The efficiency of using small-volume spraying in chemical protection of grapes from diseases in the conditions of Crimea

Natalia V. Aleinikova*,* *Yevgenia S.* Galkina, *Pavel A.* Didenko*, *Vladimir* V. Andreev, and *Vladimir N.* Shaporenko

Federal State Budget Scientific Institution All-Russian National Research Institute of Viticulture and Winemaking Magarach of the RAS, 31 Kirova Str., 298600 Yalta, Republic of Crimea, Russia

Abstract. The article presents the results of studies carried out in 2020-2021 in soil and climatic conditions of the Mountain-Valley viticultural zone of Crimea to determine the efficiency of small-volume spraying in pest control of industrial vineyards of wine grape variety 'Muscat Rose'. In experimental variant, when using small-volume spraying, the amount of working solution and the rate of pesticide application were reduced (operations on the concentration of working solution). It was established that against the background of protective measures of grape plantings in experimental and example (full-volume spraying) variants, a low level of oidium development was observed: up to 1.3% on leaves, 1.1% on bunches; and of black rot - up to 1.2% on bunches. At the same time, there was no significant difference in the intensity and dynamics of disease development in these variants. It was experimentally determined that in the experiment, when using small-volume (200-250 l/ha) and full-volume (example, 400-800 l/ha) sprayings, a good conditional yield of wine grapes 'Muscat Rose' was obtained - 2.5-2.6 kg/bush (52.4-54.7 c/ha). The use of full-volume and small-volume sprayings on experimental plots did not have a negative effect on the process of sugar accumulation (25.1-25.5 g/100 cm^3) and the level of titratable acids (6.0-6.2 g/dm^3) in grape yield. Thus, in the course of studies, it was found that using of small-volume spraying made it possible to increase the productivity of sprayers and reduce the pesticide load on ampelocenosis.

1 Introduction

Currently, according to the Food and Agriculture Organization of the United Nations, the annual damage caused by pests to agricultural crops is about 20-25% of the potential worldwide harvest of food crops, including grapes. Timely and high-quality taking of protective measures allows saving the yield and obtaining the optimal quality grape products [1-5].

When cultivating grapes, chemical protection against diseases, pests and weeds has a special place. It is known that perennial plantings are under the greatest fungicidal pressure. Depending on climatic conditions, varietal stability, agricultural technology, etc. during the

* Corresponding author: pavel-liana@mail.ru

growing season, vineyards are processed with pesticides and agrochemicals from 1-2 to 20 times. Widespread use of chemicals is the result of constantly existing in time and in almost all regions of the country environmental pollution challenge [6, 7].

To date, the most effective and common method of introducing pesticides in chemical protection of cultivated plants is a spraying. Depending on the application rate of working solution, there are full-volume, small-volume and ultra-small-volume sprayings [8].

Full-volume spraying is characterized by a high consumption of working solution, reaching of 500-1000 l/ha in vineyards, depending on the foliage, architecture of grape bushes, and the phenological stage of grapevine development. High consumption of working solution during full-volume spraying is its main disadvantage, reducing the productivity of units, increasing the cost of chemical processing, and contributing to environmental pollution [6, 7, 9]. Therefore, reducing the consumption rate of working solution during spraying, meaning the transition to small-volume processing, is of great economic importance. It significantly increases the productivity of machines, which makes it possible to carry out chemical processing in optimal terms [8].

Thus, the purpose of our work was to comparatively assess biological efficiency of protective measures in grape plantations against pests when using different types of spraying: full-volume and small-volume.

2 Study objects and methods

The studies were carried out in the soil and climatic conditions of the Mountain-Valley viticultural zone of Crimea (FSUE PJSC Massandra, Morskoye branch) during 2020-2021 in order to determine the biological efficiency of protective measures of wine grape variety ‘Muscat Rose’ from pests using common full-volume and small-volume types of spraying.

The culture - grapes; variety – ‘Muscat Rose’ (year of planting - 2004), planting pattern – 3 x 2 (2) m; bush training - one-sided cordon on a high trunk. The culture is open-earth, not irrigated. The rootstock is ‘Berlandieri x Riparia Kober 5BB’.

