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Crop Residues Reuse to Improve Agricultural Soil Quality

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ABSTRACT

Since the 70´s in The Autonomous Community of the Region of Murcia, the irrigated agricultural area has increased, especially in the agrarian district "Comarca del Campo de Cartagena", (South East of Spain). As a consequence, the amount of crop residues generated has gone up too. At the present, harvest residues constitute a very serious environmental problem because, in most cases, these residues are dehydrated on the land and burned later on with subsequent negative consequences for the environment.

Therefore, it is important to find a suitable residue management system which would be able to recycle them, solving serious environmental problems related to their final disposal.

The main aim of this study is to reuse crop residues in order to recycle nutrients and improve soil properties. To do so, we will evaluate the influence of recycle vegetables residues on the quality of soil-plant system and therefore being able to reduce the use of chemical fertilizers. Plant waste use in this study comes from pepper crops because it represents more than 90% of the surface occupied by greenhouses in this Agrarian District.

In this experiment we compare two fertilization methods: chemical fertilization used by farmers and organic amendments with crop residues. In both cases plots are divided in subplots of 5 x 4 meters in which we evaluate different doses of nitrogen, to establish the most efficient dose to reduce nutrients leaching without affecting production.

Soil samples are taken at two different depths in order to know the evolution of several physical and chemical parameters such us organic matter, nitrogen, phosphorus, bioavailable cations, metals, etc. Plant samples, will be also collected at the end of the cycle to measure quality and productivity parameters.

INTRODUCTION

In the Autonomous Community of the Region of Murcia (Southeast Spain), agriculture plays a very important role in the economy of the area and especially in the agrarian district "Comarca del Campo de Cartagena" where vegetables crops ranks first regarding cultivated lands (fig. 1), pepper being among them .

In 2006 in The Autonomous Community of the Region of Murcia there were 1777 hectares (ha) of land occupied by greenhouses. Of those 1713 ha were of vegetables, being 90.83 % peppers (CARM, 2007). As a result of the intensive vegetable production system an enormous quantity of vegetables is generated and it remains after the crop, -more than twenty thousand tons from peppers in

1650 ha of land. This is due to the greenhouse management system, in which there must be a clear up to continue with the production. Nowadays there is no procedure to minimize this waste or to reuse it.

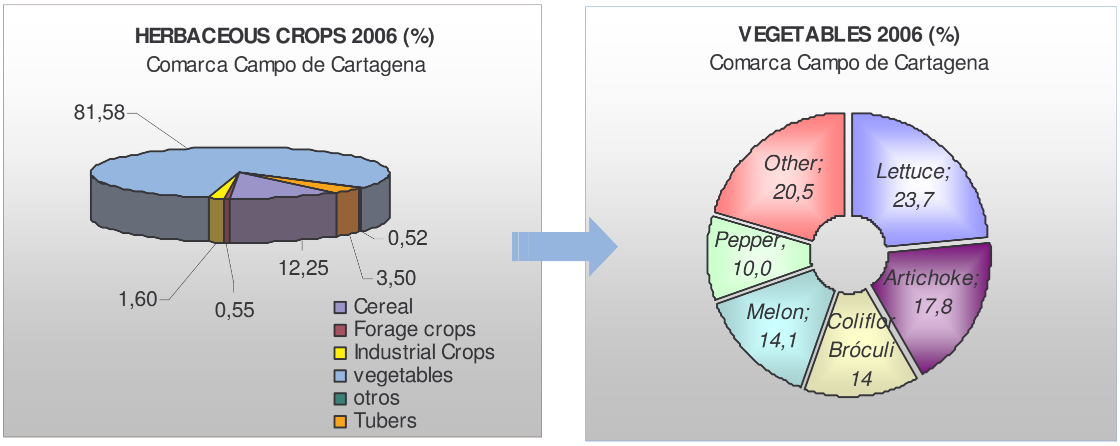

Figure 1: Area take up by herbaceous cropland and vegetables in the Agrarian District of the study

With this project we intend to establish the advantages of recycling post harvest remains from a very common crop in this area. Establishing an effective and advantageous recycling post-harvest remains procedure would be of great interest. From the agronomic point of view recycling allows an addition of organic material to the soil, improving its physico-chemical and biological characteristics Addition of organic materials is very important to maintain the fertility and productivity of soils (Lal, 1980; Lal *et al*., 1980; Maurya and Lal, 1981). Concerning the physical properties, organic matter (OM) contributes to the formation of aggregates which provide structural stability, an increase of percolation and water holding capacity (Dexter, 1988; Zhuang et al., 2008); the decreasing of surface crusting, compaction and soil erosion promote gaseous interchange. As regards chemical properties, it increases the cation exchange capacity, nutrients reserve for vegetables (Porta et al., 1999), and absorption capacity of dangerous substances such as plaguecide (Vangestel, 1996). Nowadays OM takes great interest due to the role that it plays to help to mitigate anthropogenic carbon emissions (Post et al., 2004). As regards biological properties, it enhances the mineralization process and development of plant cover. From the environmental point of view, OM also helps to the protection of the environment due to the diminution of the use of chemical fertilizers. This last contribution in relation with the use of recycling post-harvest remains is of great importance because the area covered by of this study is designated as Nitrate Vulnerable Zone by EU Directive related to the protection of waters against the pollution produced by nitrates coming from agricultural sources (91/676/CEE); this regulation has been implemented in our region through the Good Agricultural Practices Guidelines in where maximum nitrogen doses are recommended for application in agricultural fields based on crop type and irrigation.

