DEVELEOPMENT OF INTEGRATED PEST MANAGMENT STRATEGIES AGAINST LETTUCE APHID (HEM.: APHIDIDAE)

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ABSTRACT**:** This study was carried out to reveal the reasons of extreme insecticide usage for aphid management at lettuce production areas in East Mediterranean Region of Turkey and to develop solution for this problem. While there are seven different aphid species that were determined in lettuce field of the region *Hyperomyzus lactucae* (L.), *Myzus (N.) persicae* (Sulzer), and *Nasonovia ribisnigri* (Mosley), (Hemiptera: Aphididae) is most importanat ones among them. The field surveys of biological control agent in lettuce fields show us that *Metasyrphus corollae* (F.) (Diptera: Sryphidae) and *Sphaerophoria scripta* (L.) were determined as important biological control agents on lettuce aphids, but the most important and hopefull agent was *Fusarium subglutinans*, entomopathogen fungi. Chemical control methods to suppress lettuce aphids populations revealed that among active ingredients named Thiomethoxam, Spirotetramat, Pymetrozine used against lettuce aphids, the first two ones have to be applied before closing heart of the lettuce plant. Thus, pest population can be limited under the economic loss threshold.

KEY WORDS: *Nasonovia ribisnigri*, *Myzus (N.) persicae*, IPM, thiomethoxam, spirotetramat, pymetrozine, lettuce.

With its advantages for agriculture, climate, soil and ecological conditions, East Mediterranean region enables the intensive fruit and vegetable production. Among the vegetables, especially lettuce can be grown both in plain and mountainous areas for four seasons. The size of lettuce production fields could vary from a house garden to large lands of around 100 da size. Total lettuce production in the region accounts for 34% of all production in Turkey, and Mersin (17%) and Hatay (10%) provinces have the largest shares in regional production, which are followed by Adana (6%) and Osmaniye (1%) (Anonymous, 2008).

Lettuce requires relatively less irrigation on account of its growing seasons (Autumn-Spring) compared to other vegetables. Furthermore, lettuce is quite rich in mineral salts like iron, calcium and phosphor as well as A, B, C, D, and E vitamins. For these properties and its fresh consumption, it is a highly economic product widely consumed in Turkey. This economic and healthy vegetable has many harmful pests, of which the most important one is aphids due to direct nutrition and viruses it transfers. Zeren (1989) carried out a study to determine harmful aphids for this vegetable in Cukurova Region, and reported four species including *Aphis craccivora* Koch, *Acyrthosiphum lactucae* (Passerini), *Macrosiphum euphorbia* Thomas and *Myzus (N.) persicae* Sulzer; on the other hand, Toros et al. (2002) performed a study to determine general aphid flora in East Mediterranean Region and reported three aphid species for lettuce including *Acyrthosiphon lactucae* (Passerini), *M. (N.) persicae* (Sulzer) and *Nasonovia ribisnigri* (Mosley). *N. ribisnigri* is accepted as one of the most harmful pest for lettuce in East Mediterranean Region, USA, Europe and Canada (Mackenzie &

Vernon, 1988; Martin et al., 1995; Rufinger et al., 1997; Chaney, 1999; Palumbo, 2000; Palumbo & Hannan, 2002).

Liu (2004) stated that *N. ribisnigri* prefers to live in the heart of lettuce and its chemical combat with contact effective insecticides is quite difficult. Besides, Davis et al. (1997) reported that *N. ribisnigri* is also an important vector for cucumber mosaic and lettuce mosaic viruses. Rufingier et al. carried out a study to determine the resistance of two different *N. ribisnigri* populations to five different insecticides, and reported that aphids showed resistance to all insecticides. On the other hand, other studies stated that chemical combat of this pest is performed with enduring insecticides in general (Eenink & Dieleman, 1982; Van Helden et al., 1992).

In this study prepared with respect to abovementioned points, three different pesticides were applied to lettuce planted on 2 da area of Circulating Capital Enterprise of Cukurova University in three different periods, and a convenient method is developed for the integrated pest management program used on the control plot; in addition, the points to take into consideration for a successful management program and the role of biological combat in this integrated management are emphasized. Consequently, basic information is provided to develop management methods that give particular importance to human health and environment suitable to integrated management as an alternative to current intensive use of insecticides on lettuce fields in Cukurova Region.

