Improving soil conditions of permanent pastures using organic practices

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Improving soil conditions of permanent pastures using organic practices

J. Perez-Sarmentero*, A. Molina*, R. Colmenares, L. Suances** and J.M. De Miguel*****
*ETS Ingenieros Agrónomos, Departamento de Química y Análisis Agrícola,
Ciudad Universitaria sn, 28040 Madrid
**Centro de Investigaciones Ambientales de la Comunidad de Madrid
Fernando González Bernáldez (CIAM)
San Sebastián 71, 28791 Soto del Real, Spain
***Departamento de Ecología, Ciudad Universitaria sn, 28040 Madrid, Spain

SUMMARY - To improve the sustainability of livestock farming systems in a mountain area very close to Madrid city, central Spain, the response of permanent pastures soil conditions to the application of biodynamic preparations, was studied after a three and a half years period. Up to sixteen soil parameters (chemical, physical and biological) were measured in plots established in three commercial farms located along the altitudinal gradient present in the area. Results obtained suggest that these preparations have a positive influence on soil conditions depending on environmental conditions, being higher in more extreme environments, supporting thus, previous research done until now only on tilled soils.

Key words: Permanent pastures, biodynamic preparations, soil conditions, environmental conditions.

RESUME *- "Amélioration des conditions du sol dans des pâturages permanents en utilisant des pratiques biologiques". Pour l'amélioration de la viabilité des systèmes d'élevage dans une zone montagneux proche à Madrid, l'Espagne Centrale, on a étudié la réponse des sols des pâturages permanents à la application des préparations biodynamiques pendant trois ans et demi. On a mesuré seize paramètres du sol (des chimiques, des physiques, et des biologiques) dans des parcelles expérimentales établies à trois fermes commerciales dans la zone. Les résultats obtenus suggèrent que ces préparations biodynamiques avaient d'une influence positive sur les conditions du sol. Cette influence est dépendant des conditions du milieu, les plus grand lorsque les conditions du milieu sont le plus extrêmes.*

Mots-clés : Les pâturages permanents, les préparations biodynamiques, les conditions du sol, les conditions du milieu.

Introduction

There is no doubt that the fertility of soil is crucial to the long term sustainability of life on this planet, as Lampkin (1990) states in his handbook on organic farming. The concept of soil as a living entity and the prominent and central role of soils in the organic approach to farming have been key elements for the divergences existing among organic and conventional or other sustainable practices in agriculture (e.g. the integrated approach) (Mäder *et al.* 1996). Van Masvelt and Mulder (1993) show how close are the current achievements and developments of organic agriculture to the values and interests formulated by the FAO (1992) for sustainable development as a whole and not only for soil conservation.

Biodynamic agriculture, the pioneer school of modern organic agriculture, relies on new scientific paradigms based on Goethe's scientific researches further elaborated and transformed by Rudolf Steiner in new agricultural practices to regenerate modern agriculture (Steiner, 1924). The use of biodynamic preparations plays a central role in this agricultural school to enhance life processes within the farm individuality depending on particular cosmic and terrestrial rhythms. Biodynamic preparations include two sprays which are used for soils and plants: 500, based on cow manure, is applied at a rate of about 200-300 g ha^{-1}; and 501, fine ground quartz, applied at 4 g ha^{-1}. Two to 4 ppm of yarrow (*Achillea millefolium*), camomile (*Chamomilla recutita*), stinging nettle (*Urtica dioica*), oak bark (*Quercus robur*), dandelion (*Taraxacum officinale*) and valerian flowers (*Valeriana officinalis*), preparations 502-507 respectively, are added to manures and composts (Koepf, 1981). For details of how these substances

are processed and applied see Sattler and Wistinghausen (1992). There exists experimental evidence for the beneficial effects of these preparations on crops, soils and organic manures (Koepf, 1993; Mäder *et al.*, 1996).

