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Isonet LTT, a new alternative material for mating disruption of *Lobesia botrana* (Den. & Schiff.) in Turkey

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Abstract. European Grapevine Moth (EGVM), *Lobesia botrana* (Den. & Schiff.) (Lepidoptera: Tortricidae) is the key pest of grape in Turkey. The efficacy of Isonet LTT has been tested against *L. botrana* in comparison with registered Isonet L dispensers in Manisa and Canakkale, Turkey. One chemically treated vineyard was used to compare infestation levels for each location. By the emergence of the first EGVM adult, ∼320 Isonet LTT and 650 Isonet L dispensers/ha -including borders- were installed once a year. EGVM adults have been monitored in all plots by pheromone traps from the beginning of the flight until harvest. Infestation rates were compared. We indicated that both Isonet LTT and Isonet L dispensers showed excellent performance against the pest without additional treatment in 2015 and 2016. Average infestation rates of EGVM were below the threshold of 6%. EGVM infestation has been maintained at zero level by sprayings five and four times in the chemical treated vineyard in 2015 and 2016 in Manisa. Isonet LTT dispensers released 340 and 370 mg pheromone until harvest (19 August 2015 and 16 August 2016) in Manisa, whereas they released 360 and 410 mg of until harvest (27 August 2015 and 22 August 2016) in Canakkale, respectively.

1. Introduction

Turkey has more than 300 native grape varieties. Sultani Cekirdeksiz (*Vitis vinifera* L.) is the most important variety and its production is mainly undertaken in the western part of Turkey. The Aegean Region is the most important area including 28% of the vineyard surface in Turkey [1]. Production area of Sultani Cekirdeksiz is mostly placed in Manisa Province with 12% [2].

European Grapevine Moth (EGVM), *Lobesia botrana* (Den. & Schiff.) (Lepidoptera: Tortricidae) is the key pest of grape in Turkey [3,4]. Until 2000s, priority has been given to synthetic pesticide application for the control of EGVM. This moth shows three or four generations in the Aegean due to the favourable climatic conditions for the pest requiring frequent sprayings. Thus, the negative effects of the chemical control on the environment and the human health have led up to the adoption of biotechnical methods against the pest. Among them, Mating Disruption (MD) technique by Isonet-L and RAK 2R have been tested and registered against EGVM in Turkey in 2003 and 2012 [5,6].

Grape growers preferring mating disruption have been subsidized by the Ministry of Food, Agriculture and Livestock since 2010 [7].

In this study we use for the first time in Turkey the dispensers Isonet LTT, the new dispenser of Shin Etsu, testing their efficacy against EGVM in comparison with Isonet L dispensers.

1.1. Material and method

Main material of the study are grape, *L. botrana* , Isonet LTT, Isonet L and monitoring pheromone traps. The study was carried out in Sultani Çekirdeksiz (*Vitis vinifera* L.) vineyards in Manisa-Center and in a Cabernet Sauvignon vineyard in Çanakkale-Ezine in 2015 and 2016.

Pheromone treated vineyards in Manisa were organic. The vineyard in Çanakkale-Ezine was integrated. Preparations officially allowed in organic agriculture have been used against diseases in organic vineyards. If chemical control is necessary for diseases in integrated vineyards, the pesticides were selected among the less toxic preparations for the environment according to the principles in Grape Integrated Pest Management Instruction Book [8] by the official inspectors. Neither economic threshold nor pesticide selection have been taken into consideration in chemical treated (conventional) vineyard by grower.

Dispenser characteristics

Isonet-LTT: 344 mg pheromone (E-7, Z-9 dodecadienyl-1-yl acetate)/dispenser; ∼320 dispensers/ha including border, at 4 m intervals on the borders, 7 m intervals on the rows in every second row (1 dispenser/42 m^2) in the center.

Isonet-L: 172 mg per pheromone/dispenser; ∼650 dispensers including border/ha at 2 m intervals on the borders, 7 m intervals on the rows in each row (1 dispenser/21–22.5 m^2) in the center.

