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Aphid complex associated with potato in agro-climatic conditions of Kosovo

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Abstract. Field surveys for aphids infesting potato crops in three most important localities for potato production in Kosovo (Podujevë, Prishtinë and Vushtrri) were conducted in vegetation seasons of 2018–2019. With the purpose to monitor and confirm the aphid composition in potatoes, aphid leaf count was used as a method which is applied worldwide. Sampling for aphids from the leaves of potato plants was undertaken during cropping season, every 10 days, where 100 leaves were taken at random and checked in triplicates, from each field. During of this experimental work, the following aphid species were registered *Myzus persicae*, *Macrosiphum euphorbiae*, *Aphis nasturtii* and *Aulacorthum solani*. From the total number of aphids recorded (4,210 individuals), the following percentage belongs to the different aphids: *M. persicae* (57.24%), *A. nasturtii* (25.72%), *A. solani* (7.77%), *M. euphorbiae* (5.68%), and other none identified aphids (3.59%). Relying on the results of this research we have confirmed to exist statistical significant differences with regard to the number of aphid's species according to the localities and aphids that infests the potatoes. With the goal to manage and control aphids spread infields with potatoes, it is extremely useful to evaluate and to see the possibility for an Integrated Management against these pests at farmer level.

Key words: aphids, ANOVA, *Myzus persicae*, potato crop.

INTRODUCTION

The potato is a vegetable of the family *Solanaceae*, together with tomato, eggplant, pepper, tobacco, etc. (Hooker, 1986), and its origin is South America. According to Forghani et al. (2018) potato was seen as one among the best vegetables, which is consumed by human beings in daily regime.

Potatoes are produced commercially in all provinces in Kosovo. The yield and dry matter of tubers of the potatoes is affected by environmental conditions as well their changes (Eremeev et al., 2003).

During the vegetation season, potato is being attacked by several harmful organisms that cause considerable damages to this crop. The major pests of potato are aphids, whiteflies, potato tuber moth, white grubs, Colorado beetle, nematodes, leafhoppers and thrips (Hiiesaar et al., 2006; Kruus, 2012; Kumara et al., 2017). Among

the insect pests, aphids play a major role by transmitting a number of viral diseases causing qualitative and quantitative losses (Sigvald, 1990; Woodford, 1992).

Potato is seriously affected by different aphids among which *M. persicae* is extremely important. Potato production not just in Kosovo but worldwide is affected and at risk by damages caused from *M. persicae* as a very harmful insect. The direct damage is feeding on the plants and the indirect damages caused to potato planting materials as a vector of several viruses (Lapointe et al., 1987; Trivedi et al., 2002; Musa et al., 2004). *M. persicae* is known to transmit over 100 viruses in different plants (Raman, 1985).

All aphids that are known so far possess piercing-sucking type of the mouthparts. Some aphid's possess wings and can fly, while the others are wingless and cannot fly. Aphids, during their feeding activities, may cause a considerable damage on plants, but they are of even greater economic significant since they are very efficient to transmit viruses and play the role as a vector of viruses to the plants (Close & Lamb, 1961; DiFonzo et al., 1997; Davis et al., 2007; Vučetić et al., 2013; Avila et al., 2014). In this aspect the alatae (winged forms) are more important than the apterae (wingless forms). According to Woodford (1992) there are above 30 species of alate aphids transmit potato virus Y, whereas *M. persicae* is extremely efficient vector of viruses namely potato leafroll. Regarding potato seed production, in Netherlands is reported that viruses are mainly transmitted by aphids such as *M. persicae* and *A. nasturtii* (Struik & Wiersema, 1999).

The most present and abundant species in potato fields are *M. persicae*, *A. solani*, *M. euphorbiae*, but there are other aphids as well.