MATERIAL AND METHOD

Development of chemical management methods suitable to integrated management with different pesticides against aphid in lettuce

The study carried out to determine the variations in aphid populations on lettuce was performed on Research and Study plot of plant production department of Faculty of Agriculture in Çukurova University. For this purpose, thinning process was repeated for three times on lettuce seedlings (*Lactuca sativa* L. var. Velvet®) on 10 September 2009, 5 January 2010 and 19 April 2010. Seedlings were thinned on soil as double-row in back and 5000 lettuce plants per acre. Prior to each thinning period, 20 kg/acre of bottom fertilizer (15-15-15) was used. 10 kg/acre ammonium nitrate fertilizer was used near the bolting stage of lettuce. During the management of weeds on lettuce field, management was performed by hand pulling over rows and hoeing between rows. Planted lettuce seedlings were obtained from seedling firm by giving lettuce seeds. Special attention was given for seedlings to be free of insecticides while receiving the seedlings obtained from the seeds provided to firm. Thinning process was applied to form four plots in each plantation period. Plot size was kept at 15 X 20 m, and a 2.5 m safety strip was created between plots.

The success rates of three different insecticides (2 certificated and 1 uncertificated) on production field were evaluated in terms of pest management by comparing to control plot. For this purpose, a total of 16 plots were created for four different applications on production field according to randomized blocks experiment pattern (3 insecticides + 1 control plot). The number of aphids on leaves in the center part of randomly selected 10 lettuces plants was counted every week from plantation to harvest. Population development of aphids on plants was followed, and chemical management was decided considering the time before harvest when the development of aphid population reached economic loss threshold (20 individual/plant). The application number was limited to one considering the development of aphid population density and harvest time (Table 1). Lettuce habitus had an important part in insecticide application. Especially, because no or inadequate amount of insecticides can reach aphids in growing cone when head formation stage of lettuce starts, special attention was paid to apply insecticide before the head formation stage.

Aphid species on lettuce plants in the study were taken directly into tubes by means of a fine-lead brush. Preparations were prepared for the sample in tubes, and their exact identifications were made through analysis under microscope.

Determining the natural enemies fed on aphids in lettuce plants

Natural enemies fed on aphid on lettuce plants were investigated on the lettuce field composed of 16 plots in the study for all the periods including the 1st, 2nd and 3rd plantation. For this purpose, it was tried to take parasitoid, hunter and entomopathogens detected during weekly population follow-ups, and consequently, parasitoids are taken into culture, while minor hunters were given aphids to allow them reach puberty and entomopathogens were directly sent to an expert for identification.

Hunter Coccinellidae species were diagnosed by Prof. Dr. Nedim Uygun, Sryphidae species by Prof. Dr. Faruk Özgür and Entomopathogen fungus species by Assist. Prof. Dr. Evrim Arıcı. A limited number of parasitoid mummies were encountered in the study, and these parasitoids were not identified.

Statistical analyses

The study was performed in accordance with the randomized block experiment pattern, and the differences between applications were observed on weekly basis as of insecticide use date. The differences between study results and control group were tested by variance analysis. A multiple comparison test was applied to detect the different application when a difference was found between applications and control group.

Mortality rates (%) of insecticides were calculated with respect to control by Henderson Tilton equation (Karman, 1971). The equation is as follows:

$$\text{Correted Mor. } (\%) = \left\{ 1 - \frac{\text{n in Co before treatment} \ \ X \ \ \text{n in T after treatment}}{\text{n in Co after treatment} \ \ X \ \ \text{n in T before treatment}} \right\} \times 100$$

Mortality rates (%) of insecticides were calculated with respect to control by Henderson Tilton equation (Karman, 1971). The equation is as follows:

Where n: number of living aphids in parcel, T: insecticide treated parcel, and Co:control parcel.

Arcsin transformation was applied to percentage effects obtained from the equation, and then they were subjected to statistical analysis (Duncan Multiple Comparison Test) at 5% significance level by means of Totemstat Package Software.

