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Investigations

Evaluation of Black Currant Cultivars Resistance to *Aphis grossulariae* Kalt. and Effectiveness of Water Extracts of *Artemisia Absinthium* L. and *Tanacetum Vulgare* L. Against this Pest

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Abstract: This study consisted in revealing the possibility of using two ecologically safe methods to control gooseberry aphid (*Aphis grossulariae* Kalt.) in black currant cultivars: selection aphid resistant cultivars and the use of plant water extracts of wormwood (*Artemisia absinthium* L.) and tansy (*Tanacetum vulgare* L.) in the arid zone of Central Kazakhstan for protection against aphid. The study of the resistance of 15 black currant cultivars to gooseberry aphids in the field on the natural background of the population development (2015-2017) has shown that the cultivars differ significantly in their level of resistance. Mila, Sophia and Zhuravushka, which were not inhabited with aphids for three seasons, proved to be highly resistant to *A. glossulariae*, Garmoniia and Bariton-resistant, Kanakhama, Natasha and Altaiskaia pozdniaia-medium resistant, Rita, Agata and Gerkules-low-resistant and Zabava, Prestizh, Iadrenia and Pamiati Kukharskogo-non-resistant. The efficiency of the combined action of water extracts of *A. absinthium* and *T. vulgare* was high and 2 weeks after the treatment by botanical preparations it was from 87.2 to 100%.

Keywords: Gooseberry Aphid, *Aphis Grossulariae* Kalt, Black Currant, Botanical Preparations

Introduction

Central Kazakhstan has the sharply continental climate with hot, dry summers and cold winters with little snow. Black currant is one of the most important agricultural crops, the interest in which in the modern world has increased significantly thanks to its dietary and health-promoting properties, antioxidant, anti-inflammatory and bactericidal action (Gopalan *et al*., 2012; Brennan *et al*., 2012). The modern black currant genome includes genes of several species. In Lisavenko Research Institute of Horticulture for Siberia (Barnaul) black currant cultivars combining the genotypes of three subspecies *Ribes nigrum* L. (ssp. *europaeum, ssp. sibiricum,* ssp. *scandinavicum*) and *R. dikuscha* Fisch. Ex Turcz. were created by the method of remote hybridization. These cultivars combine such valuable features as winter hardiness, frost resistance of generative organs, resistance to big bud mites and gall aphids, self-fertility and high yields (Kalinina and Nazaruk, 2009).

Aphids are the most important pests for temperate climate agriculture (Minks and Harrewijn, 1987). They directly influence the health of plants and also carry the numerous viruses destructive for plants (Ng and Perry, 2004; Züst and Agrawa, 2015), causing significant damage to cultural currents in Germany (Waht and Muller, 1914), Latvia (Zirnits, 1930), Lithuania (Rakauskas and Strumskyte, 1982), United Kingdom (Cross, 1984), Finland (Tuovinen *et al*., 2008), Ukraine (Bakalova, 2010), Belarus (Petrov *et al*., 2011), England (Theobald, 2013), Russia (Kozlova, 2014; Trifonova, 2014).

During the observations of black currant plantations in Central Kazakhstan (Zhezkazgan Botanical Garden), *A. grossulariae* was the dominant species of pest insects (Fig. 1).

Fig. 1: Gooseberry aphids and ants on black currant bushes

In the 20th century, intensification of agrarian production systems has led to dramatic changes in the agricultural landscapes of Western Europe and North America (Robinson and Sutherland, 2002; Bianchi *et al*., 2006). High chemization resulted in the extinction of the entire species of animals, destruction of soil and plant microflora and, as a result, in a decrease in the immunity of crop plants and the emergence of resistant strains of harmful bacteria, populations of insects resistant to insecticides (Ay, 2005; Bass *et al*., 2014). Numerous studies are under way around the world to study the mechanisms for the emergence of insecticide-resistant aphids (Rizk *et al*., 2014; Pan *et al*., 2015; Peng *et al*., 2015; Wei *et al*., 2016).

The problems related to the use of synthetic insecticides attracted attention to alternative strategies for protecting plants from pests. One such strategy is the selection of aphid resistant plants that are able to protect themselves against attacks of pathogens and pests by incorporating multifactor (own) (Klingler *et al*., 1998; Dogimont *et al*., 2014; Zhong *et al*., 2014; Puterka, 2017). The introduction of resistant cultivars is an environmentally sustainable strategy during the control of aphids in many plant species (Meradsi, 2016; Doryanizadeh *et al*., 2016; Radchenko, 2017).

