

# Foliar Fertilizers as A Method Of Phenolic Ripeness Control

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**Abstract.** Due to global warming, there is a problem to correlate technical and phenolic ripeness in modern viticulture. This study is focused on the use of foliar fertilizers in order to combine the time of beginning of phenolic and technical ripeness. The studies were carried out in 2022 in the conditions of mountain-valley coastal viticulture zone of the Republic of Crimea. Foliar top dressing was carried out with the preparation 'Agrogemo' (LLC Pontis, Russian Federation) on wine grape varieties 'Bastardo Magarachskiy' and 'Malbec'. The Glories method was used to estimate the ripeness degree of grapes. The principle of it is to determine the total and extractable anthocyanin potential of grapes. Using of foliar fertilizers made it possible to increase the yield of 'Bastardo Magarachskiy' variety by 15.3%, and 'Malbec' variety by 18.1%. It was found that the experimental treatment scheme contributed to the later beginning of technical ripeness of grapes, i.e. a low percentage of non-extractable anthocyanins from grape skin compared to the control. Base wines obtained from grapes with the use of organic-mineral fertilizer were characterized by the intense color, balanced aroma and flavor.

## 1 Introduction

Phenolic compounds play an important role in physiological and biochemical processes running in grape plants during growing season. They regulate proliferation and apoptosis of growing plant components, take a part in the process of photosynthesis, and serve as hydrogen carriers during respiratory exchange; due to the increased content of phenolic substances, epidermal cells absorb up to 95% of ultraviolet rays. Flavonoids are P-vitamin and antioxidant active, they regulate ongoing intracellular free radical processes. [1-3].

In the studies of foreign authors, the content of phenolic substances in grapes harvested during the last month of ripening (four sampling dates in July) was analyzed. Amongst the phenolic compounds in grape skin, there was no significant difference in chlorogenic, coumaric acids and rutin. In general, phenolic substances in grape skin were reaching their maximum level during the fourth week of July, when skin had the highest content of

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quercetins, catechins and syringic acid. The content of phenolic substances in the pulp of grapes did not change significantly during ripening [4].

Iranian and Danish scientists studied the effect of pre-harvest treatments with methyl jasmonate as a chemical elicitor. Their results are suggestive of pre-harvest treatment with methyl jasmonate to be used as a sustainable approach for increasing phenolic content and antioxidant potential of grapes during storage [5].

Studies on the effect of using foliar fertilizers by Spanish scientists showed their contribution to 'Tempranillo' grape variety in the initial phase of growing to achieve both phenolic and technological ripeness of grapes, and to succeed in balancing wines either by delaying the accumulation of sugar, or by increasing the synthesis of anthocyanins and phenolic compounds. Foliar treatments with urea and phenylalanine also contributed to an increase in the content of phenolic components [6-8].

The scientists from Pakistan and Egypt together studied the effect of foliar top dressing on the quality of resulting grape products. It was found that using of treatments led to a higher accumulation of ascorbic acid, total amount of phenolic compounds, as well as the content of soluble solids in 'Perlette' grapes [9].

The effect of foliar top dressing with the amino-acid based preparation 'Siamino Pro 500' on phenolic ripeness of grapes was studied by the scientists of the Institute Magarach Levchenko S.V., Boiko V.A. et al. The treatment made it possible to achieve phenolic maturity earlier than the control. The mass concentration of anthocyanins from the skin reached 49-56%. Experimental samples of grapes were characterized by a higher content of titratable acids and lower sugar accumulation. Experimental processing scheme showed a positive effect on organoleptic properties of wines [10-12].

Proceeding from the above, the study of the effect of foliar fertilizers on the productivity and content of phenolic compounds in grapes under the conditions of specific natural and climatic zone is an urgent task now.

## 2 Materials and methods

### 2.1 Description of varieties

'**Malbec**' – ('Magdeleine Noire des Charentes' x 'Prunelard') is a French wine grape variety of medium ripening. Bunches are small and medium, conical or wide-conical, loose, less often medium dense. Berries are medium, round, dark blue, almost black, covered with a thick wax coating. Skin thickness is medium. Resistance to mildew, gray rot and anthracnose is low, to oidium - medium. This variety is weakly affected by grape moth. Not resistant to winter frosts, late spring light frosts.

'**Bastardo Magarachskiy**' – ('Bastardo' x 'Saperavi') – wine grape variety of medium-late ripening, bred by Paponov N. and Zotov V. in the Institute of Viticulture and Winemaking Magarach. Bunches are medium, cylindrical-conical or conical, winged, varying in density. Bunch rachis is thin, long. The average bunch weight is 176 g. Berries are medium-sized or small, oval, dark blue, covered with a thick pruina. Pulp is greenish, sweet and juicy, without aroma. Relatively resistant to mildew and oidium, but affected by gray rot, sufficiently resistant to soil drought in the conditions of steppe Crimea.

The study was carried out during 2022 on the basis of Morskoye branch industrial plots of FSUE PJSC Massandra and VPS Plus LLC located in the mountain-valley coastal viticultural region of the Republic of Crimea, and the Laboratory of Grape Storage of the FSBSI Institute Magarach of the RAS.

