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Combined control of *Adoxophyes orana* Fischer von Rosslerstamm (Lepidoptera: Tortricidae) on Peach trees in Imathia Greece

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Abstract
The purpose of the present study was to explore combined chemical control of *A. orana* in peach trees orchards in Imathia, Greece. Recordings of generations during season have been performed and total peach production was measured in treated and untreated part of orchard. Eight traps were placed for each year and orchard. Each trap was checked every 15 days and the pheromone was updated monthly until the end of August. Subsequently, 3 treatments were applied to the experimental orchard, with the insecticides Delegate, Lamdex and Runner, to control the insect populations. The three different insecticides used in this study managed to control *A. orana* below economic damage levels, without the development of considerable resistance of the insects. Treated orchards yielded better than untreated by almost 30%. In 2018 was better control of the insect and populations were decreased in treated orchards by 65% approximately, in comparison to 54% in 2017, indicating continuous efficiency of insecticides.

Keywords: Plant protection, tree culture, moths

Introduction

Summer fruit tortrix *Adoxophyes orana* Fischer von Rosslerstamm (Lepidoptera: Tortricidae) is a polyphagous moth species and severe enemy of peach trees in Greece (Navrozidis and Tzanakakis, 2005; Navrozidis *et al*., 2011) [14, 15] as well as in rest of Europe and Asia, and lately in North America (HYPP Zoology Fact Sheet, 2013) [10]. *A. orana* overwinters in the larval stage in a loosely woven cocoon on the host plant. The overwintered larvae feed and pupate in the spring to produce the first generation of adults which emerge during late May to late June in Europe. Males have a wingspan of 15-19mm. The forewings of the male are a light grayish-brown or yellowish-brown with distinct dark brown markings. The hing wings are light gray. The first generation of adults gives rise to the first generation of summer caterpillars. Larvae are 18-22 mm in length and greenish yellow to olive green in colour. The head of the caterpillar is brown when young and turns to a honey-yellow colour when mature. Thoracic legs are light brown. Females have a wingspan of 19-22mm. The forewings are a dullish gray-brown colour with markings that are less distinct than in the male moth. The hindwings are brown-gray. The second generation of adults flies in July in Europe and then gives rise to the third generation of fall caterpillars (in August to September) which overwinter until the following spring (Davis *et al*., 2005; Navrozidis *et al*., 2011; HYPP Zoology Fact Sheet, 2013) [7, 15, 10]. In Greece, first appear was recorded in 1985 with many damages on cherry, apple and peach trees (Savopoulou-Soultani *et al*., 1985) [18]. According to Minks and de Jong (1975) [13] it appears that the economic risk limit (loss) is determined at 5 - 10 insects/ trap /week. Sex pheromone traps (Delta-type) (Minks and Voerman, 1973; Pehlevan and Kovanci, 2014) [12, 16] are used for both surveillance and partial population control of the insect.

Against *A. orana*, a large number of insecticides are being widely used, like organophosphates with active substances chlorpyrifos - methyl, triazophos, etc., synthetic pyrethroids, but also carbamids acting through the carbaryl compound (Charmillot and Brunner, 1989; Cross, 1997; Charmillot and Pasquier, 2006) [3, 6, 4], although research by Cross (1997) [6] describes the development of considerable resistance of *A. orana* to the use of organophosphate insecticide, chlorpyrifos. Also, the organophosphate insecticide phosalone has anti-insect action.

In addition, hexaflumuron is considered a remarkable growth regulator, comparable to conventional insecticides, which has been used successfully against *A. orana*. Injections of hexaflumuron should start at the onset of laying or at the egg stage or even at the beginning of the prepupa-pupa stage. Spraying should cover the entire carpal and leaf area (Komblas *et al*., 1989) [11]. Application of the phenoxycarb carbamide growth regulator in spring, against the larval stages of the wintering generation, showed good results (de Reed *et al*., 1984; Galli, 1984; Charmillot and Blaser, 1985; Charmillot and Brunner, 1989; Cross, 1997) [17, 9, 2, 3, 6]. However, fenoxycarb is considered to be a high risk for insect pests and predators (Dorn *et al*., 1981; Staubli *et al*., 1988) [8, 19]. In addition to phenoxycarb, other growth regulators such as lufenuron, methoxyfenozide, tebufenozide, with remarkable insecticide effectiveness against *A. orana* larvae, are reported. The use of indoxacarb and the biological control chemicals like emamectin and spinosad against the insect appears to be effective (Charmillot *et al*., 2006; Charmillot and Pasquier, 2006) [4, 5].

