Influence of biostimulants on productivity and quality of grapes

Natalia Arestova[1,*] and *Irina* Ryabchun[1]

[1]All-Russian Research Institute named after Ya.I. Potapenko for Viticulture and Winemaking – Federal State Budgetary Scientific Institution Branch of Federal Rostov Agricultural Research Center, 346421, Novocherkassk, Russia

Abstract. The summary results of researches on joint influence of the biopreparation containing microbic inoculants (Bacillus pumilus bacteria, strain 3-B) and humic substances (potassium humate) on agrobiological and economic indicators of Cabernet Sauvignon grapes. For defining of biological efficiency of the biostimulant on grapes the foliar nutrition of plants of grade of Cabernet Sauvignon was carried out in phases of sap flow and initial blossom. The biological product had significant effect on forming of bunches, and berries, promoting to increase on their weight. Crop yield of options of experience increased, in comparison with check option by 14-19%. There are no differences in the quality of the crop (total sugars and acids) between the variants of the experiment. Foliar nutrition of plants the microbiological product Bacillus pumilus, + potassium humate (3,0 l/hectare) promoted increase in fungicide activity of product from mildew (active ingredient - Mankotseb + Mefenoksam). At top-dressing of plants biological product the growth-regulating activity in experience options with assignment of dose of 2,0 l/hectare and 3,0 l/hectare, in comparison with check option significantly increased. Difference on ripening of whip it is not proved as for of options of experience, in comparison with check option, and for options among themselves.

1 Introduction

Increase in production of grapes for the purpose of fuller satisfaction of needs of the population for this product and wine industry in quality primary produceis important task of modern industrial wine growing. The solution of this task is possible due to production modernization that includes development and deployment in farms of the advanced intensive technologies of cultivation of grape plantings in complex with rational use of different types of fertilizers since necessary condition of normal life activity of plants is plant nutrition

The intensive cultivation of grape plantings providing broad application of the mechanized work, pesticides and fertilizers leading to violation of soil structure and characteristics, accumulation of toxic connections in the soil and grape plants. Emergence

* Corresponding author: zash.arestova@yandex.ru

of a row of negative consequences as a result of their application egg on to searching of alternative ways of fertilizer and protection of plants which assume decrease in use of chemical pesticides due to application of ecologically safety biological products including microbical origin. By now we know a lot of microbiologic preparations for agriculture of various profiles: the growth promotion and also inhibit growth phytopathogenic bacteria and mushrooms [1-3]. The greatest value for farm-production have polyfunctioning biological products. It is supposed that the complex of the special bacteria entering these medicines at foliar nutrition of plants works as stimulator, activating biochemical process of growth and development of plants, promoting nutrient uptake.

Biological products, due to activities of beneficial microflora, promote transform to the difficult of approach accessible organic compounds containing, with nitrogen and phosphorus into the easy of approach forms, thereby improving plant nutrition. Now enough microbiological preparations which are used in farm-production as for activation of growth processes and for suppression of development of phytopathogenic mushrooms and bacteria is developed. [4-7]. In Europe and the USA, biostimulants of agricultural plants are widely applied recently. In particular, in Europe in 2012 were processed 6,2 million hectares by the biostimulants including various substances and microorganisms with growth-promoting of plants and also having protective capability. Manufacture of bacterial fertilizers has the increasing value in connection with the increasing pre-requisites to environmental safety [8-9].

Carry both microbic inoculants, and humic substances to biostimulants. Microbic inoculants are usually classified as biopesticides or biofertilizers. The majority of plants become populated by communities of the endophytic bacteria covering wide range of types and childbirth. Entophytes are not pathogenic bacteriums, they have ability to activate growth functions of plants, to inhibit development of phytopathogenes, besides it is noted that they can have a positive impact physiological and biochemical process. [10-13].