The aphidofauna in different countries of the world has been reported to be very ample and different. According to (Stufkens & Teulon, 2001) in New Zealand the aphid fauna of potato crops has been dominated by three species, *M. persicae*, *A. solani*, and *M. euphorbiae,* whereas in Iran around 14 species of aphids have been recorded and identified as harmful pests on potato fields such as *M. persicae, Aphis gossypii*, *Aphis craccivora, Therioaphis trifolii, Acyrthosiphon pisum* and *M. euphorbiae* (Rezvani, 2001; Rezvani, 2010). Some authors (De Bokx & Piron, 1990) reported that during their surveys from 1983–1987 in Netherlands 122 aphid species were confirmed in potato fields. On the other side Muthomi et al. (2009) reported that the most abundant species in water pan traps were *M. euphorbiae* as well *M. persicae*.

Darwish (2018) showed that potato cultivars tested had significant variation regarding their susceptibility against infestation by aphids as well other sucking insects.

Regarding to these pests, nymphs and adults feed on young and soft parts of the plants. They insert stylet in soft tissues of the potatoes and feed with plant juices. This feeding causes distortion mainly the leaves and tubers. Aphids secrete also substances that are sticky and are called 'honeydew'. This sweet substance attracts ants and sooty fungi which can discolor the plant making them undesirable for their sale.

The purpose of our work has been to investigate the most spread aphids and relative abundance of these pests in potatoes cultivated in three main important production regions of Kosovo.

MATERIALS AND METHODS

Localities

Field surveys for aphids infesting potato crops in three most important localities for potato production in Kosovo (Podujevë, Prishtinë and Vushtrri) were undertaken in the 2018–2019 growing season. Podujevë is situated at 42°55' latitude, 21°12' longitude, and at the altitude of 620 m above sea level. Prishtina is situated at 42°40' latitude, 21°90' longitude, and at the altitude of 597 m above sea level, whereas Vushtrri has the following geographical parameters: latitude 42°46', longitude 21°04' and altitude of 500 m.

Potato cultivar

The potato cultivar Agria from Netherlands was included in the experiment in three respective localities were the surveys was undertaken. To evaluate and verify the aphids in potatoes, aphid leaf count was used as a method which is widely applied in different countries in the world (Raman, 1985; Sigvald, 1990).

Method of sampling

With the aim to investigate and identify aphid species, from the leaves of potato crop, aphid sampling was performed every 10 days, during the entire vegetation season. In this case 100 leaves were checked in three replications, from potatoes of each experimental plot. The results obtained and shown below in Table 2 are the average numbers for potato aphids recorded in both years of this research. Every sample consisted of a look on the leaves of a potato crop by walking through the field with potato in a W pattern, as well sampling the edges of the paddock. Potato leaves of all positions were examined and all aphids found were collected.

Laboratory work

The samples were provided with a label that contained all relevant data, the date of sampling, locality, and number of the field and were brought to the Crop Protection Laboratory which is a part of the Faculty of Agriculture to identify and describe the aphid species. In the laboratory, winged and wingless aphids were differentiated (immature forms were not distinguished), whereas aphids the immature forms were identified by taking into account their proximity and similarity to the adults they were collected with. Aphids sampled from the leaves were kept and preserved in 80% alcohol and later on were prepared for future work as slide mounted. After that plant aphids were identified to species level with the use of a stereo binocular microscope using keys (Teulon, 1999; Teulon et al., 1999; Blackman & Eastop, 1984). For precise and proper identification of the aphids there were taken in consideration mainly the following morphological aspects: the shape, the size as well as the segments number in antennae, distribution of the veins in the wings, shape of cauda and cornicles, number and length of hair on the legs and cauda, etc.

Statistical analysis

The results obtained were processed statistically using ANOVA two-ways and LSD of 1% and 5%, with MSTA-C software from the University of Michigan, while data processing was done through Microsoft Office 2007.

Meteorological data

Taking into the account that temperature and rainfalls have great impact on aphid appearance and distribution, we decided to collect meteorological data from the metrological stations based in Podujevë, Prishtinë and Vushtrri (Table 1).