The purpose of the present study was to explore combined chemical control of *A. orana* in peach trees orchards in Imathia, Greece. Recordings of generations during season have been performed and total peach production was measured in treated and untreated part of orchard.

Materials and methods

This research was conducted in Imathia, Greece, during years 2017-2018. 1 Ha of peach trees orchard was used of the variety Mosiani 90 on GF 67. 0.5 Ha was the experimentation part of the orchard where the inseciticide treatment against *Adoxophyes orana* Fischer von Rosslerstamm (Lepidoptera: Tortricidae) took place, while the rest orchard was used as check (control orchard). These two areas of peach trees were about 300 m apart. The age of peach trees ranged from 10 to 12 years. The peaches were linearly arranged (4 m in line and 5 m between the lines), shaped into open cups.

White, pheromone Delta-type traps with Pherodis pheromones were suspended for the capture of males of *A. orana*. Eight traps were placed for each year and orchard. Trap posting dates were 20/4/2017 for the first year and 20/4/2018 for the second year. Each trap was checked every 15 days and the pheromone was updated monthly until 30/8/2017 and 25/8/2018 for each year respectively. Subsequently, 3 treatments were applied to the experimental orchard, with the insecticides Delegate, Lamdex and Runner (trademarks of the production companies), respectively, and their active substances are spinetoram, lambda-cyhalothrin and methoxyfenozide respectively, per year, and at 1/5/2017, 25/6/2017, 10/8/2017 for the first year of the study and 8/5/2018, 23/6/2018, 14/8/2018 for the second year, for the control of *A. orana*. No treatments were performed in the control peach pest. The cultivation cares of the two peach orchards concerned, (a) the drip irrigation method, (b) the application of nitrogen, phosphorus, potassium and iron fertilizers, and (c) the treatment of weeds with disc harrows. During the two-year experiments, the climatic conditions (temperature and relative humidity) of the area were recorded. The production of peaches in Kg per year and orchards was also measured on a weighbridge balance of 1 Kg precision, in both treated and untreated parts of orchard.

Statistics have been performed in MS-Excel spreadsheet. Sums and total were calculated. Mean values, total mean and standard deviation were also calculated. Total mean comparisons have been made using Duncan’s test at 0.05 level.

Results

The prevailing climate conditions per month (temperature, relative humidity) of the area during the two years of the survey are described in the Figures (1, 2) below.

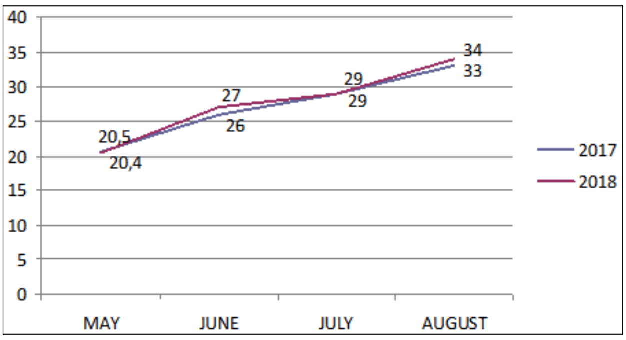

Fig 1: Mean monthly temperature of the orchard area during years 2017 and 2018

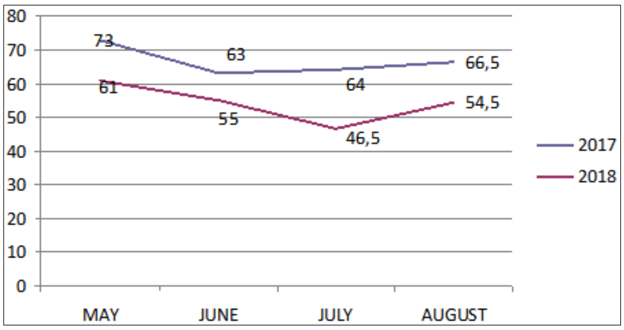

Fig 2: Mean monthly %humidity of the orchard area during years 2017 and 2018

Table 1: Male captures recording of *A. orana* in pheromone traps, in chemical treated orchard, in 2017