Experience of use of bacterial biofertilizers in the countries with the advanced winegrowing has demonstrated that due to increase in types and quantity of bacteria improves the soil structure and soil productivity, availability of nutrients, especially NPK and also synthesis of other stimulating connections increases.

The Italian scientists with use of molecular methods managed to allocate from roots, escapes and leaves of grape variety Glera (Vitis vinifera) of 381 strains of endophytic bacteria from which 30% belonged to the genus Bacillus. Also other childbirth, such as, Curtobacterium, Microbacterium, Staphylococcus, Paenibacillus, etc. were identified. These researches showed that perspective strains of the bacteria promoting as biofertilizer will allow to mark out big variety of domestic species of bacteria inhabiting grape plantings further, to increase in growth and productivity of grape plants, their resistance to stressful factors [14,15].

Genus Bacillus bacteria which possess wide range of activation and stimulation of growth processes in plant are perspective. [12, 13, 2]. They have ample opportunities for suppression of causative agents of diseases of plants. So, the authors who were engaged in selection noted presence of antagonism to the following phytopathogenic mushrooms of Alternaria, Botrytis cinerea, Phomopsis, Phytophthora, etc. Scientists noted that the strain of Bacillus pumilus QST 2808, is effective for fight against fungal disease of seeded cultures, grapes and tomatoes [16].

It is noted that use of humic substances together with bacterial preparation enhances effect of growth stimulation plant and suppression of phytopathogenes. [9,17].

In the Russian winegrowing using of new bacterial fertilizers, has no wide circulation because of their insufficient study yet. In this regard there was need for definition of influence of the microbiological preparation containing Bacillus pumilus bacteria, strain 3-B (concentration of bacteria in 1 ml of preparation not less than 109 CFU/g) and potassium

humate - 20 - 30%. on the basic economically valuable indicators of grape plants that is the exploration objective of our researches.

2 Materials and methods

For research were using the fructifying plantings of grade of variety Cabernet Sauvignon in the periods of vegetation of 2017 - 2019. Cabernet Sauvignon is under our conditions cultivated by covered grafted grape culture, rootstock - Kober 5BB. Shaped bush – long-sleeved. Stocking of bush - 36-40 pcs on bush. Planting system 3 x 1.5 m.

Soil covering in region of carrying out researches – ordinary chernozem micellar and carbonate (North Azov). Contents in topsoil of humus on Tyurin's classification is low, but the soil muck soil. Security of labile soil of phosphorus, potassium and nitrogen on Machigin's classification, Oniani classification, insufficient.

Was used the microbiological preparation containing Bacillus pumilus bacteria, strain 3-B (concentration of bacteria in 1 ml of preparation not less than 109 CFU/g) and potassium humate - 20 - 30%. Moisture content - 98 - 99%, the total solids - 1 - 2%.

Used preparation by spraying of plants by means of hand sprayers up to 9 o'clock in the morning or after 16 o'clock in the absence of precipitation. Spray material was prepared immediately prior to foliage application. Foliar nutrition of plants is carried out in the following vegetative stage: 1 – in sap flow phase, the 2nd – in phase of cease blossoming according to the scheme. Application rate by options of experience 1.0, 2.0 and 3.0 l /hectare. Control – without processing.

3 Results and Discussion

Agrobiological accounting of covered plants of grade of variety Cabernet Sauvignon showed that plants well overwintering what does it show of the full-grown buds (75-80%) and also coefficients of fruitfulness (1.2-1.3) and fructification (0.7-0.9). For experience equivalent bushes were taken therefore by options of experience there are no essential distinctions on these indicators.

Researches showed what foliar nutrition of plants microbiological fertilizer had positive impact on forming of bunches, promoting significant increase in their weight, in comparison with check option, in options with norms of top-dressing of 2.0 and 3.0 l/hectare. Between option 1 (1.0 l/hectare) and also options 2 (2.0 l/hectare) and 3 (3.0 l/hectare) distinctions are also essential. For check option and option with norm of foliar nutrition of 1.0 l/hectare and also for options 2 (2.0 l/hectare) and 3 (3.0 l/hectare) the consistent differences of distinctions is not proved (table 1).