Installation

The experiment was set in accordance with Standard Guidelines established by the General Directorate of Agricultural Researches and Policies suitable for the registration of mating disruption products in Turkey [9].

Isonet-LTT and Isonet-L dispensers were applied in neighbour organic vineyards (totally 25 ha) in Manisa-Merkez and in an integrated vineyard (9 ha)

Table 1. Trap and dispenser installation dates in Manisa and Çanakkale-Ezine in 2015 and 2016.

Manisa-Center			Çanakkale-Ezine		
Trap	First Adult	Disp. inst.	Trap	First Adult	Disp. inst.
24.03.15	09.04.15	24.03.15	01.04.15	–	01.04.16
08.03.16	15.03.16	23.03.16	06.04.16	–	06.04.16

in Çanakkale-Ezine just before the expected first adult capture in Manisa (end of March) and Canakkale-Ezine (early April).

In Manisa, untreated control vineyard is 0.1 ha and 600 m far from pheromone treated vineyards, whereas chemical treated vineyard is 0.2 ha and 300 m far from test vineyards. In Çanakkale-Ezine, the Isonet-LTT treatment area (5 ha in 2015 and 8 ha in 2016) and control plot (0.1 ha) has been separated from each other leaving a buffer zone (4 ha) treated with Isonet L in 2015 and a buffer zone (1 ha) treated with chemicals in 2016.

If required, buffer application was also applied at the same density. Flight of adults has been monitored in all treatments and compared to each other by pheromone traps (Pherocon® EGVM) from the beginning of flight period until harvest. Three each pheromone traps were installed in Isonet L and Isonet LTT plots whereas one each trap was installed in untreated control and chemical treated vineyards. Pheromone treated areas were divided into four blocks (replication). Infestation rates were determined by checking 200 bunches per block in expected critical periods during first, second and third generations and at harvest. Same assessment process was followed in untreated control and chemical control vineyards. When a living egg, larva and/or damage with larvae were found on the bunch, it was assumed as infested [9]. Means' comparisons were made using the Duncan's multiple-range test to determine whether there was a significant difference between the average values of the infestation rates. Data have been processed with SAS (Windows version 6.12) program.

Timing of chemical applications has been decided by means of Forecasting System against *L. botrana* in the chemical treated vineyards.

Pheromone release rates of Isonet LTT has been calculated by weekly weighing 5 dispensers in the experimental vineyards from the installation until harvest. After the calculation of average weights of dispensers, diagrams were drawn.

Meteorological data regarding average daily temperature, relative humidity and maximum wind speed have been recorded by the electronic station used for Forecasting System by the Extention Service in Manisa and electronic station (Metos) in test vineyard of Çanakkale-Ezine.

2. Results and discussion

Dates of trap and dispenser installation, and first adult capture in pheromone traps are included in Table 1. In Çanakkale-Ezine, first adult capture date could not been detected since any vineyard is available around test vineyard. Despite 500 m distance between them, trap catches in untreated control was negatively affected by pheromone treated area.

Table 2. Average infestation rates of *L. botrana* in Isonet-LTT, Isonet-L, Untreated Control and Chemical treated plots in Manisa in 2015 and 2016.

Date/gen.	Isonet-LTT	Isonet-L	UC[1]	CT[1]
22.05.15/1	0.25	0.1	1	4
10.06.15/2	0.38	0	5	0
28.07.15/3	0.13	0.2	2	0
12.08.15/4	0	0.25	3	0
19.08.15/harvest[2]	**0.38 b**	**0.3 b**	**29 a**	**0 b**
17.05.16/1	0	1	4	0
22.06.16/2	1	0	0	0
27.07.16/3	0.29	0	2	0
16.08.16/harvest[2]	**0.29 b**	**0 b**	**6.25 a**	**0.25 b**

[1] UC = Untreated Control, CT = Chemical Treated,
[2] $P < 0.05$.

