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Proceedings

# Cover and Management Factor for Sicilian Vineyard Systems

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**Résumé**
En Sicile, l'exploitation des vignobles requiert, généralement, jusqu'à huit opérations pour le travail du terrain pendant toute la saison de pousse. La plupart des vignobles siciliens sont assujettis à des risques d'érosion à cause de la forte inclinaison du sol et de la haute intensité des pluies, et, également, à la réduction de substance organique déterminée par le caractère intensif des travaux au terrain. Entre 1996 et 1998, on a appliqué dans un vignoble sicilien, avec une inclinaison de 25%, les suivantes techniques d'exploitation : une technique traditionnelle, qui requiert jusqu'à huit opérations pour le travail du terrain et se sert d'une herse à cinq dents ; une technique de couverture naturelle et une technique de couverture par vesce de septembre jusqu'au verdage effectué à mi-avril. On a mesuré les pertes du terrain pour chacune de trois surfaces (2m. x 100) par le moyen d'une trappe pour sédiment du type Gerlack d'un mètre de largeur. Les résultats ont mis en évidence des valeurs de C élevées, supérieures de 4-8% par rapport à celles qu'on a remarquées dans l'application de la technique traditionnelle. L'engazonnement par vesce a fait relever des valeurs de C égales à 17-26% et supérieures à celles mesurées avec la technique traditionnelle.

## Introduction

In Sicily, 125000 ha of vineyard are planted and more than 50000 ha are cultivated on sloping hillslopes. The erosion risk in these areas is high both for rainfall characteristics and noticeable soil organic matter reduction due to soil tillage. Especially during fall and winter periods, soil susceptibility to rainfall erosion is high because mulch (e.g., cover crops) is lacking.

Using one or more herbaceous species as cover crop and/or green manure may shield soil surface from rainfall impact, limit soil organic matter degradation, and improve soil humus reservoirs. Cover crop and green manure management, in fact, represent an efficient tool for improving agro-ecological cropping system efficiency in terms of autonomy, stability, external inputs reduction and environmental risk (Caporali, 1991; Pisani et al., 1984; Ravaz, 1998; Scienza e Valenti, 1983).

The aim of this research was to establish, for a semi-arid Sicilian vineyard, the effectiveness of different soil management techniques to control soil erosion. This effectiveness was estimated using the USLE (Wischmeier and Smith, 1978) scheme and calculating the seasonal crop and management factor *C* from measured soil loss data.

## Materials and Methods

A vineyard located in south-west of Sicily (37°60'N-12°30'E) was used for this investigation during the 1996 to 1998 years (Fig.1). The vineyard was managed to vertical trellis system with cane pruning (cultivar "Insolia" grafted on 140 Ru), in a rainfed system, spaced 2.80 m x 1.00 m apart. The vineyard was planted on an approximately 20% hillslope and was subjected to three different soil managements: 1) "conventional tillage" (CT), soil plowing with a five furrow plow is carried out on October, yielding clods of approximately 10 cm in diameter. Weed development is not controlled and up to eigth plowings are carried out starting from February; 2) "natural cover cropping" (N), soil surface is not tilled and weed development is not controlled; 3) "vetch cover cropping" (V) (V*icia sativa* L.), soil plowing with a five furrow plow is carried out on October and planting occurs immediately after plowing. The crop cover acts in the period October to April.

Both for N and V management systems, biomass was manured on the first ten days of April. Each soil management system was applied to a 100 m long x 2 m wide soil strip.

A Gerlach equipment (Morgan, 1997; Zachar, 1982; De Ploey e Gabriels, 1980) was installed at the bottom end of the slope. Each Gerlach trap was 1 m wide and was joined to the monitored soil area by metal strips inserted a few centimetres into the soil surface. For each erosive event, soil loss was measured collecting total runoff trapped by the Gerlach equipment in a storage tank. The suspension was oven-dried at 105 °C and soil loss $A$ (t ha$^{-1}$) was calculated by the weight of the eroded soil particles and the surface area of the monitored strip.