Table 1. Meteorological data during vegetation period (2018–2019)

Month	Podujevë		Prishtinë		Vushtrri	
	Temperature (ºC)	Precipitate (mm)	Temperature (ºC)	Precipitate (mm)	Temperature (ºC)	Precipitate (mm)
April	13.2	45.6	14.3	52.7	12.8	62.4
May	15.9	69.3	16.1	60.4	15.0	71.5
June	19.1	59.5	16.8	55.3	16.2	58.7
July	23.4	49.2	23.2	64.5	22.7	67.1
August	21.7	41.7	22.5	39.2	20.5	35.6
September	17.8	44.3	15.8	54.8	16.2	63.2
October	16.5	57.1	13.5	62.6	13.3	60.8
Average	18.2	52.4	17.5	55.6	16.7	59.9

From the Table 1, the values represents the average temperatures during the two growing seasons (2018–2019) and are as follows: 18.2 °C recorded in Podujevë, 17.5 °C in Prishtinë and 16.7 °C in Vushtrri.

As it is shown in the Table 1 the average of rainfall ranged from 52.4 mm in Podujevë, to 55.6 mm in Prishtinë and 59.9 mm in Vushtrri.

RESULTS AND DISCUSSIONS

During this experimental work, regarding to the appearance and aphid distribution in potatoes there were identified four aphid species: mostly *M. persicae* as well *A. nasturtii*, but to some extent also *M. euphorbiae* as well *A. solani* (Table 2).

Table 2. Distribution of the aphids in potato crop, growing season 2018–2019

Locality	Aphid species	Frequency of aphid sampling												Total
		1	2	3	4	5	6	7	8	9	10	11	12	
Podujevë	*M. persicae*	34	47	39	29	46	51	38	29	40	33	27	21	434
	A. nasturtii	11	25	21	15	19	14	10	8	23	16	9	14	185
	A. solani	7	15	9	7	6	9	11	3	4	10	7	5	93
	M. euphorbiae	3	9	14	9	5	7	13	19	8	7	5	2	101
	Other	3	7	6	3	4	1	5	2	2	4	3	5	45
Prishtinë	*M. persicae*	26	39	57	40	36	49	55	43	38	26	18	31	458
	A. nasturtii	9	14	34	16	12	10	9	15	9	14	21	9	172
	A. solani	2	6	12	5	9	4	11	3	8	2	9	2	73
	M. euphorbiae	6	4	8	5	3	9	6	4	7	5	2	6	65
	Other	8	3	1	3	2	2	7	5	2	2	2	4	41
Vushtrri	*M. persicae*	59	82	68	109	137	244	183	122	97	213	108	96	1,518
	A. nasturtii	32	43	41	35	52	146	98	45	32	127	54	21	726
	A. solani	17	28	25	9	16	22	14	3	9	12	4	2	161
	M. euphorbiae	10	16	13	5	7	5	2	1	6	4	3	1	73
	Other	6	9	5	6	2	4	4	3	5	11	2	8	65

Note: These values are the average of aphids from two years of investigations (2018–2019).

Based on the result we have obtained (the average number of aphids during two years of investigation per each sampling date) we can see that the number and distribution of different aphids was very heterogenic (Table 2).

During of these surveys it was confirmed that the time and frequency of appearance of different aphids throughout the monitoring season was different, depending to localities and climatic conditions, so the highest or maximum number recorded of these pests, almost of all aphids was confirm in May (Table 2). Even the other group of aphids, which we did not manage to determine precisely, but were recorded during these surveys, was present in different periods of time in different localities and has had various frequencies throughout the vegetation period, causing considerable damages to the potato crop.

