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INFLUENCE TO THE MAINTENANCE OF THE SOIL SURFACE TO THE LEAF GAS EXCHANGE AND VINE PRODUCTION (*VITIS VINIFERA*)

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Abstract

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During the period 2009-2010, there had been investigated the specification of leaf exchange and vine production (dessert variety Velika), which maintenance of the soil surface is performed in different ways. The experimental setting consisted of variants with conventional growing plantation (usage of synthetic fertilizers Basifertil, followed by plowing and disking of row spacing), mulching of the soil surface with straw, greening up of the soil surface, fertilizing the area in row spacing with manure, followed by plowing. It was concluded, that the method of maintaining the soil surface affects the leaf gas exchange and yield of the vine. For the period of the survey, with the best parameters for leaf gas exchange and with the highest yield was characterized the vines grown under conventional type and production by fertilizing with manure row spacing. The biggest advantage of the application of manure is that the effect on soil fertility, it is also environmentally friendly solution to the protection of the environment and crop production from pollution.

Key words: photosynthesis, transpiration, stomatal conductivity, productivity

Introduction

The soil fertility as a functioning ecosystem depends on the circulation of minerals and the availability of energy. In comparison to the plants, the soil is not an efficient system for capturing of the solar energy. The main source of energy in the soil is plant residues, and less degree animal excretions (manure). They are decomposed by soil microorganisms, which release the energy, needed for the functioning of the soil ecosystems (Bourguignon and Gabucci, 2000; Carpenter-Boggs et al., 2000).

The activity of the soil micro flora, which mineralized the organic residues, brings them in existing features in form accessible to the organism; it is closely related to the soil plant nutrition (Gyaneshwar et al., 2002).

The mineral elements, even though occupying an average approximately 50 $g.kg^{-1}$ of the organic mass, are indispensable components of the plant nutrition. They participate in different ways in the synthesis of all the organic substances (Thomas H. Jukes, 1995).

During the individual development of the plants, it appears and a second type nutrition-carbon, which is accomplished through the process of photosynthesis. About 950 $g.kg^{-1}$ of the plant organism consists of substances, synthesized at the expense of CO_2 in the air. That is why the both types of nutrition-carbon (photosynthesis) and mineral are the basis for the formation of the productivity of crop plants. (Kerin et al., 2011).

One of the main agronomic techniques applied in viticulture is the weed control. (Zabadal and Dittmer, 2001; Agustí-Brisach et al., 2011). The scientists are constantly looking for the rational and effective solutions for this problem. The weed control is conducted mainly by the soil cultivation, greening up and mulching (Thomson and Hoffmann, 2007). The intercrops processing was done at the depth of 12-15 cm, interlinear are also swallowed and performed manually with a hoe or a case of other milling machine. The mulching of the soil was carried out with a variety of organic materials, which lead to reduce water evaporation, hindering the development of the weeds and increasing the soil temperature. After the plowing of the mulch, into the soil enters organic substance, which stimulates its biological activity. The thickness of the mulch layer is 7-10 cm. It could be used polyethylene

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as mulch inside the lines (Ochmian et al., 2013). According to Magriso et al. (1971), the green manure (sideration) helps for enriching the soil with mineral elements; improves water-physical properties and restrict the erosion.

The aim of this study was to follow the leaf gas exchange and yield in the vineyard, grown at different ways of maintenance of the soil surface.

Materials and Methods

Subject of the study was the dessert variety Velika, planted in 2004 in the village Nayden Gerovo, municipality Saedinenie, (coordinates 42° 21′ 0″ N, 24° 28′ 58.8″). The vines were planted in accordance to the planting scheme 3.0 x 1.20 m, with a total area of 0.45 ha. The formations of the plantation were Guyot training system. The variety was grafted onto rootstock Berlandieri x Riparia SO4 The load of vines was achieved with short and mixed fruit units (6 spurs x 2 winter buds and fruit cane x 10 winter buds). The attempts were derived by the following scheme:

Vo –Control - conventional growing plantation by using a combination of short-acting synthetic fertilizer (Basifertil) N: P: K 12:10:16 - 500 kg.ha^{-1} in March. Maintenance of the soil surface after scattering the manure was done by the plowing and disking the area. Vegetative, there have been done some intercrops cultivation with a disk harrow. Interlinear distance was processed manually by hilling with a hoe or mechanically with aberrant milling machine (Figure 1).

V_1 –mulching the soil surface with straw - in the spring (the first ten days of April the soil was plowed and discounted. Immediately, after the treatment manually was made mulching of the interlinear with wheat straw at 1 kg straw per 1m^2. The second strewing was done in the second half of June with the same amount of straw (Figure 2).