The system of grape culture management is open-earth. The scheme of planting for ‘Bastardo Magarachskiy’ variety is 3.0 x 1.5 m, for ‘Malbec’ variety - 3.0 x 1.5 m. Bush training - one-sided cordon on a medium trunk.

## 2.2 Scheme of using preparations

Foliar top dressing was carried out with the preparation ‘Agrogemo’, based on organic amino acids (LLC Pontis, Russian Federation), on wine grape variety ‘Bastardo Magarachskiy’: irrigated vineyard, single treatment 5 kg/ha (working fluid consumption rate 800 l/ha). Foliar treatment of the vineyard was carried out by tractor spraying. System of agricultural actions adopted in the farming served as a control.

## 2.3 Methods of experimental study performance

Sampling was carried out in three dates for the variety ‘Malbec’: on September 8 (08.09 - first), September 15 (15.09 - second), September 21 (21.09 - third). For the variety ‘Bastardo Magarachskiy’: on September 8 (08.09 - first), September 15 (15.09 - second), September 21 (21.09 - third), September 29 (29.09 - fourth), October 13 (13.10 - fifth).

## 2.4 Indicators under analysis

The inventory of yield and outgoing product was carried out by weighing and counting of grape bunches harvested from 20 typical bushes of each variant.

Mass concentration of sugars was evaluated using refractometer in the field conditions, and hydrometer in the laboratory in conformity with GOST 27198-87. Mass concentration of titratable acids was defined using method of titration with sodium hydroxide solution in conformity with GOST 25555.0-82 [13].

The principle of Glories method is a rapid extraction of anthocyanins and proanthocyanidins from grape skin, and a partial extraction of proanthocyanidins from seeds by coarse crushing of grapes with subsequent maceration in a solvent. This method allows to evaluate the potential of present proanthocyanidins and anthocyanins, as well as their ability to be extracted from grapes during processing and subsequent technological operations [14,15].

$A_{PH} 1.0$  – mass concentration of the potential amount of anthocyanins, mg/L

$A_{PH} 3.2$  – mass concentration of easily extractable anthocyanins, mg/L

$E_a$  – the proportion of easily extractable anthocyanins, %

$A$  - the proportion of non-extractable anthocyanins from the skin of grapes, %

Base wines were produced in the conditions of microwinemaking at the FSBSI Institute Magarach of the RAS using yeast strain *Sacch. cerevisiae* I-25 (‘Cabernet 5’) from the Magarach Collection of Winemaking Microorganisms. Organoleptic evaluation of the wines was carried out by the tasting commission of the Magarach Institute (using the 10-point scale).

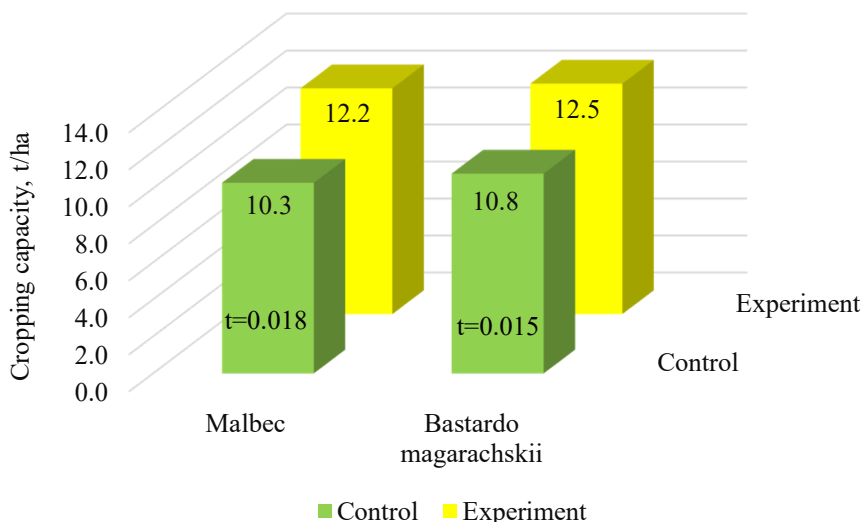
## 2.5 Methods of mathematical processing of experimental results

To determine the significance level of the effect of studied preparations on the natural loss value during long-term storage, the results obtained in the process of dispersion analysis were considered using the paired Student's t-test (at  $t < 0.05$  ‘the influence is significant’) in the SPSS Statistics 17.0 program.

### 3 Results and Discussion

#### 3.1 The effect of treatments on the cropping capacity of the studied grape varieties

As a part of the study, cropping capacity was assessed for wine grape varieties ‘Malbec’ and ‘Bastardo Magarachskiy’ (Fig.).



**Fig.** The effect of preparation on the cropping capacity, 2022

Foliar top dressing with mineral fertilizers had a positive effect on the cropping capacity of the studied grape varieties. Using of treatments made it possible to increase the yield of ‘Bastardo Magarachskiy’ variety by 15.3%, and ‘Malbec’ variety by 18.1% compared to control samples. Statistical analysis of the data showed that the use of the study fertilizer significantly affected the actual yield.

