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INFLUENCE OF THE HERBICIDE CHIKARA-DUO UPON SOIL MICROFLORA IN VINEYARDS

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Abstracts

The subject of the present study was to investigate the effect of the herbicide Chicara-Duo, applied at a dose of 300 g / da in vineyards, on soil microorganisms. The herbicide has proven to reduce the amount of soil microorganisms. The persistence of the herbicide lasts until the 60th day after treatment, which shows that the biodegradation of this herbicide, is slower and can take a longer period of time, depending on the soil type and reaction.

Key words: herbicide, degradation, soil microorganisms

INTRODUCTION

Viticulture is one of the main branches of agriculture and since ancient times it has been the main livelihood of the population in many regions of Bulgaria. In 2018, the areas occupied by vineyards on agricultural holdings reached 50,727 ha, of which 31,320 ha were renovated (MAF, 2018). The increase of the areas and the expected high yields at lower cost, raises the question of good pest control management in these plantations. Weeds compete directly with crops to satisfy their needs for nutrients, water, and they are often the host of a number of diseases and pests (Keller, 2015). The yield from the vineyards depends on a number of factors, including soil fertility, which is largely determined by the diversity and quantity of microorganisms (Chaparro et al. 2012; Zarraonaindia et al. 2015) inhabiting the soil, rhizome and phyllosphere (Pinto and Gomes 2016). The use of herbicides worldwide is central to integrated weed control programs, because they are an efefficient and cost effective way to solve the weed problem. The application of herbicides reaches 47.5% of the total pesticides used, which by the end of 2020 are expected to reach 3.5 million tons (Sharma et al., 2019). According to Miller, 2004, more than 95% of the applied herbicides and 98% of the insecticides fall on the soil, thus about 0.1% of the total amount of applied pesticides reach their initial target, and the rest of it pollutes the soil and the environment. While the effect of fungicides and insecticides on soil microorganisms has been well studied (Paoletti et al. 1998), information on the effects of herbicides on them is still insufficient and is constantly being supplemented (Zaller et al. 2018). Among the most widely used herbicides in vineyards are those based on glyphosate, glufosinate and flazasulfuron (Bauer et al. 2017; Mand et all. 2018). Glyphosate is a broad-spectrum, non-selective, vegetative herbicide widely used in agriculture. The mineralization of this herbicide is related to both the activity and the biomass of soil microorganisms. Microbial degradation of glyphosate results in the production of the major metabolite aminomethyl phosphonic acid, which later produces water, CO2 and phosphates (Forlani et al., 1999). Its presence in the soil can cause temporary changes in the bacterial population and their activity, without changing the number of fungi and actinomycetes. Glyphosate-based herbicides inhibit the synthesis of 5-enolpyruvate shiquinate 3-phosphate (EPSP), which is a key enzyme involved in the synthesis of aromatic amino acids. Inhibition of EPSP leads to depletion of the amino acids tryptophan, tyrosine and phenylalanine, which are necessary for protein synthesis.

Flasasulfuron belongs to the group of sulfonylureas. It is an organic, selective systemic, broad-spectrum herbicide, with soil and foliar application, originally discovered in the 80s. Flazasulfuron is absorbed through the roots or leaves of plants and moves through the xylem and phloem to the meristematic tissues. The activity of this group of herbicides is expressed in the inhibition of the synthesis of the enzyme acetolactase synthase (ALS), responsible for the formation of the amino acids isoleucine, leucine and valine. A few hours after the application of the herbicide, the plants stop growing. Symptoms include a change in the color of the leaves, drying, necrosis and the plants die 20-25 days after application. The selective nature of flazasulfuron is due to the different specific abilities of plants to metabolize the compound to inactive substances.

Flasasulfuron has a broad spectrum of application against both annual and perennial broad leaved weeds.

The aim of the present study was to determine the effect of the herbicide Chikara-Duo, applied in vineyards upon soil microorganisms.

MATERIALS AND METHODS

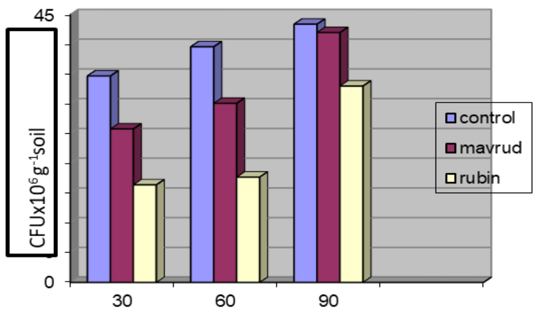
The research was conducted in a vineyard, a combination of the varieties Rubin and Mavrud, located next to the land of the village of Gornoslav, Asenovgrad municipality, with an altitude of 538 m. The average annual temperature varies from + 8.4°C to + 12.7 ° C. The seasonal distribution of precipitation has a spring-summer maximum and a winter minimum. Most precipitation falls in May - June, and the least in August and September. The annual amount of precipitation ranges from 480 - 550 mm. The soils are deluvial, with clay mechanical composition - 74.7% physical clay, pH 6.98, mineral nitrogen content 52.4 mg / 1000g, phosphorus 4.8 mg / 100g and potassium - 16.5 mg / 100g in the layer 0-30 cm.

