

Conference Paper

Numerical and Species Composition of Insects Transmitting Viral Infection in North Ossetia

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Abstract

One of the major tasks in the production of original and elite potato seeds is to prevent the rapid re-infection of the healthy material with viruses in the open field. The high rate of infection with each subsequent reproduction reduces seed productivity and worsens the tuber varietal quality. Currently, about two dozen viruses that infect potatoes have been identified. In the field, most of the harmful viruses of potatoes are transmitted by insects such as aphids, cicadas and bedbugs. The purpose of our research was to study the species composition of transmitters and the intensity of their flight in North Ossetia. Studying the activity of the winged aphid vector is a prerequisite for the implementation of protective measures against re-infection of the sanitized material with viruses. The most important criteria characterizing aphids in transferring potato viruses during the growing season were as follows: the species composition, the dynamics of the potato planting periods, the timing of the critical threshold with regards to the number of aphids, and the total vector intensity during the growing season. There are very few aphid vectors in the mountain zone of the Republic of North Ossetia, which is at and above an altitude of 1,650 meters above sea level. Therefore, mountain regions of this height are a natural insulator against viral infection. In the foothill zone, the most numerous aphid vectors are bean, buckthorn, and alder buckthorn-willowherb aphids, whose number varies from 35 to 280 individuals per year on a Merike trap.

Keywords: potatoes, insect vectors, a Merike trap, mountain zone, spatial isolation.

1. Research Methodology

In 2015 - 2018 studies on establishing the species composition of insects transmitting potato viruses in the Republic of North Ossetia - Alanya were continued. The dynamics of the aphids' flight development was determined depending on the zone of distribution,

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stages of a host plant organogenesis and the influence of weather conditions. The studies were carried out in three stationary nurseries of selective breeding, specifically, in the foothill and at two altitudes of the mountain zone 1,400 m and 1,650 m above sea level [1].

Aphid number was determined using Merike water traps.

Yellow cups were put directly on the soil surface, on a 5x5 m area of clean steam, at the edge of a potato field. Water was poured into the cups, just over the yellow paint edge. On a day-to-day basis, aphids were taken out from yellow cups by filtering through a gauze wad. Then the gauze wad with the insects remaining on it was put into a bottle with 80% alcohol. In the laboratory, gauze wads were unrolled on watch glasses [2-5]. Aphids were counted and identified under a binocular loupe. Alcohol samples can be preserved for several months. Wingless aphids were counted by 100 leaves once every ten days from the moment of crops emergence to top necrosis. Leaves of the lower, middle, and upper layers were taken for accounting. Leaves were collected in polyethylene bags in the morning, and aphids were counted on the same day [6, 7].

Experiment options:

Foothill zone:

Planting potatoes without isolation

Spatial isolation at a distance of 1,000-1,200 m

Spatial isolation by crops of spring oats

Mountain zone:

Planting potatoes at an altitude of 1,400 m above sea level without isolation

Altitude of 1,400 m above sea level. Spatial isolation at a distance of 1,000-1,200 m

Planting potatoes at an altitude of 1,650 m above sea level without isolation

Altitude of 1,650 m above sea level. Spatial isolation at a distance of 1000-1200 m

2. Results and Discussions

The green peach aphid (*Muzodes persicae* Sulz.). The main host plants are as follows: peach, almond, apricot. Summer generations can feed on herbaceous plants of many families. The pest can hibernate as adult insects on perennial plants, wintering weeds, tubers and root crops in storages. Peach aphid is a carrier of viruses L, Y, A, M, S, F, spindle tuber.

The buckthorn aphid (*Aphis nasturtii* Kalt.). It hibernates in the egg stage on the main host being laxative buckthorn (*Rhamnus cathartica* L.). Summer hosts are herbaceous



plants, mainly buckwheat, nightshade, crucifers. It is widespread in all zones. Buckthorn aphid is a carrier of viruses, L, Y, A, M, S, F but comes short of the latter significantly in its transmitting ability. The leaf-rolling virus transmits only in 5-10% of cases.

The alder buckthorn-willowherb aphid (*Aphis frangulae* Kalt.). By morphological and biological characteristics, this species is similar to the previous one. The main host is the alder buckthorn (*Frangula alnus* Mill), on which some of the aphids remain throughout the growing season, the other part migrates to potatoes and herbaceous plants [8-10].