Table 1. Influence of the microbiological preparation Bacillus pumilus + potassium humate on the formation of a cluster of Cabernet Sauvignon varieties (average for 2017 - 2019)

Experience option	Consumption rate, l / ha	The number of bunches per bush, pieces / bush	Mass of bunches	
			kg / bush	1 bunch, g
1	1.0	38.0	3.9	103
2	2.0	40.0	4.4	111
3	3.0	40.5	4.7	116
4	Control (no processing)	38.5	3.8	99
lsd_{05}		2.6	0.4	8

Distinctions on number of bunches on bush between options are insignificant since before experimenting the rationing of bushes on loading is provided by stocking and inflorescences.

Top-dressing of plants biological product influenced forming of berries in bunch, having increased their weight and quantity. The importance of differences on the lump of berries in cluster, in comparison with control, is proved for options with norm of top-dressing of 2,0 l/hectare and 3.0 l/hectare and also for options 2 (2.0 l/hectare) and 3 (3.0 l/hectare) in comparison with option 1 (1.0 l/hectare). At the consumption rate of preparation of 1.0 l/hectare the difference with control on the mass of berries is insignificant (table 2).

Table 2. Influence of the microbiological preparation Bacillus pumilus + potassium humate on the formation of Cabernet Sauvignon berries (average for 2017-2019)

Experience option	Consumption rate, l / ha	number of berries, pieces / bunch	Average weight of berries	
			in a bunch, g	one berry, g
1	1.0	102	100.5	0.99
2	2.0	110	112.7	1.03
3	3.0	113	115.4	1.02
4	Control (no processing)	98	95.0	0.97
lsd_{05}		8	7.6	0.04

The average mass of one berry also differed by experience options. This indicator, in comparison with control, is significantly higher in options with norms of top-dressing than 2.0 l/hectare and 3.0 l/hectare and also in option 2 (2.0 l/hectare) in comparison with option 1 (1.0 l/hectare).

The essentiality of differences on number of berries in cluster is proved for options with the consumption rates of 2.0 l/hectare and 3.0 l/hectare, in comparison with control. Differences on number of berries in cluster between option with norm of top-dressing of 1.0 l/hectare and control and also between options with options of top-dressing of 2.0 l/hectare and 3.0 l/hectare are not proved.

Thus, effect of biostimulant of Bacillus pumilus, + humate of potassium had beneficial effect on forming of berries and clusters, promoting increase in their quantity and weight and also, accordingly, yield (table 3).

Table 3. Influence of the microbiological preparation Bacillus pumilus + potassium humate on the formation of the yield of plants of the Cabernet Sauvignon variety (average for 2017 -2019)

Experience option	Consumption rate, l / ha	Productivity, t / ha	Increase in control,	
			t / ha	%
1	1.0	8.1	0.2	3
2	2.0	9.2	1.3	14
3	3.0	9.7	1.8	19
4	Control (no processing)	7.9	-	-
lsd_{05}		0.6		

Experimental data show that significant yield increase for 14-19%, in comparison with check option, is reached with use top-dressing by microbiological product at consumption rates of product of 2.0 l/hectare and 3.0 l/hectare. Between option with application rate of top-dressing of 1.0 l/hectare and option 2 (2.0 l/hectare) and 3 (3.0 l/hectare) distinctions on productivity are also essential. Between option with application rate of top-dressing of 1.0 l/hectare and check option and also options with application rate of top-dressing 2.0

l/hectare and 3,0 l/hectare the importance of distinctions on yield is not proved.

Accounting of quality characteristics of juice of berries when harvesting did not reveal essential differences on total sugars and acids between options and control and also between options of experience (table 4).

