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Pest and beneficial complex in organic viticulture at the conditions of Gokceada Island

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Abstract. Population densities of harmful and predatory insects have been compared in six table (Trakya İlkeren, Alphonse Lavallée, Tekirdağ Çekirdeksizi, Cardinal, Italia, Amasya beyazı x 28/259-1) and six wine (Cabernet Sauvignon, Merlot, Syrah, Kalabaki, Sauvignon Blanc, Özer Karası) grape varieties in Gokceada between 2008 and 2011. No difference was determined among table grape varieties. Trakya llkeren has been the most suitable grape variety for Gokceada as it is rarely infested by the pests. Population density of *Colomerus vitis* Pgst. was statistically different in wine varieties in 2010. Cabernet Sauvignon has continuously been infested by the pest. *Arboridia adanae* Dlabola and Thrips spp. were harmful in Cabernet Sauvignon in 2011. Merlot has been infested with higher populations of insect pests in some years. Hence, Cabernet Sauvignon and Merlot should not be preferred in Gokceada. Kalabaki had the lowest population density. Effect of four combinations of green manure, farm manure and olive cake compost was observed on the population density of harmful and beneficial insects on Trakya Ilkeren and Cabernet Sauvignon. The combinations tested had no important effect on the population density of insect pests and predators. Organic fertilization program should be selected according to what grape and vine tree need.

1. Introduction

Gokceada Island is more advantageous when compared to other agroecological zones in Turkey. Synthetic pesticides and fertilizers are rarely used in the Island. It is not exposed to pollution because of the 14-mile-distance from mainland. Subsistence of strong wind is in favour of organic production. District Governorate of Gokceada supported constitution of organic agriculture and vineyard plantations in the Island since 2002.

In the study, the population densities of harmful and predatory insects have been monitored in six table (Trakya Ilkeren, Alphonse Lavallée, Tekirdag Çekirdeksizi, Cardinal, Italia, Amasya beyazi x 28/259-1) and six wine (Cabernet Sauvignon, Merlot, Syrah, Kalabaki, Sauvignon Blanc, Ozer Karasi) grape varieties established in Gokceada conditions between the years of 2008 and 2011 aiming at the selection of the most suitable varieties intended to be popularized in the Island. Additionally, effects of four different combinations of green manure, farm manure and olive cake compost were observed on the population density of harmful and beneficial insects on Trakya Ilkeren and Cabernet Sauvignon resembling table and wine grape varieties, respectively, to determine the optimum organic fertilization program for the Island.

1.1. Material and method

Pest and beneficial insects, table and wine grape varieties, farm manure, green manure (vetch), olive cake compost were the main material. The vineyard examined was established in 2006. Seedlings were grafted on Kober 5BB and planted by 2.5 m interval between the rows and 2.5 m-interval between the vine trees. Acreage was 20.2 ha.

1.1.1. Trial design of suitable variety selection

Table and wine varieties were grouped between each other. Each trial was designed as randomized blocks with 6 treatments (varieties) and 3 replications.

Table Grape Varieties: Trakya Ilkeren, Alphonse Lavallée, Tekirdag Cekirdeksizi, Cardinal, Italia, Amasya beyazi x 28/259-1 Wine Grape Varieties: Cabernet Sauvignon, Merlot, Syrah, Kalabaki, Sauvignon Blanc, Ozer Karasi.

1.1.2. Trial design of fertilization

Table (Trakya Ilkeren) and wine (Cabernet Sauvignon) were tested in different parcels by using randomized blocks with 4 treatments of fertilization and 3 replications.

Each plot has 10 vine trees. One row was left between two plots for confidence.

Composition and source of manures applied:

Olive cake compost was prepared by mixing remains of green manure, farm manure, olive cake, straw and leaves from organic orchards.

Farm manure was provided from an organic livestock farm in the Island.

Green manure was obtained from vetch (*Visia villosa* L.). Treatments:

A-Green manure + Farm manure
B-Green manure + Olive cake compost

Table 1. Economic threshold of grape pests.

