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Aryfova Z.I., Gorb N.N. Garden strawberry: assessment of prospective hybrids based on economically valuable characteristics under conditions of the Crimea // Bull. of the State Nikit.BOtan. Gard. – 2015. - № 114. – P. 51-54.

The article presents assessment results of prospective garden strawberry hybrids (Krymchanka, Aroza, Belrubi, Red Gontlet, Sunrise) based on the complex of economically valuable properties: crop capacity, average mass, biochemical composition of a berry, frost- and fungous diseases-resistance. These hybrids were bred by crossing of cultivars from national and foreign selections.

The most promising hybrids for high crop capacity, large fruitedness and high tastes were marked out in terms of the research: № 20-9, 4-10, 6-10.

Key words: *strawberry, cultivar, blooming, mass of a berry, crop capacity, large fruitedness, biochemical composition, the Crimea.*

PLANT PROTECTION

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ASSESSMENT OF NEW PHYTOFAGE INJURIOUSNESS - *ARBORIDIA KAKOGAWANA* MATS. – ON AREA OF THE CRIMEAN VINEYARDS

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Introduction

Arboridia kakogawana Mats. (Hemiptera, Auchenorrhyncha, Cicadellidae, Typholocybinae) is an invasive (alien) species in the Crimea. Its natural habitat is Japanese islands (Matsumura, 1932), Korean peninsula (Dworakowska, 1970) and south of Far East of Russia (Anufriyev and Yemeljanov, 1988), where it was found on wild grape cultivars in mixed and broad-leaved forests [2, 3, 6, 8, 9, 10, 12, 13, 15].

In recent decades intensive economical activity resulted considerable increasing of *Arboridia kakogawana* Mats. areal and its damaging effect on cultivated grape species. In 2005 *A. kakogawana* was registered as a grapevine pest in Republic of Korea [8, 10]. In the European part of Russia this pest was found for the first time on the territory of private vineyards in Krasnodarskiy Kray, since 2004 that leafhopper (*Arboridia kakogawana* Mats.) became the main damaging species of leafhopper complex of industrial grape plantations within West Ciscaucasia [3, 9, 10, 12]. On territory of the Crimean peninsula the first site of this invader development was found in 2008 within industrial plantations of South Coast of the Crimea, since 2012 its colonization was registered on vineyards of Piedmont and Steppe Crimea [2, 8].

A. kakogawana belongs to suborder Auchenorrhyncha suctorial insects, which possess huge biotical potential. These insects are characterized by capability to develop several generations during one season, high fecundity, available winged forms in their development; high ecological plasticity which favors insects mass propagation [13].

Mouthparts of *A. kakogawana* are piercing-sucking. Maggots of all development stages and adult insects feed piercing a grape leaf epidermis from down side. During feeding saliva ferments of insects damages chlorophyll in leaves and a shrub becomes chlorotic. According to scientific literature and own investigations there is information that maximum density of *A. Kakogawana* population on grape leaves occurs in the second half of vegetation. Percentage of damaged and decolorized leaves in this period can reach 80-100% in places, some of them wither and fall off [2, 3, 6, 8, 9, 10, 12, 13, 15]. Naturally enough vine communities are concerned about this problem which stimulates development of necessary measures to protect vineyards from this species of leafhopper.

According to Tanskoj V.I. (1975), parameter of phytophage injuriousness is a ground to assess economical suitability of protection measures for plants [11]. Modern protection of vineyards isn`t aimed at damage of particular harmful species, but the common optimization of phytosanitary situation of plantations, what is also possible having objective information about grapevine state and degree of phytophage injuriousness [12, 13]. In scientific literature there is a lack of data about injuriousness of *A. kakogawana* at vineyards [13]. This problem wasn`t investigated before in the Crimea, but today it is quite actual.

Research objective is to assess effect of a new invasive leafhopper species on agrobiological parameters and parameters of biological productivity of vine plants on territory of the Crimean peninsula.