V_2 –Grassy soil surface - for this type, there were not performed any soil cultivations. The grass has developed on the surface. During the vegetating there have been done some grass mowing – in the beginning of April for the first mowing, the second and the third-in May, the fourth, fifth and sixth respectively in June, July and August (Figure 3).

V_3 – Manuring - well-putrid livestock manure was applied in the autumn, at the beginning of the experiment (40

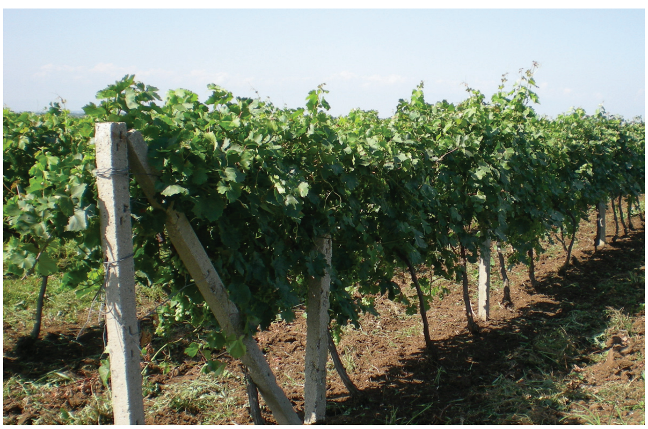

Fig. 1.

Fig. 2.

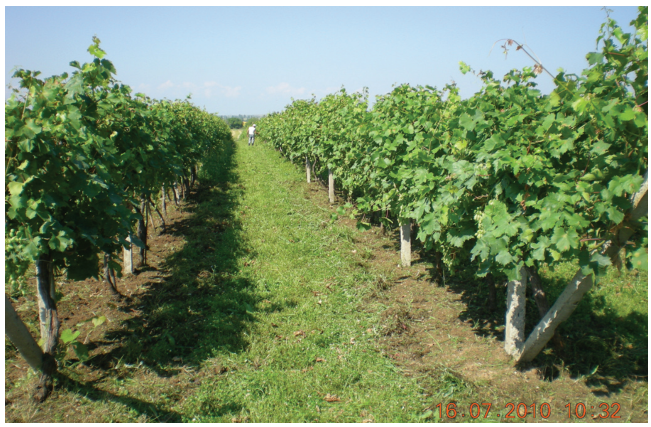

Fig. 3.

Fig. 4.

000 kg.ha^{-1}), after which the soil was plowed again. The plowing was made early in the spring. In the vegetation period we made some shallow disking to maintain the rows free of weeds (Figure 4).

During all these options, the area between the vines was treated manually with a hoe or mechanical milling machine with aberrant. In each option were included 100 vines (4 repeats of 25 vines).

The measurement of the leaf gas exchange (P_n - speed of photosynthesis, E - intensity of transpiration and g_s - stomatal conductance) was performed with photosynthetic system LCA - 4 (ADC, England), between 10.00 and 12.00 h, with light intensity (PHARE) 1200-1800 μmol m^{-2}s^{-1}. For these analysis were used the 5th and 10th leaf of the leading shoot, derived from this spur. Measurements were performed in phases (bloom, pea grain and technological ripeness) with intact plants in three replications.

The leaf gas exchange was tested during two experimental years (2009-2010) and was found similar trends in the studied parameters.

The results were processed statistically. The reability of differences was determined by Student's t criteria at the following levels of significance: *P≤ 0.05; **P≤ 0.01.

Results and Discussion

The improved leaf gas exchange is a precondition for higher productivity of plants (Lawlor and Mitchell, 1991; Pereira, 1994). Our researches show that (Table 1) the method of maintaining the soil surface affects the leaf gas exchange. In the phase of blossoming, the increasing of the intensity of photosynthesis is best expressed in the application of manure (V_3), and in the 5th and in 10th leaf (respectively with 150 g.kg^{-1} and 560 g.kg^{-1} relatively to the control). In the phase of pea grain, in all options, is established improved leaf gas exchange, and the rate of photosynthesis is higher in vines, grown by application of manure. Lower value of the intensity of photosynthesis (P_N) in phase technological ripeness are due to the increased flow of assimilates to the grapes in the ripening process. This is related with the attenuation of growth of the leaves, gradually chloroplast degradation and reduction of chlorophyll content (Pandeliev, 1987).

The force of generative organs is most visible in variants when is used manure.

The transpiration affects the rate of absorption of mineral substances and on their flow in the plant. It is considered that the more intense the transpiration is, the greater is the rate of absorption of minerals from the soil. Our research shows (Table 2) that during the first two phases of the process, the speed is significantly higher in all the experimental versions than with the control. This provides a better distribution of the plants with water and diluted in it nutrients.