Recording date	No of trap										Generation & Treatment
	1	2	3	4	5	6	7	8	Total	Mean	
1 - 15/5	64	22	66	153	104	196	74	45	724	90.5	20/5, First generation
15 - 31/5	10	11	15	20	5	4	6	10	81	10.13	Treatment/application
1 - 15/6	20	2	18	5	30	11	9	45	140	17.5	Treatment/application
15 - 30/6	84	27	114	65	34	73	164	61	622	77.75	17/6, Second generation
1 - 15/7	10	11	15	20	5	4	6	10	81	10.13	Treatment/application
15 - 31/7	11	4	10	11	8	7	8	18	77	9.625	Treatment/application
1 - 15/8	69	44	105	60	44	68	139	109	638	79.75	10/8, Third generation
15 - 25/8	29	35	26	37	32	19	24	28	230	28.75	End of generation
Sums	297	156	369	371	262	382	430	326	2593	324.1	Standard dev. 43.44

Differences of means were statistically significant at 0.05 level

Table 2: Male captures recording of *A. orana* in pheromone traps, in untreated orchard (check), in 2017

Recording date	No of trap										Generation
	1	2	3	4	5	6	7	8	Total	Mean	
1 - 15/5	135	126	141	120	110	125	121	115	993	124.1	20/5, First generation
15 - 31/5	56	60	71	70	80	85	91	74	587	73.38	
1 - 15/6	75	81	100	79	85	92	98	81	691	86.38	
15 - 30/6	103	119	123	115	125	109	111	112	917	114.6	17/6, Second generation
1 - 15/7	59	67	54	58	61	62	64	54	479	59.88	
15 - 31/7	68	70	84	82	83	85	91	69	632	79	
1 - 15/8	106	122	113	105	115	114	116	117	908	113.5	10/8, Third generation
15 - 25/8	65	62	51	52	53	61	59	65	468	58.5	End of generation
Sums	667	707	737	681	712	733	751	687	5675	709.4	Standard dev. 25.44
Differences of means were statistically significant at 0.05 level											

Table 3: Male captures recording of *A. orana* in pheromone traps, in chemical treated orchard, in 2018

Recording date	No of trap										Generation & Treatment
	1	2	3	4	5	6	7	8	Total	Mean	
5 - 20/5	121	89	142	136	78	74	65	95	800	100	17/5, First generation
20/5 - 5/6	14	1	15	7	6	1	2	3	49	6.125	Treatment/application
5 - 20/6	17	3	10	8	10	5	2	14	69	8.625	Treatment/application
20/6 - 5/6	87	32	63	24	41	28	29	56	360	45	17/6, Second generation
5 - 20/7	4	1	6	4	5	3	1	4	28	3.5	Treatment/application
20/7 - 5/8	32	13	33	24	16	1	4	17	140	17.5	Treatment/application
5 - 20/8	91	48	61	121	57	78	86	66	608	76	14/8, Third generation
20 - 30/8	10	7	9	8	12	8	6	9	69	8.625	End of generation
Sums	376	194	339	332	225	198	195	264	2123	265.38	Standard dev. 36.88
Differences of means were statistically significant at 0.05 level											

Table 4: Male captures recording of *A. orana* in pheromone traps, in untreated orchard (check), in 2018