Objects and research methods

Researches were carried out in 2012-2014 on territory of industrial vineyard "Livadiya" GK NPAO "Massandra", the city of Yalta, South Coast of the Crimea (SCC), in a long-standing site of *A. kakogawana* development with industrial grape cultivars: Cabernet Sauvignon, Aligote and Muscat White. In terms of investigations standard methods in plant protection and viticulture were applied.

Entomological methods were applied to determine damage degree of grape leaves by invasive for the Crimea pest. In stationary experiment the improved for this test 9-point scale was successfully applied, it was grounded on conventional in plant protection scale [14]:

0 point – no marks of damage by leafhopper;
1 point – up to 2,5% of decolorized area on a leaf;
2 points – 2,6-5% of decolorized area on a leaf;
3 points – 6-10% of decolorized area on a leaf;
4 points – 11-15% of decolorized area on a leaf;
5 points – 16-25% of decolorized area on a leaf;
6 points – 26-50% of decolorized area on a leaf;

7 points – 51-75% of decolorized area on a leaf;
8 points – more than 75% of decolorized area on a leaf.

Findings about number of damaged leaves (P, %) and degree of their injury by pest (point) were used to calculate damage intensity (R, %) of leaf apparatus on pattern shrubs of three vine cultivars.

Agrotechnical methods were applied to study injuriousness of *A. kakogawana* according to potential productivity of grape plants including coefficient of fruiting (K_1) and fruitfulness (K_2), content of principal pigments (chlorophyll *a* and *b*), quantity and quality of crop and vine ripening [5, 7].

Design and statistical methods were necessary to process received results and determine the least marked difference between test variants for data verification [4].

Meteorological conditions on South Coast of the Crimea during years of observation differed from average data of many years by increased air temperatures and uneven distribution of rainfall during grape vegetation. In general, according to moisture and warmth supply the most favorable years for vine in south-coastal zone of viniculture were 2013 and 1014.

Results and discussion

On long-term habitat of *A. kakogawana* within the experimental ground the following was determined: development of no less than 3 pest generations with a high intensity of imago flight and occupancy of leaves by maggots during the second half of grape vegetation. For three years of investigations minimal population density of pests was registered in 2012, maximum value was in 2013, population size in 2014 took interposition.

Data about *A. kakogawana* damage rate on leaf apparatus of various grape cultivars was received under conditions of South Coast of the Crimea for three years of investigations (table 1).

Table 1

***A. kakogawana* damage rate on leaf apparatus of three grape cultivars**
(GP "Livadiya", experimental ground, on average for 2012-2014)

Cultivar	Leaf damage, P, %			Damage rate, R, %		
	June	July	August	June	July	August
Cabernet Sauvignon	55,3	88,3	**99,3**	25,0	41,8	**60,9**
Aligote	48,8	82,2	**96,9**	20,8	37,9	**54,5**
Muscat White	46,9	79,8	**96,4**	19,7	35,2	**51,0**

According to this information, the highest percentage of damaged leaves (P) was registered for cultivar Cabernet Sauvignon: from 55% in June up to 99% in August; while on shrubs of Aligote cultivar a part of damaged leaves made 49% in June and 97% in August; and Muscat White suffered from this pest as follows: 47 - 96% relatively in June-August.

Fast increasing of damage rate (R) of leaf apparatus on pattern grape shrubs was determined in summer period (June-August): Cabernet Sauvignon – from 25% up to 61%; Aligote – from 21% up to 55%; Muscat White – from 20% up to 51%.

Therefore out of three studied grape cultivars the most suffering from *A. kakogawana* was Cabernet Sauvignon. This cultivar is characterized by the most intensive indumentums of leaves [1], what is probably a direct reason of damage by studied phytophage.

In general received data about damage rate (discoloration) of leaves by *A. kakogawana* indicates considerable decreasing of photosynthesizing grape leaf surface in especially important phases of development (growing and berries ripening): 20-25% in June, 35-42%

in July and 51-61% in August. It`s well-known, that during phase of berry ripening occurrence of organic matters in a grape plant reaches maximum value due to photosynthesis. Perhaps registered considerable loss of photosynthesized leaf surface in July-August doesn`t favor a good quality crop.