Pest	Economic threshold
EGVM	First egg/100 bunches
Thrips spp.	Av. 3 thrips/bud-leaf
Leaf hoppers	Av. 5 individuals/leaf
Grape erineum mite	First gal/20–25 vines
Twospotted spidermites	Av. 8 individuals/leaf

C-Farm manure + Olive cake compost
D-Green manure + Olive cake compost + Farm manure.

1.1.3. Management of pests in organic agriculture

Population densities of the key pest, European Grapevine Moth (EGVM), *Lobesia botrana* Den.-Schiff), secondary pests such as black vine weevils (*Otiorhynchus* spp., *Megamecus shevketi* Marsch.), Grape thrips (*Rubiothrips vitis* (Priesner), *Mycterothrips albidicornis* Knechtel, *Mycterothrips tschirkunae* (Jachontov), *Frankliniella occidentalis* (Pergande), *Drepanothrips reuteri* Uzel and *Thrips tabaci*), Grape erineum mite (*Colomerus vitis* Pgst.), Grape leaf hoppers (*Arboridia* (=*Erythroneura*) *adanae* Dlabola) and twospotted spidermites (*Tetranychus urticae* Koch.) were monitored and compared to economical threshold (Table 1) to decide when a spraying is necessary. Forecasting system was used as a decision tool in the management of *L. botrana* [1].

1.1.4. Monitoring key and secondary pests

Pheromone traps of *L. botrana* were used to monitor adults. One trap each installed into suitable variety selection and fertilization plots. Traps were checked and counted weekly. Pheromone capsules changed once a month, whereas sticky surfaces changed when needed. Grape flowers and bunches were observed to find egg and larvae of *L. botrana* during critical periods according to the rules of Forecasting system [1].

From the beginning of vegetation period until autumn, 5–10 homogenous leaves were sampled from each plot, forthnightly. Sampled leaves were put into paper bags and transported into lab in an icebox. Stereomiscroscope was used during observation. Harmful insects were counted and recorded. Average gal number of *C. vitis* was taken into account in 2008, whereas average damage rate was calculated using rate of total gal surface to total leaf area in each infested leaf/replication in 2009, 2010 and 2011. Population densities were compared to economical threshold.

1.1.5. Monitoring predator insects and mites

Predators were counted during samplings as well as observations of leaves under microscope. Additionally, species caught were recorded during beating method used two times in 2011.

1.2. Assessment

For *L. botrana*, infested berries were counted in 16 bunches selected from 4 directions of 4 vines in each plot just before harvest. Additionally, average berry number of each variety were determined counting 10 selected bunches same day. Damage rates (%) were determined by comparing infested berry number to average berry number. Analysis of Variance is applied onto transformed values. LSD is used when comparing average values of different varieties and applications [2].

For secondary pests and predators, square root transformation and Analysis of Variance was applied to the total number of individuals per leaf in each replication. LSD is used when comparing average values of different varieties and applications. Average damage rate of *C. vitis* was calculated using rate of total gal surface to total leaf area in each infested leaf/replication. Analysis of Variance is applied onto transformed values. LSD is used when comparing average values of different varieties and applications [3].

2. Results and discussion

In 2008, vines were two years old and fruitless, yet. Since the number of leaves was limited on vines, any chemical was not applied. The vines began to produce fruit in 2010. They were first trained during pruning in 2010.

