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Competitive relations between young vines and weed species for mineral nutrients uptake in the nursery

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Abstract

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During the period 2017 – 2020, a study was carried out on the weed – vine competitive relations in the nursery and the opportunities for control through herbicide treatment. Grafted cuttings of the Cabernet Sauvignon variety to Berlandieri X Riparia SO4 rootstock, rooted without mulching the beds with polyethylene foil, were used. The soil type was leached chernozem formed on clay loess. The treatment with Gardoprim plus Gold (312.5 g/l s-metolachlor + 187.5 g/l terbuthylazine) at a dose of 0.4 l/da was performed by micro-spraying immediately after the cuttings were planted in the nursery. The content of N (%), P (%), K (%), Ca (%), Mg (%) and Fe (mg/kg) in the vine leaves and the weeds' vegetative mass was recorded at the end of the vine growth.

The weed species *C. arvensis*, *A. blitoides* and *P. oleraceae* appeared to be highly aggressive competitors of young Cabernet Sauvignon vines in nutrient uptake in the area of the nursery. *C. arvensis* plants from the herbicide-free plots accumulated larger amounts of P, K and Fe; *A. blitoides* – K, Ca, Mg and Fe*; P. oleraceae* – K, Mg and Fe. Despite the insufficient sensitivity of the three weed species to the herbicide; their response included statistically significant changes in nutrients export. The minimal changes found in the amounts of N, P, K, Ca, Mg and Fe in the leaves of Cabernet Sauvignon young vines after treatment with Gardoprim plus Gold did not affect their growth and development and did not create preconditions for latent or overt phytotoxic reaction.

Keywords: vine; nursery; weeds; competition; mineral nutrients; herbicide

Introduction

Weeds had been distinguished for the exceptional ability to propagate and regenerate their populations, regardless the measures taken to control them. That was largely due to their capacity to make the most of the environmental conditions. One of the reasons for their high ecological plasticity had been the tendency to accumulate in their vegetative organs larger amounts of nutrients than cultivated plants (Lopes et al., 2004). The studies had revealed higher ratios of nitrogen, phosphorus, potassium and magnesium in the leaf mass (stems and leaves) in a number of weed species (Qasem, 1992; Hristeva et al., 2014; Staneva & Rankova, 2017).

The competition for the basic biotic factors absorption significantly retarded the normal growth of vines. It was found that the species *Convolvulus arvensis* L., *Sinapis arvensis* L., *Amaranthus retroflexus* L. и *Cynodon dactylon* (L.) Pers., *Chenopodium album* L.*, Cirsium arvense* L.*, Malva neglecta* L.*, Taraxacum officinale* L. etc. had much more intense transpiration than vine. In addition to more water, weeds extracted larger amounts of nutrients from the soil (Boychev A., 1980, Boychev A., 1985). A study of the competitive relationship between perennial ryegrass (*Lolium perenne* L.) and Chardonnay vines (*Vitis vinifera* L.) showed that the grass species had reduced the concentration of N, Fe, S, Ca, B, Mn and the total content of all measured nutrients in the vine leaves (Tan & Crabtree, 1990). The role of the various elements taken by the vine plant organism for the implementation of its vital functions had been strictly specific. The amounts it absorbed, especially in the early stages of its development, might have a decisive influence on the young vine growth and formation. The high degree of weed infestation usually resulted in underdeveloped shoots and reduced quantity and quality of the vine propagation material (Prodanova–Marinova, 2012; Prodanova–Marinova, 2014).

High soil moisture and air humidity, heat and fertilization created optimal conditions for weeds development in the nursery. All of them interact both with the vine plants and between them and the main driving mechanism of this interaction had been the competition for nutrients absorption. Herbicide treatment had a significant effect on these processes. Flumioxazin had been shown to promote the accumulation of more potassium, magnesium and nitrogen in vine leaves and reduce the iron content not only in Cabernet Sauvignon but also in *P. oleraceae* and *A. blitoides* (Prodanova-Marinova & Staneva, 2018).

The objective of the present study was to establish the level of competition between vine and weed for the uptake of mineral nutrients in the nursery and to investigate the possibility of regulating them through herbigation.

