

INFLUENCE OF SOIL MAINTENANCE SYSTEMS AND FRUIT LOAD ON GRAPES QUALITY UNDER DROUGHT CONDITIONS

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Abstract

In order to diminish the disturbing effect of climatic changes in viticulture there were studied two agrotechnical factors which have an important impact on water regime in soil and on vine growth, respectively the soil maintenance system and fruit load. In comparison with black furrow (considered as control) there were experimented the total mulching with straws, the partial mulching (between the rows) with marc compost and minimum tillage. To reduce the negative impact of drought conditions in case of each soil maintenance systems a reduction of normal fruit load with 20 and 40% was also experimented. The experimental data obtained revealed that soil maintenance systems by mulching had a positive effect especially on the technological features of the grapes, assuring higher values for grain composition index and for efficiency index, that is a higher must content in grapes and a higher winemaking efficiency. The chemical properties of the grapes (sugar content, acidity, glucoacidimetric index) were not influenced in an obvious manner. Opposite, the reduction of fruit load determined in case of all soil maintenance systems an increase of sugar content in grapes, parallel with an evident decrease of must acidity, determining high values of the glucoacidimetric index, unfavorable for obtaining qualitative and typical wines. The changes induced in grapes quality by the two experimental factors have been reflected also in the wines quality (alcoholic degree, total acidity, unreducing extract). Ranking the wines obtained from all the experimental variants (combinations between the two experimental factors) by using the synthetic index of wines quality (Ntaj) one could notice that the soil maintenance systems by mulching and the fruit load of 15-18 buds/m² had a positive effect on wines quality under drought conditions.

Key words: grapevine, climatic changes, technological solutions, grape quality

INTRODUCTION

The climatic studies undertaken in the last two decades in our country have shown a tendency of climatic changes in most viticultural regions, put into evidence by the increase of thermal regime and by a deficient and generally unfavorable distribution of the rainfalls, leading to the appearance of severe soil drought conditions, especially during the growing season of the vine (Busuioc et al., 2004). Although the vine is considered a resistant plant to drought conditions, this phenomenon can affect in an obvious manner the vegetative development of the vine, the production potential and especially the qualitative potential of the grapes (Bindi et al., 2001; Tate, 2001; Jones et al., 2005; Dejeu et al., 2007). To diminish this disturbing effect of the climatic changes in the last years there were experimented new agrotechnical solutions in order to preserve the water in soil and to reduce the vine transpiration. These agrotechnical solutions were focused

especially on the soil maintenance system and on the rationalization of fruit load (Șerdinescu et al., 2013). The aim of our study was to find in which manner the use of different soil maintenance systems and different fruit loads can influence the yield quality under drought conditions.

MATERIALS AND METHODS

The researches were conducted during two years (2012 and 2013) in Valea Călugărească viticultural center, in an experimental plot with Fetească regală/SO4 located on hills in the conditions of a mollic reddish-brown soil. There were studied two agrotechnical factors which have an important impact on water regime in soil and on vine growth and productivity. One of them was the soil maintenance system, with the following variants: black furrow (considered as control), total mulching with straws (in a layer of 10 cm), partial mulching (interval between rows) with marc compost (in a layer of 10 cm) and

minimum tillage. The second factor was the fruit load. For each soil maintenance system three different fruit loads were experimented, respectively: 18 buds/m² (considered as normal fruit load), 15 and 12 buds/m² (a reduction with 20 and 40% of the normal fruit load). The investigations were carried out using a bifactorial split plot experiment with 12 variants representing the combinations between the two experimental factors. All the variants received during the experimental period the same amounts of fertilizers and the same plant protection treatments. In order to determine the effect of the two experimental factors on grapes quality there were determined the following parameters: the weight and volume of 100 berries, sugar content, acidity, glucoacidimetric index (GAI) and the technological features (by using the data obtained from the mechanical analysis). It was also investigated the effect of the changes in grapes quality on wines quality, respectively on the alcohol degree, total acidity and unreducing extract. Based on these parameters it was calculated the synthetic index of wine quality (Ntaj), in order to rank the experimental variants (combinations between the two experimental factors).

RESULTS AND DISCUSSIONS

The climate during the experimental period was characterized by an excessive thermal regime and by a deficient and generally unfavorable distribution of precipitations, especially during the growing season of the vine (Table 1).