Table 4. Influence of foliar feeding with the microbiological preparation Bacillus pumilus + potassium humate on the qualitative characteristics of the yield of Cabernet Sauvignon plants (average for 2017 -2019)

Experience option	Consumption rate, l / ha	Mass concentration	
		sugars, g / dm^3	titratable acids, g / dm^3
1	1.0	233	8.7
2	2.0	238	8.4
3	3.0	234	8.7
4	Control (no processing)	234	8.9
lsd_{05}		6	0.4

These indicators, both in control option, and by application rate of top-dressing 1.0; 2.0; and 3.0 l/hectare, conforms to the variety standards necessary for production of quality wine materials.

Foliar nutrition of plants the microbiological product Bacillus pumilus, + potassium humate (3.0 l/hectare) promoted increase in biological effectiveness of product Mankotseb + Mefenoksam from downy mildew (*Plasmopara viticola)*. Increase in fungicide activity of product with Difenokonazol active ingredient concerning other main diseases -powdery mildew (*Uncinula necator)* and, excoriose (*Phomopsis viticola*) by foliar nutrition the microbiological product Bacillus pumilus, + potassium humate by our researches it is not proved (table 5).

Table 5. Influence of foliar feeding with the microbiological preparation Bacillus pumilus + potassium humate on the biological effectiveness of preparations against the main phytopathogens, Caberne Sauvignon variety (average for 2017 -2019)

Option	Biological effectiveness, %		
	Plasmopara viticola	***Uncinula necator***	***Phomopsis viticola***
1. Mancozeb + Mefenoxam (active ingredient))	89	-	-
2. Mancozeb + Mefenoxam (active ingredient) + bacillus pumilus microbiological preparation + potassium humate (3.0 l / ha)	94	-	-
3. Difenoconazole (active ingredient)	-	83	71
4. Difenoconazole (active ingredient) + Bacillus pumilus + potassium humate (3.0 l / ha)	-	80	73
Control - no processing	-	-	-
lsd_{05}	4.5	4.3	3.9

Our researches showed that foliar nutrition the microbiological product Bacillus pumilus, + humate of potassium affected growth activity of whip (figure 1).

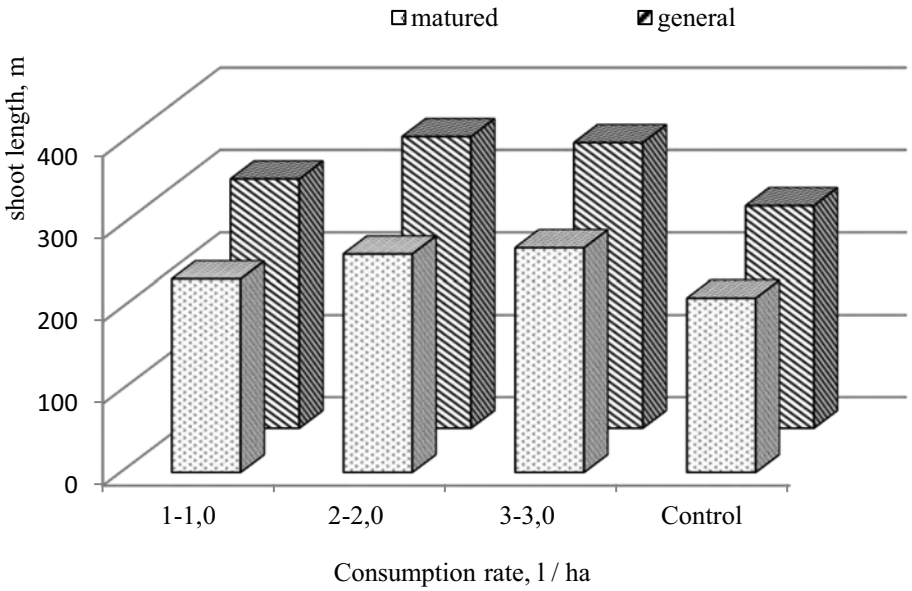

Fig. 1. Influence of foliar feeding with the microbiological preparation Bacillus pumilus potassium humate on the growth and maturation of shoots in Cabernet Sauvignon plants (average for 2017 - 2019)