STUDY RESULTS AND DISCUSSION

Development of chemical management methods suitable to integrated management with different pesticides for aphids on lettuce

The identification of samples taken during population follow-ups from the plots in Circulating Capital Enterprise of Agriculture Faculty of Cukurova University revealed that samples were composed of *N. ribisnigri*, *M. (N.) persicae* and *H. lactucae* species. Considering the frequency rates of species, the first species was determined at 68% and the second species was determined at 24%. On the other hand, the frequency rate of *Hyperomyzus lactucae* was found as 8%.

For this reason, studies performed both in insecticide experiments and other experiments were accepted to be carried out on *N. ribisnigri* and *M. (N.) persicae* constituting over 90% of the population.

Lettuce cultivation was performed in three different times, the first of which occurred on 9 October 2009. Experiments were prepared with four repetitions according to randomized block design. Thiomethoxam (Actara 240 SC), Spirotetramat (Movento SC 100) and Pymetrozine (Plenum WG50) preparations were used in the experiments, control plots were taken into account for comparison purposes.

Following the preliminary count of aphid, count was repeated on the 3rd, 7th and 14th days after insecticide application (Table 2).

In the study, biological activity percentages were evaluated in the table formed by Actara counts on the 3rd, 7th and 14th days, and consequently, the biological activity levels were found as 98.6%, 97.93% and 97.09%, respectively, while the biological activity level of Movento was determined as 98.87%, 99.96% and 99.71%, respectively (Table 2). The evaluation of biological activity levels revealed that both insecticides had very high biological activity. On the other hand, biological activity of Plenum was determined rather low as 33.35%, 44.67% and 41.34%, respectively (Table 2). The reason of this situation is attributed to the low activity of Plenumun against aphid on lettuce, which has antifeedant characteristic and no systemic effect. It is more useful to apply and retry this insecticide before the formation of aphid population. However, in this case, pestiide should be used more frequently for the control of aphid on growth cone of rapidly and actively growing lettuce plants. In the comparison of biological effects of three inseticides, no statistically significant difference was detected between Actara and Movento for all the three days, while a significant difference was detected between these two insecticides and Plenum (Table 2).

The second lettuce cultivation was performed on 10 January 2010, and biologic effect of Actara was determined as 92.96%, 98.87% and 82.57%, respectively, while the biologic effect of Movento was 91.96%, 98.51% and 95.23%, respectively (Table 3). Plenum demonstrated higher effects compared to its performance in the first cultivation, but its effects were lower than those of Actara and Movento. In the statistical evaluation, no significant difference was detected between Plenum and other pesticides (Tables 4,5). As a result of this study, the results in Table 2 and 3 were found parallel.

The third lettuce cultivation was performed on 30 April 2010, but the insecticide experiment could not be made as the aphid population did not form at the time. The reason for the absence of aphid population was attributed to negative effects of increasing temperatures as of May and aphid did not prefer lettuce and could not develop on lettuce on account of the rancidity of lettuce with milk formation.

In the study, it was determined that pesticide application time had no significant effect on biologic activity of insecticide used on lettuce. Near the harvest of lettuce, a habitus bolting and covering the developing bolt formed. This structure appearing in the last stage of lettuce corresponds with the period when pest approaches the economic loss threshold. In the integrated management, spending time on the economic loss threshold without using chemical management methods could cause not to obtain the desired success in lettuce plant. For this reason, it is required to establish an early warning system in the pest management method for this plant, and based on this system, a management threshold should be formed without spending time on pest population in the field. In the early warning system trapping winged animals, water traps or siphon traps with certain height are widely used in Europe and America to control aphids on potato and fodder plants and epidemic virus carried by aphids (Tatchell, 1985).

Satar et al. (2011) reported that the number of aphids falling into water trap for 8 months was 191, and the number of species was 12 in their study carried out on lettuce lands to follow up population with water traps. In addition, the species of *H. lactucae* (41%), *N. ribisnigri* (16%) ve *M. (N.) periscae* (24%) accounted for 81% of the total population captured on lettuce and *N. ribisnigri*, an important pest of lettuce, was reported to fall into traps in October and February months when the 1st and 2nd product lettuce cultivation was performed and started to grow. This is one of the findings suggesting that this pest is identified with lettuce. In this study, the population of aphids on lettuce was observed to increase in lettuce cultivation period or at 18-23°C.

