *Phytoparasitica*, *50*(5), 1091-1096.

Heluta V.P., Makarenko N.V., & Al-Maali G.A., (2019). First records of *Erysiphe corylacearum* (Erysiphales, Ascomycota) on *Corylus avellana* in Ukraine. *Ukrainian Botanical Journal*, *76*(3), 252-259.

Kalmár, K., Desiderio, F., & Varjas, V. (2023). First report of *Erysiphe corylacearum* causing powdery mildew on hazelnut in Hungary. *Plant Disease*, *107*(2), 579.

Mazzaglia, A., Drais, M.I., Turco, S., Silvestri, C., Cristofori, V., Aymami, A. Casadó, V., & Rovira, M. (2021). First report of *Erysiphe corylacearum* causing powdery mildew on *Corylus avellana* in Spain. *New Disease Reports*, 44(1), 1-3.

https://doi.org/10.1002/ndr2.12035.

Meparishvili, G., Gur, L., Frenkel, O., Gorgiladze, L., Meparishvili, S., Muradashvili, M., & Jabnidze, R. (2019). First report of powdery mildew caused by *Erysiphe corylacearum* on hazelnuts in Georgia. *Plant Disease*, *103*(11), 2952.

Mezzalama, M., Guarnaccia, V., Martano, G., & Spadaro, D. (2021). Presence of powdery mildew caused by *Erysiphe corylacearum* on hazelnut (*Corylus avellana*) in Italy. *Plant Disease*, *105*(05), 1565.

Özsoy, E. (2023). *Bazı bitki uçucu yağlarının fındıkta tahripkâr külleme hastalığı etmeni erysiphe corylacearum'a karşı in vitro antifungal etkinliğinin belirlenmesi.* Master's thesis, Ordu University, Ordu.

Rosati, M., Bogoescu, M., & Spadaro, D. (2021). First report of *Erysiphe corylacearum*, agent of powdery mildew, on hazelnut (*Corylus avellana*) in Romania. *Plant Disease*, *105*(9), 2728.

Sezer, A. (2016). Fındıkta külleme. *Ünye Ticaret Borsası Dergisi*, *2*, 42-45.

Sezer, A., Dolar, F.S., Lucas, S.J, Köse, Ç., & Gümüş, E. (2017) First report of the recently introduced, destructive powdery mildew *Erysiphe corylacearum* on hazelnut in Turkey. *Phytoparasitica, 45*, 577-581. https://doi.org/10.1007/s12600-017-0610-1

Sezer, A., Bilgen, Y., Duyar, Ö., Köse, Ç., Gümüş, E., & Er, T. (2019). *Erysiphe corylacearum*'un neden olduğu külleme hastalığına karşı Giresun ili fındık üretim alanlarında kimyasal mücadele olanaklarının belirlenmesi. *Akademik Ziraat Dergisi*, *8*(Özel Sayı), 71-78.

Tanrıvermiş, H., Gönenç, S., & Terzioğlu, S.B. (2006). Türkiye'de fındık üretiminin sosyo-ekonomik yapısı tamamlayıcı gelir kaynaklarını geliştirilebilme olanakları ve etkilerinin değerlendirilmesi. In 3. Milli Fındık Şurası (p. 125-144). Giresun.

Townsend, G.R., & Heuberger, J.W. (1943) Methods for estimating losses caused by diseases in fungicide experiments. *Plant Disease Reporter, 27*, 340-343.

Tuğlu, Ş.Ç., & Coşkuntuna, A. (2019). Sakarya ilinde fındık bahçelerinde külleme hastalığının mücadelesi. H. Demir (Ed.) In II. International Agricultural and Forest Congress Abstract Book (p. 22). İzmir.

Türkkan, M., Erper İ., Eser Ü., & Baltacı A. (2018). Evaluation of inhibitory effect of some bicarbonate salts and fungicides against hazelnut powdery mildew. *Gesunde Pflanzen*, 70, 39-44.

https://doi.org/10.1007/s10343-017-0411-y

Yıldırım, İ. (2022). Effects of eco-frıendly treatment programs on powdery mildew (*Erysiphe corylacearum* Braun & Takam) in hazelnut. *The Journal of Animal and Plant Sciences*, *32*(4), 1018-1027.

Zajc, J., Rot, M., Snoj, D., Žerjav, M., Schroers, H.-J., Piškur, B., Ogris, N., & Brglez, A. (2023). First report of *Erysiphe corylacearum* on *Corylus avellana* and *C. colurna* in Slovenia. *New Disease Reports*, *47*. e12160. https://doi.org/10.1002/ndr2.12160.