Many literary sources speak about the resistance of cultivars of various plant species to aphids. For example, in recent years, there have been data on the resistance of three cultivars of North American soybean (*Glycine max* (L.) Merr) Dowling, Jackson and Plant Introduction (PI) 71506 to soybean aphid (*Aphis glycines* Matsumura) (Fox *et al*., 2014). On the wild form of cowpea accession TVNu 1158, the smallest number of aphid species (*Aphis craccivora* Koch) per seedling was noted among 105 vigna cultivars (*Vigna unguiculata* L. Walp.) and 92 wild forms (Souleymane *et al*., 2013).

The Medina *(Medicago sativa* L.) alfala cultivar has demonstrated antibiosis to cowpea aphid (*Aphis craccivora* Koch), the Carmina and Victoria cultivars showed tolerance to this pest (Descamps *et al*., 2015). Cultivars of faba beans (*Vicia faba* L.) and sugar beet (*Beta vulgaris* L.) showed resistance to black bean aphid (*Aphis fabae* Scopoli) and [*Aphis craccivora* (Koch)] (Salman *et al*., 2015; Golizadeh *et al*., 2016; Meradsi, 2016). Eight of the 30 selections of cucumbers (*Cucumis sativus* L.) have shown the resistance to melon aphid (*Aphis gossypii* Glover) (Liang *et al*., 2015). The current field trials have shown that the Galaxy-2013 bread wheat (*Triticum aestivum* L.) was resistant to wheat aphid (*Schiz aphis graminum* R.) (Shafiq *et al*., 2015). Studies of 2,616 samples of bread wheat (*Triticum aestivum* L.) and 1,911 samples of durum wheat (*Triticum durum* Desf.) in various ecogeographical zones on the natural and provocative background of expansion in the field have shown that 48 forms were weakly populated with a bird cherry-oat aphid (*Rhopalosiphum padi* L.) and a large grain aphid (*Sitobion avenae* F.) (Radchenko, 2000).

Another ecologically safe and rational way to control pests is the use of natural botanical substances isolated from plants being the sources of biologically active substances, such as natural botanical pesticides and antifeedants that can be used against plant diseases and insect pests (Gonzalez-Coloma *et al*., 1998; Enriz *et al*., 2000; Nauen *et al*., 2001; Isman, 2006). Due to this, undoubted interest is represented by wormwood extracts that have pesticidal, nematicidal and fungicidal properties (Ramezani *et al*., 2004; Saddi *et al*., 2007; Utkina *et al*., 2014). For example, the extracts of wormwood (*Artemisia absinthium* L.) suppressed the effect of house flies (*Musca domestica* L.) (Kaul *et al*., 1978). *A. absinthium* essential oils had acaricidal effect on *Tetranychus urticae* Koch (Chiasson *et al*., 2001). The extracts of *A. judaica* proved to be toxic and repellent against the two-spotted spider mite *Tetranychus urticae* C. L. Koch in the laboratory setting (El-Sharabasy, 2010).

A plant like tansy is also a rich source of plant-derived nutrients. Common tansy (*Tanacetum vulgare* L.) is widely used as an insecticide and repellent. For example, the insecticidal effect of tansy water extracts on Colorado potato beetle [*Leptinotarsa decemlineata* (Say)] and leafroller (*Chloristoneura rosaceana* (Harris)] (Panasiuk, 1984; Schearer, 1984; Hough-Goldstein, 1990; Larocque *et al*., 1999) has been proved. The essential oils of the aromatic tansy inflorescences extract on thecastor bean tick (*Ixodes ricinus* L.) (Palsson *et al*., 2008) exerted a repellent effect. T. *vulgare* essential oils proved to be toxic to the two-spotted spider mite (*Tetranychus urticae* C. L. Koch) (Chiasson *et al*., 2001).

The scope of this study was to reveal the possibility of using two ecologically safe methods to control gooseberry aphid (*Aphis grossulariae* Kalt.) in black currant cultivars: Selection of aphid resistant cultivars and the use of plant water extracts of wormwood (*Artemisia absinthium* L.) and tansy (*Tanacetum vulgare* L.) in the arid zone of Central Kazakhstan for protection against aphid.