Table 4 and 5 demonstrate the weekly changes in aphids, insecticies and control group data on the 1st lettuce cultivation field which was planted on 10 October 2009 by randomized block design. As can be seen in the tables, pest population was low for all the four characters until October, while an increase was noted in population at the end of October and beginning of November. As a result of the pesticide application made after this increase, population was found near zero on fields subjected to Actara and Movento plots; however, it started to increase in Plenum and Control plots. The initial weeks of November during which the population started to increase corresponded with period when the mean temperature declined to 20°C (Figure 2). This increase lasted until lettuce harvest.

The results of the statistical analysis performed according to randomized block design of the first experiment are given in Table 4.

In the investigation of Table 4, the effect of interaction was found significant for four experiments. DUNCAN multiple comparison test was applied to determine the significant ones, and the results are given in Table 5.

When the columns in Table 5 are investigated in order, an increase is noted for Actara as of the 5th week and a considerable decrease is observed in the mean value as of the 6th week. Similarly, in the investigation of Movento, a considerable decrease is noted beginning on the 6th week when the pesticide was applied. On the other hand, in the investigation of Plenum, no effect is determined and the increase continued after the 6th week when the pesticide was applied. Lastly, there was also a constant increase observed in the control group.

The results of DUNCAN test performed for three insecticides and their differences with control group for each week revealed no significant difference between these four groups during the initial three weeks. Flowing the 5th week, Actara and Movento was considered in the same group, while Plenum and Control remained in the same group, and this grouping became definite as of the 6th week, and maintained this situation until the last measurement week. In this case, Actara and Movento formed a group, and Plenum and Control formed another group (Table 5).

Seedlings on the second cultivation plot were thinned on 5 January 2010.about one week later than this cultivation time, population follow-up was started. Population followed a course lower than economic loss threshold for all characteristics until the end of March. This low population was observed especially from February to the end of March. Climate records during these months demonstrated that humid atmosphere resulting from the rain showers starting at 11 February and lasting until the last week of March was one of the main reasons for low population of *Fusarium subglutinans* (Wollenw & Reinking) which develops well in the humid weather. Both in population follow-up studies performed in field and surveys, there were many populations killed by entomopathogen in rainy seasons. For this reason, this supported the idea that the fungus has a natural enemy which should be investigated. Similar results were reported by some researchers studying in Cukurova Region and also by some laboratory studies (Biçer 1998, Erkılıç et al. 1999, Satar 2004). The situation of the population on the second plot increased between the beginning and end of March with no specific rainfall (Table 7 and Figure 2). Population reached its maximum in all plots especially at the end of March. The mean temperature changed between 15-22 °C for the same period. This is the most suitable air temperature for the development of *N. ribisnigri* (Pulambo and Hannan 2002). A decrease was also noted in control group plots in April due to the increasing temperature similar to plots subjected to pesticide applications (Table 7 and Figure 2).

The results of the analysis performed by randomized block design of the second experiment are given in Table 6.

Table 6 indicates the important effect of interaction for four experiments. DUNCAN multiple comparison test was applied to determine the important ones, and the results are given in Table 7.

There is a significant increase for Actara in the second experiment starting from the 10th week when the columns in Table 7 are separately investigated; however, a significant decrease is noted as of the 12th week when the pesticide application was performed. An increase was observed for Movento starting from the 11th week, and similarly, a significant decrease was noted as of the 12th week. Similar decreases were also observed for Plenum and control groups starting from the 12th week, but the population number was determined high. The results of DUNCAN test performed to determine the difference in three insecticides and their differences with control group demonstrated that there was no significant difference between four groups for nearly the initial 6 weeks, and especially Actara and Movento were determined in the same group, while Plenum and Control were characterized in the same group as of the 14th week. In this case, Actara - Movento and Plenum – Control formed two separate groups.

The last lettuce cultivated field was subjected to thinning process on 19 April 2010. Subsequently, aphid population on lettuce leaves was followed. No evident aphid population occurred on the third cultivation plot, and with the increasing air temperature, it grew rapidly and milky formation (rancidity) was observed on lettuce in bolting stage. As a result of the increasing temperature and milky formation, no population could develop on lettuce (Figure 2).

