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# MONITORING OF APHIDS SPECIES IN THE POTATO CROP FROM “ŢARA BÂRSEI”

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## ABSTRACT

**With a high capacity for adaptation and colonization in many ecological systems, including crops, aphids are interesting models of study. Aphids can cause damages to potato plants by inducing feeding injuries and transmitting plant viruses. In order to evaluate the fluctuations of aphids in potato crop, an investigation was carried out in area of Ţara Bârsei from Braşov (Romania), using 56 years long time series data. To identify the aphid species and to assess the relevance of their structure and abundance, between the years 1963 and 2018, a study of these pests in potato crop was conducted. Aphid monitoring was carried out using the method of yellow water traps, suitable for studies on aphid population structure, abundance and flight activity. Species were identified using keys for identification of alatae aphids. Great differences were observed on aphid structure, abundance, distribution and flight activity over the studied years. For seed potato crop, the greatest interest was presented by *Myzus persicae* species, the main viral vector from this crop. The monitoring of aphid populations, the analysis of the abundance of aphid species contribute to the knowledge of the activity and evolution of the aphid fauna specific to potato crops over long periods of time.**

**Keywords:** aphids, potato crop, *Myzus persicae*.

## INTRODUCTION

Aphids or greenfly (*Hemiptera*) are the most widespread groups of insects harmful to agricultural systems. Potato seed crops are directly affected (nutrient sap collection) and indirectly (virus transmission) by the abundance, diversity and activity of the aphid population.

Among of plant viruses vectors, aphids represent a considerable percent. There are more than 4500 species who feed on agricultural and horticultural crops throughout the world (Blackman and Eastop, 2000). The main aphid species associated with potatoes worldwide are non-specific to this crop (Saguez et al., 2013). Aphids can cause damages to potato plants by inducing feeding injuries, as well by transmitting plant viruses (Rajagopalbabu et al., 2013).

Potato yield reduction due to virus infections can reach 88%. Currently, more than 50 different viruses infecting potatoes have been identified worldwide (Kolychikhina et al., 2021). Diseased plants remain small, twisted, yellowish, covered with a sweet, sticky secretion which, due to the fungi that develop on the sweet substances, becomes black and photosynthesis takes place with difficulty.

In potato crop were identified important colonizing aphid species such as: *Myzus persicae* Sulzer, *Macrosiphum euphorbiae* Thomas, *Aulacorthum solani* Kaltenbach, *Aphis nasturtii* Kaltenbach., and species potentially virus vectors not colonizing but feeding on potato: *Aphis fabae* Scopoli, *Aphis frangulae* Kaltenbach, *Rhopalosiphum padi* Linnaeus, *Acyrthosiphon pisum* Harris, *Brachycaudus helichrysi* Kaltenbach, *Phorodon humuli* Schrank (Kostiw, 1980; Harrington et al., 1986; De Bokx and Piron, 1990). More than 50 aphid species are vectors of PVY virus on potatoes. With a high capacity of transmitting or spreding viruses of potatoes (potato leafroll virus - PLRV, potato virus Y - PVY, potato virus A - PVA, potato virus S - PVS, potato virus M - PVM, alfalfa

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mosaic virus - AMV) *M. persicae* is the most important aphid vector in potato crop. *M. persicae* colonizes potatoes and is the most virulent virus vector, being involved in transmitting most types of potato viruses. *Aphis fabae* and *Aphis* spp. are non-colonizing species, but they fly frequently and in large numbers in potato crops. Literature data mention them as potential vectors of virus Y.

Different techniques have been used over time to monitor aphid populations, to understand the relationships between the structure of aphid population, population dynamics and virus spread in crops. These methods aim to estimate the number of migrating aphids at different times of the year, the structure of the populations, and to determine those with an impact on the phytosanitary quality of crops. The association of virus spread with aphid flight activity is well documented (Hille Ris Lambers, 1972; Van Harten, 1983). This is a long-standing practice in the UK (Woiwod et al., 1984), the Netherlands (Hille Ris Lambers, 1972), Germany (Müller, 1987), Sweden (Sigvald, 1992), Canada (Boiteau and Parry, 1985), USA (Halbert et al., 1990) and elsewhere.