Material and Methods

The trial was carried out in the years 2017-2019, on the territory of the Experimental Base of IVE – Pleven. The soil type was leached chernozem formed on clay loess. The humus horizon was too short and there was no transition between it and the B horizon, typical for leached chernozem of more pronounced nature. Carbonates were missing at a depth of up to 60 cm, and below that depth their amount reached 24.18%. The active calcium in the carbonate horizons reached 5.96-6.67%. The soil reaction was in accordance with that – in the carbonate-free horizons it was neutral, and in the carbonate ones – slightly to moderately alkaline (Krastanov & Dilkova, 1963).

The data for the meteorological conditions were obtained from METOS WEATHER data 000003 CA station, located on the territory of the experimental base. Figure 1 showed the average monthly temperatures and the precipitation rate during the months from planting the cuttings in the nursery (May) to the end of the young vines active growth (August).

Cabernet Sauvignon cuttings grafted to Berlandieri X Riparia SO4 rootstock were used, rooted, according to the technology adopted by IVE, without mulching the beds with

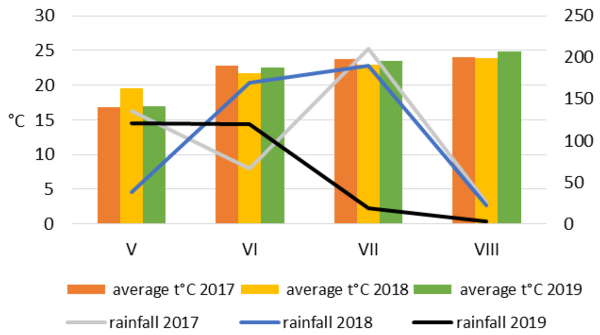

Fig. 1. Climatic characteristics for the period May – August, 2017 – 2019

polyethylene foil (Dimitrova et al., 2007). The treatment with Gardoprim plus Gold (312.5 g/l s-metolachlor + 187.5 g/l terbuthylazine) at a dose of 0.4 l/da was done immediately after planting the cuttings in the nursery with the irrigation water. For this purpose, microsprinklers Water Bird VI Classic with flow rate q = 156 L h^{-1} at 0.2 MPa pressure and range r = 5.0 m were used. A square scheme of location was applied with a distance between the sprinklers a = 1.42r = 7 m, where the irrigated area of one device was Fi = $2r^2$ = 50 m^2, and the intensity was i = q/Fi = 3.12 mm/h. The calculation of the weeds' density was done by the quantitative method (Tonev et al., 2002).

The rate of N (%), P (%), K (%), Ca (%), Mg (%) and Fe (mg/kg) in the leaves of the vines and the vegetative mass of the weeds was recorded at the end of the vine growth. Average samples from maximally developed leaves (6^{th} – 8^{th} leaf from the shoot top to the base) and average samples from whole weeds were analyzed. The individual elements rate was determined as follows: nitrogen – by the Kjeldahl method through distillation; potassium – flame photometrically; phosphorus – spectrometrically, with hydrazine sulfate reducer; calcium and magnesium – complexometrically; and iron – spectrophotometrically, after reaction with sulfosalicylic acid.

The trial was set in two variants – herbicide-treated and untreated. Each of the variants included four plots (repetitions). Data were processed by analysis of variance (Dimova & Marinkov, 1999).

Results and Discussion

During the study period, 16 weed species were identified in the plots of the nursery, divided into four classification groups (Table 1).

The weed association structure in the different years remained almost similar. The found slight variations (*S. arvensis* was observed only in 2017, while *C. album* and *C.*

Table 1. Classification of weed species found in the nursery in the period 2017 – 2019

No.	Perennial root-sprouting	Perennial rhizome weeds	Annual early spring	Annual late spring
1	*Aristolochia clematitis* L	*Cynodon dactylon* (L.) Scop.	*Sinapis arvensis* L.	*Amaranthus blitoides* L.
2	*Convolvulus arvensis* L.	*Sorghum halepense* (L.) Pers.	–	*Chenopodium album* L.
3	*Cardaria draba* L.)	–	–	*Coniza* canadensis L.
4	*Cirsium arvense* (L.) Scop	–	–	*Heliotropium europaeum* L.
5	*Sonchus arvensis* L.	–	–	*Portulaca oleracea* L.
6	–	–	–	*Solanum nigrum* L.
7	–	–	–	*Setaria viridis* L.
8	–	–	–	*Xanthium strumarium* L.

canadensis – only in 2019) had not affected its type and it was defined as row weeds.