A 100% trap shut down was obtained in Isonet-L plot in both the experimental years. Isonet-LTT succeeded 100% and 99,27% of capture reduction in 2015 and 2016 when compared with trap catches (116 and 46 adults) in untreated control in Manisa. Capture reduction was 100% in Isonet-L and Isonet-LTT plots when compared with trap catches (2 and 6 adults) in untreated control of Çanakkale-Ezine.

No insecticide has been applied against *L. botrana* in the pheromone treated and untreated control vineyards whereas fungicides have been applied against diseases. Sulphur in the control of *Erysiphe necator* 'Sch'Burr. and *Colomerus vitis* Pgst. and copper in the control of *Phomopsis viticola* (Sacc.) Sacc.) and (*Plasmopara viticola* (Berk. Et M. A. Curtis) were used.

When discussed two year-results related to Isonet-LTT, it has been perceived that the infestation rates have been under the threshold (5–6%) in all pheromone treated areas in Manisa and Çanakkale-Ezine.

Average infestation rates of Isonet-LTT before harvest have been at an acceptable level, accounting for 0.38% and 0.29% on 19 August 2015 and 16 August 2016 in Manisa (Tables 2), 1.13% and 1.5% on 27 August 2015 and 22 August 2016 in Çanakkale-Ezine (Table 3), respectively.

Isonet LTT dispensers showed sufficient efficacy against the pest without additional treatment in 2015 and 2016, since the infestation rate of the pest has been suppressed below 6% by two year-successive MD applications. Comparison treatment of Isonet-L provided the best performance both in 2015 and 2016 (Table 2 and 3) with almost zero infestation.

After the application of Duncan's test to square transformed average infestation rates, Isonet-LTT, Isonet-L and Chemical treatment were in the same statistical

Table 3. Average infestation rates of *L. botrana* in Isonet-LTT, Isonet-L, Untreated Control and Chemical treated plots in Çanakkale-Ezine in 2015 and 2016.

Date/gen.	Isonet-LTT	Isonet-L	UC[1]	CT[1]
26.05.15/1	0	0	0	–
24.06.15/2	0.2	0	1	–
29.07.15/3	1.3	0	5	–
27.08.15/harvest[2]	**1.13 b**	**0 c**	**18 a**	**–**
30.05.16/1	0	–	0	0
28.06.16/2	1.5	–	3	0
26.07.16/3	1	–	5	0
22.08.16/harvest[3]	**1.5 ab**	**–**	**4.5 a**	**1 b**

[1] UC = Untreated Control, CT = Chemical Treated, [2] $P < 0.01$, [3] $P < 0.05$.

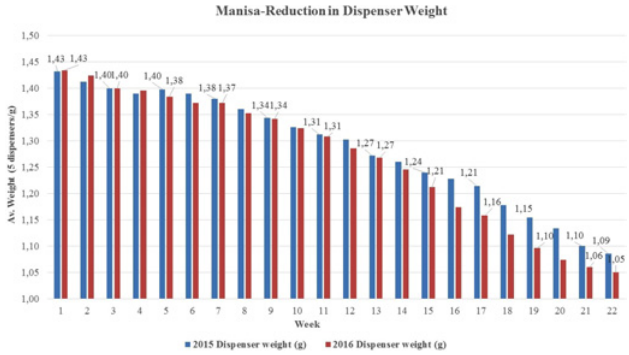

Figure 1. Weekly weight of Isonet-LTT dispensers in Manisa in 2015–2016.

group differing from untreated control in Manisa in 2015 and 2016 ($P < 0.05$). The infestation rates of *L. botrana* have been maintained at zero level in chemical treated vineyard of Manisa by five sprayings (lambda cyhalothrin, chlorpyrifos methyl) in 2015 and four sprayings (*Bacillus thuringiensis*) in 2016. It is usual to apply chemicals against the pest in the centre of Manisa Province four or five times per season.