Laboratory researches were carried out to determine value of green pigments content (chlorophyll *a* and *b*) which provide photosynthesis in plants. Grape leaves of Cabernet Sauvignon cultivar with different damage degree were used with that purpose.

Table 2 presents researches results.

Table 2

Content of pigments in grape leaves damaged to varying degree by *A. kakogawana*

(GP "Livadiya", cultivar Cabernet Sauvignon, 21.08.2014)

Damage of leaf, point (damaged leaf surface, %)	Chlorophyll *a*		Decrease %	Chlorophyll *b*		Decrease %	Chlorophyll *a+b*		Decrease%
	mg/g	%		mg/g	%		mg/g	%	
0 (0%)	1,19	100	-	2,36	100	-	3,55	100	-
1 (till 2,5%)	0,90	75,6	**24,4**	1,78	75,4	**24,6**	2,68	75,5	**24,5**
2 (till 5%)	0,81	68,1	**31,9**	1,61	68,0	**32,0**	2,41	68,0	**32,0**
3 (till 10%)	0,71	59,7	**40,3**	1,43	60,1	**39,9**	2,14	60,3	**39,7**
4 (till 15%)	0,71	59,7	**40,3**	1,41	59,7	**40,3**	2,13	60,0	**40,0**
5 (till 25%)	0,69	58,0	**42,0**	1,37	58,0	**42,0**	2,07	58,3	**41,7**
6 (till 50%)	0,68	57,0	**43,0**	1,35	57,0	**43,0**	2,03	57,2	**42,8**
7 (till 75%)	0,59	49,6	**50,4**	1,17	49,6	**50,4**	1,76	49,6	**50,4**
8 (over 75%)	0,58	48,7	**51,3**	1,16	49,1	**50,9**	1,74	49,0	**51,0**
HCP_{05}	0,40	-	-	0,80	-	-	1,20	-	-

According to study results it`s obviously that grape leaves which have 10% or more of decolorized surface due to leafhopper nutrition, contain much less of chlorophyll *a* and *b,* than uninjured leaves do. So, undamaged leaves with 1,19 mg/g of chlorophyll *a* increased this value in damaged leaves (3-8 points) 40,3 – 51,3% more, otherwise content of chlorophyll *a* in the latter made 0,71 – 0,58 mg/g. While content of chlorophyll *b* in undamaged leaves made 2,36 mg/g, decrease of this value in decolorized (3 or more points) leaves was corresponding – 39,9% - 50,9% less, that is 1,43 – 1,16 mg/g.

Thus considerable decrease (40-51%) of the total value of mentioned pigments in grape leaves proves a significant reduction of photosynthesize activity of leaf apparatus due to maggots and imagoes nutrition.

Annually against the background of leafhopper natural development (control variant) and investigation of biological efficiency of modern insecticides in protection against *A. Kakogawana* (experimental variants) potential productivity of grape plants were assessed in the end of May, and in September-October quantitative and qualitative parameters of three studied cultivars crop were estimated.

During the whole period there was not registered considerable difference between agrobiological indices of potential productivity of control and experimental shrubs of three grape cultivars (with probability of 95%). To our point, it is partly caused by not enough protection of grape shrubs (experimental variants) against the new pest species: biological efficiency of studied modern insecticides and biopreparations in June-July ranged from 42 up to 100%; another reason is perhaps peculiarities of the very pest, characterized by high flight activity and population peak in July-September.

Nevertheless analyzing long-term data of potential productivity of control plants (Cabernet Sauvignon and Aligote) annual reduction of fruiting (K_1) and fruitfulness (K_2) was registered: K_1 - from 1,7 down to 1,2 and from 1,8 down to 1,6 relatively; K_2 - from 1,8 down to 1,4, from 1,9 down to 1,7 relatively (table 3). This tendency wasn`t revealed for control plants of Muscat White (the least damaged of three cultivars).