#### 3.2 The effect of treatments on the content of phenolic substances

In the ripening dynamics of wine grape varieties ‘Bastardo Magarachskiy’ and ‘Malbec’, the effect of preparation on the mass concentration of phenolic substances was studied (Table 1).

As a study result, foliar top dressing of the variety ‘Bastardo Magarachskiy’ had a positive effect on the phenolic composition of grapes. Grapes of the fourth sampling date were characterized by the highest proportion of easily extractable anthocyanins. In experimental variant this indicator was 27% higher than the control.

Treatments of ‘Malbec’ grape variety were characterized by better proportion of easily extractable anthocyanins in the first and second sampling dates by 4–6%. Experimental variant of the last sampling date proved to be inferior to the control one.

**Table 1.** The effect of treatments on the mass concentration of phenolic substances in the studied grape varieties

Grape variety	Date	A <sub>pH1.0</sub>	A <sub>pH3.2</sub>	E <sub>a</sub>	A
		mg/L	mg/L	%	%
‘Bastardo Magarachskiy’, control	08.09.2022	1292	488	38	62
‘Bastardo Magarachskiy’, experiment	08.09.2022	1106	369	33	67
‘Bastardo Magarachskiy’, control	15.09.2022	1351	564	42	58
‘Bastardo Magarachskiy’, experiment	15.09.2022	2023	943	47	53
‘Bastardo Magarachskiy’, control	21.09.2022	2184	929	43	57
‘Bastardo Magarachskiy’, experiment	21.09.2022	1803	830	46	54
‘Bastardo Magarachskiy’, control	29.09.2022	1412	497	35	65
‘Bastardo Magarachskiy’, experiment	29.09.2022	1393	877	63	37
‘Bastardo Magarachskiy’, control	13.10.2022	2364	677	29	71
‘Bastardo Magarachskiy’, experiment	13.10.2022	1684	679	40	60
‘Malbec’, control	08.09.2022	1636	602	37	63
‘Malbec’, experiment	08.09.2022	1208	523	43	57
‘Malbec’, control	15.09.2022	2641	758	29	71
‘Malbec’, experiment	15.09.2022	1271	417	33	67
‘Malbec’, control	21.09.2022	3077	1568	51	49
‘Malbec’, experiment	21.09.2022	2333	1015	44	56
Student's t-test (for paired samples)	-	0.4	0.2	0.002	0.004
HCP <sub>05</sub>	-	8.3	2.7	0.31	0.05

### 3.3 The effect of treatments on tasting assessment of base wines prepared from the studied grape varieties

As a result of the analysis of the studied data on the effect of the fertilizer on the physico-chemical parameters of grapes, it was found that the use of the ‘Agrogemo’ contributed to a higher sugar accumulation.

In the ripening dynamics of wine grape varieties ‘Bastardo Magarachskiy’ and ‘Malbec’, the effect of treatments on the organoleptic quality assessment of base wine samples was studied (Table 2). This provided a higher content of ethyl alcohol in wines. It is noted that when using the studied fertilizer, the wines are characterized by higher tasting ratings compared to the control variants.

It was noted that base wines of ‘Bastardo Magarachskiy’ variety, produced from experimental batches of grapes, in comparison with the corresponding control batches, were characterized by a more balanced and harmonious aroma and flavor, which was reflected in the better tasting assessment by 0.01-0.04 points. Two variants collected on September 29 were characterized by the best rating level of 7.74 points.

Base wines made of ‘Malbec’ grape variety, from both control and experimental batches, were characterized by a complex berry-spicy aroma with corresponding high tasting scores of 7.84.

**Table 2.** Organoleptic quality assessment of base wine samples prepared from wine grape varieties ‘Bastardo Magarachskiy’ and ‘Malbec’

№	Sample name (scheme of experiment)	Physicochemical characteristics		Average score
		Volume fraction of ethyl alcohol, %	Mass concentration of titratable acids, g/L	
1.	‘Bastardo Magarachskiy’, control, 15.09	12.1	4.1	7.67
2.	‘Bastardo Magarachskiy’, experiment, 15.09	13.1	4.7	7.71
3.	‘Bastardo Magarachskiy’, control, 29.09	12.7	5.1	7.74
4.	‘Bastardo Magarachskiy’, experiment, 29.09	13.5	5.0	7.74
5.	‘Bastardo Magarachskiy’, control, 13.10	12.7	4.9	7.65
6.	‘Bastardo Magarachskiy’, experiment, 13.10	13.5	4.6	7.69
7.	‘Malbec’, control, 15.09	13.5	7.2	7.84
8.	‘Malbec’, experiment, 15.09	14.0	5.6	7.84
	Student's t-test (for paired samples)	0.002	0.001	0.001
	HCP <sub>05</sub>	0.4	0.2	0.01

## 4 Conclusion

This study showed that foliar treatments with the preparation ‘Agrogemo’ help to increase the yield of wine grape varieties. Processed grapes were characterized by the best extractability of anthocyanins, which, in its turn, had a positive effect on the assessment of base wines in comparison with the control.

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