The present study was focused on three of the species most densely spread during the period – field bindweed (*Convolvulus arvensis* L.), white amaranth (*Amaranthus blitoides* L.) and pigweed (*Portulaca oleracea* L.) – Figures 2 and 3. They comprised a total of 46% and 57% of the weeds' density in the manually weeded out and the herbicide-treated plots.

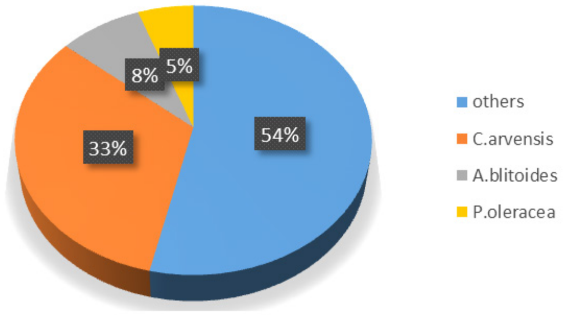

Fig. 2. Ratio of weed species in the untreated with Gardoprim plus Gold plots on the average for the period

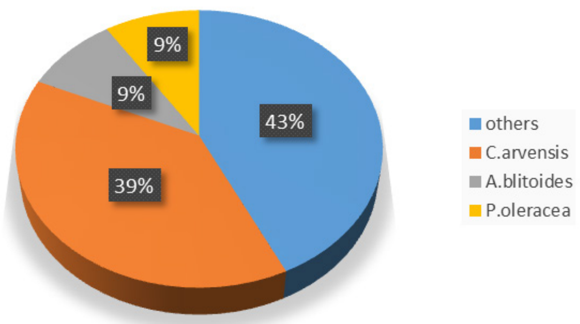

Fig. 3. Ratio of weed species in the treated with Gardoprim plus Gold plots on the average for the period

In the specific microclimate of the nursery the three species showed to be mesophytes. It was assumed the species of *Amaranthus*, *P. oleracea* and *C. arvensis* were nitrophile plants (Kolev, 1963; Janjic, 1996). The results of the present study revealed that the amounts of nitrogen that the three weed species extracted in their vegetative mass did not differ significantly from those accumulated in the leaf apparatus of young Cabernet Sauvignon vines (Table 2). The ratio between their phosphorus content and the representatives of *A. blitoides* and *P. oleracea* was similar. The amount of this element in *C. arvensis* was twice higher.

Potassium had been extremely important for the vine development. *Vitis vinifera* L. accumulated significant amounts of this element in its young organs and that had been a prerequisite for fierce competition with other potassium-loving species (Kurtev et al., 1979; Arutunyan, 1981; Ashley, 2011). The results demonstrated that *A. blitoides* and *P. oleracea* manifested to be such ones and accumulated significant higher rates of potassium, compared to the young vines of the Cabernet Sauvignon variety – *A. blitoides* (3 times more) and *P. oleracea* (3.5 times more) (Table 2). *C. arvensis* could not be classified as a potassium-loving species, but larger amounts of this element were also found in its vegetative mass (0.457% more).

The calcium amount had been shown to be higher in the biomass of *A. blitoides*. In the other two species it was lower than in the leaves of young vines, but the differences were irrelevant and not significant (Table 2). The competitive relations for Mg uptake had been much more intense. *A. blitoides* absorbed 1.7 times more and *P. oleracea* 3.8 times. The increase in the amount of Mg in *C. arvensis* compared to that in vines was not significant.

Both magnesium and iron had been essential for photosynthesis (Prokoshev, 2005; Yurchencko, 2014). Providing it in sufficient quantities for the vine growth and development was most affected by the competitive relationship with the three weed species, the object of this study. The results clearly showed they accumulated significantly more iron than young vines. *A. blitoides* and *P. oleracea* accumulated

Table 2. Content of essential nutrients in the vegetative mass of Cabernet Sauvignon vines and weed species in the herbicide-free plots on the average for the period