In this paper we provide for the first time experimental data about the effect applying biodynamic preparations alone (i.e. no fertilizers were applied) on non-tilled soils and non-cropped plants, i.e. Mediterranean permanent pastures growing under polar opposite environmental conditions.

Material and methods

The study area is located at the NW of Madrid city, in the centre of Spain, on the south-facing slopes of the Central System with a continental Mediterranean climate very much conditioned by a strong gradient in altitude existing in the area. (In only 60 km the altitude varies from 600 m a.s.l. nearby Madrid city, with 13.8°C annual mean temperature and 432 mm annual rainfall, to 2,300 m a.s.l., with 6.3°C temperature and 1,331 mm rainfall.) The rock composition is mainly granite, gneiss, gravel and sand. The main traditional land uses in the area are forests and grasslands with extensive livestock systems.

To investigate experimentally the effect of the application of biodynamic practices on the soils under the permanent pastures of the area a set of four 50 square meter plots (two control and two treated with the biodynamic preparations) with a latin square lay-out was established in three commercial farms within the study area located at 750 m a.s.l. Farm 1 (F1); 1,050 m Farm 2 (F2); and 1,460 m Farm 3 (F3) respectively. The experiment lasted for a three and a half years period (1992-1995).

The biodynamic preparations were applied according to the recommendations of the biodynamic method (Sattler and Wistinghausen, 1992): compost preparations as cow pat pit (Maria Thun preparation) in late autumn or early winter, and the two field sprays (500 and 501) at the time of early spring growth and full growth respectively. A proportion of 3 g of Thun preparation, 5 g of 500 and 0.1 g of 501 in one litre per each 100 square meters of treated plots in each farm was used. The repetitions and timing of the applications were done according to local conditions at every altitude every year. Soil samples were taken from every plot before the experiment started (spring 1992) and three years later (spring 1995). Two depths were considered in all cases: 0-5 cm and 5-10 cm. Up to a total of sixteen parameters were measured besides soil texture: pH, organic matter (OM), N, phosphate (P_2O_5), K, Ca, Na, Mg, C/N ratio, Esterases activity, Phosphatases activity, ß-Galactosidases activity, PF0, Field Capacity (PF 2.7), Wilting Point (PF 4.2), Water Holding Capacity (PF 2.7 - PF 4.2).

Results and discussion

Soils at the three locations presented a sandy loam texture. However, the coarse fraction (>2 mm) was very different in each location: at F1 the percentage was 38%, the same for the upper and lower layers; at F2 it was 23% and 19% respectively; and at F3 it was 10% and 29% respectively. The pastures at F1 were oligotrophic, at F2 mesotrophic and at F3 distrophic (nearly peat soils).

Applying a multivariate ordination method (Correspondence Analysis) to the samples in both years, 1992 and 1995, we can observe the changes of soil conditions after the three years of the experiment taking into account the sixteen parameters above mentioned (Fig. 1). The main variation trend in the samples was due to the altitudinal gradient existing in the area: cold and moist at F3 and warm and dry at F1; leading to a gradient of organic matter building up to organic matter breakdown. The parameters "% of OM" and "Esterases activity" presented the highest absolute contribution to the positive side of the first axis and pH value did the same for the negative one. The second main variation trend was the depth of the sample: the upper layer with more availability of minerals and with the ß-Galactosidases activity as the parameter showing the highest absolute contribution on the positive side of the second axis; and the lower layer with low availability of mineral nutrients and with Na content and ratio C/N as the parameters presenting the highest absolute contribution for the negative side.