The table 6-Influence of Foliar Nutrition the microbiological medicine product Bacillus pumilus + potassium humate on

By top-dressing of plants the microbiological product Bacillus pumilus + potassium humate the growth activity of whip in options of experience 2 (2.0 l/hectare) and 3 (3.0 l/hectare), in comparison with control option significantly increased. The essentiality of differences on length of whip is not proved for option 1 (1.0 l/hectare) in comparison with control and for options 1 (1.0 l/hectare), 2 (2.0 l/hectare) and 3 (3.0 l/hectare) among themselves. The essentiality of differences on ripening of whip is not proved both for options of experience in comparison with control, and for options among themselves. In control option and options of experience the size of ripening of whip is sufficient for successful overwintering of plants.

4 Conclusions

Foliar nutrition of plants the microbiological product Bacillus pumilus + potassium humate positively affected on forming of cluster, promoting significant increase in its weight in comparison with control (99 g) at consumption rates of fertilizer of 2.0 l/hectare (111 g) and 3.0 l/hectare (116 g). The average mass of one cluster by application rate of top-dressing of 1.0 l/hectare (103 g) increased, in comparison with control (99 g), it is insignificant. Distinction on this indicator, in comparison with control, are proved for options with norms of top-dressing of 2.0 l/hectare and 3.0 l/hectare. For control and option with application rate of top-dressing of 1.0 l/hectare and also for options with application rate of top-dressing of 2.0 l/hectare and 3.0 l/hectare the importance of distinctions is not proved.

Distinctions on number of bunches on bush between options are insignificant since before experimenting, according to technique the rationing of bushes on loading is provided

by stocking and inflorescences.

Top-dressing of plants microbiofertilizer influenced forming of berries in cluster, having increased their weight and quantity. The importance of differences on aggregate weight of berries in cluster, in comparison with control (95,0 g), is proved for options with application rate of top-dressing of 2.0 l/hectare (112,7 g) and 3,0 l/hectare (115,4 g) and also for options with application rate of top-dressing of 2.0 l/hectare and 3,0 l/hectare in comparison with option with norm of top-dressing 1.0 l/hectare (100,5 g). At the consumption rate of preparation of 1.0 l/hectare the difference with control on the mass of berries is insignificant.

The essential difference on number of berries in cluster between control (98 pcs) and options with norms of top-dressing of 2.0 l/hectare (110 pcs) and 3.0 l/hectare (113 pcs) is noted. Between control and option with application rate of top-dressing of 1.0 l/hectare (102 pcs) and also between options with application rates of top-dressing of 1.0 l/hectare and 2.0 l/hectare of difference on number of berries in cluster are not proved.

The microbiological product Bacillus pumilus + humate of potassium promoted increase in yield for 14-19% which appeared, in comparison with control (7.9 t/hectare), is significantly higher at top-dressings with the consumption rates of 2.0 l/hectare (9,2 t/hectare) and 3,0 l/hectare (9,7 t/hectare) due to increase than both the mass of berries and clusters, and number of berries in cluster. Between option with norm of top-dressing of 1,0 l/hectare (8,1 t/hectare) and control and also options with application rate of top-dressing of 2,0 and 3,0 l/hectare the importance of distinctions on productivity is not established.

Increase in productivity on 14-19 % in options with application rate of top-dressing of 2.0 l/hectare and 3.0 l/hectare, in comparison with control, did not worsen quality of harvest what the lack of importance of differences on total sugars and acids between options and control and also between experience options testifies to.

Foliar nutrition of plants the microbiological product Bacillus pumilus, + potassium humate (3.0 l/hectare) promoted increase in fungicide activity of product from mildew (active ingredient - Mankotseb + Mefenoksam). Increase in fungicide activity of product with Difenokonazol active ingredient concerning other main diseases (oidium, blackspot) by foliar nutrition the microbiological product Bacillus pumilus, + potassium humate by our researches it is not proved.

