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SOIL PROPERTIES AS AFFECTED BY DIFFERENT LAND USE PRACTICES IN THE LANGUEDOC REGION OF SOUTHERN FRANCE

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INTRODUCTION :

The Languedoc-Roussillon region of southern France, mostly dominated by vineyard monoculture, consists of three principal landscapes: scrubland (garrigue), fallow (jachère) and vineyards. This region accounts for approximately 30% of the total area of about 954 740 ha in vineyard production in France. The vineyards (330 335 ha, 1992 data) also accounts for 29.5 % of the area under fruit crops. The intense rain storms, sloping relief, low soil fertility and the ancient human occupation of the mediterranean area along with the recent mechanized farming systems make the soil susceptable to erosion. Intensive mechanical cultivation of soil under vineyard production results in soil erosion. Heavy runoff transports fine soil particles, large quantities of nutrients and pesticides into water streams adversely affecting the quality of soil and water.
For the past several years, the vineyard growers have been worried by the continuing fall in production, considered from 20 to 30% in 1998 (Le Monde, 12 September, 1998). The decline in production is attributed to the land degradation resulting from the modern mechanized forms of cultivation. However, the data on the status of the soil quality is lacking. This study was therefore initiated in an area representative of the Languedoc-Rousillon region. Our objective was to determine changes in surface soil properties resulting from three different land use practices in the Languedoc region of southern France.

MATERIAL AND METHODS :

The study site is located about 1 km south of Corconnes town (~ 30 km northwest of Montpellier). The area is characterised by 3 principal types of land use : the vineyard, scrubland and fallow . The climate is Mediterranean, with an annual precipitation of 950 mm (1951-1980 average). The most rainy months are September, October and November, and the rainfall intensity varies from 55mm/hr (once in 10 years) to 80mm/hr (once in 100 years). The soils in the area are classified as Calcic Luvisol (Haploxeralf –US System) and are silt loam in texture, developed on limestone/ blue marls jurassic formation. While the soil under garrigue and fallow have well developed A and B horizons, the A horizons of the vineyard soils are completely removed.

The land use systems compared with each other were : undisturbed scrubland (garrigue – G), predominantly oak, thyme, rosemary and grasses (*Brachypodium retusum*), 25-yr old fallow (F) with dense grass cover (*Brachypodium retusum*), young vineyard for 5-yr (YV) with inter-row spaces bare of vegetation, controlled by glyphsate and vineyard for 15-yr (AV) mulched with dry vine shoots. It is a common practice that the growers prepare their fields by using heavy machinery (e.g. bulldozers) scraping the A horizons. This is also true for the two vineyards soils selected for this study. Five replicates from each treatment were sampled to determine soil properties ; rainfall simulation and related measurements were done in triplicate.

Soil samples were taken from 0-5 cm depth. Bulk density was estimated by determining the oven dry (105 °C) weight of a soil core of known volume. Carbon (after removal of carbonates by acidification) and nitrogen were determined by NA2000 Analyzer, pH by Zeromatic pH metre, and texture and aggregate-size distribution by wet sieving and laser diffraction technique (Malvern instruments, UK).

The rainfall simulation study was conducted in triplicate on March 2-5, 1999 with the ORSTOM type apparatus (ASSELINE and VALENTIN, 1978). The tests were carried out on an area of 1m^2, enclosed by a metal frame sunk into the soil. Each rainfall simulation was conducted for one hour with an intensity of 60mm/hr, representing an event with a return period of >10 yr. Runoff was collected and measured at 1-min. intervals to the total time of 1 hr in a series of bottles at the downslope end of the frames. The antecedent (initial) and saturation(final) soil moisture at 0-5cm depth was determined gravimeterically. Statistical analyses were done by using Statistica software and Newman and Keuls tests.

RESULTS AND DISCUSSION :

The soils under the three ecosystems are silt loam in texture (~ 50% silt, 20% clay and 30% sand). The A1 horizons of soils under garrigue (G) and fallow (F) have well-developed friable and granular structure with low bulk density (~ 1.16 g/cc for G and 1.19 g/cc for J), and high porosity and biological (roots and fauna) activity. The G soil also has a 5 cm thick compact layer just below the A1 horizon. The vineyard soils are more compact (bulk density ~ 1.47 g/cc) which is attributed to the loss of the organic-rich mineral horizons and the influence of the heavy machinery used in initial clearing of the land and the subsequent vineyard production for several years. Despite the textural similarity, soils under the G and F had 6 to 7 times more macroaggregates (1-2 mm) than soils under the vineyards.

All the ecosystems differed significantly from each other in organic C and N. Undisturbed soil under G had the maximum C (41.8 mg/g) followed by the F system (30.5 mg/g) while the intensely cultivated soil (YV) had the minimum C contents (5.4 mg/g). The loss of C, presumably by mineralization, was the highest in the YV soil, as indicated by its low C:N (11.7 in YV vs~ 17.2 in G). The data showed much higher amounts of C under the natural garrigue and grassland fallow systems than in vineyard soils. We attribute this high level of C to the addition of freshly decomposed residue (Angers and Giroux, 1996; Puget et al., 1995).

In our rainfall simulation study, the maximum runoff was observed in the garrigue and vineyard ecosystems, although the highest soil losses occurred in the vineyard soils. No significant soil loss occurred in the G and F soils because of better protective cover and soil structure. The soil loss for the G, F, YV and AV ecosystems were 3.89, 0.00, 160.3 and 83.3 g/m2, respectively. Lower soil loss in the AV than in the YV was attributed to the protective cover created by the mulching practice adopted by the growers. Incorporation of mulch in the AV system also increased the organic matter in this soil, compared to the YV. No runoff was observed in the F while 50% of the rainfall was recorded as runoff for the G system. The two vineyard soils retained the least amount of rain (‘imbibition’ water; 9 mm) followed by the G soil (23 mm) and the F system (42 mm).

In summary, our data demonstrate that the inappropriate management systems currently in use for vineyard production at the study site resulted in destruction of soil structure, loss of organic matter and deterioration of environmental quality.

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