Materials and Methods

Place of the Experiment

The experiment was conducted at Zhezkazgan Botanical Garden, a branch of Institute of Botany and Phytointroduction. Zhezkazgan Botanical Garden is located in Central Kazakhstan, Zhezkazgan (47°48'N, 67°43'E). Central Kazakhstan (Karaganda region) is an area in the northwestern part of the Central North-Turan sub-province in the subzone of northern deserts in the center of the Eurasia continent, practically equidistant from the Arctic and Indian, Atlantic and Pacific oceans. The climate is sharply continental and arid one (Akzhigitova *et al*., 2003). Climatic data of Zhezkazgan over the past 10 years: The minimum temperature is -39.2°C, the maximum temperature is 42°C, the average temperature of the coldest month is -16.3°C, the average temperature of the hottest month is 24.6°C and the average annual precipitation is 220.1 mm.

Plant Material

To assess the 15 cultivars and hybrids of currant, the annual plants were imported from Lisavenko Research Institute of Horticulture for Siberia (Barnaul, Russia) and planted in the autumn of 2009 in a randomized design on a site with a homogeneous, low-carbonate, heavy loamy soil by 20 plants of each cultivar according to the 0.75×1.5 m scheme. To test the plant resistance to gooseberry, the following hybrid cultivars of *Ribes nigrum* L. (European and Siberian subspecies) x *R. dikuscha* Fisch Ex. Turcz were selected: Agata, Altaiskaia Pozdniaia, Bariton, Garmoniia, Gerkules, Iadrenaia, Kanakhama, Mila, Natasha, Pamiati Kukharskogo, Prestizh, Rita, Sofia, Zhuravushka and Zabava, which turned out to be the most promising for practical gardening in the region. In the arid zone of Central Kazakhstan these cultivars have high winter hardiness (Andrianova *et al*., 2016), large berries and good yields. During the experiment, standard agrotechnical methods recommended for practical gardening in the region were used, but without the use of chemical protection against diseases and pests. Weeds were weeded by hand.

Preparation of Water Extracts

Raw materials were prepared in the vicinity of Zhezkazgan Botanical Garden, Zhezkazgan, Kazakhstan. The coordinates of the locus of propagation of wormwood (*A. absinthium*) – N 47°45′66′′, E 67°46′94′′, common tansy (*T. vulgare*) – N 47°45′89′′, E 67°46′85′′. The species were identified by PhD, Professor M. Ishmuratova from Buketov Karaganda State University. To obtain an aqueous extract of wormwood, bitter plants have been harvested in May before the beginning of flowering, by cutting off the stems without lignified parts. In the first version of the experiment, 1 kg of row phytomass has been boiled for 15 min in 3 liters of tap water, then the broth was cooled, filtered and water was added up to 10 liters (Shek and Shek, 1983). In the second version of the experiment 2 kg of row material have been used.

To prepare water extract of common tansy, the plants were cut in the full flowering phase near the base of the stem in late August-early September. The dried material was used. In the first version of the experiment 1 kg of phytomass was taken for infusion and 10 liters of distilled water were added, infused for 24 h (Pylnov, 1955), in the second version - 2 kg of dried materials were used.

For treatment, a mixed solution of tansy and wormwood (hereinafter MSTW) from 5 liters of tansy infusion and 5 liters of wormwood brew was used in the first or the second version of the experiment.

Resistance to Aphids

The resistance to gooseberry aphid was estimated according to the degree of expansion of gooseberry aphids (*A. grossulariae*). In estimating the resistance, the average number of adult female aphids and larvae in 10 bushes of each hybrid cultivar was counted, starting from the day when 1 adult aphid was detected, with an interval of one week on a natural background at Zhezkazgan Botanical Garden site in the field. The degree of stability corresponded to the degree of expansion of aphid in plants and was given in points (from 1 to 5): 1 point - no expansion (highly-resistant cultivar); 2 points - insignificant expansion, up to 30 pests per bush (resistant cultivar); 3 points - the average affection, from 31 to 60 pests per bush (medium-resistant cultivar); 4 points - strong expansion, from 61 to 90 aphid species per bush (low-resistant cultivar); and 5 points - very strong expansion, more than 90 aphid species per bush (non-resistant cultivar).

The Extracts' Efficiency

The herbal extracts' efficiency had been determined in 12 cultivars out of 15, since there were no aphids detected on 3 cultivars during three years. To determine the efficiency of MSTW, black currant was treated on day 14 after the detection of the first aphid (May 19, 2015; May 21, 2016 and May 18, 2017) about a week before reaching the aphid peak identified by previous studies (Likhacheva and Andrianova, 2016). To determine the biological efficiency, as in the resistance assessment, the average number of live aphids per bush was counted on 10 plants of each cultivar. Untreated plants (10 bushes of each cultivar), the same plants on which the resistance of gooseberry aphid cultivars was studied, were used as control. Two versions of experiment ("Preparation of aqueous extracts" subsection) were used. The MSTW efficiency was determined as a percentage by the Abbott (1925):

$$Effectiveness\ \% = \left(\begin{array}{l} 1 - n\ in\ T\ after\ the\ treatment \\ /n\ in\ Co\ after\ the\ treatment \end{array} \right) x\ 100$$

Where:
n = Was Insect population (number of aphids per bush)
T = (number of aphids per bush) was treated
Co = (number of aphids per bush) was control

The efficiency was counted in a week and 2 weeks after the treatments.