Nutrients	Cabernet sauvignon	*Convolvulus arvensis* L.	*Amaranthus blitoides* L.	*Portulaca oleracea* L.
N (%)	2.59	2.70 ^{ns}	2.32 ^{ns}	2.570^{ns}
P (%)	0.42	0.84 ***	0.49 ^{ns}	0.51 ^{ns}
K (%)	1.42	1.88 *	4.33 ***	5.13 ***
Ca (%)	2.74	2.68 ^{ns}	3.72 **	2.58 ^{ns}
Mg (%)	0.49	0.57 ^{ns}	0.85 ***	1.89 ***
Fe (mg/kg)	248.74	729.64 ***	462.20 **	411.54 **

Significant respectively at 5% – (*); 1% – (**); 0.1% – (***) and < 5% – (n.s) – not significant

similar rates – *A. blitoides* 1.9 times more and *P. oleracea* 1.7 times more (Table 2). The iron in *C. arvensis* biomass was 2.9 times more and that determined it as a major competitor for its uptake from the environment.

The one-time application of Gardoprim plus Gold, before the rooting of the grafted cuttings and the young vines formation, changed the conditions for growth and development of the species in the nursery and largely regulated the competitive relations. Its action increased the ratio of some elements in the plant biomass and caused a decrease in others. The Cabernet Sauvignon vines response to the herbicide was slightly contrasting and mathematically not significant – the analyses showed an increase in the amount of macronutrients in the young vine leaves, with the most significant difference (0.506%) in K content and decrease in Ca and Mg (Figure 4).

The herbicide treatment reduced the rates of N, P and Ca in the biomass of *C. arvensis*, as the reduction of P (***) had been statistically significant. Mg ratio was not affected by Gardoprim plus Gold. The recorded significant increase in K (0.818%) remained unproven (Figure 4).

A. blitoides responded to the herbicidal action with a slight decrease in P, K and Mg. In the biomass of this species there was a minimal higher rate of N and a significant increase in Ca (*), (Figure 4).

In *P. oleracea* vegetative mass the ratio of N and K dropped down and the amount of P, Ca and Mg went up, as only the difference in the increase of P (**) was significant (Figure 4).

The effect of the herbicide on the accumulated amounts of Fe was presented in Figure 5. Gardoprim plus Gold caused a decrease in the ratio of this element in the young vine leaves and in the weeds' biomass from the three species. External signs of chlorosis caused by Fe deficiency in Cabernet Sauvignon were not observed. The difference in its content was not significant and did not suggest the manifestation of latent phytotoxicity.

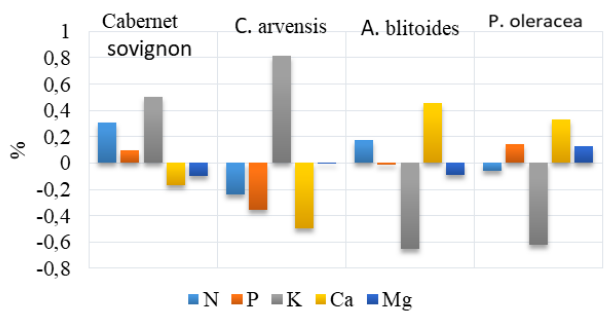

Fig. 4. Differences in the ratio of N, P, K, Ca and Mg in the leaves of young Cabernet Sauvignon vines and the biomass of weeds from untreated and treated plots with Gardoprim plus Gold

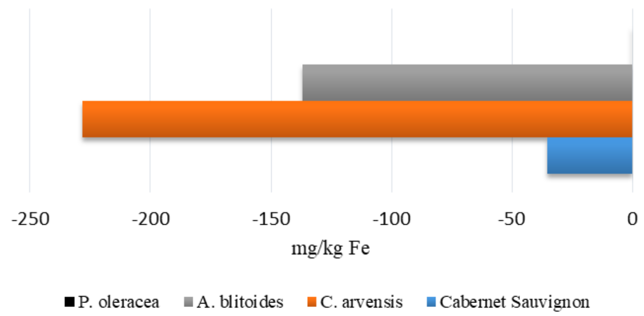

Fig. 5. Differences in the ratio of Fe in the leaves of young Cabernet Sauvignon vines and the biomass of weeds from untreated and treated plots with Gardoprim plus Gold

The amount of iron in *P. oleracea* vegetative mass from the treated and untreated plots was practically the same. The reduction in the other two weed species was more significant. The differences in the ratio of Fe were significant (*) and demonstrated the effect of the herbicide on the photosynthesis of *A. blitoides* and *C. arvensis*. The field bindweed response was especially strong – the reduced iron rate caused chlorosis and growth inhibition

