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Cover crops for the soil protection in hillside vineyards under Mediterranean climate

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The vineyard is one of the most distinctive cultures of the Mediterranean areas. In Spain, it takes up more than 1 million hectares, often in hillsides and subjected to erosion and land degradation due to the plow management. The use of plant cover is relatively common in more humid countries. It is used mainly to control the vigour of the vines, the erosion control is an added benefit. This practice is not as widespread in the Mediterranean area as the scarcity of water may jeopardize the viability of the crop. It is not easy to convince a winegrower from a semi-arid climate to sow the soil of his vineyard. This is the experience of a whole year of plant cover treatment between the rows of an unirrigated vineyard located in the center of the Iberian Peninsula, in the SE of Madrid. The aim of the paper is to check whether under these semi-arid conditions (the average annual rainfall is 378 mm, 30 years mean), this management can be feasible for erosion control without harming the crop.

The soil is classified as Calcic Haploxeralf, the organic matter content is 1.3 $\pm$ 0.1%. Three treatments of soil cover were tested: i) minimum tillage ii) soil covered by *Brachypodium dystachion* ($B.d.$) allowing selfsowing, and iii) soil covered by *Secale cereale (S.c.)*, mown in April. Three closed plots of 0.5 x 4 m in length were installed per treatment (n=9), all of them on a 12% slope. The sediment yield was collected after each erosive rainfall event in the Gerlach type trough, placed at the base of each plot. The runoff was recorded on a continuous basis through an automatic sensor tipping bucket system. The soil moisture was recorded daily at two different soil depths, 10 and 35 cm using ECH2O sensors.

The results clearly indicate that grass cover protect from erosion, as the tilling treatment (bare soil) lost an average of 1059 g m^{-2} year^{-1}, compared to 62 and 70 g m^{-2} year^{-1} lost in soil covered with $S.c.$ and $B.d.$,respectively. However, we have to point that these losses were not always so different, only they were significantly different in extreme rainfall events, such as those that took place in May, July and October 2007. Specifically, in the most intense episode, on May 20th , when there was a shower of 42 mm in just 4.5 hours. But most importantly, that day a rainfall intensity of 200 mm h^{-1} was surpassed for 5 minutes. In that single episode, the plots of bare soil lost an average of 786 g m^{-2} event^{-1}, compared with 19 and 26 g m^{-2} event^{-1} in plots covered with *S.c. and B.d.* respectively, i.e., in a single extreme event was lost between half and three quarters of the annual total rainfall. In most normal rainfall episodes, there were no significant differences in sediment yield in plots.

As for the runoff is concerned, a high variability has been found among the plots, including those with the same type of cover. Under usual moderate rainfall, the runoff coefficient didn't exceed 1% in any of the treatments. However, under heavy rains, the bare soil showed maximum values of 12.5%, compared to 20 % of runoff coefficient in $S.c.$ plots, and to 11% in ***B.d.*** *plots*. It is necessary to take into account the sow technique for the explanation of these results: a row seeder in the case of $S.c.$, *versus* by hand-sowing in the case of $B.d.$cover, that is, this last one presented a better soil surface cover. On the other hand, the lack of tillage leads to a certain soil sealing that was not present in the terrain of bare soil freshly tilled in the previous days.

The plant cover influences the soil moisture (units in m^3 m^{-3}), that was measured until veraison. Particularly, the soil covered by $S.c.$ present less moisture in depth (35 cm), showing an average of 0.08, quite different from 0.12 at the surface (10 cm depth). That difference does not exist in the soils covered by $B.d.$, showing mean values ranging 0.16. The bare soil, conversely, showed a drier soil surface: 0.14 compared to 0.16 m^3 m^{-3} in depth. Despite the lack of significant differences in the osmotic potential of vines that was measured until veraison, we found some differences in the grape production -although it does not mean less wine quality (the wine is currently in the process of malolactic fermentation)-. In vines located in covered soils, the weight of bunches of grapes was about 40% lower than those of bare soil, however, precisely because of the heavy rains in May, there was a significant decline the grape harvest, this is why it is necessary to contrast these results with those obtained in successive years. On the other hand, this year is within the average rainfall (350 mm in the year 2007) and we still do not know how the system will behave in dry years.

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