The experiment was carried out with the herbicide Chikara - Duo, which consists of two active substances: flazasulfuron - 670g / kg, and glyphosate 288 g / kg +344.4 g / kg sodium salt. It is registered for control of annual wheat and broad leaved weeds in vineyards and perennials. The herbicide was soil applied at a dose of 300 g / da. The control variant was not treated.

Soil samples for microbiological tests were taken from the 0-20 cm layer in dynamics on the 30th, 60th and 90th day after application of the herbicide. The amount of tested groups of microorganisms was reported by a soil-dilutions plate technique using appropriate agar medium for their development (Koleshko, 1981). Total biological activity is determined by the amount of CO_2 released (Stotzky, 1965).

RESULTS AND DISCUSSIONS

The effect of herbicides on soil microorganisms depends on their toxicity, their behavior in the soil, the processes of adsorption, decomposition, evaporation, degree of uptake by plants and others. These processes control the amount of bioavailable pesticides in the soil and have a direct impact on the microbial populations. Microbial degradation is considered to be the most important of the transformation processes that determine the resistance of herbicides in the soil (Souza et al., 1999). The development of the soil microflora after the application of the herbicide, shows a different degree of dynamics in the amount of bacteria transforming the organic nitrogen compounds in the indicated periods of research. From the data presented in Fig. 1, a slight inhibition effect in the development of ammonifying bacteria was established until the 60th day. In the case of the Rubin variety, lower indicators are reported compared to the Mavrud variety, and only at the last reading they do reach a larger number. In the Mavrud variety, the values established on the 90th day, reach the amount of bacteria in control.



Fig,1. Total amonifying bacteria

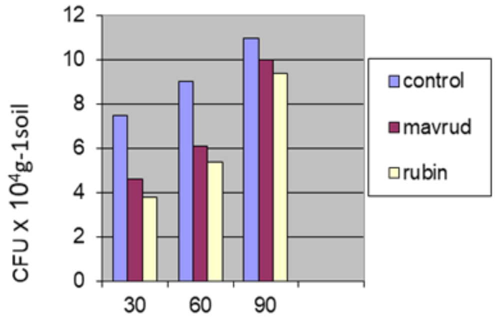


Fig.2. Sporeforming bacteria

The changes in the aerobic spore-forming bacteria are presented in Fig.2. The amount of spores decreased during the first two reporting periods, with the suppression being almost four times stronger than the control variant. The reduction in the number of spores is an indication that the herbicide used stimulates the spore-forming bacteria. After this period, their development is suppressed, as evidenced by the higher content of spores in both of the reported options. These results show that the herbicide is not completely degraded, which may delay the mineralization of organic matter in the soil and will affect adversely the soil fertility. At higher levels of the soil reaction, the resistance of herbicides increases, because only biodegradation takes place, while at pH values below 6.8, chemical decomposition takes place, and the rate of inactivation of herbicides in the soil increases.

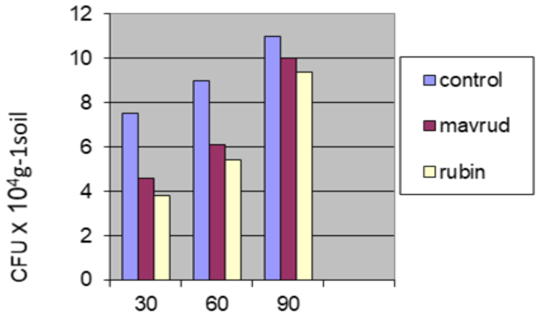


Fig.3. Cellulose decomposing bacteria

Quantitative changes in the development of cellulose-degrading bacteria (Fig. 3) indicate that the use of the herbicide Chikara- Duo inhibits their development until the 60th day after treatment. After this period, an increase in the number of studied variants was found, and on the 90th day the highest values were reported.