2.1. Monitoring the key pest, *Lobesia botrana*

Pheromone traps of *L. botrana* were installed into plots on 21 April 2008, 12 April 2009, 19 April 2010 and 25 April 2011. However, no adult has been captured in weekly checkings in 2008, 2009 and 2010. Only one egg of *L. botrana* was found in Trakya Ilkeren on 07 August 2009. Due to low population density of *L. botrana*, damage did not occur in test plots until harvest in 2008 and 2009. Any preventive measure required in the first two years of the study. Upon 7% infestation of bunches by *L. botrana* eggs on 24 June 2010, Rebound Bioinsecticide (150 g *Bacillus thuringiensis* var. *kurstaki* WP 16000 IU/mg and 1 kg granule sugar/100 l water) was used on 26 June 2010. The checkings continued until harvest but, no new egg or larva damage were found in test plots. Damage did not occur in Trakya Ilkeren and Cardinal plots until their harvest on 28 July 2011 because the population density of *L. botrana* was quite low. However, 6,5% infestation rate was determined in the bunches by *L. botrana* eggs on 15 August 2011 and Rebound Bioinsecticide (150 g *Bacillus thuringiensis* var. *kurstaki* WP 16000 IU/mg and 1 kg granule sugar/100 l water) was used on 18 August 2011. The checkings continued until harvest of other varieties on 25 August 2011, but no new egg or larva damage were found in test plots.

2.2. Monitoring secondary pests, predator insect and mites in table grapes

In 2008, the number of gals per leaf was taken into account during counts of *C. vitis*. Then, we thought that using damage rate calculated by comparing rate of total gal surface to total leaf area would be more realistic than number of gals per leaf. In 2010, number of sampling unit per plot increased to 10 leaves from 5 because the vegetative growth of vines is more vigorous.

Table 2. Groups formed as a result of LSD in table varieties in 2011.

Factor A (Variety)	Araneidae*	LSD ($P < 0,05$)
Trakya Ilkeren	1,623 *a*	0,137
A. Lavallee	1,410 *b*	
T. Cekirdeksizi	1,410 *b*	
Italia	1,410 *b*	
Cardinal	1,410 *b*	
A.beyazi x 28/259	1,410 *b*	
Factor A (Variety)	**Predatory mites****	**LSD ($P < 0,01$)**
A. Lavallee	3,240 *a*	0,904
A.beyazi x 28/259	3,207 *a*	
Italia	2,033 *b*	
T. Cekirdeksizi	1,820 *b*	
Cardinal	1,713 *b*	
Trakya Ilkeren	1,623 *b*	

*: Araneidae (*c.v.: 7,15*), **Predatory mites (*c.v.: 33,66*).

There was no important difference among table grape varieties in terms of population density and damage rate of pests as well as predators in 2008, 2009 and 2010, and of pests in 2011, statistically. Moreover, population densities of thrips species and *A. adanae* did not reach to economic threshold in those years. *C. vitis* was not observed in Trakya Ilkeren, Alphonse Lavallee and Tekirdağ Cekirdeksizi plots in 2008, but determined in Alphonse Lavallee and Tekirdağ Cekirdeksizi plots in 2009 at very low density, once. Gals of *C. vitis* were observed in small numbers in Cardinal and Amasya beyazıx 28/259 plots on 17 June 2008 and 1 July 2009, and in Italia on 4 August 2008 and 15 July 2009 for the first time. The lowest damage rate of *C. vitis* was in Trakya Ilkeren in 2010. The pest was not determined in Trakya Ilkeren in 2011. On the other hand, it was observed that the population density of *C. vitis* started to increase in other table varieties in 2010 and 2011 without statistically important difference. Damage rate was particularly higher in Italia and Amasya beyazi x 28/259 in 2010, and in Italia, Amasya beyazi x 28/259 and Alphonse Lavallee in 2011.

Although the highest population density of *T. urticae* was counted in Cardinal in 17 July 2008 (totally 91 ind./15 leaves; av. 6,07 ind./leaf), it did not reach to the economical threshold (av. 8 ind./leaf) in any of table varieties. It has been considered that increasing number of predatory mites starting from 17 July 2008 might have supressed the phytophagous ones. Population density of *T. urticae* was at an all-time low in 2009 in contrast to 2008, as a matter of fact it could not be determined in Italia, Tekirdag Cekirdeksizi and Amasya beyazi x 28/259 in 2009. Accordingly, predatory mites have been observed in only plots of A. Lavallee and Amasya beyazi x 28/259 in small numbers in 2009 on the contrary of the previous year. It was considered that repeated WP sulphur applications against Powdery mildew (*Erysiphe necator* Schwein.) and *C. vitis* on 13 May, 23 May and 25 June 2009 decreased the population density of predatory mites.