Table 1. Climatic conditions during the experimental period

Climatic parameters	Multiannual average value (1936-2012)	2012	2013
Sum of active temperatures (°C)	3645	4502	4063
Sum of useful temperatures (°C)	1738	2282	1883
Mean temperature of the air (°C)	11.2	12.3	11.9
Precipitations (mm)	612.5	665.9	661.3
Sunshine duration (hours)	2017	2520	2255

As compared with the multiannual average values, the mean temperature of the air, the sum of active temperatures and the sunshine duration presented higher values. The annual precipitations were in normal limits, but during the growing season of the vine there were some intervals (shorter or longer) with very low values of precipitations which induced severe soil drought conditions. Along with the climatic conditions, the experimented soil maintenance systems influenced in an obvious manner the evolution of soil moisture during the growing season of the vine, having a strong impact on grapevine productivity and on the quality of the grapes. Analysing the evolution of soil moisture on the depth of 0-60 cm during the two years of experimentation we can notice that at the beginning of the growing season (in April and May) the soil moisture was at a normal level, but after that period decreased constantly until the end of the growing season, reaching values under the value of Pmin (50% from active soil moisture interval), closed to the limit of wither coefficient (CO), especially in August and September (Figure 1).

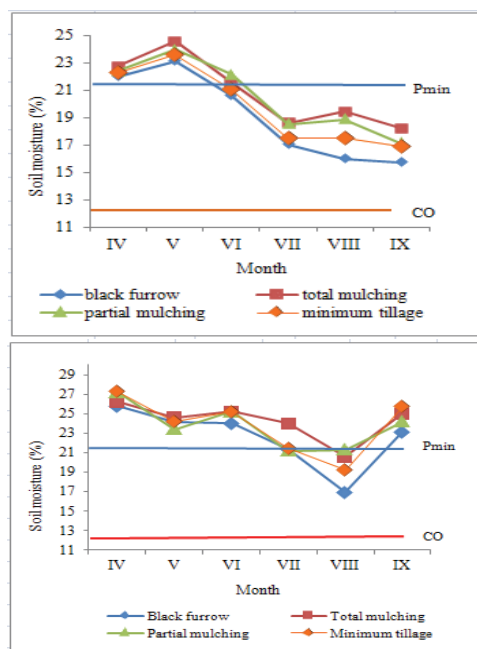


Figure 1. Influence of soil maintenance systems on soil moisture during the growing season of the vine (values for 2012 and 2013)

In comparison with the black furrow the soil maintenance systems by mulching ensured higher values of soil moisture, as a result of reducing water evaporation at the soil surface. The changes occurred in the soil water regime had an obvious effect on grapes quality. Thus, we can observe that soil maintenance systems by mulching had a positive influence on the weight and volume of 100 berries and on must acidity, determining optimum values for the glucoacidimetric index (Table 2).

Table 2. Influence of soil maintenance systems on grapes quality (average values for the three fruit loads)

Soil maintenance system	Weight of 100 berries g	Volume of 100 berries cc	Sugars g/l	Acidity g/l H ₂ SO ₄	GAI
Black furrow	194.0	177.0	188.7	3.43	55.0
Total mulching	177.9	161.7	178.3	3.96	45.0
Partial mulching	204.0	186.7	182.7	3.86	47.3
Minimum tillage	197.3	179.5	182.4	3.40	53.6

More evident was the effect of soil maintenance systems on the technological features of the grapes.

The experimental data obtained shown an obvious increase of the values of grain composition index and of the efficiency index in case of using the soil maintenance systems by mulching (total or partial), suggesting that in case of severe drought conditions these systems can ensure a higher must content in grapes and as a consequence a high winemaking efficiency (Table 3).

Table 3. Influence of soil maintenance systems on the technological features of the grapes (average values for the three fruit loads)

Soil maintenance system	Technological indices			
	Grape comp. index	Grain index	Grain comp. index	Efficiency index
Black furrow	41.69	67.13	7.94	5.22
Total mulching	35.79	63.18	10.85	6.41
Partial mulching	30.86	62.86	10.02	6.06
Minimum tillage	33.50	61.79	9.60	5.64

Concerning the influence of the reduction of fruit load (with 20 and 40%) on the grapes quality we can notice an increase of the weight and volume of 100 berries, of sugar content and a decrease of must acidity, parallel with the decrease of fruit load from 18 to 12 buds/m² (Table 4).