Of the total number of plant aphids found, the largest numbers were wingless in relation to winged forms (Table 3). The relationship between wingless and wingless forms also varied. The smallest ratio was found in other species of plant aphids in the locality Vushtrri (2.42) and the highest in *M. persicae* in Podujevo (32.38) while the average ration regardless of the aphid species was 8.44. Winged forms, though smaller in numbers, are more dangerous, especially in potato seed production, due to the transmission of virus diseases. The winged aphids fly very well but are also helped by the wind and quickly are spread over long distances thus spreading viral diseases, so winged forms of plant aphids are largely responsible to spread the viruses. According to various authors worldwide aphids as vectors of potato viruses transmit them in two agronomically relevant ways: either persistently or none persistently. According to Struik & Wiersema (1999), not all aphids can transmit potato viruses. On the other hand, some viruses can be transmitted by many different aphids, whereas other viruses require specific vectors.

Table 3. Aphid ratio records between alata and aptera

Locality	Aphid species	Aphids		Ratio aptera/ alata
		Aptera	Alata	
Podujevë	*M. persicae*	421	13	32.38
	A. nasturtii	157	28	5.61
	A. solani	72	21	3.43
	M. euphorbiae	85	16	5.31
	Other	38	7	5.43
Prishtinë	*M. persicae*	413	45	9.18
	A. nasturtii	145	27	5.37
	A. solani	54	19	2.84
	M. euphorbiae	49	16	3.06
	Other	37	4	9.25
Vushtrri	*M. persicae*	1,392	126	11.05
	A. nasturtii	659	67	9.84
	A. solani	140	21	6.67
	M. euphorbiae	56	17	3.29
	Other	46	19	2.42
Total		3,764	446	8.44

There are also large differences among aphids species with regard to the efficiency with which they transmit viruses. A highly efficient species is *M. persicae*, while species such as *A. nasturtii* is 2 times less efficient than M. persicae or *M. euphorbiae* is 10 times less efficient than *M. persicae*, and hence are much less threatening (Struik & Wiersema, 1999).

From the total numer of aphids collected (4,210 individuals) in Vushtrri were recorded 2,543 individuals (60.40%). The number of plant aphids in the Podujevë and Prishtina sites was approximately similar, whith 859 individuals (20.38%) and 809 (19.22%) individuals recorded (Fig. 1).

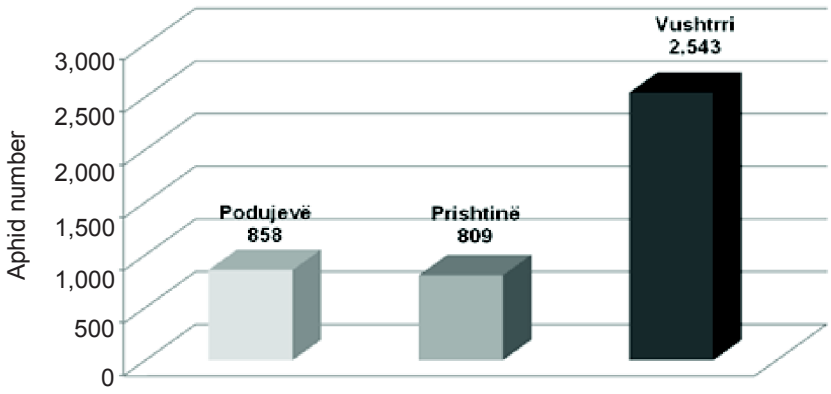

Figure 1. Number of aphid species during vegetation season 2018–2019.

The highest number of aphids present in the locality of Vushtrri according to our opinion is because of several factors, (a) potato mono-cropping pattern, where traditionally in this locality the potato crop is grown in monoculture, year by year in the same field, with consequent favorable conditions to the over-wintering of almost all aphid species, (b) nitrogen application in high doses, which stimulates plant growth, (c) a mild climate compared to the other localities, (d) low altitude level with higher aphid pressure compared with other sites, and (e) insecticides use with broad spectrum from the farmers which is in this locality very often at high rates that have great impact to predators and other parasites of aphids as well. It was proved by Jansson & Smilowitz, 1986 that population of *M. persicae* tend to increase with increasing levels of nitrogen application, while Barlow (1962) reported the correlation of weather parameters and the level of aphids. Aphid specific predators like syrphids, coccinellids and chrysopids are considered of particular importance to decrease aphid populations. In this respect Zamani et al. (2007) reported also for the importance of two parasitoids *Aphidius matricariae* as well *Aphidius colemani*.