Average population density of predatory mites and Araneidae species were statistically different in table varieties in 2011 (Table 2).

Table 3. Groups formed as a result of LSD in wine varieties in 2008.

Factor A (Variety)	*T. urticae**	LSD ($P < 0,05$)
Sauvignon Blanc	7,455 *a*	3,097
Kalabaki	3,519 *b*	
Syrah	3,449 *b*	
Cabernet Sauvignon	3,398 *b*	
Merlot	2,938 *b*	
Ozer Karasi	1,859 *b*	

*: *T. urticae* (*c.v.: 27,9744*).

Table 4. Groups formed as a result of LSD in wine varieties in 2009.

Factor A (Variety)	Thrips *	LSD ($P < 0,05$)
Merlot	1,715 *a*	0,391
C. Sauvignon	1,276 *b*	
Kalabaki	1,276 *b*	
Sauvignon Blanc	1,244 *b*	
Italia x Favli 149	1,183 *b*	
Syrah	1,000 *b*	

*: Thrips (*c.v.:25,0953*).

2.3. Monitoring secondary pests, predator insect and mites in wine grapes

In 2008, statistical importance has been determined among wine varieties with respect to the population density of *T. urticae*. Population densities of thrips species and *A. adanae* did not reach to economic threshold. Gal numbers of *C. vitis* were higher in wine varieties than table varieties. The highest gal numbers were counted in Cabernet Sauvignon and Ozer Karasi. *T. urticae* was noticed in wine varieties on 17 July 2008, generally. The highest population density exceeding economic threshold occurred in Sauvignon Blanc (totally 164 ind./15 leaves; av. 11 ind. /leaf). However, no application was made against the pest because of the presence of predatory mites in all varieties since 17 July 2008. The pest was suppressed. Sauvignon Blanc had the highest population density of *T. urticae* (*a*) (Table 3).

Orius sp., Chrysopidae, *Coccinella septempunctata*, *Aeolothrips* sp. and Araneidae species were rarely observed in plots in contrast to predatory mites.

It has been considered that the number and diversity of pests and predators could be resourced from newly establishment of vineyard and unavailability of viticulture around.

Similar to table varieties, population densities of thrips species and *A. adanae* did not reach to economic threshold in 2009. *C. vitis* exceeded economic threshold being higher in wine varieties than table varieties. The highest gal numbers were counted in Cabernet Sauvignon and Kalabaki, but not statistically important. The difference among wine varieties were statistically important with respect to the population of thrips (Table 3). It was observed in wine varieties on 4 June 2009, being the highest in Merlot (0,4 ind. /leaf, *a*) but lower than economic threshold (av. 3 ind. /leaf) (Table 4).

Table 5. Groups formed as a result of LSD in wine varieties in 2010.

Factor A (Variety)	*C. vitis* *	**LSD** (*P<0,01*)
C. Sauvignon	25,733	11,241
Sauvignon Blanc	19,127	
Italia x Favli 149	13,440	
Kalabaki	12,967	
Merlot	12,537	
Syrah	9,010	

*: *Colomerus vitis* (*c.v.: 52,1141*).

Population densities of thrips, *A. adanae* and *T. urticae* did not exceed economic threshold in wine varieties in 2010 and 2011. However, in 2010, wine varieties were statistically different from each other with respect to the average damage rate of *C. vitis* (Table 5). The highest total damage rate was determined in Cabernet Sauvignon (57,64%) followed by Sauvignon Blanc (34,91%), Italia x Favli-149 (19,91%), Kalabaki (19,69%), Merlot (15,21%) and Syrah (8,8%) in 2010.