## MATERIAL AND METHODS

In order to evaluate the fluctuations of aphids in potato crop, an investigation was carried out using 56 years long time series data. This monitoring of aphids in potato crop was conducted between the years 1963 and 2018 in area of Ţara Bârsei at Braşov and aimed to identify the aphid species and to assess the relevance of their structure and abundance.

Moericke's studies showed that many of the aphids are attracted to the color that reflects light within the spectrum range of 500-700 nm, therefore yellow pan traps are used for aphid flight monitoring (Moericke, 1951). Aphid monitoring was carried out using the method of yellow water traps, suitable for studies on aphid population structure, abundance and flight activity. The data obtained using this method can help build an image of aphid risk to potato crops in this region as part of broader aphid monitoring. This monitoring method using yellow pan traps placed in potato crops was used in an extensive network and the obtained data have been published by Robert, (1981), Heie et al. (1981), Taylor (1983). Vučetić et al. (2013) studies showed that this is a good method monitoring aphids as vectors of viruses and is suitable for insect diversity research.

The investigation was performed immediately after the emergence of potato plants and it continued until potato vines started yellowing. To be visible to the aphids during potato plant growth the trap have been raised gradually so to be at the same level with the potato vegetation. Samples were taken daily in the morning, until 9 am, then sorted from other insect groups and preserved until species identification in alcohol in hermetically sealed glass containers.

Species were identified using keys for identification of alatae aphids (Basky, 1993; Autrique and Ntahimpera, 1994; Remaudiere and Seco Fernandez, 1990; Blackman and Eastop, 2000, 2007) and a stereomicroscope (Matic).

## RESULTS AND DISCUSSION

The average number of aphids calculated for 56 years, on the growing season of the seed potato in Ţara Bârsei (from May to September) indicates the presence of aphids in June and July of each experimented year. Also, in these months the massive presence of aphids is registered, the highest average number being in July (3235), with a maximum of 34673. The coefficient of variation 168%, indicates the great differences of abundance in the researched years (Table 1).

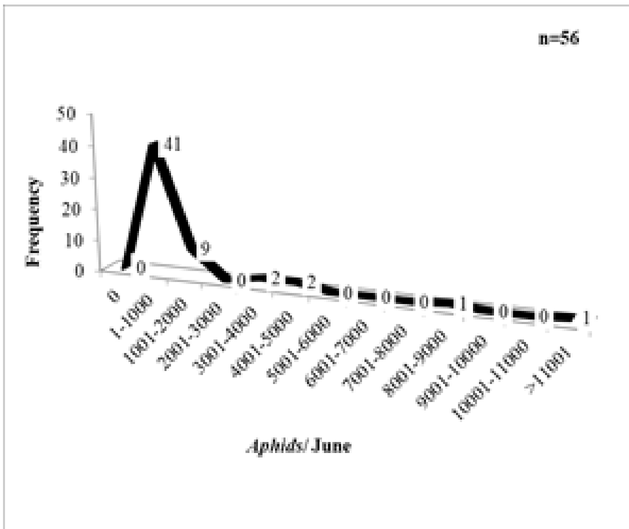
Results of *M. persicae* species abundance are also summarized in Table 1 pointing out great variability, even in the months with higher abundance. The highest mean value of 492 for colected *M. persicae* individuals was reported in July, with a maximum of 8151 and a CV of 276%.

*Table 1.* Summary statistics for total aphids and *Myzus persicae* in the last 56 years

| | | N | Min | Max | Mean | Stand. dev | Coeff. var |
|---|---|---|---|---|---|---|---|
| Total aphids | May | 56 | 0 | 1701 | 108 | 265 | 244 |
| | June | 56 | 24 | 11789 | 1131 | 2060 | 182 |
| | July | 56 | 27 | 34673 | 3235 | 5421 | 168 |
| | August | 56 | 0 | 3436 | 585 | 876 | 150 |
| | September | 56 | 0 | 5005 | 144 | 687 | 478 |
| *Myzus persicae* | May | 56 | 0 | 7 | 1 | 1 | 213 |
| | June | 56 | 0 | 588 | 32 | 94 | 294 |
| | July | 56 | 0 | 8151 | 492 | 1359 | 276 |
| | August | 56 | 0 | 2448 | 127 | 371 | 293 |
| | September | 56 | 0 | 99 | 3 | 13 | 470 |

Over the years, the abundance of total aphids and *M. persicae*, in June and July, had a great variation (Figures 1, 2). While for the *M. persicae*, in June, less than 80 individuals were captured in 38 of the experimental years, in 14 of the years, no individuals being captured, a large number of aphids was identified for the same month of the analyzed period.