The type of plot soil is alluvial-deluvial solonchak-like, medium gravel-stony heavy loamy on alluvial-deluvial deposits. Parent and base rock - loamy gravel-stony deposits of the skeleton 50-70%, stones 10-20%. Mechanical composition is heavy loamy. Depth of the humus horizon is 100 cm.

In experimental plots, all necessary agrotechnical operations were carried out in accordance with technological maps: dry tying-down and first green tying, breaking-off shoots and topping of young vines, row-spacing cultivation.

In the process of study we used methods generally accepted in plant protection [10].

The system of grape protection in the enterprise consisted of 8 stages of pesticide processing against a complex of pests and basic diseases (Table 1).

Table 1. Scheme of the research.

Processing No.	Variant			
	Stage of grape development to the moment of processing	Number of spraying nozzles	Example (full-volume spraying)	Experiment (small-volume spraying)
			Volume of working solution (l/ha)	
1.	2-3 leaves	10	400	200
2.	Shoot length 15-20 cm	10	400	200
3.	Before flowering	10	400	200
4.	End of flowering	6	800	250
5.	Berries goat-sized	6	800	250
6.	Bunches hang	6	800	250
7.	Berries beginning to tough	6	800	250

8.	Berries beginning to ripen	6	800	250

During the processing of vineyard, sprayers of the OBC-2000 brand, injector sprayers, and a Comet pump base (Italy) were used. Spraying was carried out with a working pressure of 10 atm. and a speed of 5-6 km/h. Reduction of consumption of the working solution was achieved through the use of sprayers of different diameters: experimental - 1.2 mm and example - 2.0 mm.

3 Results and discussion

In the Mountain-Valley viticultural zone of Crimea, weather conditions of growing season of 2020-2021 were favorable for the growth and development of grapevine. Passing of all phenological stages of grape vegetation during the years of research did not differ by terms from the average long-term parameters.

During the research period, the development of two grape diseases, oidium and black rot, was observed.

In the conditions of 2020, on grape plants of the Mountain-Valley Crimea (MVC), the oidium was developing by epiphytotic type. The first visual display of the disease on leaves and bunches was registered in the first decade of June. During further observations, the intensity of oidium development was rapidly increasing on leaves and bunches, and to the second decade of July it reached high (epiphytotic) level of 64.1% and 71.8%, respectively.

In 2021, in the vineyards of MVC under conditions of moderate air temperatures in the second half of May and in the first half of June, a visual display of oidium development was observed from the second decade of June on leaves and from the first decade of July on bunches. In general, the disease developed according to the late (or slow) epiphytotic type. To the beginning of August the leaves were affected by 63.7%, bunches - by 100%.

Under the conditions of epiphytotic development of oidium during the years of research on experimental and example variants, very low dynamics and intensity of disease development were observed (Table 2). The maximum development was noted during ripening of berries: 0.9-1.3% on leaves and 0.7-1.1% on bunches.

Table 2. The dynamics of oidium development (R, %) depending on the application rate of working solution ('Muscat Rose' variety, 2020-2021).

No.	Variant	Oidium development, R, %			
		24.07		13.08	
		leaves	bunches	leaves	bunches
2020					
1.	Example (full-volume spraying)	0.1	0.3	0.1	1.1
2.	Experiment (small-volume spraying)	0.1	0.4	0.5	0.7
HCP_{05}		0.01	0.02	0.03	0.1
2021					
No.	Variant	10.08		26.08	
		leaves	bunches	leaves	bunches
1.	Example (full-volume spraying)	0.6	0	0.9	0
2.	Experiment (small-volume spraying)	0.4	0	1.3	0
HCP_{05}		0.03	-	0.1	-

In the conditions of 2020-2021, against the background of protective measures, a weak development of black rot was observed on growing grape berries, the level of which did not exceed 1.2% during ripening period (Table 3).

Table 3. The dynamics of distribution and development of black rot on bunches depending on the application rate of working solution (Morskoye branch, 'Muscat Rose' variety, 2020-2021).