Table 4. Influence of fruit load on the grape quality (average values for the four soil maintenance systems)

Fruit load	Weight of 100 berries g	Volume of 100 berries cc	Sugars g/l	Acidity g/l H ₂ SO ₄	GAI
18 buds/m ²	190.5	172.5	175.7	3.73	47.1
15 buds/m ²	191.5	174.3	184.6	3.57	51.7
12 buds/m ²	198.0	181.9	188.8	3.49	54.1

In case of the technological features of the grapes the experimental data didn't allow to formulate a pertinent conclusion.

However, we can notice that the reduction of fruit load led to a slow decrease of the values of the grain composition index and of the efficiency index (Table 5).

Table 5. Influence of fruit load on the technological features of the grapes (average values for the four soil maintenance systems)

Fruit load	Technological indices			
	Grape comp. index	Grain index	Grain comp. index	Efficiency index
18 buds/m ²	35.90	66.26	10.17	6.12
15 buds/m ²	35.22	66.46	9.90	5.93
12 buds/m ²	35.26	58.51	8.74	5.45

As a consequence of these changes in grapes quality the wines quality was also influenced. Thus, high values for the alcoholic degree and for unreducing extract were obtained in case of using the partial mulching with marc compost and black furrow as soil maintenance systems (Table 6).

The reduction of fruit load determined, as a consequence of the increase of sugar content in grapes, an increase of the alcoholic degree and of unreducing extract of wines, but also a decrease of the total acidity, conducting to the obtaining of unequilibrated wines (Table 7).

Table 6. Influence of soil maintenance systems on wines quality (average values for the three fruit loads)

Soil maintenance system	Alcoholic degree % vol	Total acidity g/l	Unreducing extract g/l
Black furrow	12.04	6.52	19.44
Total mulching	11.69	6.11	19.41
Partial mulching	12.27	5.68	19.66
Minimum tillage	11.50	6.06	18.59

Table 7. Influence of fruit load on the wines quality (average values of the four soil maintenance systems)

Fruit load	Alcoholic degree % vol	Total acidity g/l	Unreducing extract g/l
18 buds/m ²	11.79	6.15	18.49
15 buds/m ²	11.83	6.05	19.21
12 buds/m ²	12.11	5.89	20.13

Using the synthetic index of wines quality (Ntaj), which allow an interpretation of the general composition of the wines, we could do a classification of the wines obtained in case of the 12 experimental variants (combinations between the two experimental factors). Depending on the values of this index the wines were grouped in three classes: high quality wines, medium quality wines and common wines.

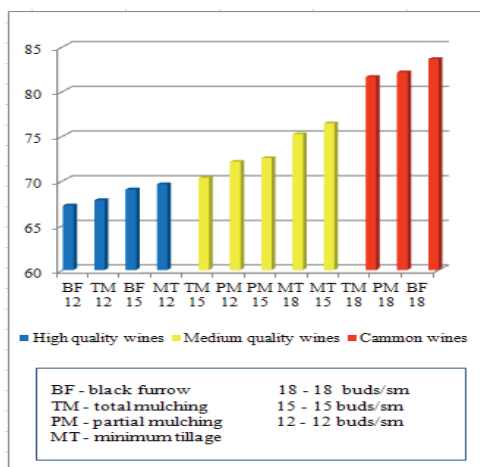


Figure 2. Classification of the experimental variants using the synthetic index of wine quality (Ntaj)

One can notice that in the first class, which include the high quality wines, are presented the wines obtained from the variants with

mulching soil maintenance systems and a fruit load of 18 buds/m².

CONCLUSIONS

Under severe drought conditions the soil maintenance system applied and the amount of fruit load have an obvious influence on grapes quality and, as a consequence, also on the quality and typicality of the obtained wines.

The soil maintenance systems by mulching (total or partial) had a positive effect especially on the technological features of the grapes, suggesting that in case of a severe drought stress these systems can ensure a higher must in grapes and a high winemaking efficiency.

The reduction of fruit load (with 20 and 40%) determined in case of all soil maintenance systems an increase of sugar content in grapes, parallel with a decrease of must acidity, determining high values of glucoacidimetric index, unfavourable for obtaining typical and qualitative wines. For this reason, this agrotechnical operation is indicated to be used only in the conditions of an excessive soil drought, which can affect in an irreversible manner the vegetative development of the vine.

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