The experimental data for July hightlights that in the most of the years (37) less than 3000 aphids were collected, just in one year being identified a record number of individuals (more than 30000). Regarding the number of *M. persicae* for the same month, during the experimental period, in 43 year less than 1000 individuals were collected, being identified also years (8) when no individuals were captured in July.



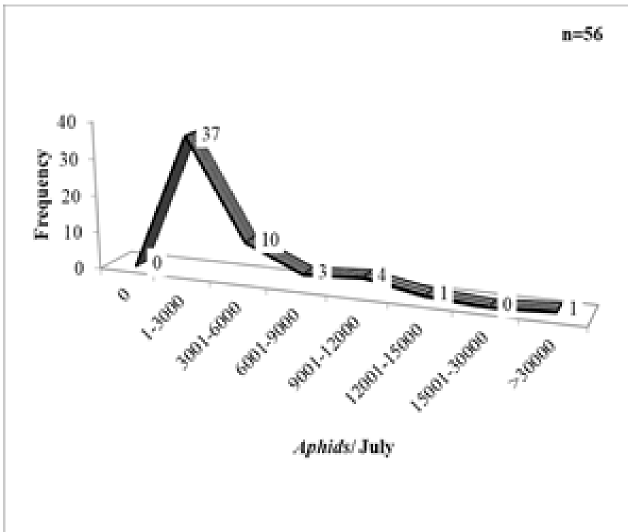




*Figure 1.* Frecquency of the years for abundance of total aphids and *M. persicae*, in June and July (1963-2018)

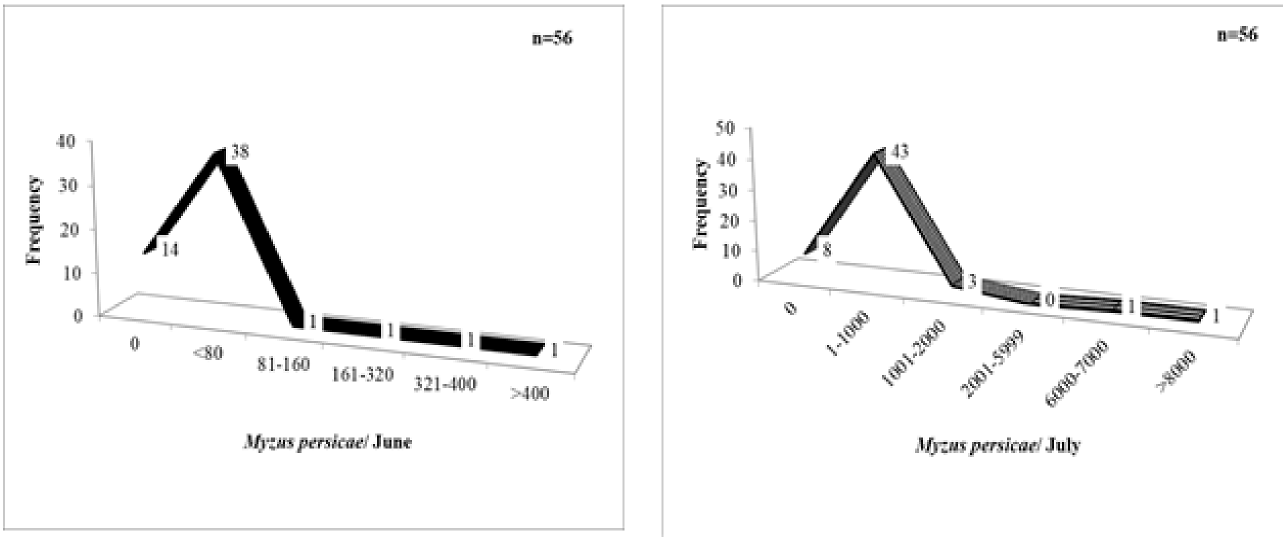
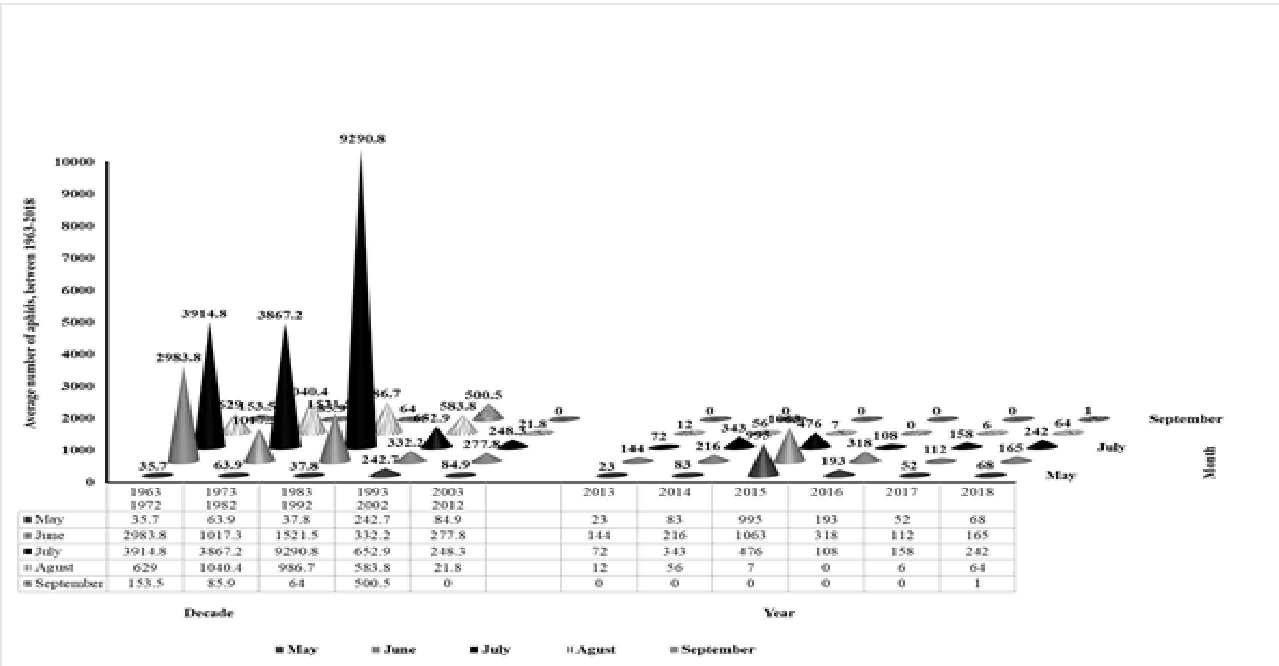