At the same time, the increased intensity of transpiration during the hot summer days, causes cooling of the plants and creates thermal conditions for normal functioning of the physiological and biochemical processes. The lack of differences between the versions in the intensity of transpiration (E) in phase technological maturity is due to the aging of the leaves. The factors, limiting the photosynthesis process may have stomatal conductance and mesophilic character. It is known that the role of the stomatal is associated mainly with the provision of access of CO_2 to the mesophilic cells.

The changes in the intensity of the photosynthesis (Table 1) and lack of significant differences in the degree of openness of the stomatal (g_s) (Table 3) between the experimental variants is showing that there exist mesophilic changes. They can include both photochemical and biochemical processes of Calvin's cycle.

The leaf gas exchange largely determines the plant's productivity, expressed by the yield of grapes, which is one of

Table 1
Rate of net photosynthesis (P_N) μmol CO_2 m^{-2}s^{-1}

Leaf №	V_0	V_1	V_2	V_3
Flowering				
5-th leaf	16.45±0.24	17.34±0.31	13.25±0.21*	18.90±0.46*
10-th leaf	10.51±0.11	7.09±0.12**	6.65±0.10**	16.41±0.31**
Pea grain				
5-th leaf	9.52±0.38	13.23±0.27**	10.21±0.16*	17.61±0.47**
10-th leaf	8.73±0.22	10.10±0.32*	9.62±0.18*	14.57±0.22**
Technological maturity				
5-th leaf	8.92±0.20	6.25±0.10**	5.38±0.19**	5.14±0.17**
10-th leaf	9.29±0.28	5.40±0.11**	10.71±0.21*	8.76±0.14

*P ≤ 0.05; **P ≤ 0.01;

the most important parameters, which determine the economic efficiency of the applied agricultural activities.

The yield of the grapes in versions is in range from 6.25 kg to 7.35 kg per vine (Table 4).

Table 2
Intensity of transpiration (E) mmol H_2O $m^{-2}s^{-1}$

Leaf №	V_0	V_1	V_2	V_3
Flowering				
5-th leaf	1.88±0.10	2.48±0.10**	2.88±0.09**	2.67±0.08**
10-th leaf	1.84±0.07	2.32±0.06**	2.53±0.08**	2.22±0.11**
Pea grain				
5-th leaf	0.85±0.05	1.69±0.04**	1.71±0.05**	1.53±0.09**
10-th leaf	1.28±0.12	1.47±0.10	1.62±0.14*	1.84±0.12*
Technological maturity				
5-th leaf	2.37±0.20	2.30±0.12	2.34±0.21	1.76±0.10*
10-th leaf	2.65±0.09	1.99±0.09*	2.66±0.08	2.63±0.10

*P ≤ 0.05; **P ≤ 0.01;

Table 3
Stomatal conductance (g_s) mol H_2O $m^{-2}s^{-1}$

Leaf №	V_0	V_1	V_2	V_3
Flowering				
5-th leaf	0.04±0.001	0.04±0.002	0.05±0.003*	0.04±0.002
10-th leaf	0.03±0.002	0.03±0.001	0.04±0.002	0.03±0.002
Pea grain				
5-th leaf	0.03±0.001	0.10±0.004**	0.07±0.003**	0.03±0.001
10-th leaf	0.03±0.003	0.05±0.001*	0.06±0.003**	0.05±0.001*
Technological maturity				
5-th leaf	0.09±0.003	0.11±0.002*	0.09±0.004	0.08±0.003
10-th leaf	0.11±0.004	0.08±0.002*	0.10±0.001	0.11±0.004

*P ≤ 0.05; **P ≤ 0.01;

Table 4
Quantitative changes in the production of grapes

Variant	Year	Average yield per vine, kg				Average yield per ha, kg	Average cluster weight, g			Average weight 0f 100 grains, g
		Spur	Fruit cane	Total	LSD		Spur	Fruit cane	Average	
V_0	2009	4.2	2.8	7.00 b	0.51	19390	404	359	381	1155
	2010	4.32	3.38	7.70 c	0.33	21320	445	396	420	1434
	Average	4.26	3.09	7.35	1.44	20360	425	378	401	1295
V_1	2009	3.9	2	5.90 a	0.51	16340	444	300	368	1068
	2010	4	2.6	6.60 a	0.33	18280	356	350	353	1036
	Average	3.95	2.3	6.25	1.44	17310	400	325	361	1052
V_2	2009	3.7	2.3	6.00 a	0.51	16620	415	361	388	1018
	2010	4	2.98	6.80ab	0.33	18830	430	380	405	1281
	Average	3.85	2.64	6.4	1.44	17730	423	371	397	1150
V_3	2009	4\	2.8	6.80 b	0.51	18830	448	340	394	1163
	2010	4.06	3	7.06 b	0.33	19550	425	395	410	1400
	Average	4.03	2.9	6.96	1.44	19190	437	375	402	1282

The highest one is the production of wine grapes in V_0, followed by V_3 (the difference between them is not proven), V_2 and V_1. The differences are proven in the yield of V_1 and V_2 in benefit of the control. In all versions, spurs form the majority of the yield. The average mass of grape varies in the same sequence. Grapes with the highest mass are in V_0, followed by V_3, V_2 and the smallest are in V_1. The average weight of grapes from spurs in all variants is higher than that of the fruit canes.