Statistical Processing of Data

The essential difference between the cultivars was determined through the Fisher analysis (ANOVA). Differences between the values were determined according to the Duncan test.

Results and Discussion

Selection of Resistant Cultivars

To identify black currant cultivars which are resistant to *A. grossulariae*, the dynamics of development of the aphid population were studied in the field in the experimental section of black currant of Zhezkazgan Botanical Garden for 3 years (2015-2017). The first aphid appeared on black currant plants in 2015 - on May 6, in 2016 - on May 8, in 2017 - on May 5. No significant differences were noted between the average number of aphids in 2015, 2016 and 2017 on the 7th and 14th days after the detection of the first adult aphid. On the 21st day after the detection of the first adult aphid in 2017, the average number of aphids was higher than those in 2015 and 2016. On the 28th day after the detection of the first adult aphid in 2017, the number of aphids was higher than in 2016, but the number of aphids in 2015 did not differ from the number of aphids in 2015 and 2016 (Table 1).

The data obtained on the number of aphids for 2015-2017 could be explained by the fact that the conditions of May in those years were practically the same (Table 2).

Observations of the aphid population development have shown no signs of aphids on the 7th day after the first aphid detection in 2015 in the Bariton black currant cultivar, in 2017 - in Garmoniia. During the study period, the maximum number of aphids was observed on 25.05.17 in the Pamiati Kukharskogo (405 adults and larvae on the bush), Iadrenaia (320 adults and larvae on the bush) and Prestizh (295 adults and larvae per bush) cultivars. On average, the increase in the population of aphids in three years continued until the 21st day after the detection of the first aphid. The number of aphids at the peak of development averaged 71.6 aphids per bush. In different cultivars the maximum of population development occurred on different days: In Pamiati Kukharskogo, Iadrenaia, Gerkules - on the 21st day after the discovery of the first aphid, in Zabava, Agata, Altaiskaia Pozdnyaia, Natasha and Kanahama - on 25th day and in Bariton, Garmoniia, Prestizh and Rita - on 28th day (Fig. 1).

When studying the development of the aphid population in wheat cultivars Shafiq *et al*. (2015) notes that the aphid population reaches its maximum at different times, depending on environmental conditions. According to the results of this study, the peak of population development in arid conditions in different cultivars occurred on average on a 21st to 28th day after the detection of 1st aphid (Fig. 2).

The results of the study showed that black currant cultivars differed on their resistance to gooseberry aphid. Mila, Sophia and Zhuravushka were not populated by aphids for three years of research. The maximum average density of the population for 3 years was noted in the Pamiati Kukharskogo, Iadrenaia and Prestizh cultivars (Table 3).

The level of resistance was determined by the maximum average number of aphids per bush for 3 years (Table 4).

The study of the resistance of 15 black currant cultivars to gooseberry aphid in Zhezkazgan Botanical Garden for three years (2015-2017) showed that the cultivars differed significantly in their level of resistance. Mila, Sophia and Zhuravushka are highly resistant to *A. glossulariae*. Garmoniia and Bariton are resistant. Kanakhama, Natasha and Altaiskaya Pozdnyaia are medium resistant. Rita, Agata and Gerkules are low-resistant and Zabava, Prestizh, Iadrenia and Pamiati Kukharskogo are non-resistant. Mila, Sophia, Zhuravushka, Garmoniia and Bariton black currant cultivars are also resistant to currant borer (*Eriophyes ribis* Nal.) and two-spotted spider mite (*Tetranychus urticae* Koch). They are very winter hardy, have berries with average weight from 1.4 to 2.8 *g*. These cultivars can be recommended for use in the organic production of berry crops and can be cultivated without insecticides.