*Figure 2.* Frecquency of the years for abundance of *M. persicae*, in June and July (1963-2018)

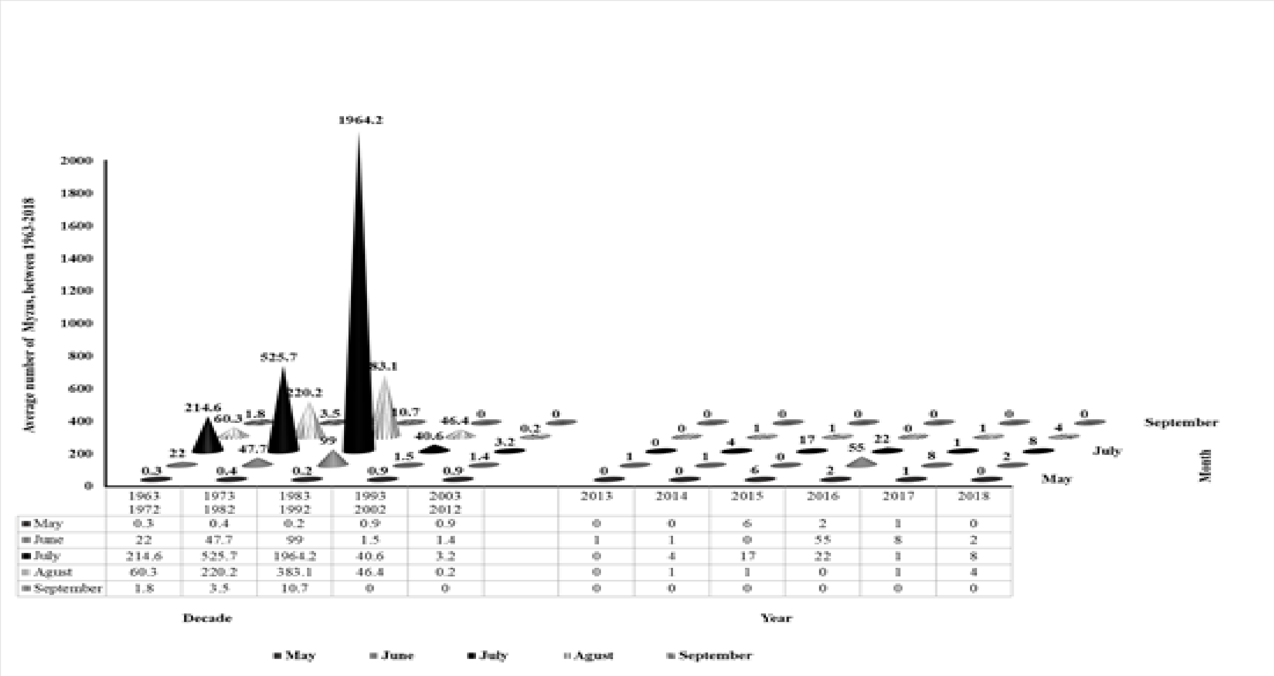
In order to limit damages caused by aphids, especially by *M. persicae*, and to provide a sustainable development of seed potato crop through better management decisions, the study of these insects becomes essential. By analyzing the abundance of aphids in the last 56 years beginig whith 1963, in Ţara Bârsei Braşov, on decades, there has been observed a decrease of their number, after the year 1993 (Figure 3) climate change.