Natural enemies of aphids observed in lettuce fields in East Mediterranean Region

In the field studies performed on areas of Circulating Capital Enterprise of Agriculture Faculty of Cukurova University between October 2009 and May 2010, some natural enemies were detected for aphid species; however, their occurrence frequencies were quite low (Table 8). Pest activity is generally low between October and March, which is also the period of lettuce cultivation, due to the low air temperature.

Species in Sryphidae family of Entomoafag pests was the most frequent species, followed by Coccinella septempunctata L. in Coccinellidae family (Table 8). All of these snatural enemies in Insecta class were collected from lettuce experiment plots in Balcalı Campus of Cukurova University. In the fields studies performed in lettuce lands in the region, no natural enemy was detected from Insecta class. In addition, *F. subglutinans* of Entomopathogen fungus was a natural enemy observed in all lettuce fields in the region. Similarly, Erkılıc et al.

(1999) detected 7 species of Hyphomycetes class in aphids in East Mediterranean Region and determined the highest mortality rate for *F. subglutinans* under climate room conditions. Bicer (1998) reported that *F. subglutinans* was isolated from *N. ribisnigri* aphid on lettuce. Satar (2004) performed a study to determine the biologic activity of *F. subglutinans* under greenhouse conditions, and reported that aphid population was completely suppressed after two weeks of fungus application. In the field studies, the aphid populations observed in the second lettuce cultivation demonstrated an evident decrease especially after rainfall.

CONCLUSION

The present study performed on lettuce cultivation fields between 2009 and 2010 determined that *N. ribisnigri* and*M. Persicae* populations could exceed the economic loss threshold. Furthermore, producers and consumers demand that there should be no pest on lettuce, and thus the market price of lettuce with aphid damage decreases. Consequently, produces do not comply with the economic loss threshold or the criteria of other integrated management methods in insecticide application. On the other hand, pests on lettuce plants with 8-10 weeks of production period and fresh consumed should be suppressed in a way that poses no threat to human and environment health. In addition, habitus differences of the plant like leaves bound to main body, overlapping leaves, heading in the later seasons and closing growth cone limit the use of contact and systemic insecticides on this culture plant. *M. corollae* and *S. scripta* are important hunters and natural enemies of aphids on lettuce, but they are inadequate in number, while F. *subglutinans* has a chance in combat against these pests and should be further investigated in field studies. It was concluded that thiomethoxam (Actara) and spirotetramatnun tried in chemical management could reduce the level of pest under economic loss threshold with correct applications on correct times contrary to its previous 4-5 applications in lettuce production. For this reason, establishing an early warning system which determines the population through water or siphon traps that can capture the winged creatures for aphid management on lettuce and enables the management before reaching the economic loss threshold will increase the success rate of insecticide applications and protect human and environment health by avoiding unnecessary insecticide use.

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Table 1. Commercial names, application doses and waiting periods of insecticides to be used in lettuce cultivation fields.

Product	**Effective agent**	**Application dose**	**Waiting period**
Actara 240SC	Thiomethoxam	20ml/da	7 days
Movento SC100	Spirotetramat	75ml/da	3 days
Plenum 50WG*	Pymetrozine	25gr/da	7 days
Kontrol	Water	-	-

*uncertificated for lettuce. However, it is a suitable insecticide with antifeedant effect for the management of aphids.

Table 2. Biological activity was measured based on the Handerson-Tilton Equation of three different insecticides on the first lettuce product.

Insecticide (dose/ decare)	Repetition	Preliminary count	3rd day	7th day	14th day	Efficiency %*		
						3rd day	7th day	14th day
Actara 240 SC 20ml/hl	I	12	19	1	51	96.43	99.84	9397
	II	16	2	0	0	98.88	100.00	100.00
	III	25	4	25	0	96.95	91.88	100.00
	IV	26	0	0	8	100.00	100.00	94.38
	Mean	19.8	6.3	6.5	14.8	98.06 a**	97.93 a	97.09 a
Movento SC 100 75 ml/hl		4	3	0	29	99.81	100.00	98.86
		4	3	0	0	99.58	100.00	100.00
	III	38	2	0	0	97.68	100.00	100.00
	IV	22	2	2	0	98.40	99.15	100.00
	Mean	17.0	2.5	0.5	7.3	98.87 a	99.79 a	99.71 a
Plenum WG 50 15 g/hl	I	36	156	94	141	12.03	54.68	49.97
	II	20	121	82	113	15.38	18.08	20.98
	III	25	41	112	264	68.71	63.62	41.78
	IV	24	72	124	73	37.25	42.29	52.64
	Mean	26.3	97.5	103.0	147.8	33.35 b	44.67 b	41.34 b
Control	I	57	112	131	178			
	II	22	130	91	130			
	III	52	63	148	218			
	IV	27	102	191	137			
	Mean	39.5	101.8	140.3	165.8			