The results obtained, with regard to the aphids in potatoes, in the three localities where this crop was cultivated, revealed that both *M. persicae* as well *A. nasturtii* are most prevalent species among the aphids recorded (Fig. 2). From the total number of aphid species collected, as an average of two years of survey, from the leaves of potato plants (4210 aphids) *M. persicae* participated with 2,410 individuals (57.24%), *A. nasturtii* with 1,083 individuals (25.72%), *A. solani* with 327 individuals (7.77%) and *M. euphorbiae* with 239 individuals (5.68%). Other aphid species, presented as other participated with 151 individuals (3.59%). Our results are approximately in line with the results of the other authors who confirmed the highest presence of these aphids in potato crop (Miln, 1978; Berlandier, 1997; Stufkens & Teulon, 2001).

During of these surveys it was shown that *M. persicae* tends to colonize the lower senescing leaves of potato plants, whereas *M. euphorbiae* and *A. solani* are found mainly on new leaves of the potato plants. Regardless the species of plant aphids present or plant part where they were concentrated, the damage was considerable. During their feedings these pests with their stylet or piercing mouth apparatus extracted nutrients from the affected parts of the plants, especially from the leaves, resulting in increased plant deformations, twisting and plant stagnation. These attacks of plant tissues from these

pests finally leaded to a decrease the quality as well the yield of potato plants. Concerning the plant aphids that where present and the damages caused to potato plants, there is a tremendous work worldwide by various authors and the results of our research are approximately similar to the data reported by these researchers (Musa et al., 2004; Vučetić et al., 2013; Avila et al., 2014).

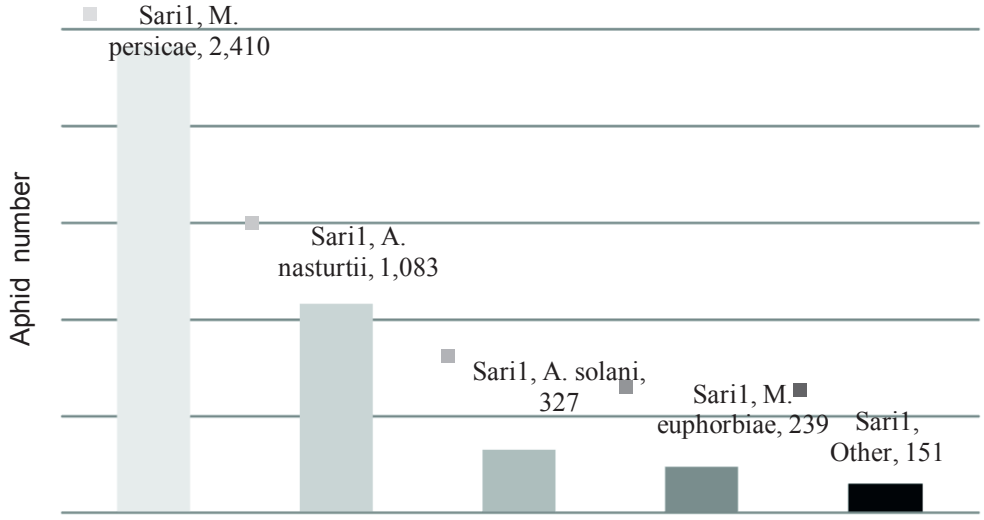

Figure 2. Aphid species composition in potato crop in three localities.