Recording date	No of trap										Generation
	1	2	3	4	5	6	7	8	Total	Mean	
5 - 20/5	125	136	129	121	110	113	141	115	990	123.75	17/5, First generation
20/5 - 5/6	76	73	69	81	85	87	95	96	662	82.75	
5 - 20/6	80	91	101	84	87	93	110	104	750	93.75	
20/6 - 5/6	164	153	148	170	175	161	159	141	1271	158.88	17/6, Second generation
5 - 20/7	70	75	68	60	65	80	90	84	592	74	
20/7 - 5/8	99	79	98	75	78	71	85	91	676	84.5	
5 - 20/8	127	119	132	125	150	145	148	152	1098	137.25	14/8, Third generation
20 - 30/8	27	30	24	25	23	35	38	29	231	28.875	End of generation
Sums	768	756	769	741	773	785	866	812	6270	783.75	Standard dev. 39.77
Differences of means were statistically significant at 0.05 level											

Table 5: Total orchard yield in Kg for treated and check parts of orchards in years 2017 and 2018

2017		2018	
Treatment	Check (untreated)	Treatment	Check (untreated)
19,820	15,220	20,650	15,832
Weighbridge balance of 1 Kg precision			

Differences in chemically treated and untreated orchards were obvious in both years (Tables 1, 2, 3, 4). Statistically significant differences were found between mean values found across time and generations.

Differences between years were also obvious, especially for treatment application efficiency. In 2018 were better control of the insect and standard deviations were similar in treated and untreated orchards (in comparison to 2017).

According to the results (Table 5), total yield of peach production in the experimental orchard was 19,820 Kg, while in the check (untreated control) production reached 15,220 Kg in 2017. For 2018, the treated orchard production was 20,650 Kg and in the check (untreated control), 15,832 Kg. In year 2018 production was somewhat higher in comparison to 2017 and difference between treated and untreated orchards was better for 2018 (4,818 Kg in comparison to 4,600 Kg).

Discussion

Treated orchards showed lower numbers of captured males after insecticide applications. This resulted in lower mean values between treated and untreated orchards showing the efficiency of insecticide applications. Environment-friendly insecticides have been proven efficient (Dorn *et al*., 1981; Charmillot *et al*., 2006) [8, 4], especially for methoxyfenozide, with remarkable insecticide effectiveness against *A. orana* larvae (Borchert *et al*. 2004) [1], which was used in the present study.

Efficiency between years was found different. In 2018 were better control of the insect and populations was decreased in treated orchards by 65% approximately, in comparison to 54% in 2017. This may be due to effective insecticide application in two continuous years, without the development of considerable resistance of *A. orana* to the use of other insecticides Cross (1997) [6]. This result is also depended on the use of three different insecticides in the present study.

Treated orchards yielded better than untreated by almost 30%. This was in accordance to reported damages by Savopoulou-Soultani *et al*. (1985) [18]. Also, efficiency was in accordance to Minks and de Jong (1975) [13] reports where economic risk limit (loss) was determined at 5 - 10 insects/ trap /week. Production levels were in accordance to the expected ones for the insecticide treated peach tree orchards (Tavoularis, 2012) [20], indicating satisfactory efficiency of applications.

Concluding, the three different insecticides used in this study managed to control *A. orana* below economic damage levels, without the development of considerable resistance of the insects. In 2018 was better control of the insect and populations were decreased in treated orchards by 65% approximately, in comparison to 54% in 2017, indicating continuous efficiency of insecticides.