Table 1: Average number of aphids by observation dates by factor year (2015-2017)

Year of observation	Date of observation 7th day	14th day	21st day	28th day
2015	22.1 a	47.9 a	65.21 b	56.3 ab
2016	18.4 a	42.6 a	66.35 b	54.5 b
2017	16.0 a	47.8 a	83.21 a	65.0 a
LSD	-	-	12.06	10.20

Table 2: Some meteorological data of the month of May (2015-2017)

Year of observation	Indicators: Average monthly temperature	Minimum temperature	Maximum temperature	Average monthly precipitation
2015	17.0°C	4.5°C (May 21)	29.9°C (May 30)	19 mm
2016	15.9°C	0.8°C (May 5)	29.5°C (May 31)	20 mm
2017	17.1°C	0.6°C (May 2)	33.6°C (May 12)	6 mm

Table 3: Average number of aphids by observation dates (2015-2017)

Cultivar	7th day	14th day	21st day	28th day
Agata	22.5 cd	66.4 cd	82.0 cd	67.6 bc
Altaiskaia Pozdniaia	4.8 ef	24.1 gh	45.4 ef	38.5 de
Bariton	2.1 ef	12.3 hi	20.8 fg	24.7 ef
Garmoniia	3.7 ef	11.3 hi	17.0 fg	20.7 ef
Gerkules	26.0 bc	59.1 de	90.7 c	58.0 cd
Iadrenaia	40.8 ab	117.8 b	189.3 b	92.7 b
Kanakhama	18.3 cde	32.6 gh	42.4 ef	20.6 ef
Mila	0.0 f	0.0 i	0.0 g	0.0 f
Natasha	7.2 def	27.1 gh	45.0 ef	37.0 de
Pamiati Kukharskogo	53.4 a	158.2 a	252.3 a	197.3 a
Prestizh	48.4 a	85.3 c	147.0 b	181.0 a
Rita	14.5 cdef	36.1 ef	55.3 de	60.6 cd
Sopfia	0.0 f	0.0 i	0.0 g	0.0 f
Zabava	40.7 ab	61.2 d	86.7 bc	89.1 bc
Zhuravushka	0.0 f	0.0 i	0.0 g	0.0 f
Mean number of aphids per bush	18.8	46.1	71.6	58.6
LSD	16.7	23.23	30.28	25.65

Table 4: Resistance of black currant cultivars to gooseberry aphid

Cultivar	Maximum average aphid number per bush	The day on which the maximum number of aphids was recorded	Resistance of cultivars: Number of aphids per bush	Degree	Score
Mila	0	-	0	Highly resistant	1
Sof'ia	0	-			
Zhuravushka	0	-			
Garmoniia	20.7	28	>0 but ≤ 30	Resistant	2
Bariton	24.7	28			
Kanakhama	46.7	25	≥ 31 but ≤ 60	Moderately resistant	3
Natasha	50.0	25			
Altaiskaia Pozdniaia	55.6	25			
Rita	60.6	28	≥ 61 but ≤ 90	Low-resistant	4
Agata	84.0	25			
Gerkules	85.2	21			
Zabava	90.8	25	≥ 91	Non-resistant	5
Prestizh	181.0	28			
Iadrenaia	189.3	21			
Pamiati Kukharskogo	252.3	21			

Determination of the Efficiency of Herbal Extracts Action on Gooseberry Aphid

A study of the efficiency of MSTW action on the aphid population showed that the combined use of wormwood and common tansy reduced the number of aphids in both the first and second experiments (Fig. 3).

The average Number of Aphids Per Currant Bush (ANACB) among the 12 cultivars in the control one week after the treatment was 89.49 aphids/bush, 2 weeks after the treatment - 73.22 aphids/bush. ANACB in the first version of the experiment a week after the treatment was 44.69 aphids/bush, in 2 weeks - 33.39 aphid/bush. ANACB in the second version of the experiment a week after the treatment was 18.22 aphids/bush, in 2 weeks - 3.92 aphids/bus. One week after the treatment and two weeks after the treatment there were significant differences between the number of aphids in the control, the first and the second versions of the experiment. LSD = 26.04 one week after the treatment, LSD = 24.67 - 2 weeks after the treatment. A week after the treatment, the number of aphids in the control untreated samples increased significantly (Table 5 and 6).