Number of predators was higher in wine varieties than table varieties in parallel to secondary pest populations. Besides *C. vitis*, population density of *A. adanae* was also higher in wine varieties. It was reported that grape leafhoppers cause less damage in seedless varieties since leaf epidermis is thicker, firmer and more hairy in seeded ones, generally [4]. When considered monthly average temperatures as another limitation factor in population increasing of *A. adanae,* especially June 2009 (22 °C) and June 2010 (23 °C) were quite lower than June 2008 (30 °C).

Damage rate of *C. vitis* were higher in wine varieties than table varieties in 2011 similar to 2009 and 2010. The highest damage rate was in Sauvignon Blanc, Ozer Karasi and Cabernet Sauvignon, respectively, but no statistical difference was determined. Research studies presented that Eriophyidae species can easily be sheltered from predatory mites due to their small body structures but host plants did not remain passive to their damage and resisted changing their structures [5]. *C. vitis* is a common pest species of vineyards in Switzerland. However, it was determined that the negative effect of the pest on photosynthesis can be ignored in Muscat variety and acaricide applications can be avoided if slight infestation is present [6].

In 2011, wine varieties were statistically different from each other with respect to the population densities of thrips, *A. adanae* and predatory mites (Table 6).

The highest numbers of thrips were found in Cabernet Sauvignon (*a*) and Merlot (*ab*), whereas the highest population density of *A. adanae* occurred in Merlot (*a*), Syrah (*a*), Cabernet Sauvignon (*a*) and Ozer Karasi (*ab*). As a result of analysis, a positive correlation was found between thrips and predatory mites ($P < 0,05$, $r = 0,481$). Similarly, a positive correlation was determined between *A. adanae* and predator Chrysopidae species ($P < 0,05$, $r = 0,550$). It is well known that *Chrysoperla carnea* (Steph.) (Neuroptera: Chrysopidae) is a polyphagous predator feeding on aphids, some scales, eggs and larvae of moths, psyllids, larvae of Chrysomelidae species, thrips, mites, whiteflies and leafhoppers [7–9].

Table 6. Groups formed as a result of LSD in wine varieties in 2011.

Factor A (Variety)	**Thrips***	**LSD** ($P < 0,05$)
C. Sauvignon	3,480 *a*	0,756
Merlot	2,920 *ab*	
Syrah	2,573 *bc*	
Kalabaki	2,517 *bc*	
Sauvignon Blanc	2,127 *c*	
Ozer Karasi	1,963 *c*	
Factor A (Variety)	*A. adanae* **	**LSD** ($P < 0,05$)
Merlot	2,610 *a*	0,638
Syrah	2,573 *a*	
C. Sauvignon	2,447 *a*	
Ozer Karasi	2,020 *ab*	
Sauvignon Blanc	1,793 *b*	
Kalabaki	1,517 *b*	
Factor A (Variety)	**Predatory mites*****	**LSD**($P < 0,01$)
Cabernet Sauvignon	2,310 *a*	0,473
Sauvignon Blanc	2,033 *ab*	
Ozer Karasi	1,713 *bc*	
Merlot	1,607 *bc*	
Syrah	1,410 *c*	
Kalabaki	1,410 *c*	

* *Thrips* spp. *(c.v.: 25,93).*
** *Arboridia adanae (c.v.: 25,35).*
*** Predatory mites *(c.v.: 23,96).*

Table 7. Groups formed as a result of LSD in wine varieties in 2008.

Factor A (Variety)	**Araneidae***	**LSD** ($P < 0,05$)
C. Sauvignon	1,667 *a*	0,359
Trakya Ilkeren	1,083 *b*	

*: Araneidae (*c.v.: 34,0503*).

2.4. Monitoring secondary pests, predator insects and mites in different organic fertilization programs

In 2008, 2009, 2010 and 2011, there was no important difference among four different fertilization programs in Trakya Ilkeren, table variety, and Cabernet Sauvignon, wine variety, in terms of population density and damage rate of pests as well as predators, statistically. None of the secondary pests exceeded the economic threshold except *C. vitis* in these plots throughout the study. When compared both varieties and fertilization programs together, population density of Araneidae species were different among varieties in 2008. Cabernet Sauvignon had the highest population density of the predator with *a* (Table 7).