References

1. Borchert DM, Walgenbach JF, Kennedy GG, Long JW. Toxicity and residual activity of methoxyfenozide and tebufenozide to codling moth (Lepidoptera: Tortricidae) and oriental fruit moth (Lepidoptera: Tortricidae). Journal of Economic Entomology. 2004; 97(4):1342-52.
2. Charmillot PJ, Blaser C. Le fenoxycarb, un regulateur de croissance d' insectes homologue contre la tordeuse de la pelure *Adoxophyes orana* F. v. R. *Revue suisse* de Viticulture, Arboriculture, Horticulture. 1985; 17(2):85-92.
3. Charmillot PJ, Brunner JF. Summerfruit tortrix, *Adoxophyes orana*, life cycle, warning system and control. Entomologia Hellenica. 1989; 7:17-26.
4. Charmillot PJ, Pasquier D. Efficacite et remanence de differents insecticides sur les chenilles de capua (*Adoxophyes orana*). Revue suisse de Viticulture, Arboriculture, Horticulture. 2006; 38(6):371-276.
5. Charmillot PJ, Blanc G, Pasquier D. Premier cas de resistance en Suisse de la tordeuse de la pelure capua (*Adoxophyes orana*) aux insecticides. Revue suisse de Viticulture, Arboriculture, Horticulture. 2006; 38(2):87-93.
6. Cross JV. Susceptibility of the summer fruit tortrix moth, *Adoxophyes orana* (Lepidoptera: Tortricidae), to chlorpyrifos and strategies for insecticidal control in orchards. Annals of Applied Biology. 1997; 131:197-212.
7. Davis EE, French S, Venette RC. Mini risk assessment: summer fruit tortrix moth, *Adoxophyes orana* (Fischer von Roslerstamm, 1834) (Lepidoptera: Tortricidae). USDA - CAPS Pest Risk Assessment, 2005.
8. Dorn S, Frischknecht ML, Martinez V, Zurfltih R, Fischer U. A novel non – neurotoxic insecticide with a broad activity spectrum. *Zeitschrift fuer Pflanzenkrankheiten und Pflanzenschutz*, 1981; 88L:269-275.
9. Galli P. Use of natural enemies to control the apple fruit tortrix. *Obstbau – Weinbau*. 1984; 21:289-292.
10. HYPP Zoology Fact Sheet. Summer Fruit Tortrix Moth. November 10, Wayback Machine. Massachusetts Dept. of Agricultural Resources, 2013.
11. Komblas K, Tsakonas P, Lysandrou M, Elia T. Control of insect pests on fruit and field crops with hexaflumuron in North Greece. Entomologia Hellenica. 1989; 7:35-41.
12. Minks AK, Voerman S. Sex pheromones of the summerfruit tortrix moth, *Adoxophyes orana*, trapping performance in the field. Entomologia Experimentalis et Applicata. 1973; 16:541-549.
13. Minks AK, de Jong DJ. Determination of spraying dates for *Adoxophyes orana* by sex pheromone traps and temperature recordings. Journal of Economic Entomology. 1975; 68:729-732.
14. Navrozidis EI, Tzanakakis ME. Tomato fruits as an alternative host for a laboratory strain of the olive fruit fly *Bactrocera oleae*. *Phytoparasitica*. 2005; 33:225-236.
15. Navrozidis E, Zartaloudis Z, Argyropoulos D, Servis D, Mpozoglou K. Sex confusion with sprayers RAK 3+4 και RAK 5+6 for insect control of *Adoxophyes orana*, (Lepidoptera: Tortricidae), *Anarsia lineatella* (Lepidoptera: Gelechiidae) and *Grapholitha molesta* (Lepidoptera: Tortricidae) in Imathia. 14th Hellenic Entomology Society Congress, 11-14, Nafplio, Greece, 2011, 316-317.
16. Pehlevan B, Kovanci OB. First report of *Adoxophyes orana* in northwestern Turkey: population fluctuation and damage on different host plants. Turkish Journal of Agriculture and Forestry. 2014; 38:847-856.
17. de Reede RH, Groendijk RF, Wit AKH. Field tests with the insect growth regulators, epofenonane and fenoxycarb, in apple orchards against leafrollers and sideeffects on some lefroller parasites. *Entomologia Experimentalis et Applicata*. 1984; 35:275-281.
18. Savopoulou – Soultani M, Hatzivassiliadis A, Vlug HJ, Minks AK, Tzanakakis ME. First records of the summer fruit tortricid, *Adoxophyes orana* Fv.R. in Greece. Entomologia Hellenica. 1985; 3:65-66.
19. Staubli A, Baillod M, Charmillot P, Guignard E. Le point sur la lutte contre certains ravageurs importants en vergers. Revue suisse de viticulture arboriculture horticulture. 1988; 20(1):21-29.
20. Tavoularis K. Mean production of main cultivations in Greece. Ministry of Agriculture, Statistics department. Greece, 2012.