In Çanakkale-Ezine, all groups were statistically different from each other. Isonet-L showed the best performance with zero infestation followed by Isonet-LTT with an acceptable level of infestation (1.13%) under the threshold (6%) in 2015 ($P < 0.01$). In 2016, Isonet-LTT showed sufficient efficiency (1.5%) just behind the chemical treatment (1%) ($P < 0.05$). *L. botrana* population density was lower in untreated control plots of both locations in 2016 than 2015 (Tables 2 and 3). Due to lower temperature in Çanakkale, the pest has shorter flight period and produces less generations 2–3 than Manisa (3–4) per year [10]. The pest has been suppressed by three sprayings of spinosad in Chemical treated plot.

Temperature can be one of the most important factors affecting efficacy and stability of the synthetic pheromone in outer conditions. Isonet LTT dispensers released 340 and 370 mg pheromone blend until harvest (19 August 2015–16 August 2016) in Manisa (Fig. 1). The released amounts were 360 and 410 mg until harvest (27 August 2015–22 August 2016) in Canakkale, averagely (Fig. 2)

Table 4. Monthly average temperature (°C), relative humidity (%) and wind speed (m/sec) in Manisa in 2015 and 2016.

Month	2015			2016		
	Temp.	R. H.	Wind	Temp.	R. H.	Wind
April	13.86	56.94	1.35	17.54	56.71	1.45
May	21.67	51.56	1.29	19.06	61.80	1.18
June	23.78	58.33	1.13	25.50	56.42	1.05
July	29.10	42.31	1.50	26.65	56.08	1.14
August	29.67	47.38	1.29	27.20	59.36	1.06

Table 5. Monthly average temperature (°C), relative humidity and wind speed (m/sec) in Çanakkale-Ezine in 2015 and 2016.

Month	2015			2016		
	Temp.	R. H.	Wind	Temp.	R. H.	Wind
April	11.94	68.17	1.93	16.0	63.5	2.3
May	20.43	60.84	1.43	18.1	65.2	2.8
June	23.73	58.97	1.24	24.4	57.8	3.6
July	27.79	52.16	2.51	26.5	52.1	4.5
August	27.47	57.50	2.40	26.6	57.1	4.9

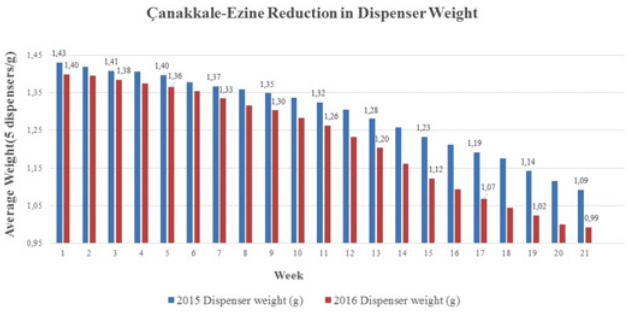

Figure 2. Weekly weight of Isonet-LTT dispensers in Manisa in 2015–2016.

Despite lower monthly average temperature, (Tables 4 and 5), in Manisa and Çanakkale-Ezine, higher pheromone amount has been released from the dispensers in 2016 than 2015.

Wind speed is also one of the important factors affecting the efficacy and stability of pheromone in outer conditions. An ideal dispenser should release less pheromone when strong wind blows and mating does not usually occur. On the other hand, any possible decrease in release rate during stable periods after strong winds can have risk in terms of mating. If wind speed increases from 1 m/s to 2.5 m/s, pheromone release rate increases 13% but pheromone concentration in the atmosphere decreases by half [11]. In Manisa, wind speed was generally low remaining ≤ 1.5 m/s. Therefore, we may conclude that the wind is unimportant to limit the performance of Isonet LTT in 2015 and 2016. However, in Çanakkale-Ezine, wind was much stronger in 2016 than 2015 as well as both two year-wind speed of Manisa (Tables 4 and 5). For that reason, the highest pheromone release/season (410 mg) occurred in Çanakkale-Ezine in 2016 (Fig. 2).

3. Conclusion

In the Aegean Region Isonet-LTT dispensers can be used to control *L. botrana* in the vineyards. In this study, both Isonet-L and Isonet LTT have provided very good performance. Isonet-L is still the best with zero adult capture and infestation in parallel to the biological efficiency study of RAK 2 R compared with Isonet L in Manisa [12].

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