Table 3

Influence of *A. Kakogawana* development on potential productivity of grape plants
(GP "Livadiya", experimental ground, control variant, 2012-2014)

Observation year	A number of eyelets, unit/shrub	A number of growing shoots		Fruiting cane		Inflorescence, unit/shrub	K_1*	K_2**
		unit/shrub	%	unit/shrub	%			
Cabernet Sauvignon								
2012	**59,3**	**56,2**	**94,8**	**51,8**	**87,3**	**96,0**	**1,7**	**1,8**
2013	62,0	59,7	96,3	52,9	85,3	89,4	**1,5**	**1,7**
2014	58,3	53,2	91,2	47,2	81,0	65,5	**1,2**	**1,4**
Aligote								
2013	53,2	48,5	91,2	45,6	85,7	86,6	**1,8**	**1,9**
2014	43,8	40,5	92,5	35,7	81,5	62,7	**1,6**	**1,7**
Muscat White								
2012	**41,5**	**35,7**	**86,0**	**31,2**	**75,2**	**41,5**	1,2	1,3
2013	49,2	45,8	93,1	39,5	80,3	49,0	1,0	1,2
2014	43,3	38,7	89,4	32,7	75,5	43,5	1,2	1,4

Notes:
K_1* - coefficient of fruiting;
K_2** - coefficient of fruitfulness.

According to table 4 after crop assessment of Cabernet Sauvignon, the most damaged grape cultivar by *A. kakogawana,* reliable difference between estimate crop indicators of control and experimental variants was registered: 10,2 and 12,2 kg/shrub.

Table 4

Influence of *A. Kakogawana* development on parameters of crop and its quality
(GP "Livadiya", cultivar Cabernet Sauvignon, 2012-2014)

Variant	Average weight of 1 bunch, g	A number of bunches, units/shrub	Crop, kg/shrub	Mass concentration	
				sugars, g/100 sm^3	titrating acids, g/dm^3
2012 r					
Control	111,3	94,0	10,5	23,3	7,4
Experimental	117,8	**93,6**	11,0	23,9	7,4
HCP_{05}	11,9	10,2	0,7	1,3	1,5
2013 r					

Control	117,8	86,4	**10,2**	23,1	7,2
Experimental	137,8	88,2	**12,2**	24,1	8,3
HCP_{05}	22,2	12,1	0,9	2,4	1,6
2014 г					
Control	**83,8**	65,5	**5,5**	**20,5**	**8,9**
Experimental	**112,7**	71,2	**8,0**	**23,5**	**7,5**
HCP_{05}	11,9	8,1	0,8	1,5	0,2

In 2014 considerable difference between experimental variants was registered, it concerns not only quantum indices (average mass of bunch – 83,8 and 112,7g, shrub crop – 5,5 and 8,0 kg/shrub in relative to control and experimental variants) but qualitative characteristics were also considered: mass concentration of sugars in control variant made 20,5g/100sm^3, experimental variant – 23,5g/100 sm^3, mass concentration of titrating acids – 8,9 and 7,5 g/dm^3 relatively.

Received in meteorological conditions data (2012-2014) about long-term dynamics of plant crops characteristics of Cabernet Sauvignon cultivar (control variant) indicate an abrupt decrease of the following indices in the third year of observation: average bunch mass (24,7 – 28,9%), a number of bunches (30,3 – 25,2%), bush crop (47,6 – 46,1%) and sugar mass concentration in berry juice (12,0 – 11,3%).

Therefore in terms of Cabernet Sauvignon cultivar, one of the main industrial vine cultivars on the peninsula, it`s worth to discuss a considerable negative effect of leafhopper *A. Kakogawana* development on biological productivity of this cultivar vine plants in the third year of our investigations allowing for a big population size of pests.

Vine ripening on pattern bushes of three studied cultivars was assessed within the experimental ground in 2013-2014 (table 5).

