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Aphid composition in lettuce (*Lactuca sativa*) cultivated in greenhouses in Kosovo

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Abstract
Aphids are considered serious pests of agriculture crops in Kosovo and worldwide. Objective of this paper was to confirm the most present plant aphids in some hybrids of lettuce grown in greenhouses. Experiment was conducted during the cropping season of 2017-2018 in five greenhouses located in Bernice, municipality of Prishtina. Experiment was set according to randomized Fisher blocks in three replications. With purpose to confirm the aphid species in lettuce cultivated in greenhouses, as a method was performed aphid leaf count of 100 lettuces leaves. From the total number of plant aphids' recorded (5685 individuals) *Myzus persicae* participated with 53.49%, *Macrosiphum euphorbiae* with 21.65%, *Aphis gossypii* with 9.02%, *Aulocarthum solani* with 8.32% and *Myzus ascalonicus* with 7.51%. The results we have obtained during of this research were shown to have statistical significant differences regarding the number of these pests in lettuce hybrids that were grow in greenhouses.

Keywords: Aphid leaf count, *Myzus persicae*, *Aphis gossypii*

1. Introduction
Lettuce is a vegetable crop form the family Asteraceae which in Kosovo mainly is grown as a vegetable for its leaves, as well in seed production. In different countries worldwide, also in Kosovo, there are a huge number of aphids in different field crops, in lettuce as well [9, 7, 16]. These tiny pests are polifagous and are present everywhere in the world causing both direct (sucking plant sap from plant tissues) or indirect damages as vectors of plant viruses to cultivated crops [3, 8, 12].

There are several species of plant aphids which live on the leaves of lettuce, both under glass and outdoors [21, 17]. Some authors [15] reported the aphids as very serious and dangerous pests of lettuce in Europe, and in many other countries of the world. The other authors reported that Nasonovia ribisnigri and Myzus persicae are very important lettuce pests in western part of the United States [1]. The other authors [19], in Mediterranean region o Turkey reported that seven aphid species were confirmed, Aphis gossypii, Aulacorthum solani, Hyperomyzus lactucae, M. persicae, Pemphigus bursarius, Rhopalosiphum nymphaeae and N. ribisnigri, from the Hemiptera and family Aphididae.

Infestation of lettuce plants with aphids in greenhouses represents an important and very problematic issue for growers of this crop. In most cases these aphids usually attack lettuce that is grown in greenhouses, N. ribisnigri, M. euphorbia and M. persicae. According to [6], Nasonovia ribisnigri is extremely serious pest because this aphid extracts the plant sap from the leaves during their youngest stages and colonizes very quickly entire crop. In Turkey, in the region called Çukurova, four aphid species, Macrosiphum euphorbiae, Aphis craccivora, Acyrthosiphom lactucae and Myzus persicae were reported on lettuce [24].

From the other data, fifteen species from the aphids (aphididae), Pemphigus spp., Trama caudata, Trama troglodytes, Aphis gossypii, Aphis fabae, Uroleucon formosanus, Macrosiphum euphorbiae, Uroleucon ambrosiae, Nasonovia ribisnigri, Aulacorthum circumflexum, Aulacorthum solani, Myzus persicae, Aulacorthum lactucae and Uroleucon cichori were recorded in lettuces worldwide [2].

When the lettuce plants are infested the leaves are curled and blistered, in latter stages the plants is very week and fail very quickly. The honeydew, sweet liquid, excreted by the aphids is like a sticky layer in the leaf surface to which dust and aphid skins adhere which can seriously reduce the quality of the crop. Besides direct damages to the plants during their feeding, aphids may spread the plant viruses that cause stunting and distortion of the leaves [16].

There are a lot of techniques and procedures developed and conducted worldwide to monitor the infestation of agriculture crops with plant aphids. Some of them that are well-known are, yellow water traps (Moerick traps), aphid leaf and plant, aphids sucking devices, the use adhesive traps of yellow color [12, 18], etc.

The goal of this paper was to monitor and identify the aphids present in five hybrids of lettuce, and the relationship among these pests in lettuce grown in greenhouse condition, in the locality of Prishtina. The data obtained regarding plant aphids will help to set up an effective control strategy within IPM and to apply the methods that are suitable for aphid control.

2. Material and Methods
2.1 Locality
These investigations were performed during the period of time April-June of the cropping season 2017-2018, in the village Bernica, which belongs to the Prishtina municipality and is suited 595 m above sea level. This locality has continental climate and the average of air temperature was 23.98°C during two years of these surveys. The experiment was performed in five greenhouses each of them with 0.25 ha, were the lettuce hybrids were planted. As a previous crop in these greenhouses were pepper, tomato, cucumber,

onion, spinach, etc.

2.2 Plant Material
In this research five hybrids of lettuce were included in the experiment, Humil, Zolltan, Mars, Karminova and Roseta. Sampling of plant aphids from the leaves of lettuce crop, with purpose to determine them, was performed during April-June of respective years of investigations. To monitor lettuce aphids in greenhouse, aphid leaf count of 100 leaves was used as a method [18].