Fig. 6. *C. arvensis* from plot untreated with Gardoprim plus Gold

Fig. 7. *C. arvensis* from plot treated with Gardoprim plus Gold

(Figures 6 and 7). The effect of Gardoprim plus Gold on iron accumulation was probably influenced by various factors (variety, soil and air temperatures, fertilization, etc.), thus in another study of ours it was shown an increase in its amount in Muscat Plevenski and *A. blitoides* and *P. oleracea* after the treatment (Prodanova-Marinova & Staneva, 2019).

The treatment with Gardoprim plus Gold changed the ratios in the amounts of nutrients accumulated by young vines and weed species (Table 3). The analysis of their biomass from the treated plots did not reveal significant differences in the rate of N and P. The amounts of K in weed species remained higher than in the leaves of young vines, but the ratios had already decreased significantly – *A. blitoides* accumulated 1.9 times more K, *P. oleracea* – 2.3 times, and despite its increased content in *C. arvensis* the difference compared to Cabernet Sauvignon was not significant. The rise in the amounts of Ca uptake by young vines and *A. blitoides* in the treated plots did not reduce the difference between them – weeds had been shown to accumulate more of this element in their biomass.

The elements associated with the photosynthesis (Mg and Fe) in *C. arvensis*, *A. blitoides* and *P. oleracea* and in the treated plots were in larger quantities than in the young vines. The ratio of Mg in *C. arvensis* was 1.4 times higher, in *A. blitoides* – 1.8 times and in *P. oleracea* – 4.9 times. The iron exceeded that in Cabernet Sauvignon 2.3 times in *C. arvensis*, 1.5 times in A. *blitoides* and 1.9 times in *P. oleracea*.

Conclusions

Weed species *C. arvensis*, *A. blitoides* and *P. oleraceae* appeared to be highly aggressive competitors of young Cabernet Sauvignon vines in nutrient uptake in the nursery – *C. arvensis* plants from the untreated plots accumulated larger amounts of P, K and Fe; *A. blitoides* – K, Ca, Mg and Fe; *P. oleraceae* – K, Mg and Fe.

Table 3. Content of essential nutrients in the vegetative mass of Cabernet Sauvignon vines and weed species in the herbicide-treated plots on the average for the period

Nutrients	Cabernet Sauvignon	*Convolvulus arvensis* L.	*Amaranthus blitoides* L.	*Portulaca oleracea* L.
N (%)	2.90	2.46 ns	2.50 ns	2.51 ns
P (%)	0.52	0.48 ns	0.48 ns	0.650ns
K (%)	1.93	2.70 ns	3.68 *	4.51 **
Ca (%)	2.58	2.19 ns	4.13 **	2.91 ns
Mg (%)	0.41	0.56 ns	0.76 **	2.02***
Fe (mg/kg)	213.41	501.45**	325.47 ns	411.46 *

Significant respectively at 5% – (*); 1% – (**); 0.1% – (***) and < 5% – (n.s) – not significant

Despite the insufficient susceptibility of the three weed species to the herbicide Gardoprim plus Gold at a dose of 0.4 l/da, their response included statistically significant changes in the nutrient exports. In *C. arvensis* the rate of P and Fe dropped down; in *A. blitoides* Fe decreased and Ca went up, and in *P. oleraceae* there was a rise in the amount of P in the vegetative mass.

The established minimal changes in the amounts of N, P, K, Ca, Mg and Fe in the leaves of young vines of Cabernet Sauvignon variety after treatment with Gardoprim plus Gold did not affect their growth and development and did not create preconditions for latent or overt phytotoxic response to the herbicide.

References

Arutunyan, S. S. (1981). The content of nitrogen, phosphorus and potassium in the organs of grapes in connection with the mineral nutrition of the vine. *Biological Journal of Armenia*, *XXXIV (8),* 861-866.

Ashley, R. (2011). Grapevine Nutrition – an Australian Perspective. Foster's Wine Estates Americas, 62-70. http://ucanr.org/sites/nm/files/76731.pdf

Boychev, A. (1980). Studies on the water and nutrition regime of weeds in the Vineyards. *Gradinarska i Lozarska Nauka*, *2,* 98-103, (Bg).