*Biological activity averages were subjected to arcsin transformation before the statistical analyses. **When the average values were observed from top to down, the difference was concluded statistically significant by Duncan test if it did not contain the same value on condition that it should be separately investigated for each day (α=0.05).

Table 3. Biologic activities of three different insecticides on the second product lettuce plants by Handerson-Tilton equation.

Insecticide (dose/ decare)	Repetition	Preliminary count	3rd day	7th day	14th day	Efficiency %*		
						3rd day	7th day	14th day
Actara 240 SC 20ml/hl	I	268	3	1	2	89.44	97.12	92.59
	II	283	20	2	17	85.26	98.36	50.20
	III	199	3	0	0	97.14	100.00	100.00
	IV	390	0	0	1	100.00	100.00	87.30
	Ort.	285.0	6.5	0.8	5.0	92.96 a**	98.87 a	82.52 a
Movento SC 100 75 ml/hl	I	222	7	2	0	79.59	95.23	100.00
	II	205	5	2	9	97.33	98.81	80.90
	III	134	10	0	0	93.59	100.00	100.00
	IV	284	1	0	0	97.31	100.00	100.00
	Ort.	211.3	5.8	1.0	2.3	91.96 a	9.51 a	95.23 a
Plenum WG 50 15 g/hl	I	359	11	11	31	48.14	57.57	-53.76
	II	375	16	21	29	84.38	77.17	-12.58
	III	380	12	7	30	78.18	79.85	-48.05
	IV	354	10	10	10	66.48	66.48	-15.23
	Ort.	367.0	12.3	12.3	25.0	69.29 b	70.27 b	-32.41 b
Control	I	94	81	99	77			
	II	230	167	150	42			
	III	220	95	60	35			
	IV	96	110	110	32			
	Ort.	160.0	113.3	104.8	46.5			

*The mean biologic activities were subjected to arcsin transformation before statistical analysis. ** When the average values were observed from top to down, the difference was found statistically significant if it did not contain the same letter when separately investigated for each day (α=0.05).

Table 4. Variance analysis table for Actara, Movento, Plenum and Control groups included in the first lettuce cultivation plot.

Sources	Degrees of freedom	Actara	Movento	Plenum	Control
		Sum of squares	Sum of squares	Sum of squares	Sum of squares
Interaction	1	149.511**	152.100**	5848.336**	8084.544**
week	8	146.389**	128.400**	7903.739**	10110.056**
repetition	3	120.000	12.456	554.697**	481.656**
week*repetition	24	271.300**	101.644**	3883.328**	3519.544**
error	324	844.800	695.400	10076.900	16954.200

**P<0.05 significance level

Table 5. Population development of *Nasanovia ribisnigri* in Actara, Movento, Planum and Control groups experimented in the first lettuce cultivation plot .

Weeks	n	Actara	Movent	Plenum	Control
		$\overline{X} \mp SH$	$\overline{X} \mp SH$	$\overline{X} \mp SH$	$\overline{X} \mp SH$
02.10.20099	40	0.02±0.023^{aA}	0.10±0.05^{aA}	0.05±0.03^{aA}	0.27±0.10^{aB}
14.10.20099	40	0.05±0.03^{aA}	0.67±0.17^{abA}	0.45±0.16^{aA}	0.37±0.14^{aA}
21.10.2009	40	0.07±0.04^{aA}	0.42±0.11^{aA}	0.50±0.21^{aA}	0.40±0.11^{aA}
28.10.2009	40	0.17±0.06^{aA}	0.27±0.08^{aA}	1.50±0.24^{aB}	0.25±0.08^{aA}
11.11.2009	40	0.67±0.22^{bA}	1.15±0.32^{bcAB}	2.45±0.60^{aBC}	2.85±0.57^{aC}
18.11.2009*	40	1.97±0.39^{cA}	1.70±0.54^{cA}	2.62±0.73^{aB}	3.95±0.60^{aB}
02.12.2009	40	0.62±0.23^{abA}	0.25±0.08^{aA}	9.75±2.34^{bB}	10.17±1.92^{bB}
09.12.2009	40	0.65±0.25^{abA}	0.05±0.03^{aA}	10.30±2.48^{bB}	14.02±2.26^{cC}
21.12.2009	40	1.48±0.62^{bcA}	0.72±0.16^{abA}	14.77±2.34^{cB}	16.57±2.41^{cB}