The clusters developed from fruit canes are thin and equalized in size of grains, especially at the top of their part. The average weight of 100 grains is the biggest one at V_0 (1295 g), followed by V_3 (1282 g), V_2 (1150 g) and V_1 (1052 g). When vines are fertilized with manure, the average mass of the cluster and the average weight of 100 grains gives away to the control, because the number of grapes is 4 more (Table 4).

The performed analysis of variance (Table 5) for the influence of certain factors on the yield of grapes for the period of the study shows that the proven influence on the yield exerts the ways of maintaining the surface of the soil and the year, with a degree of influence with (η – 86) and with (η - 83). The interaction of the factors on the yield of grapes is still not proven and has a degree of influence (η - 24).

Conclusions

The way of maintenance of the soil surface affects the leaf gas exchange and the yield of the vine. For the period of study, with the best parameters of leaf gas exchange are characterized the vines, where the row spacing is fertilized with manure.

The highest yield of grapes is under conventional type of production, followed by the fertilization, achieved in the area of manure, and the difference between them is still not mathematically proven.

Great advantage of the application of manure is that it effects on the soil fertility, and is environmentally friendly solution of the problem for the environmental and plant production from pollution.

References

Agustí-Brisach, C., D. Gramaje, M. Léon, J. García-Jiménez and J. Armengol, 2011. Evaluation of Vineyard Weeds as Potential Hosts of Black-Foot and Petri Disease Pathogens. *Plant Disease*, **95** (7): 803-810.

Bourguignon, C. and L. Gabucci, 2000. Comparisons of chemical analysis and biological activity of soils cultivated by organic and biodynamic methods. Proceedings of the 6th International Congress on Organic Viticulture, IFOAM 2000: *The World Grows Organic*. H. Willer and U. Meier (Eds), Stiftung Okologie & Landbau, Bad Durkheim, Germany, pp. 92-99.

Carpetner-Boggs, L., A. C. Kennedy and J. P. Reganold, 2000. Organic and biodynamic management: Effects on soil biology. *Soil Sci. Soc. Am. J.,* **64:** 1651-1659.

Gyaneshwar, G., G. Naresh, L. Kumar, J. Parekh and P. Poole, 2002. Role of soil microorganisms in improving P nutrition of plants. *Plant and Soil,* **245**: 83-93.

Jukes, T. H., 1995. Mineral nutrition of plants. *Photosynthesis Research,* **46** (1-2): 13-15.

Kerin, V., M. Berova, A. Vasilev, N. Stoeva and Z. Zlatev, 2011**.** Plant Physiology. *Academic Published Agricultural University-Plovdiv,* p. 320.

Lawlor, D. and R. Mitchell, 1991. The effects of increasing CO_2 on crop photosynthesis and productivity: a review of field studies. *Plant, Cell & Environment,* **14** (8): 807–818.

Magrisso, Y. U., B. Danailov, G. Peshakov and A. Georgiev, 1971. Effect of green manure on the fertility of vineyards. *Zemizdat. Sofia* (Bg).

Pandeliev, S., 1987. Agro-biological foundations of the structure and productivity of photosynthetic potential of the vine. Dissertation for the degree “Doctor of Agricultural Sciences” – Plovdiv (Bg).

Pereira, J., 1994. Gas Exchange and Growth. Ecophysiology of Photosynthesis. *Springer Study Edition,* **100:** 147-181.

Thomson, L. J. and A. Hoffmann, 2007. Effects of ground cover (straw and compost) on the abundance of natural enemies and soil macro invertebrates in vineyards. *Agricultural & Forest Entomology,* **9** (3): 173-179.

Ochmian, I., J. Grajkowski, P. Chelpinski and R. Strzelecki, 2013. The impact of cutting and mulching grapevine Regent on yielding and fruit quality. *Folia Pomer. Univ. Technol. Stetin. Agric., Aliment., Pisc., Zootech.,* **304** (26): 87–96.

Zabadal, T. and W. Dittmer, 2001. Influence of weed control, nitrogen fertilization, irrigation and pruning severity on the establishment of ‘Niagara’ grapevines. *Small Fruits Review,* **1** (3): 21-28.

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