For each soil strip, an accurate topographic survey was carried out and the slope profile was determined. The procedure by Di Stefano et al. (2000) was then applied to include the effect of the profile curvature on the calculation of the topographic factor of the USLE. In particular, the topographic factors of Moore and Burch (1986) were multiplied by the following correction factor     (Di Stefano et al., 2000):

$$= \ 6.503\, n^3 + 26.283\, n^2 \quad 35.354\, n + 16.454 \qquad (1)$$

where $n$ is the curvature factor ($n$>1 for a concave profile, $n$<1 for a convex profile, and $n$=1 for a uniform profile with a constant slope steepness $H/\ $ ), that was estimated by fitting the following power function to the pairs distance $x$ –elevation $y$ (Fig.2)

$$y = H\ 1\ \frac{x}{\ } \div^{\,n} \qquad (2)$$

where    (m) is the slope length and H (m) is the slope difference in height.

Fig.1. View of the experimental area

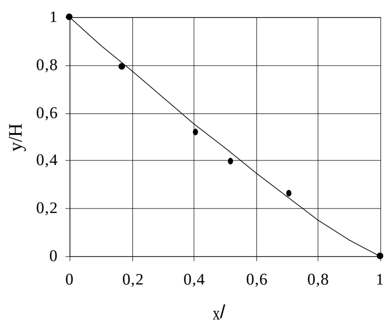


Fig.2. Profile of a soil strip

Soil loss data were measured in the periods December 1996-February 1997 (1996/97 season) and October 1997-March 1998 (1997/98 season).

The seasonal value of the rainfall factor, R (MJ mm ha$^{-1}$ h$^{-1}$) was estimated for both seasons according to Bagarello and D'Asaro (1994), using daily rainfall data collected at the Gibellina raingauge.

Six soil samples were collected from each soil strip to estimate the soil erodibility factor by the Wischmeier et al. (1971) nomograph. The analysis suggested that a single $K$ value, equal to 0.035 t ha$^{-1}$ ha h MJ$^{-1}$ mm$^{-1}$, can be used for the whole experimental area.

The $P$ factor was set equal to 1 given that no support practice control was applied.

## Results

For each season, the USLE scheme was applied to estimate the seasonal cover and management factor C:

$$C = \frac{A}{R\ K\ LS_c\ P} \qquad (3)$$

where $LS_c$ is the corrected topographic factor.

For each season and soil management system, the topographic factor and the seasonal values of the measured soil loss $A$, the rainfall factor, $R$, and the calculated $C$ factor were listed in Table 1. Seasonal values of $C$ were also plotted in Fig.3.

In both seasons, the minimum $C$ values were obtained for the N management system and the maximum ones were observed for the CT system. In all examined cases, $C$ was less than 0.017. According to the USLE scheme (maximum $C$ value equal to 1 for a bare soil in tilled continuous fallow), the observed values suggested an high soil conservation ability of all soil management systems.

Table 1. Soil loss, topographic factor and cover and management factor for each season and each soil management system

| Season | Variable | Soil Management System | | |
|---|---|---|---|---|
| | | **Conventional tillage, CT** | **Natural cover cropping, N** | **Vetch cover cropping, V** |
| 1996/97 ($R$=444) | $A$ | 1.5 | 0.1 | 0.375 |
| | $LS_c$ | 5.79 | 5.31 | 4.81 |
| | $C$ | 0.0167 | 0.0012 | 0.0050 |
| 1997/98 ($R$=1221) | $A$ | 1.45 | 0.055 | 0.225 |
| | $LS_c$ | 5.79 | 5.31 | 4.81 |
| | $C$ | 0.0059 | 0.0002 | 0.0011 |