It has been considered that the number and diversity of pests and predators could be resourced from newly establishment of vineyard, unavailability of viticulture around and lower average monthly temperatures in 2009 than 2008. It was determined that population density of *Empoasca vitis* increased during summer and possible reasons of thie increase were phenological stages of vines and growing parameters such as leaf density and clorofil concentration in leaves, topographic characteristics of test plots, and flora around [10]. In our test plots, we considered that population density of *A. adanae* was very

Table 8. Groups formed as a result of LSD in 2010.

Factor A (Variety)	*C. vitis* *	**LSD ($P < 0,01$)**
C. Sauvignon	18,355 *a*	**7,282**
Trakya Ilkeren	2,004 *b*	
Factor A (Variety)	*L. botrana* *	**LSD ($P < 0,05$)**
C. Sauvignon	0,737	0,701
Trakya Ilkeren	0,0	

*: *Colomerus vitis* and *Lobesia botrana* (*c.v.:34,05*).

Table 9. Predatory species and number of individuals determined in Canakkale-Gokçeada by beating in 2011.

Date	Species/Order/ Family	Treatment/Variety/ Replication	#
15.08.11	Psyllobora vigintiduopunctata L. (Col.: Coccinellidae)	Tab./A. Lavallee/3	1
		Table/T.Cekirdeksiz/2	2
		Table/Italia/1	2
		Wine/Merlot/3	1
		Fertilization-C/T. Ilkeren/2	1
		Fertilization-C/C. Sauvignon/2	2
26.08.11	*Orius* sp.	Fertilization-A/T. Ilkeren/3	1
	Chrysopidae sp.	Fertilization-A/T. Ilkeren/2	1

low because of regular removal of weeds by mechanical control, low leaf density in young vines and lower daily temperatures than other viticultural areas such as Manisa and Izmir in the Aegean Region. It was reported that grape leafhoppers cause less damage in seedless varieties since leaf epidermis is thicker, firmer and more hairy in seeded ones, generally [4]. In our study, we found that population density of *A. adanae* was higher in wine varieties of which leaves are more hairy and thicker, generally. Sensitivity and preferability of host plants may also depend upon climatic conditions, agricultural system, hairiness of leaves and stress conditions [11,12].

In 2010, there was an important difference between Cabernet Sauvignon and Trakya Ilkeren in terms of average damage rates of *C. vitis* and *L. botrana*. The highest damage rate was determined in Cabernet Sauvignon (*a*) (Table 8).

Beating method was only used in 2011 two times because the vines were too small, young and fragile to do it. Predatory species and numbers determined were given in Table 9.

3. Discussion

As a result, no difference has been determined among the table grape varieties in terms of the population density of harmful insects including the key pest, European Grapevine moth (*Lobesia botrana*), and secondary pests. Population density of any harmful species has reached to economic threshold except Grape erineum mite (*Colomerus vitis*) as reported in organic vineyards before [13]. Trakya lkeren is the most suitable grape variety recommended for Gokceada as it has been rarely infested by the insect pests throughout the study. When considered *C. vitis*, the most common and intensive pest species in Gokceada, its population density reached the economic level every year of the study besides statistically important difference among wine grape varieties in 2010. Cabernet Sauvignon has continuously been infested by *C. vitis*. Additionally, *Arboridia adanae* Dlabola and *Thrips* spp. were harmful in Cabernet Sauvignon in 2011. Merlot has been infested with higher populations of insect pests in some years. Hence, Cabernet Sauvignon and Merlot should not be preferred at Gokceada because of the difficulty in the management of these pests in organic agriculture. Kalabaki, one of the local and endangered wine grapes in Gokceada, has been the variety having insect pest problems least. Different organic fertilization programs had no important effect on the population density of insect pests and predators found in Trakya Ilkeren and Cabernet Sauvignon. Moreover, any harmful species except *C. vitis* has reached economic level in both of two varieties. For this reason, organic fertilization program should be selected according to what grape and vine tree need.

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