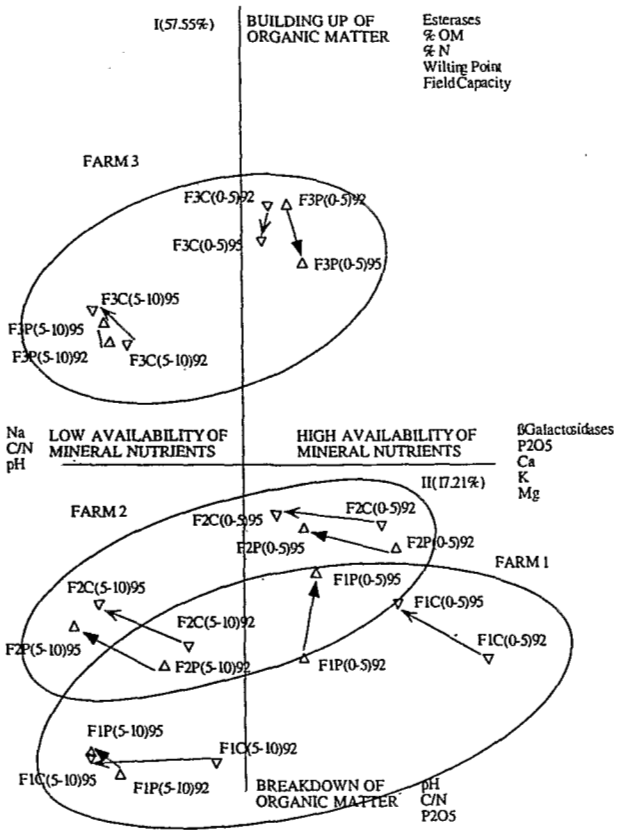

Fig. 1. Multivariate ordination (Correspondence analysis) of the experimental plots for the year 1992 (before the experiment started) and 1995 (three years later) according to the sixteen soil parameters mentioned in the text. Every plot of the figure is identified by the farm number (F), the treatment (C for non treated and P for treated), the soil layer (0-5 cm or 5-10 cm) and the year of the sample. The parameters with high absolute contribution on each extreme of the axes are shown also. Changes between years for every plot are shown with arrows.

Weather conditions during the experimental period were rather dry and warm in the area with the exception of year 1993 which was wetter and colder (Colmenares and De Miguel, 1997). This fact could explain why most of the arrows in Fig. 1 go towards a net loss of nutrient availability, especially in F1 and F2, probably due to a loss of biological activity and soil-plant exchange under dry conditions. On the other hand, we found a net breakdown of organic matter in F3 as the opposite effect produced by warmer conditions at this altitude, which led to a higher biological activity and the increase of the soil-plant interaction. Plots treated with biodynamic preparations showed the clearest influence under the extremes of the altitudinal gradient: F1 and F3. Changes in the lower layer of both locations are more buffered, especially in F1. And, in the upper layer, although opposite effects were found in both locations, the trend was always towards an improvement of soil conditions, i.e. those of the upper layer in mesotrophic conditions.

Due to the limitations of the experimental design, including the short period of time that biodynamic preparations were applied, our results can not be considered conclusive regarding its effect on Mediterranean permanent pastures soils. Nevertheless, the tendencies presented here, along with previous and related results obtained in this experiment (Colmenares and De Miguel, 1997; Suances *et al.*, 1997), are in accordance with results reported before (see below), although in the current study we dealt for the first time with non-tilled, non-fertilized soils and with non-crop plants. Several studies, some of them lasting longer than 30 years on cultivated soils (Koepf, 1993; Mäder *et al.*, 1996), agree with the fact that biodynamic preparations tend to increase the length and biomass of plant roots improving soil physical conditions. Soil organic matter and humus content also increase, as does the soil biological activity in terms of microbial biomass, soil respiration and the activity of certain enzymes.

Conclusions

(i) The application of biodynamic preparations to permanent pasture soils shows a slight improvement of soil conditions already after a period of three and a half years.

(ii) Soil improvement by biodynamic preparations is clearer under extreme environmental conditions.

(iii) The improvement of soil conditions by the application of biodynamic preparations is higher in warm, dry environments, where the climates have enhanced fluctuations, than in colder and moister climates, which generate more stable environments.

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