[a] When the average values were observed from top to down, the difference was found statistically significant by DUNCAN test if it did not contain the same letter when separately investigated for each day. [A] When the average values were observed from left to right, the difference was found statistically significant by DUNCAN test if it did not contain the same letter when separately investigated for each day. *insecticide application date

Table 6. Variance analysis table for Actara, Movento, Plenum and Control groups taken in the experiment on the second lettuce cultivation plot.

Sources	Degrees of freedom	Actara	Plenum	Movento	Control
		Sum of squares	Sum of squares	Sum of squares	Sum of squares
Interaction Week	1	9408.960**	6706.727**	8573.357**	7259.282**
Repetition	14	28678.240**	15658.023**	9764.183**	4594.093**
Week*repetition	3	100.333	55.473	487.510	18.645
Error	42	2505.067	1665.777	14428.947**	5695.680**
	540	25745.400	21454.000	45678.367	19901.300

**P<0.05 significance level

Table 7. Population development in Actara, Movento, Plenum and Control groups experimented on the second lettuce cultivation plot.

Weeks	n	Actara	Movento	Plenum	Control
		$\overline{X} \mp SH$	$\overline{X} \mp SH$	$\overline{X} \mp SH$	$\overline{X} \mp SH$
14.01.2010	40	$1.37±0.27^{aA}$	$1.87±0.40^{abA}$	$1.85±0.36^{aA}$	$1.45±0.29^{abA}$
21.01.2010	40	$1.45±0.71^{aA}$	$1.85±0.86^{abA}$	$2.07±0.32^{aA}$	$1.47±0.37^{abA}$
28.01.2010	40	$1.12±0.51^{aA}$	$1.57±0.61^{abA}$	$1.80±0.34^{aA}$	$1.52±0.29^{abA}$
04.02.2010	40	$1.57±0.57^{aA}$	$1.87±0.82^{abA}$	$1.17±0.31^{aA}$	$1.35±0.29^{abA}$
11.02.2010	40	$1.62±0.62^{aA}$	$1.70±0.94^{abA}$	$1.77±0.52^{aA}$	$1.17±0.28^{abA}$
18.02.2010	40	$3.17±1.11^{aA}$	$2.80±1.04^{abcA}$	$3.10±0.49^{aA}$	$4.05±2.51^{abcA}$
25.02.2010	40	$3.27±1.60^{aAB}$	$5.62±2.30^{cA}$	$3.00±0.62^{aB}$	$3.70±0.72^{abcAB}$
04.03.2010	40	$3.27±1.46^{aA}$	$2.82±1.92^{abcA}$	$4.15±1.38^{aA}$	$3.65±1.09^{abcA}$
11.03.2010	40	$1.30±0.77^{aAB}$	$1.02±0.62^{abB}$	$2.82±1.23^{aBC}$	$0.65±0.26^{aA}$
18.03.2010	40	$2.27±1.18^{aAB}$	$2.40±1.14^{aA}$	$1.92±0.45^{aAB}$	$4.27±1.17^{bcB}$
25.03.2010	40	$8.55±3.91^{bB}$	$3.80±1.28^{bcAB}$	$5.77±1.02^{aA}$	$5.97±2.72^{cAB}$
01.04.2010*	40	$28.50±6.08^{cB}$	$21.12±6.49^{dB}$	$36.70±6.55^{bC}$	$12.25±2.13^{dA}$
08.04.2010	40	$0.65±0.32^{aA}$	$0.57±0.41^{abA}$	$1.22±0.81^{aB}$	$4.30±0.46^{bcC}$
15.04.2010	40	$0.07±0.42^{aA}$	$0.10±0.09^{aA}$	$1.22±0.81^{aB}$	$3.17±0.43^{abcB}$
22.04.2010	40	$0.50±0.31^{aA}$	$0.22±0.31^{aA}$	$2.50±1.31^{aB}$	$3.17±0.43^{abcB}$