Table 5

Influence of leafhopper *A. Kakogawana* on ripening of annual shoots of three studied cultivars
(GP "Livadiya", experimental ground, on average for 2013-2014)

Experimental pattern	Shoot length, sm	Length of the ripened shoot part, sm	Ripened parts of a shoot, %
Cabernet Sauvignon			
Control*	159,0	111,2	69,9
Experimental**	166,4	120,6	72,5
Aligote			
Control	174,7	124,1	71,0
Experimental	163,8	124,3	75,9
Muscat White			
Control	161,7	106,0	65,6
Experimental	184,3	127,3	69,1

Notes:
Control* - unprotected grape plants
Experimental** - grape plants being protected by special measures.

It was registered that such parameters as shoot length and length of ripened shoot part of control and experimental variants were close. It was determined that percentage of ripened shoot part on control bushes of three cultivars is just 2,6 – 4,9% less, than on pattern plants; in spite of cultivar and protection measures, ripening of all variants is satisfied, because ripened part makes no less than 2/3 or 66,6% of the total shoot length. Vine ripening on the control variant of Muscat White (without protection measures against leafhopper) had a low level of ripening: 65,6%, that is lower than limiting value of acceptable.

Therefore on average for two years of investigations reduction of vine ripening degree of pattern plants (Cabernet Sauvignon and Aligote) wasn`t registered against the background

of long-term development of leafhopper; at the same time Muscat White, non-protected patterns, was characterized by certain decrease of shoot ripening.

Conclusion

For the first time in the Crimea injuriousness of *A. kakogawana* was investigated under conditions of its habitat within industrial vineyard.

1. Fast increasing of this phytophage damage rate (decoloration) of grape leaves was determined in summer period (June-August): Cabernet Sauvignon – from 25% up to 61%; Aligote – from 21% up to 55%; Muscat White – from 20% up to 51%.

2. It`s obviously that grape leaves which have 10% or more of decolorized surface (3 – 8 points according to rating scale) due to leafhopper nutrition, contain much less of chlorophyll *a* and *b*, than injurious leaves do: 1,41 – 1,81 mg/g or 39,7 – 51,0% less.

3. Against the background of leafhopper *A. kakogawana* natural development, fruiting (C_1) and fruitfulness (C_2) coefficients of Cabernet Sauvignon and Aligote were reduced annually: C_1 (Cabernet Sauvignon) - 1,7 - 1,2; C_1 (Aligote) - 1,8 - 1,6; C_2 (Cabernet Sauvignon) - 1,8 - 1,4; C_2 (Aligote) 1,9 - 1,7. This tendency wasn`t revealed for control plants of Muscat White. In the third year of observations an abrupt decrease of the following was registered for Cabernet Sauvignon cultivar: average bunch mass (24,7 – 28,9%), a number of bunches (30,3 – 24,2%), bush crop (47,6 – 46,1%) and sugar mass concentration in berry juice (12,0 – 11,3%).

4. Evident reduction of crop estimate indicator per 1 bush was registered for the most damaged by leafhopper *A. kakogawana* grape cultivar Cabernet Sauvignon having compared fruiting characteristics in natural conditions and being protected by special measures: in 2013 it became 2 kg/bush less, in 2014 - 2,5 kg/bush less, allowing for biological efficiency of preparations 42-100%. In the third year of investigations considerable deterioration of crop qualitative parameters was fixed: mass concentration of sugars decreased till 3,0 g/100 sm^3 while mass concentration of titrating acids became 1,4 g/dm^3 more.

5. Negative effect of *A. Kakogawana* development on annual shoot ripening of three industrial grape cultivars wasn`t revealed.

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Negative effect of *Arboridia kakogawana* mats. on growth and development of industrial grape cultivars (Kaberne-Sovinyon, Aligote, Muskat white) was investigated for the first time in the Crimea in 2012-2014. The rate of leaf damage caused by the phytophage activity reached 51 – 61%. As a result of insect nutrition the level of chlorophyll *a+b* in decolorized leaves reduced till 40 – 51%. The coefficients of fruiting and fruitfulness as well as the qualitative and quantitative crop parameters also went down.

Key words: *Arboridia kakogawana Mats., grape cultivars, injuriousness, damage rate, chlorophyll, biological productivity.*