The foxglove aphid (*Aulacorthum solani* Kalt.). It develops without the obligatory change of hosts on many herbaceous plants, specifically, potatoes, foxglove, buttercups, etc. It is widespread in almost all zones but in smaller quantities than buckthorn aphid. The foxglove aphid is a transmitter of viruses Y, A, M, F.

The large potato aphid (*Macrosiphum euphorbiae* Thorn, *M. solanifolii* Ashm.). This species does not change hosts. It develops parthenogenetically on many herbaceous plants, including potatoes. It is widespread mainly in areas with mild winters. The large potato aphid is a transmitter of mosaic viruses and partly of curlytop virus.

The black bean aphid (*Aphis fabae* Scop). The main hosts are spindle (*Evonymus europaeus* L.), guelder-rose (*Viburnum opulus* L.), sweet mock orange (*Phyladelphus coronarius* L.). In summer it feeds on legumes, beetroots, poppy seeds. In terms of the ability to transmit viruses infecting potatoes, the black bean aphid comes short of all previous species. However, during the years of mass reproduction it can have a significant effect on the planting material infection [11, 12].

3. Foothill Zone

The first winged aphids were recorded in the foothill zone in 2015 in the second decade of May. Mass flights were noted in the third decade of June, when 497 individuals on average were collected from one trap per season, including 382 transmitters of the viral infection. The foxglove aphid (*Aulacorthum solani* Kalt) was the most numerous that year, specifically, 156 specimens per trap on average and the green peach aphid (*Muzodes reg-sicae* Sulz) showed 126 specimens. Mass flights of buckthorn aphid (*Aphis nasturtii* Kalt) and alder buckthorn-willowherb aphid (*Aphis frangulae* Kalt) were recorded in the second decade of July with an average number of 80-90 individuals.

In 2015-2016 mass flight of aphids was not observed. In 2015, no wingless aphids were found in June and July. In option 2, at the beginning of the first decade of August, the maximum number of wingless aphids on 100 leaves was observed on potato plants and was averaged by 20 individuals [13, 14].



In July 2015, no wingless aphids were found. In the second decade of August single individuals of wingless aphids were observed on 100 leaves on potato plants (5-7 individuals) for one Merike trap. It is believed that 0-20 aphids per 100 potato leaves indicate a good potato condition in the area. A critical number of aphids of more than 80 individuals per 100 planting leaves can be severely affected by a viral infection. The next two years of research showed that the flight period of aphids began in the second or third decades of May and lasted until the third decade of August. The beginning of the mass flight is strongly influenced by the intensity with which the positive temperatures accumulate in the spring. The earlier this happens, the earlier the period of dispersal of winged aphids from the primary host begins.

TABLE 1: Comparative data on number of insect vectors of viral infection in the North Ossetia vertical zonality

option	2015		2016		2017		2018		On average	
	Aphids, totally	Vectors out of this number	Aphids, totally	Vectors out of this number	Aphids, totally	Vectors out of this number	Aphids, totally	Vectors out of this number	Aphids, totally	Vectors out of this number
1	497	382	474	304	327	277	520	427	454	347
2	266	232	209	122	104	56	302	179	220	122
3	297	171	274	111	127	72	391	204	272	139
4	38	28	39	20	24	17	49	38	37	26
5	19	11	27	12	19	9	14	12	21	13
6	-	-	0	0	12	7	17	10	10	6
7	-	-	0	0	11	8	9	0	7	3

The total number of winged aphids varied depending on the climatic conditions of June and July. The main and most important factor was the stability of a favorable temperature (19-23°C) and humidity. Drought usually limited the number of aphids severely. The number of aphids in 2017 was higher than in the previous years and amounted to 67 pieces of aphid for one Merike trapping vessel. The total number of aphids for all periods of capture in 2018 in the isolation area was 391 and 302, including 139 and 122 vectors of viral infection. Various types of isolation protected the potato plantings from the winged individuals to varying degrees. In the option when the oat crops served as an isolation barrier, the number of trapped insects was higher than in the potato plantations that were in spatial isolation. On average, over four years in option 2, the number of virus transmitters was 272 individuals and in option 3, it was 220 individuals.