[a] When the average values were observed from top to down, the difference was found statistically significant by DUNCAN test if it did not contain the same letter when separately investigated for each day. When the average values were observed from left to right, the difference was found statistically significant by DUNCAN test if it did not contain the same letter when separately investigated for each day *Insecticide application date

Figure 8. Natural enemies detected on lettuce plants in Circulating Capital Enterprise of Agriculture faculty of Cukurova University between October 2009 and May 2010.

Order	**Family**	**Number**	**Species**
Diptera	Syrphidae	15	*Metasyrphus corollae* (Fabr.)
		9	*Sphaerophoria scripta* (L.)
Neuroptera	Chrysopidae	2	*Chrysoperla carnea* (Stephens)
Coloptera	Coccinellidae	12	*Coccinella septempunctata* L.
Hypomycetes*		-	*Fusarium subglutinans* (Wol. & Rein.)

*Entomopathogen fungus

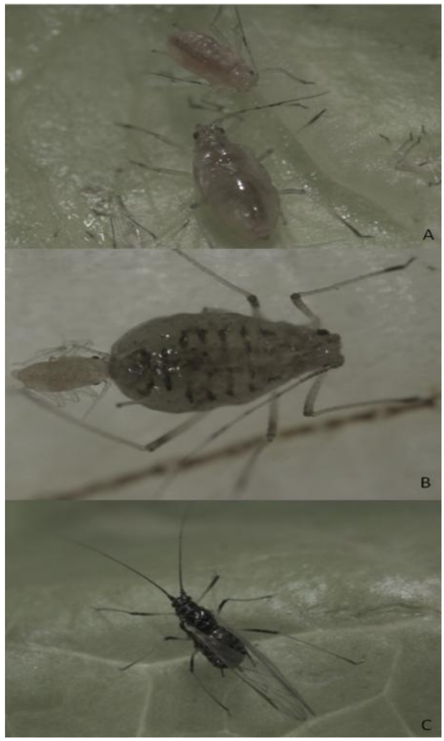

Figure 1. Winged and wingless nympha (A) of *Nasonovia ribisnigri* (Mosley), adult spawning wingless creatures (B) and winged adult (C).

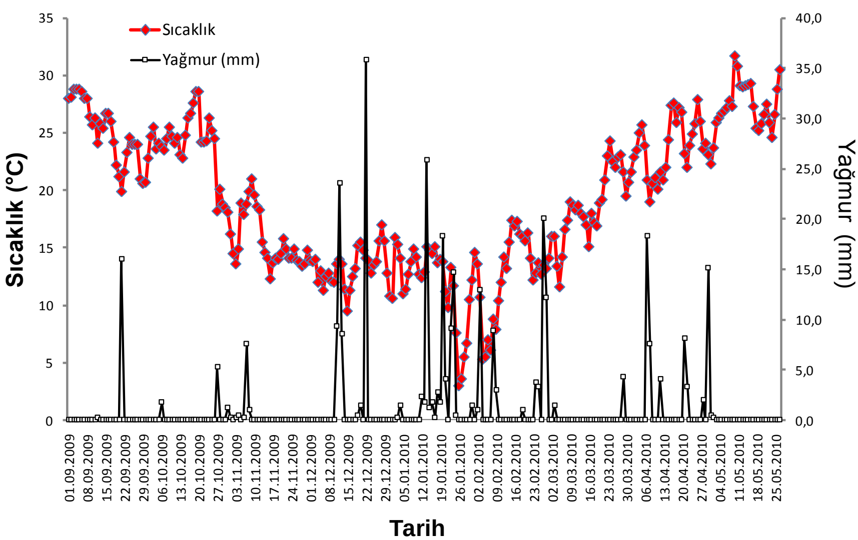

Figure 2. Daily temperature and rainfall values between 1 September 2009 – 25 May 2010 for Balcalı Campus, Faculty of Agriculture, Çukurova University (Anonymous, 2010).