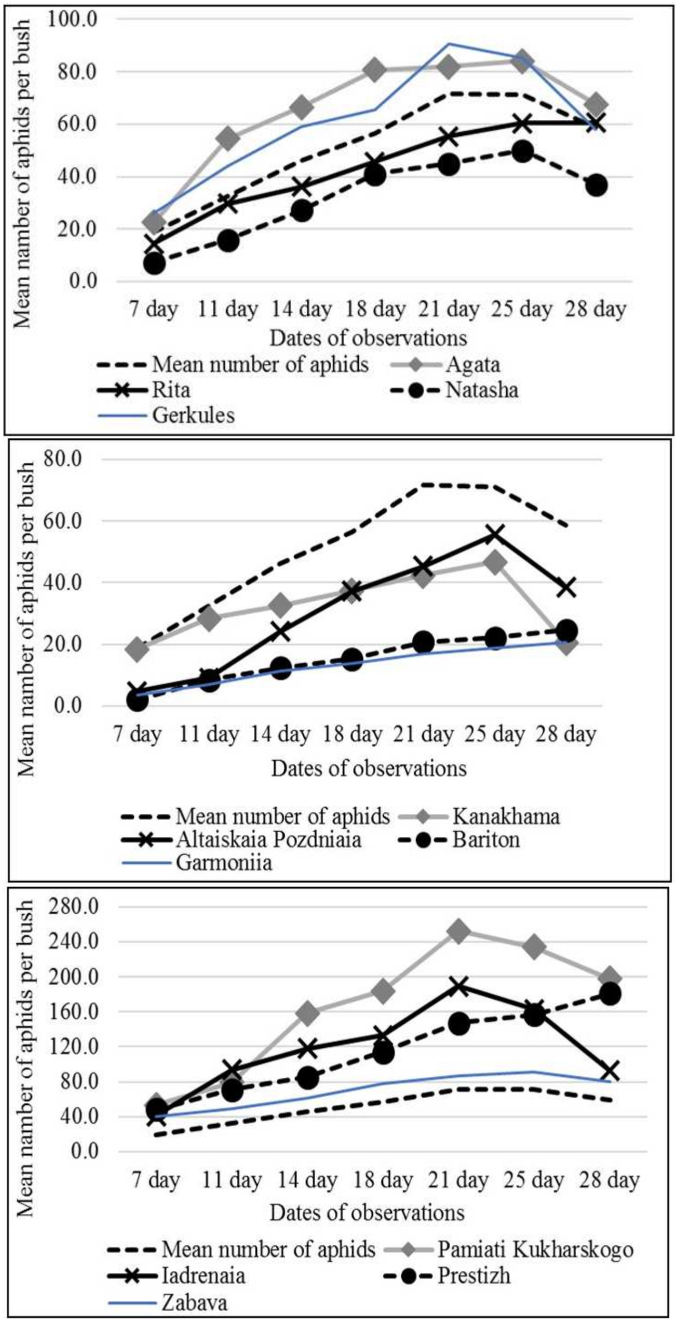

Fig. 2: Average number of aphids by observation dates (2015-2017)

In a week after the treatment in the control, in the first and second versions of the experiment the maximum average number of aphids was noted in Pamiati Kukharskogo cultivar (252.3 aphids/bush, 113.67 aphids/bush and 54.38 aphids/bush, respectively).

Two weeks after the treatment, the maximum number of aphids in the control plants (untreated with herb extracts) was recorded in Pamiati Kukharskogo cultivar (197.33 aphids/bush), in the first version of the experiment the maximum number of aphid species was noted in Prestizh (74.43 aphids/bush) cultivar and in the second version of the experiment-in Pamiati Kukharskogo cultivar (25.33 aphids/bush).

A week after the treatment, the Average Efficiency of the Herb Extracts (AEHE) (common tansy + wormwood, MSTW) on gooseberry aphid varied from 35.44% (in Bariton) to 59.94% (in Kanakhama) in the first version of the experiment. AEHE varied from 66.14% (in Garmoniia) to 87.74% (in Altaiskaia Pozniaia) in the second version of the experiment.

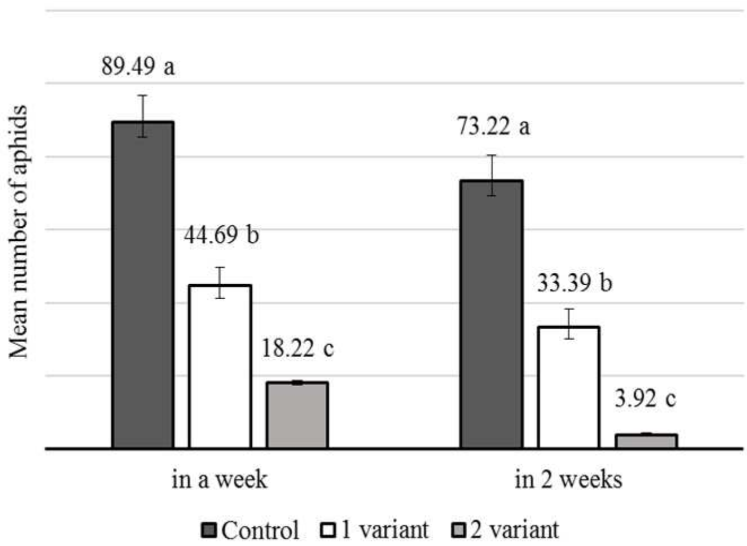

Fig. 3: Average number of aphids for three years (2015-2017) on currant bushes when processed with the herb extracts