In the area without insulation, there were significantly more aphids (454 individuals), which is almost twice more than in the areas with isolation. When determining the species composition, the following types of aphids were found: green peach aphid,



bean aphid, buckthorn aphid, alder buckthorn-willowherb aphid, large potato aphid, black bean aphid and single individuals of spindle, guilder-rose and sweet mock orange. The part of buckthorn and alder buckthorn-willowherb aphids trapped in 2016 was 58.1%, foxglove aphids – 21.7%. Wingless aphids were noted in July during the growing season of 2016 in the forest-steppe zone in potato plants isolated from a viral infection and there were 19 individuals of aphids. 37 aphids were found on not isolated plants (control option).

In the catching of 2017, the large potato aphid prevailed, accounting for 20% and green peach for 14.4%. The proportion of these species of aphids in the first years of observations was slightly higher. In 2017, there was half the number of viral infection transmitters in the isolated area than in the area without isolation, where the infection of potato plants with a viral infection was much greater. The data on wingless aphids counting in 2018 showed the same pattern. In an isolated area, 18 aphids were noted, without isolation there were 38 aphids.

Thus, recording of winged and wingless aphids in the foothill zone showed that the number of vectors in a potato field located at a distance of 1,000-1,200 meters from possible sources of viral infection for four years on average was two times less than on the areas commonly planted with potatoes. Isolation of a potato field by planting oats, in comparison with the control option, contributed to a decrease in the total number of aphids by 30-35%, spatial isolation by 55-58%. Despite the significant number of captured individuals, the number of aphids for the entire observation period in the foothill zone did not reach a critical threshold. The critical threshold is the total number of harmful winged aphids caught from the beginning of the growing season for one trap in the number of more than 50 specimens.

4. Mountain Zone

In mountainous conditions, there are much less transmitters of viral infection than in the foothill zone. The productivity of natural isolation changes with regards to the location of the potato plantings in vertical zonality. At an altitude of 1,400 m and on average over four years during the growing season, 37 individuals got into the Merike trap while at an altitude of 1,650 m this figure was equal to 10 individuals. In the mountain zone, the highest flight intensity of aphids at an altitude of 1,400 m was observed in general potato plantations in the immediate vicinity with a collection nursery of varieties characterized by different ripening periods (option 4). Long-growing plantings of potatoes attracted winged aphids, whose total number was 49 individuals. Spatial isolation at this height

reduced the figure to 12 pieces. It was indicative that the flight of aphids practically stopped at an altitude of 1,650 meters above sea level. 7 individuals were caught in Merike traps in the nurseries of mini tubers and PP-1 planted there. In option 6, where not only vertical natural but also spatial (absence of nearby common plantings of potatoes and other suspected sources of infection) isolation was observed. On average 3 individuals were recorded over 3 years. The species composition was somewhat different from the composition spreading on the plane. The foxglove aphid and green peach aphids were the most numerous. The third and fourth places were occupied by buckthorn and alder buckthorn-willowherb aphids.

5. Conclusion

1. In the foothill zone of the Republic of North Ossetia, the most numerous representatives of aphids vectors are as follows: bean, buckthorn, alder buckthorn-willowherb, the number of which per standard trap varies from 35 to 280 per year on a Merike trap.
2. The degree of recontamination of potato plantings is related to the number of aphids during the growing season. In the foothill zone, under the conditions of spatial isolation by crops of oats, the number of aphids over 4 years was on average 30-35% less than in the option without isolation. The remoteness from the sources of infection at a distance of 1,000-1,200 m increased the selection efficiency by 55-58%.
3. In the mountain zone of the Republic of North Ossetia-Alania, at an altitude of 1,650 meters above sea level and higher, there are practically no aphids transmitting viruses. Therefore, the mountainous regions of the republic of this height are a natural isolator from viral infection.
4. Spatial isolation of primary potato nurseries from the sources of viral infection (potato crops affected by the virus) in the mountain zone turned out to be unnecessary at an altitude of 1,650 m above sea level. Horizontal insulation is necessary at an altitude of 1,400 m above sea level.

6. Confirmation

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Conflict of Interest

The authors declare that they have no conflicts of interest regarding the presented results.

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