MATERIALS AND METHODS

Site Description and Field Experimental Design: the study area is located in the Centro de Transferencia Tecnológica El Mirador, (San Javier), South east of the Autonomous Community of the Region of Murcia, (Fig 2).The study area is divided in two halves. Plot A treated with a chemical fertilization and plot B with organic amendment using crop residues –pepper- dry and crushed.

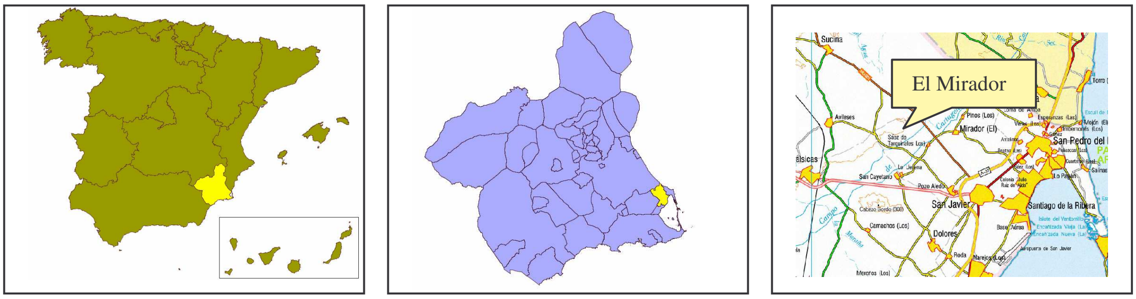

Figure 2: Geographical location

Each plot is divided in twelve sub-plots of 5 m x 4 m receiving four different input treatments per triplicate in order to establish the optimum dose. The plots are distributed in a random way and the doses are as follow: blank = 0 kg N ha^{-1}; dose 1 =170 kg N ha^{-1}; dose 2 = 255 kg N ha^{-1} and dose 3 = 383 kg N ha^{-1} (Fig. 3). After applying the different doses, broccoli will be planted and monitored.

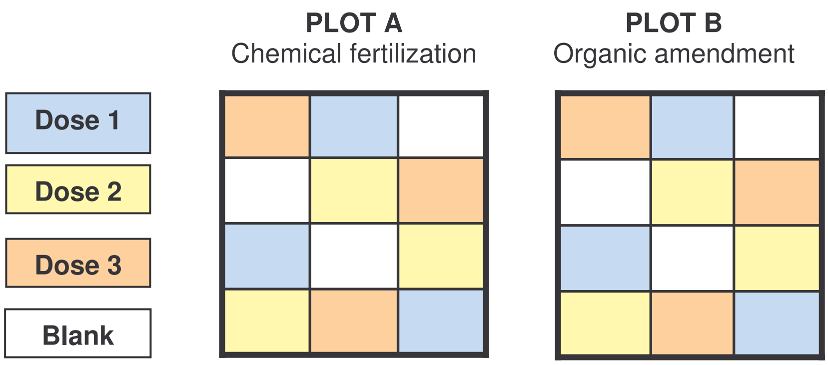

Figure 3: Experimental design of two plots for every study area

Sampling and Analysis: Total amount of Nitrogen (TON) is measured from the dry and crushed crop residues using Duchafour (1970), calculating in this way the amount of residues necessary to obtain the recommended doses All the plots are sampled at two depths: 0-30 cm, arable layer, and subsurface horizon between 30 y 60 cm, beneath the plough level. To obtain statistically significant measurements, 3 samples per plot are taken per each of the two depth mentioned, averaging them to obtain one single sample. On this single sample the following soil analysis are carried out: pH (Peech, 1965), electrical conductivity in 1:5 (w/v) aqueous solution (Bower and Wilcox, 1965), particle size (pipette Robinson) using FAO-ISRIC (1990) to determine the texture, and available phosphorus (Watanabe and Olsen, 1965). Total nitrogen is determined using Duchafour (1970) method, while equivalent calcium carbonate is determined by the volumetric method using a Bernard calcimeter. Organic carbon is determined using Anne (1945); Cation exchange capacity (CEC) by Chapman method (1965), Fe, Mn, Zn y Cu and exchangeable cations according to Pratt (1965). Water aggregate stability in > 0.25 mm size is measured (USDA, 1999), modified using a convection oven at 110 ºC (Soil Science Society of America, 1986.). Soil samples are taken again after the brocoli crop has been harvested. Broccoli plant sampling is collected at the end of harvest. Chemical and other parameters are determined to measure quality and production efficiency.

Expected Results: With this study, we hope to improve our knowledge on the influence of recycling vegetables residues on the quality of the soil-plant system. At the same time, we can compare two methods of fertilization and establish recommendations for the agricultural sector regarding the use of crop residues as an organic amendment in the Campo de Cartagena. The results will allow us to determine alternative disposal procedures to minimize the environmental risks from agriculture practices.

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