Boychev, A. (1985). Herbicides in the Vineyards. *Zemizdat,* Sofia, 149, (Bg).

Dimitrova, V., Peykov, V., Tsvetanov, E., Encheva, H. & Chelebiev, M. (2007). Optimization of Grafted Rooted Vines Production Technology. In: *Proceedings Jubilee Scientific Workshop with International Participation,* Pleven, 99-106.

Dimova, D. & Marinkov, E. (1999). Experimental Works and Biometry. *Academic Publishing House of HAI,* Plovdiv, 233, (Bg).

Hristeva, Ts., Dekalska, T. & Bozhinova, **R.** (2014). Weeds and Root Parasite Broomrape Nutrient Uptake in Oriental Tobacco Crop. *Plant Science*, *LI (2-3),* 67-71, (Bg).

Janjic, V. (1996). Triazine Herbicides. Institut za istraživanja u poljoprivredi, Srbija, Beograd, 476, (Sr).

Kolev, I. (1963). Weeds in Bulgaria. *Publ. House of BAS,* Sofia, Bulgaria, 566, (Bg).

Krastanov, S. & Dilkova, **E.** (1963). The Soils in the Experimental Field of the Institute of Viticulture and Enology in the Town of Pleven. Institute of Soil Science "N. Poushkarov", Sofia, Bulgaria, (Bg).

Kurtev, P., Tsankov, B. & Todorov, **H. (**1979). Viticulture. "*Hristo G. Danov"*, Plovdiv, 460 (Bg).

Lopes, C., Monteiro, A., Rückert, F. E., Gruber, B., Steinberg, B. & Schultz, **H. R. (**2004). Transpiration of Grapevines and Co-habitating Cover Crop and Weed Species in a Vineyard. A "Snapshot" at Diurnal Trends. *Vitis*, *43*(3), 111.

Prodanova-Marinova, N. (2012). Study on the Efficiency and Selectivity of Soil Herbicides of Grapes to Grey rot. *Plodovodstvo I vinogradarstvo Juga Rossii*, *25*(01), 1-10, (Ru).

Prodanova-Marinova, N., Dimitrova, M., Dimitrova, V. & Zhelyazkov, I. (2014). Influence of Some Soil Herbicides on the Yield of Grafted Rooted Grapevines from Variety Misket Kaylashki and Their Biometric Characteristics. *Plant Science, 51*(2-3), 53-56, (Bg).

Prodanova-Marinova, N. & Staneva, **I.** (2018). Some Weed Species Competitiveness in a vine Nursery. In: *Proceedings of National Scientific Conference with International Participation „Ecology and health"*, Plovdiv 07 June 2018, 170-174.

Prodanova-Marinova, N. & Staneva, **I.** (2019). Influence of Gardoprim plus Gold on the Competitive Relations in the Grapevine Nursery *Journal of Mountain Agriculture on the Balkans*, *22*(1), 302-314.

Prokoshev, V. V. (2005). Place and Importance of Potassium in an Agroecosystem. *Russian Chemical Journal*, *XLIX*(3), 35-43.

Qasem, J. R. (1992). Remove from marked Records Nutrient accumulation by weeds and Their Associated Vegetable Crops. *Journal of Horticultural Science*, *67*(2), 189-195.

Staneva, I. & Rankova, **Z.** (2017). Competition for Mineral Nutrients between Cultural Plants and Weeds in a Nursery. *Journal of Mountain Agriculture on the Balkans*, *20*(4), 299-307, (Bg).

Tan, S. & Crabtree, G. D. (1990). Competition Between Perennial Ryegrass Sod and Chardonnay' Wine Grapes for Mineral Nutrients. *HortScience*, *25*(5), 533-535.

Tonev, T., Zhelyazkov, I., Kalinova, Sht., Dimitrova, M. & Zhalnov, I. (2002). Practical Guide for Exercises in Herbology. *Acad. Publ. House of AU-Plovdiv*, Bulgaria, 193, (Bg).

Yurchencko, E. (2014) Influence of Potassium and Silicon Helats on Resistance Activation of Grapes to Grey rot. *Plodovodstvo I vinogradarstvo Juga Rossii, 25*(1), 1-10, (Ru).

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