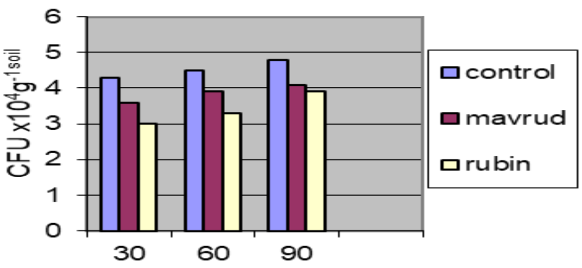


Fig.4. Microscopic fungi

Data on the number of microscopic fungi (Fig. 4) show that the herbicide used had a weak inhibitory effect on the 30th day, seen more in the Rubin variety in the soil, favors the development of heterotrophic microorganisms, such as microscopic fungi, but reduces the amount of bacteria. It was determined that the effect of the herbicide on the overall biological activity of the soil didn't have a large effect on the rate of CO_2 release in the soil. On the 30th day there is a slight suppression in the production of CO_2 (Table 1), and on the 60th and 90th day, the values in the sample and treated variants are insignificant. These differences in the development of the studied groups of microorganisms follow the changes in the amount of CO_2 released.

Table 1 Effect of Chikara-Duo on the total biological activity in soil (mg CO_2/100g soil)

Variants	Days after treatments		
	0	0	0
Control	4,2	5,1	5,8
Mavrud	2,1	0,6	1,5
Rubin	1,3	0,7	0,9

CONCLUSION

The herbicide Chikara, applied in a dose of 300 g / da, reduces the amount of soil microflora from the 30th to the 60th day. The inhibitory effect on the amount of microorganisms in the Mavrud variety is weaker in comparison with the Rubin variety. The effect of the herbicide does not significantly change the amount of soil microscopic fungi. The output of the emitted CO_2 changes insignificantly.

REFERENCES

Колешко, О.И. 1981.Экология микроорганизмов почвы. Выш школа. Минск. МЗГХ, отдел „ Агростатистика“ – „Наблюдение на производството на грозде и вино – реколта 2018“.

Bauer K, Regner F, Friedrich B 2017. Weinbau. Cadmos Verlag, Munich

Chaparro JM, Sheflin AM, Manter DK, Vivanco JM 2012 Manipulating the soil microbiome to increase soil health and plant fertility. Biol Fertil Soils 48:489–499

Forlani,G., Mangiacalli, A., Nielsen, E., Suardi, C.M., 1999. Degradation of the phosphonate herbicide glyphosate in soil; evidence for a possible involvement of unculturable microorganism. Soil Biol. Biochem. 31 (7), 991-997

Keller, 2015. The science of grapevines, 2 edn. Elsevier, Oxford

Mandl, K., Cantelmo, C., Gruberm E., Faberm F., Friedrich, B., Johann G. Zaller, J. G., 2018. Effects of Glyphosate, Glufosinate and Flazasulfuron Based Herbicides on Soil Microorganisms in a Vineyard. Bulletin of Environmental Contamination and Toxicology, Springer

Miller, G.T., 2004. Sustaining the Earth;Brooks/Cole: Montrerey County, CA,USA;ISBN 9780534400880

Paoletti MG, Sommgio D, Favretto MR, Petruzzelli G, Pezzarossa B, Barbafieri M 1998.

Earthworms as useful bioindicators of agroecosystem sustainability in orchards and vineyards with different inputs. Appl Soil Ecol 10:137–150

Pinto C, Gomes AC 201.) Vitis vinifera microbiome: from basic research to technological development. BioControl 61:243–256

Sharma Anket, Kumar, V., Shahzad, B., Tanveer, M., Sidhu, G., Handa, N.,Kohli, S., Yadav, P., Bali , A., Parihar, R., Dar, O., Singh, K., Jasrotia, Sh., Bakshi, P., Ramakrishnanm M., Kumar, San., Renu Bhardwaj, R., Kumar, Ash.,2019. Worldwide pesticide usage and its impacts on ecosystem, Springer Nature Switzerland AG.

Stotzky, G., 1965. Methods of soil analysis, part 2,pp. 1550-1572

Souza, A.P., Ferreira,F. A., Silva, A.A., Cardoso, A.A., Ruiz, H.A., 1999. Respiracao microbiana do solo sob doses de glyphosate e de imazapyr. Planta Daninha 17 (3), 387–398

Zaller et al. 2018. Zaller JG, Cantelmo C, Santos GD, Muther S, Gruber E, Pallua P, Mandl K, Friedrich B, Hofstetter I, Schmuckenschlager B, Faber F (2018) Herbicides in vineyards reduce grapevine root mycorrhization and alter soil microorganisms and the nutrient composition in grapevine roots, leaves, xylem sap and grape juice. Environ Sci Pollut Res 25:23215–23226

Zarraonaindia I, Weisenhorn MOS, West P, Hempton-Marcell K, Lax J, Bokulich S, Mills NA, Martin DA, Taghavi G, Van der Lelie S, Gilbert D JA 2015.) The soil microbiome influences grapevineassociated mecrobiota. Mbio 6:e02527–e02514