2.3 Field and laboratory work
Sampling frequency was conducted with an interval of 10 days between two samplings. In this case 100 leaves from different hybrids of the lettuce were controlled in three replications, from each greenhouse. Plant aphids that were present, both nymphs and imagoes were collected and placed in plastic sheets. These samples were supplied with a label containing the relevant data, the date of sampling, lettuce hybrids, etc. Aphids being collected were taken to the laboratory of Crop Protection at the Agriculture and Veterinary Faculty to determine and describe the plant aphids. Morphological features such as: shape and size of the antennae, the shape and body size of plant aphids, shape and size of the tail (cauda), the shape and size of cornicles, etc. During the process of aphid identification we have used different aphid keys [2, 22] and stereomicroscope as well.

2.4 Statistical analysis
The data we have obtained during of these researches statistically were processed through ANOVA via MSTAT-C software from the Michigan University, USA. Analysis of variance and LSD-test were applied to confirm the differences in aphid concentrations in lettuce hybrids, whereas the level of significance for the differences was accepted at $p<0.05$ and $p<0.01$. Interaction factors were calculated as well from the table of ANOVA.

3. Results & Discussion
After the two years of researches, regarding the appearance a distribution of different species of aphids in five hybrids of lettuce, we have confirmed to be present Myzus persicae, Aphis gossypii, Macrosiphum euphorbiae, Aulacorthum solani and Myzus ascalonicus.

From the results we have obtained it is easy to see that distribution of various aphids was different and very heterogenic (Table 1). These results have confirmed that the frequency of appearance and dispersal of various aphids during of these researches was different with regard to different lettuce hybrids. The frequency of individuals as a maximum, almost for all species was confirmed at beginning of the summer, in June (Table 1).

From the total of aphids number recorded in five lettuce hybrids (5685) it was clear that these hybrids have had different sensitivity towards aphids as extremely dangerous pests. Lettuce hybrid Humil appeared to be the most affected with a number of 1418 aphids or 24.94%, while the least affected was Zolltan with 577 aphids or 10.15% (Figure 1). The number of plant aphids recorded in other three lettuce hybrids was somehow in between, in Mars, Roseta and Karminova, with 1342 (23.61%), 1193 (20.98%) and 1155 (20.32%).

The susceptibility of hybrids of agricultural crops, in first place vegetables with a particular emphasize on lettuces, was shown from different authors [16, 12] and in this respect our data are closely with the results presented by these authors.

In opposition of some authors [11, 13, 5, 14, 20, 4] lettuce aphid Nasonovia ribisnigri which is almost the most dangerous aphid specie in lettuce was not found during of these researches.

From collected number of aphids (Figure 2) in total (the mean aphid number of two years of investigations) from the leaves of lettuce hybrids (5685) Myzus persicae participated with 3041 individuals (53.49%), Macrosiphum euphorbiae with 1231 (21.65%), Aphis gossypii with 513 individuals (9.02%), Aulocarthum solani with 473 individuals (8.32%) and Myzus ascalonicus with 427 individuals (7.51%).

Table 1: Aphid frequency in lettuce during cropping season 2017-2018

Hybrids	Aphids	Sampling							
		I	II	III	IV	V	VI	VII	VIII
Humil	*M. persicae*	23	51	96	134	217	106	48	152
	M. euphorbiae	11	27	19	45	64	41	62	44
	A. gossypii	0	0	12	15	26	10	29	31
	A. solani	0	5	18	9	2	7	15	13
	M. ascalonicus	6	11	5	12	17	23	10	2
Roseta	*M. persicae*	17	23	41	56	33	178	144	102
	M. euphorbiae	4	11	25	13	15	41	46	59
	A. gossypii	0	0	0	8	12	27	13	24
	B. solani	10	6	17	34	16	29	15	41
	M. ascalonicus	0	8	13	17	22	46	10	17
Mars	*M. persicae*	57	92	76	112	87	105	139	88
	M. euphorbiae	19	26	45	38	57	42	83	46
	A. gossypii	8	17	10	14	5	16	28	11
	A. solani	0	10	8	19	6	12	3	5
	M. ascalonicus	5	12	15	10	3	5	1	7
Karminova	*M. persicae*	19	43	56	92	117	123	94	109
	M. euphorbiae	6	14	25	10	52	47	26	14
	A. gossypii	4	10	12	18	43	15	9	3
	A. solani	1	6	9	14	29	26	8	6
	M. ascalonicus	12	19	21	2	15	10	14	2
Zolltan	*M. persicae*	21	35	33	57	26	23	11	5
	M. euphorbiae	4	12	7	25	21	56	19	10
	A. gossypii	0	0	5	16	43	12	5	2
	A. solani	2	2	13	6	15	21	9	6
	M. ascalonicus	5	14	8	6	2	11	7	2

The results obtained during of these researches are approximately in concordance with data reported from the other authors who confirmed that those aphids are present in lettuce in high number [11, 10, 24, 12, 23].