| | 1963 1972 | 1973 1982 | 1983 1992 | 1993 2002 | 2003 2012 | | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| May | 35.7 | 63.9 | 37.8 | 242.7 | 84.9 | | 23 | 83 | 995 | 193 | 52 | 68 |
| June | 2983.8 | 1017.3 | 1521.5 | 332.2 | 277.8 | | 144 | 216 | 1063 | 318 | 112 | 165 |
| July | 3914.8 | 3867.2 | 9290.8 | 652.9 | 248.3 | | 72 | 343 | 476 | 108 | 158 | 242 |
| Agust | 629 | 1040.4 | 986.7 | 583.8 | 21.8 | | 12 | 56 | 7 | 0 | 6 | 64 |
| September | 153.5 | 85.9 | 64 | 500.5 | 0 | | 0 | 0 | 0 | 0 | 0 | 1 |

*Figure 3.* Abundance of aphids in the last 56 years

*M. persicae* is the most important potato virus vector with negative consequences on seed potato crop yield and quality. By analyzing the frequency of this species in the last 56 years, on decades, similar results to other aphid species were obtained. With an average of 1964.2, the highest mean value for *M. persicae* individuals captured was recorded in July between 1983 and 1992 (Figure 4). After 2013, a small percentage of the aphids was represented by *M. persicae,* in recent years, obvious changes in the structure of aphids being observed.




| | 1963-1972 | 1973-1982 | 1983-1992 | 1993-2002 | 2003-2012 | | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| May | 0.3 | 0.4 | 0.2 | 0.9 | 0.9 | | 0 | 0 | 6 | 2 | 1 | 0 |
| June | 22 | 47.7 | 99 | 1.5 | 1.4 | | 1 | 1 | 0 | 55 | 8 | 2 |
| July | 214.6 | 525.7 | 1964.2 | 40.6 | 3.2 | | 0 | 4 | 17 | 22 | 1 | 8 |
| Agust | 60.3 | 220.2 | 383.1 | 46.4 | 0.2 | | 0 | 1 | 1 | 0 | 1 | 4 |
| September | 1.8 | 3.5 | 10.7 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 |

*Figure 4.* Abundance of *M. persicae* in the last 56 years

If *M. persicae* represented an important part in the diversity of aphids in the first part of the analyzed period, being estimated at 56 percentage in 1977, in the last years, in Ţara Bârsei, a significant decrease ($r=-0.26^0$) of *M. persicae* percentage occurred (Figure 5).