From the table of analysis of variances and LSD (Table 4), it is shown that significant differences were confirmed between three localities where the potato was cultivated (Podujevë, Prishtinë and Vushtrri).

Table 4. Comparison of aphid frequency in potato crop, ANOVA

Localities (A)	Aphid species (B)					Average (A)
	M. persicae	*A. nasturtii*	*A. solani*	*M. euphorbia*	Other	
Podujevë	36.17	15.42	7.75	8.42	3.75	14.30*
Prishtinë	38.17	14.33	6.08	5.41**	3.42	13.48**
Vushtrri	126.50**	60.50	13.42	6.08	5.42	42.38**
Average (B)	66.94**	30.08**	9.08 Ns	6.64 Ns	4.19**	Interaction A × B**
Factor		A	B	B × A		A × B
LSD	0.01	12.8795	10.3128	20.8130		17.8623
	0.05	9.4757	7.8345	13.5698		15.5404

The highest number of plant aphids, regardless aphid species, as an average of two years, was recorded in the locality Vushtrri (42.38 aphids), whereas the lowest number of aphids was recorded in the locality Prishtinë (13.48 aphids). The differences observed in terms of the number of aphids in Vushtrri compared to the other two localities were proved to be highly significant, while no statistically significant differences were found between the two other localities (Podujevë and Prishtinë). In this regard we can state that

potato crop cultivated in the locality of Vushtrri has been the most affected by plant aphids whereas potato cultivated in other two localities has been less affected by aphids.

Statistically highly significant differences similarly were shown regarding to aphid species recorded (Factor B). In fact, regarding the aphids the highest number was recorded with *M. persicae* (66.94 aphids), while the lowest number of individuals was confirmed to *M. euphorbiae* (6.64). The differences, concerning to aphid numbers, recorded between *M. persica*e to *A. nasturtii*, also the differences between these two aphids and other species recorded during these researches, are statistically highly significant (Table 4), whereas between *A. solani* and *M. euphorbiae* these differences statistically were confirm to be no significant.

With respect to interaction of factors A × B (locality × aphid species), there were recorded statistically significant differences at different level, concerning the aphid numbers in the leaves of potatoes. In this respect, for example, the highest number of aphids was recorded for *M. persica* in Vushtrri (126.5 aphids) whereas the lowest one for *M. euphorbiae* in the locality of Prishtinë (5.41 aphids).

CONCLUSIONS

Based on these researches conducted during two years of experimental work with regard to aphid distribution in potato crop cultivated in agro climatic condition of Kosovo, the following conclusions might be drawn: Plant aphids are very common in potato crop cultivated in different agro-climatic condition in Kosovo. The results obtained showed that *M. persicae* as well *A. nasturtii* were the most prevalent aphid species found in potato crop. Regarding the other two species, *A. solani* also *M. euphorbiae* they were registered in potato crop as well. During of these surveys we have found that *M. persicae* tends to colonize the lower senescing leaves of potato plants, whereas *M. euphorbiae* and *A. solani* are found mainly on new leaves of the potato plants. Aphids, during their feedings, may cause a considerable damage on plants, but they are of even greater economic significant since they are very efficient to transmit viruses and have the role as a vector of viruses to the plants. The time as well the frequency of certain types of aphids in potato was different throughout the vegetation season, causing considerable damage to this crop. Based on the ANOVA and testing with LSD, highly significant statistical differences were shown among the localities included in the experiment regarding aphids recorded there. The highest number of aphids was recorded in Vushtrri and the smallest number in Prishtina and Podujevë. Significant differences also were shown to exist as well regarding the other aphids. The highest number of plant aphids, almost to all species, was confirm at the beginning of summer (June-July), when necessarily measures should be applied to prevent potato damages that might be caused by aphids. With the aim to get rid such a pest from potato crop, it would be extremely useful to investigate the opportunity of an Integrated strategy for Pest Management at farmer level.

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