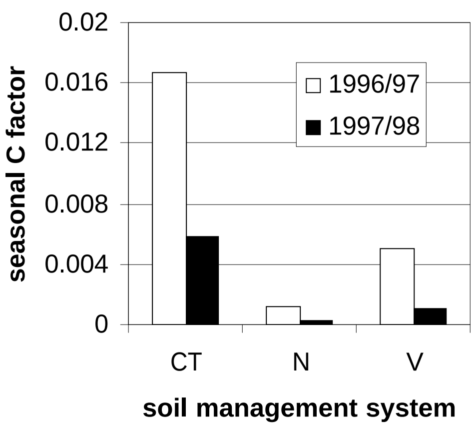


Fig.3. Seasonal values of the $C$ factor

Even if the C values of a given soil management system were different between seasons, the measured $C$ ranking was consistent between seasons and it was also in agreement with the expected one from a physical point of view. The $C$ factor was highest for the CT management system because the soil surface was tilled at the beginning of the erosive period and weed development was not highly effective to determine a high level of surface cover. The V system was characterized by the same tillage operation and timing and performed a more effective antierosive action than the CT system because vetch seeding produced a more uniform crop cover of the soil surface. Finally, the most effective antierosive system was the N one because the soil was not disturbed by tillage and its detachability was low. Weed development was comparable with the one of the CT system.

## Conclusion

Traditional Sicilian vineyard system uses up to eight tillage operations during the growing season. This system is believed to reduce evaporation, conserve rainfall and reduce weeds. However, tillage may determine the development of a smooth and unstable soil surface that seals easily due to raindrop impact, reducing water storage and increasing runoff. On the contrary, no tillage techniques and/or cover crop management are highly effective to protect soil surface and improve soil infiltration rate.

Using the USLE scheme and the measured soil loss values, the cover and management factor, $C$, was determined for different soil management techniques including "conventional tillage", "natural cover cropping", and "vetch cover cropping".

The cover management factor was always less then 0.017 and the observed $C$ values suggested an high soil conservation ability of each examined soil management system.

## References

Bagarello, V., D'Asaro, F. (1994), *Estimating single storm erosion index*, Transactions of the ASAE, 37(3), 785-791.

De Ploey J., Gabriels D. (1980) - Measuring soil loss and experimental studies. In: M.J. Kirby, R.P.C. Morgan. Soil erosion. J. Wiley and Sons.

Caporali F. (1991), *Ecologia per l'agricoltura*, Utet, Torino.

Di Stefano, C., Ferro, V., Porto, P., Tusa, G. (2000), *Slope curvature on soil erosion and deposition processes*, Water Resources Research, Vol. 36, 2, 607-617.

Moore, I.D., Burch, F.J. (1986), *Physical basis of the length-slope factor in the Universal Soil Loss Equation*, Soil Science Society of America, 50, 1294-1298.

Morgan R.P.C. (1977) - Soil erosion. Topic in applied geography. Longmans, London, p113.

Pisani, P.L., Di Collalto, G., Mattii, G.B. (1984), *Influenza esercitata da differenti tecniche colturali del terreno sull'attività vegetativa e produttiva delle viti della cv "Sangiovese"*, Atti Acc. It. Vite e Vino, vol XXXVI:437-447.

Ravaz, L. (1998), *Influence des opèration culturales sur la vègètation et la production de la vigne*, Ann. E.N.A., Montpellier, VIII.

Scienza, A., Valenti, L. (1983), *Il ruolo di alcuni interventi colturali del terreno sulle caratteristiche fisico-chimiche del suolo e sul comportamento vegeto-produttivo del "Cortese" in Valle Versa*, Vignevini, supplemento al n° 6:57-72

Wischmeier, W.H., Smith, D.D. (1978), *Predicting rainfall-erosion losses – A guide to conservation farming*, U.S. Dept. of Agric., Agr. Handbook no. 537.

Wischmeier, W.H., Johnson, C.B., Cross, B.V. (1971), *Soil erodibility nomograph for farmland and construction sites*, Journal of Soil and Water Conservation, 26, 189-193.

Zachar D. (1982) - Soil erosion. Developments in soil science. N. 10, Elsevier Sci Pub. Company, p. 547.