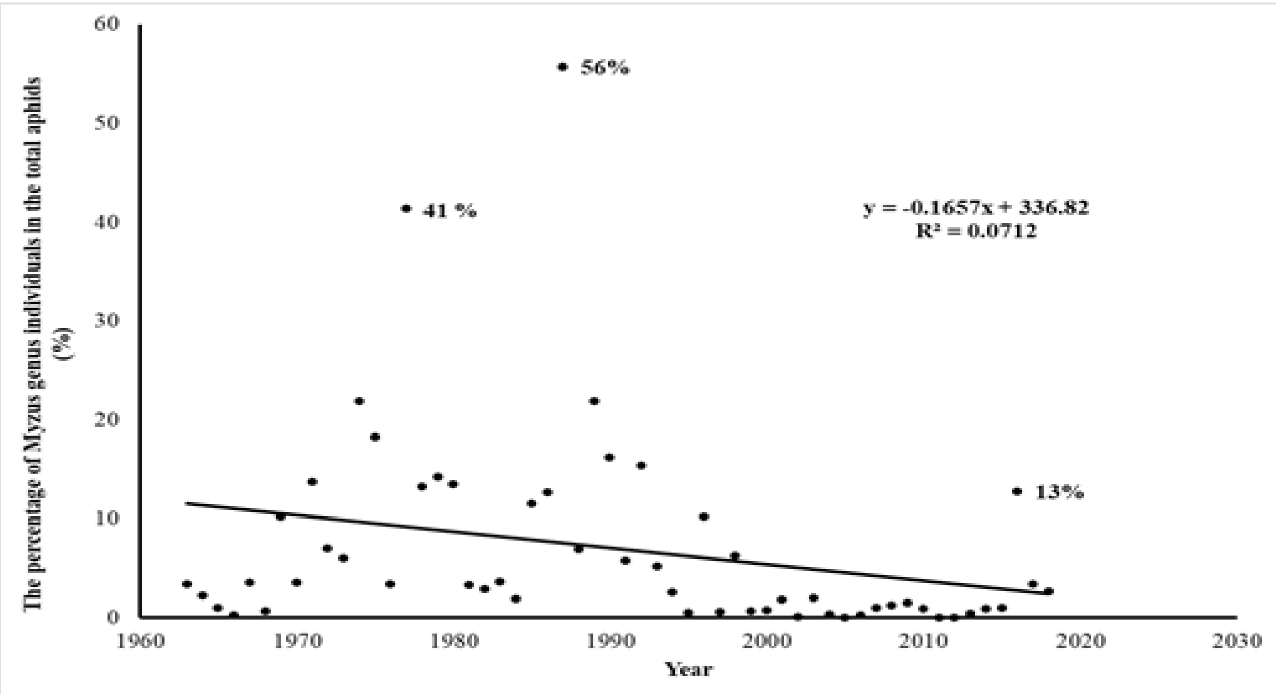



*Figure 5.* Dynamics of *M. persicae* in total aphid number, between 1963-2018

Based on the annual collections, we can see the pronounced decreasing trend, since 2000, the percentage of *M. persicae* in the total aphids being less than 10%.

Temperature is one of the key factors for aphid geographic distribution. These insects are well adapted to regions with a cold winter, during which they survive in the form of eggs. The minimum temperature at which aphid development occurs is generally around 4°C, but this figure varies between species. Optimal temperatures and upper limits are also variable but usually in the range of 20 to 25°C and 25 to 30°C, respectively. Lower temperature thresholds for flight are generally around 13-16°C and upper thresholds around 31°C. (Robert, 1979; Hulle et al., 2010). The number of aphid generations depends on the temperature requirements of aphid species. Aphids reproduce either entirely parthenogenetically throughout the year or year-round parthenogenetic reproduction is interrupted in the autumn by the establishment of an amphigotic generation producing eggs, production that is regulated by temperature (Hullé et al., 2010). After Blackman (1974) cited by Hullé et al. (2010) an increase in temperatures above 20°C might delay or even totally prevent sexual reproduction.

Analyzing the constant trend of the average temperature increasing during the potato vegetation period (April-October) in Braşov according to the long-term evaluation 1921-2015 and forecast for next years 2017-2030 (Figure 6) the following aspects were observed:

- between 1969 and 1985 the annual average temperatures were below the multiannual average, but since 1987 (except 1997) they have continued to rise, with an estimated upward trend in average temperatures. These increases in the multiannual average temperature have led to an increase and diversification of the identified species and even to the appearance of some rare species for Braşov area;
- the estimated trend of average temperature increase in the coming years is already noticeable. Winters are getting milder, with little precipitation and few frost days, which has led to a very intense flight of aphids in the first days of spring (March-April-May);
- the activity of *M. persicae* is increasingly earlier and more intense in the early months of potato vegetation which puts a lot of pressure on the phytosanitary quality of seed potatoes;
- summer months with temperatures above the limits of activity and even the survival of aphids have much reduced activity and species diversity;
- these new aspects will put pressure on the technological elements of seed potato cultivation in terms of controlling aphid populations and reducing the degree of viral infection.