Table 5: Efficiency of herbal extracts (common tansy and wormwood) upon action on gooseberry aphid on black currant cultivars (1

Cultivar	n before spray	Control: n in control after spray (in 1 week)	Control: n in control after spray (in 2 weeks)	1 experiment version, In a week: n in treated after spray	1 experiment version, In a week: Effectiveness of extracts	1 experiment version, In 2 weeks: n in treated after spray	1 experiment version, In 2 weeks: Effectiveness of extracts
Agata	66.44 cd	82.00 de	67.60 c	47.00 d	42.65 ab	30.0 d	55.74 b
Altaiskaia Pozdniaia	24.12 fg	45.40 fg	38.45 de	19.00 fgh	57.44 ab	17.3 ef	54.47 b
Bariton	12.32 fg	20.77 g	24.67 e	13.33 gh	35.44 c	10.6 fg	56.69 b
Garmoniia	11.33 g	17.00 g	20.67 e	9.33 h	45.28 ab	8.67 g	58.15 b
Gerkules	59.13 de	90.67 d	58.00 cd	53.33 d	41.58 bc	44.6 c	22.81 c
Iadrenaia	117.83 b	189.33 b	92.67 b	75.67 b	59.94 a	62.6 b	31.87 c
Kanakhama	32.65 fg	42.40 fg	20.58 e	27.67 ef	32.93 c	23.6 de	20.90 c
Natasha	27.09 fg	45.00 fg	37.01 de	23.33 efg	48.92 ab	17.0 efg	54.37 b
Pamiati Kukharskogo	158.23 a	252.33 a	197.33 a	113.67 a	54.82 ab	76.3 a	61.28 ab
Prestizh	85.28 c	147.00 c	181.00 a	66.47 bc	53.97 ab	45.6 c	74.43 a
Rita	36.12 ef	55.33 ef	60.57 cd	31.47 e	43.37 ab	25.3 de	58.07 b
Zabava	61.25 cd	86.67 de	80.14 bc	56.00 cd	35.52 c	38.6 c	51.90 b
Mean number of aphids per bush of 12 cultivars	57.65	89.49	73.22	44.69	45.99	33.39	50.06
LSD	24.78	32.07	25.00	10.61	18.18	8.58	13.66

n is the average number of aphids per bush in one cultivar

Two weeks after the treatment AEHE of MSTW, against the gooseberry aphid was from 20.90% (in Kanakhama) to 74.43% (in Gerkules) in the first version of the experiment. AEHE varied from 87.16% (in Pamiati Kukharskogo) to 100% (in Altaiskaia Pozdniaia, Garmoniia, Iadrenaia, Kanakhama and Zabava) in the second version of the experiment.

The results showed that between cultivars there were significant differences in the effectiveness of MSTW on aphids. Perhaps this is due to the different resistance of the cultivars to the pest.

AEHE was 45.99% in the first version of the experiment (single concentration of herbs) in a week after treatment. AEHE amounted to 50.06% 2 weeks after treatment. AEHE was 77.52% in the second version of the experiment (double concentration) one week after treatment. AEHE was the highest and reached 95.59% in the experiment with a double concentration of herbs 2 weeks after treatment. AEHE of MSTW was very high until two weeks after treatment of the plants with herbs. Therefore, when using mixed solution of common tansy and wormwood should not expect quick effects of the botanical preparation in *A. grossulariae*. Efficiency of the herbs is very high after 2 weeks after treatment.

It should be noted the potentially high economic efficiency of using bitter wormwood and common tansy to control pests. The cost of MSTW under local conditions is five times lower than the cost of pesticides.