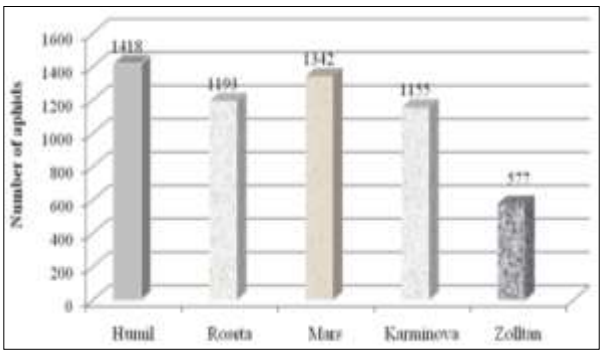

Fig 1: Aphids in lettuce hybrids during cropping season 2017-2018

The frequency of the appearance of certain species of plant aphids was very different during these investigations, which are shown clearly in Figure 2.

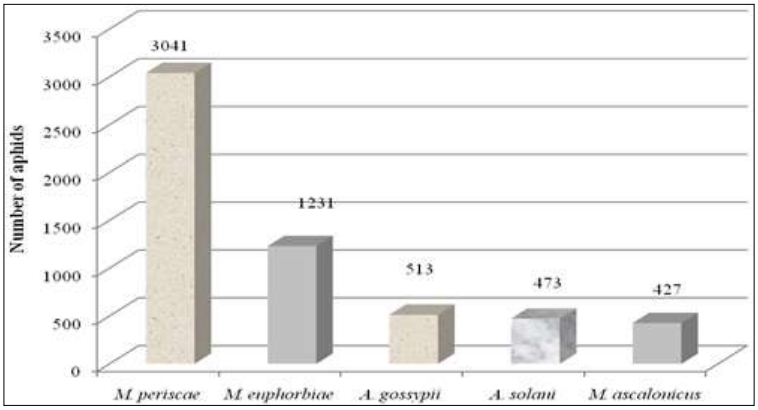

Fig 2: Aphid distribution in lettuce

From the table of analysis of variances and the LSD test it might be seen that highly significant statistical differences were found between five hybrids of lettuce involved in the experiment (Humil, Zolltan, Mars, Karminova and Roseta). The highest number of plant aphids, as an average during vegetation period, was recorded to the hybrid Humil (35.45 aphids), whereas the lowest number of aphids was recorded to the hybrid Zolltan (14.43 aphids). In this regard we can say that hybrid Humil has been the most affected by plant aphids whereas the hybrid Zolltan has been less affected by aphids in general.

Table 2: Aphid species in lettuce hybrids, two ways ANOVA

Hybrids (A)	Aphids (B)					Average (A)
	M. persicae	***M. euphorbia***	***A. gossypii***	***A. solani***	***M. ascalonicus***	
Humil	103.38	39.13	15.38	8.63	10.75	35.45
Roseta	74.25	26.75	10.50	21.00	16.63	29.83
Mars	94.50	44.50	13.63	7.88	7.25	33.55
Karminova	81.63	24.25	14.25	12.38	11.88	28.88
Zolltan	26.38	19.25	10.38	9.25	6.88	14.43
Average (B)	76.03	30.78	12.83	11.83	10.68	Interaction A x B**
Factor		A	B	B x A	A x B	
Lsd	1%	15.3432	11.3697	25.4234	27.7201	
	5%	11.3727	8.6374	19.3139	20.8234	

Legend: ** = highly significant, * = Significant, NS = No significant

Regarding the other lettuce hybrids the aphid number as an average was as following: Mars 33.55, Roseta 29.83 and Karminova 28.88 aphids.

Similarly, statistically significant differences were shown with regard to aphid species recorded (Factor B). In fact, the highest number of aphids was recorded with Myzus persicae (76.03 aphids), whereas the lowest number of aphids was recorded with Myzus ascalonicus (10.68 aphids). The differences, regarding to the aphids number recorded with M. persicae compared to M. euphorbiae as well as the differences between these aphids and other aphid species recorded during these surveys, are statistically highly significant, whereas between Aphis gossypii and Aulacorthum solani compared to Myzus ascalonicus there were confirmed no significant differences (Table 2). Regarding to interaction of factors A x B (hybrid x aphid species), also there were recorded significant differences at different level, concerning the frequency of the aphids species per hybrid of lettuce crop.

6. Conclusions

Regarding to aphid's distribution the results we have obtained showed that Myzus persicae and Macrosiphum euphorbiae are the most prevalent aphid species found in lettuce. The other aphids, Aphis gossypii, Aulacorthum solani and Myzus ascalonicus also were recorded in lettuce hybrids. The time of appearance and frequency of certain types of plant aphids in lettuce was different throughout the cropping season, causing considerable damages to this crop. Lettuce hybrids showed different level of susceptibility against plant aphids. Humil has been the most affected lettuce hybrid, whereas Zolltan was the less attacked by these pests. The maximum of aphid's number, almost of all species, was registered at the beginning of summer, when necessarily all measures must be performed to keep aphid pressure at low level. With the aim to get away of plant aphids from lettuce, it would be highly useful to assess at farmer level, as well to incorporate a wide broad integrated strategy and approach for management of these aphids.

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8. References

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