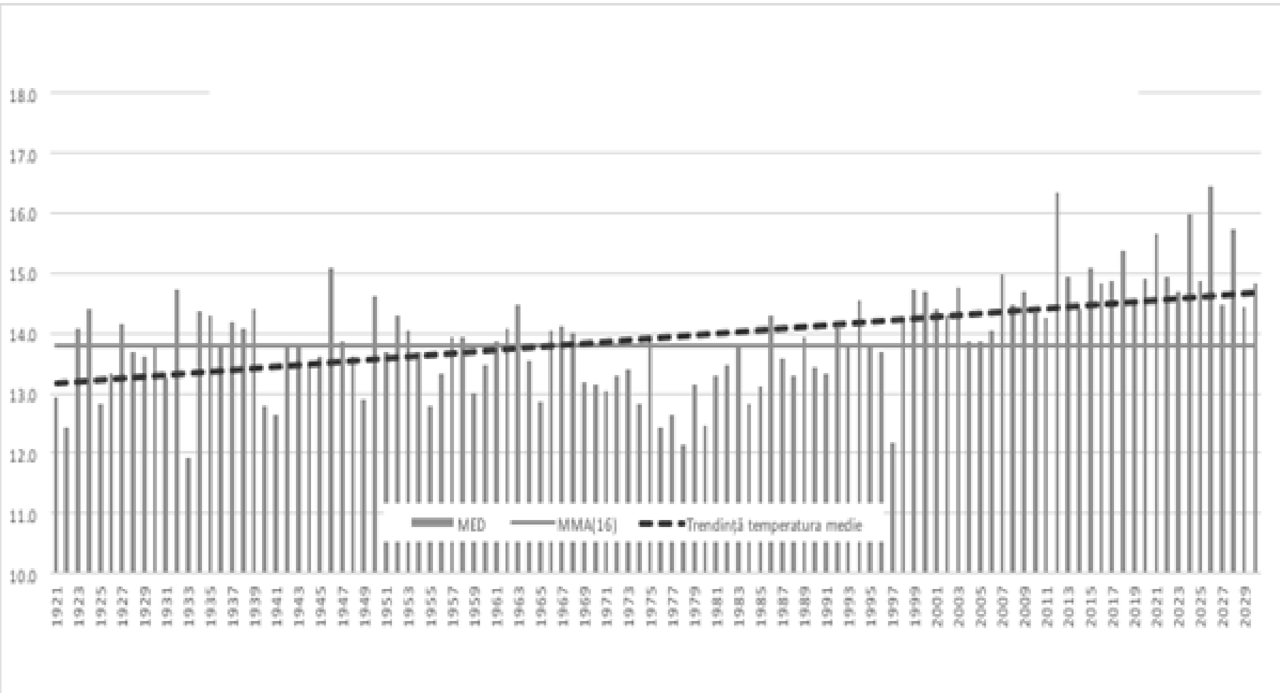



*Figure 6.* Evaluation of long-term changes in the average temperature in the Braşov area (1921-2015) and forecast 2017-2030 (Olteanu et al., 2016 adapted after Pristavu et al., 2015)

## CONCLUSIONS

During the fifty-six years studies, the aphid species collected were identified on different taxa. Great differences were observed on aphid structure, abundance, distribution and flight activity over the studied years. These differences were caused by the different influence of climatic factors and the evolution of cultivation technologies.

Some aphid species were more or less regularly trapped on potato crops during the years. For seed potato crop, the greatest interest was presented by *M. persicae*, the main viral vector from this crop.

The monitoring of aphid populations, the analysis of the abundance of aphid species contribute to the knowledge of the activity and evolution of the aphid fauna specific to potato crops over long periods of time.

Monitoring aphids in potato crops helps to assess the risk of spreading viruses, particularly virus Y. The data obtained every year form the basis for determining the optimum time to stop the seed potato crops vegetation, maximizing yield without risking seed potato health**.**

## ACKNOWLEDGEMENTS

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