Table 6: Efficiency of herbal extracts (common tansy and wormwood) upon action on gooseberry aphid on black currant cultivars (2 version of the experiment)

		Control		2 experiment version			
				In a week		In 2 weeks	
Cultivar	n before spray	n in control after spray (in 1 week)	n in control after spray (in 2 weeks)	n in treated after spray	Effectiveness of extracts	n in treated after spray	Effectiveness of extracts
Agata	66.44 cd	82.00 de	67.60 c	14.73 cd	82.08 abc	2.00 de	97.04 a
Altaiskaia Pozdniaia	24.12 fg	45.40 fg	38.45 de	5.93 efg	87.74 a	0.00 e	100.00 a
Bariton	12.32 fg	20.77 g	24.67 e	4.70 g	77.28 abcd	2.33 cde	90.54 a
Garmoniia	11.33 g	17.00 g	20.67 e	5.69 fg	66.14 d	0.00 e	100.00 a
Gerkules	59.13 de	90.67 d	58.00 cd	13.59 cdef	84.88 abc	3.44 cd	94.07 a
Iadrenaia	117.83 b	189.33 b	92.67 b	37.39 b	80.28 abc	0.00 e	100.00 a
Kanakhama	32.65 fg	42.40 fg	20.58 e	14.07 cde	66.65 d	0.00 e	100.00 a
Natasha	27.09 fg	45.00 fg	37.01 de	12.17 defg	73.15 bcd	1.83 de	95.05 a
Pamiati Kukharskogo	158.23 a	252.33 a	197.33 a	54.38 a	77.88 abcd	25.33 a	87.16 a
Prestizh	85.28 c	147.00 c	181.00 a	20.95 c	85.50 ab	5.08 bc	97.19 a
Rita	36.12 ef	55.33 ef	60.57 cd	14.47 cd	72.64 cd	7.00 b	88.44 a
Zabava	61.25 cd	86.67 de	80.14 bc	20.63 c	76.06 abcd	0.00 e	100.00 a
Mean number of aphids per bush of 12 cultivars	57.65	89.49	73.22	18.22	77.52	3.92	95.59
LSD	24.78	32.07	25.00	8.24	12.59	2.88	-

n is the average number of aphids per bush in one cultivar

The cost of the solution mixture (1000 l) for treatment of 1 hectare is $ 2, while the cost of the same amount of pesticide is equal to $ 10. Low cost of MSTW is connected with the easy availability of wild stocks of these herbs, their wide distribution and relatively high productivity in the conditions of the arid zone of Central Kazakhstan. Bitter wormwood has wide distribution in almost all regions of the worlds (Radchenko, 2000; 2011; Souleymane *et al*., 2013; Descamps *et al*., 2015; Golizaden *et al*., 2016; Liang *et al*., 2015; Shafiq *et al*., 2015; Meradsi, 2016). Maggi *et al*. (2005) with co-authors say: "For these to be practical and economical, the selected species must meet some requirements, such as being cultivatable and having a potent active principle, high stability and a good yield". Bitter wormwood and common tansy meet all these requirements and cfn be recommended for control of *A. Glossulariae* in those regions of the worlds where that have wild stocks of these herbs (Kaul *et al*., 1978; Panasiuk, 1984; Schearer, 1984; Hough-Goldstein, 1990; Larocque *et al*., 1999; Chiasson *et al*., 2001; Ramezani *et al*., 2004; Saddi *et al*., 2007; Palsson *et al*., 2008; El-Sharabasy, 2010; Utkina *et al*., 2014).

Conclusion

In accordance with the results of this study, 15 black currant cultivars differ significantly in their levels of resistance to gooseberry aphid in Zhezkazgan Botanical Garden. Mila, Sophia and Zhuravushka cultivars proved to be highly resistant to *A. Glossulariae*, Garmoniia and Bariton - resistant, Kanahama, Natasha and Altaiskaia Pozdnyaia - medium resistant, Rita, Agata and Gerkules - low-resistant and Zabava, Prestizh, Iadrenaia and Pamiati Kuharskogo - non-resistant, which is consistent with numerous studies that indicate the resistance of cultivars of various plant species to aphids. The peak of the aphid population development during the three years of the study had fallen on the 21st day after the detection of the 1st aphid on black currant plants. The efficiency of the use of water extracts of herbs (wormwood + common tansy) to control gooseberry aphid on black currant cultivars was high (from 87.16 to 100%). The results about the pesticidal effect of plant water extracts acknowledge the data of the studies of researchers from many countries that speaks about potential application of this method in international practice.

Thus, Mila, Sophia and Zhuravushka, Garmoniia and Bariton black currant cultivars are highly resistant and resistant to *A. glossulariae.* These cultivars can be recommended for use in the organic production of berry crops. The use of water extracts of bitter wormwood and common tansy is an ecologically safe and economical way to control pests and can be useful in the implementation of programs to control pests and plant diseases in the countries that have wild stocks of these herbs.

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Author's Contributions

All authors equally contributed in this work.

Ethics

Authors declare no conflicts of interest.

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