By top-dressing of plants the microbiological product Bacillus pumilus + potassium humate the growth activity of whip in application rates 2 l/hectare and 3 l/hectare, in comparison with control option significantly increased. The essentiality of differences on ripening of whip is not proved both for options of experience in comparison with control, and for options among themselves. In control option and options of experience the size of ripening of whip is sufficient for successful overwintering of plants.

References

1. B. Sivcev, I. Sivcev, Z. Rankovic Grapevine growing Journal of Agricultural Sciences **55(1)**, 103-122 (2010) doi:10.2298/JAS1001103S
2. A. E. Temitope, B. O. Oluranti, Frontiers in Microbiology, **9**, 2213 (2018) doi: 10.3389/fmicb.2018.02213
3. G. G. Gamboa, G. Romanazzi, T. Garde-Cerdán, E. Pérez-Álvarez, J Sci Food Agric. **99**, 1001-1009 (2019) doi:10.1002/jsfa.9353
4. G. Deza-Borau, M. L. Peschiutta, V. D. Brito, V. L. Usseglio, M. P. Zunino, J. A. Zygadlo Vitis, **59**, 127–132 (2020) doi:10.5073/vitis.2020.59.127-132
5. S. Furuya, M. Mochizuki, Y. Aoki et al. Biocontr. Sci. Techno.l., **21(6)**, 705-720 (2011) doi:10.1080/09583157.2011.574208

6. A. Mastan, D. Rane, S..Dastager, C.S.Vivek Babu, Microbiological Research, **227**, 126310 (2019) doi:10.1016/j.micres.2019.126310
7. N. Bisht, S. Tiwari, P. C. Singh, A. Niranjan, P. Singh Microbiological Research, 223–225, 110-119 (2019) doi:10.1016/j.micres.2019.04.007
8. Y. Bashan, L.E. de- Bashan, S.R. Prabhu, Plant Soil, **378**, 1-33 (2014) doi:10.1007/s11104-013-1956-x
9. P. Calvo, L. Nelson, J.W. Kloepper, Plant Soil, **383**, 3–41 (2014) doi: 10.1007/s11104-014-2131-8
10. I. Mnif, D. Ghribi, Crop Prot., **77**, 52-64 (2015) doi: 10.1016/j.cropro.2015.07.017
11. B. Berger, S. Patz, S. Ruppel, K. Dietel, S. Faetke, H. Junge, M. Becker, Biomed Res. 2018, 6439481 (2018) doi: 10.1155/2018/6439481
12. J. Basheer, A. Ravi, J. Mathew, R.E. Krishnankutty, Probiotics & Antimicro. Prot., **11**, 256–263 (2019) doi: 10.1007/s12602-018-9386-y
13. E. Baldan, S Nigris, C. Romualdi, et al. PLoS One., **10(10)**, e0140252 (2015) doi: 10.1371/journal.pone.0140252
14. R. J. Akinrinlola, G. Y. Yuen, R. A. Drijber, A. O. Adesemoye, Int. J. Microbiol, 1–11 (2018) doi: 10.1155/2018/5686874
15. I. S, Sawant, P. N.Wadkar, Y. R. Rajguru, N. H. Mhaske, V. P. Salunkhe, S. D. Sawant, et al. Biocontrol Sci. Technol., **26**, 964–979 (2016) doi: 10.1080/09583157.2016.1174770
16. R. J. Akinrinlola, G. Y. Yuen, R. A. Drijber, A. O. Adesemoye, International Journal of Microbiology, **11**, 5686874 (2018) doi: 10.1155/2018/5686874
17. M. Pereira, E. Marques, D. Martins et al., Journal of Agricultural Science, **11**, 268 (2019) doi: 10.5539/jas.v11n7p268