No.	Variant	24.07		13.08	
		P, %	R, %	P, %	R, %
2020					
1.	Example (full-volume spraying)	1.6	0.2	5.4	1.2
2.	Experiment (small-volume spraying)	1.4	0.3	5.5	1.1
HCP_{05}		-	0.01	-	0.2
2021					
No.	Variant	10.08		26.08	
		P, %	R, %	P, %	R, %
1.	Example (full-volume spraying)	0.6	0.1	3.3	0.9
2.	Experiment (small-volume spraying)	0.5	0.1	3.0	0.7
HCP_{05}		-	0.01	-	0.2

Thus, in the conditions of 2020-2021, in the vineyards of 'Muscat Rose' variety in experimental and example variants, high biological efficiency was obtained in the control of grape diseases. A decrease in the amount of working solution by 200-550 l/ha with small-volume spraying of grape plants did not affect the level of oidium, as one of the main grape diseases.

In experimental variants, when using different types of spraying, a good (2.5-2.6 kg/bush and 52.4-54.7 c/ha) and conditioned (25.1-25.5 g/100 cm^3) grape yield was obtained. For all the parameters studied, no significant difference was registered between the experiment and the example during years of research (Table 4). In terms of sugar concentration in the juice of grape berries, the yield from all variants of research was suitable for preparation of strong dessert wines.

Table 4. The effect of working solution application rate during chemical processing on the productivity and quality of grape yield ('Muscat Rose' variety, 2020-2021)

Variant	Average bunch weight, g	Number of bunches, pcs/bush	Yield, kg/bush	Cropping capacity, t/ha	Mass concentration of… in the juice of grape berries	
					sugars, g/100 cm^3	titratable acids, g/dm^3
2020						
Example (full-volume spraying)	228.1	11.4	2.6	52.0	25.2	6.3
Experiment (small-volume spraying)	233.3	12.0	2.8	56.0	25.1	6.1
HCP_{05}	11.7	0.6	0.2	-	1.3	0.2
2021						
Example	153.6	15.4	2.4	52.7	25.8	6.0

(full-volume spraying)						
Experiment (small-volume spraying)	156.7	15.9	2.4	53.3	25.1	6.2
HCP_{05}	2.34	2.1	0.4	-	1.4	0.2
Average for 2020-2021						
Example (full-volume spraying)	190.9	13.4	2.5	52.4	25.5	6.2
Experiment (small-volume spraying)	195.0	14.0	2.6	54.7	25.1	6.1

Thus, the results of two-year studies indicate high efficiency of small-volume spraying in protecting vineyards from pests. The use of small-volume spraying can reduce the pesticide load on ampelocenosis and increase the profitability of production, while not decreasing the efficiency of protective measures for grapes.

4 Conclusion

Therefore, for the first time in production vineyards of the Mountain-Valley Crimea, the studies on assessing the biological efficiency of regulations for the use of modern equipment when providing full-volume and small-volume sprayings, and determining the level of pest development against this background, were carried out. There was no significant difference in the intensity and dynamics of pest development, quantitative and qualitative indicators of grape yield.

References

1. M. Costas, G. Emilio, G. Montserrat, K. Loukas, C.S. Menelaos, International Journal of Pest Management (2020)
2. M. Costas, G. Emilio, G. Montserrat, C.S. Menelaos, Agriculture, **11**, 178 (2021)
3. V.M. Zarutsky, FSBEI HE «Gorsky State Agrarian University», 360-364 (2018)
4. A.K. Lysov, Plant protection and quarantine, **8**, 47 (2007)
5. A.K. Lysov, S.A. Volgarev, Plant protection and quarantine, **7**, 35-37 (2014)
6. E.S. Galkina, N.V. Aleinikova, E.A. Bolotianskaia, V.V. Andreyev, P.A. Didenko, Viticulture and winemaking, **49**, 127-130 (2020)
7. E.A. Yegorov, G.A. Shadrina, G.A. Kochian, Gardening and viticulture, **6**, 7-13 (2012)
8. P.A. Dogoda, Simferopol «Tavria», 140 (2000)
9. I. Pertot, T. Caffi, V. Rocci, L. Mugnai, C. Hoffmann, M.S. Grado, C. Gary, D. Lafond, C. Duso, D. Thiery, V. Mazzoni, G. Anfora, Crop Protection, **97**, 70-84 (2017)
10. Guidelines for registration tests of fungicides in agriculture. Edited by V.I. Dolzhenko (St.-Pb.), 378 (2009)