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Sustainable management in pecan cultivation in Argentina

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Abstract: Pecan nut "*Carya illinoensis*" is native from central and western U.S.A. and arrived in Argentina in the nineteenth century. The difference with other nuts is that it presents an 80% oil composition, with polyunsaturated fatty acids omega 3 and 6 that help to reduce cholesterol and also prevent the risk of cardiovascular disease. It contains an antioxidant: vitamin E, and has a high content of fibre that helps to prevent colon cancer. Reduces bad cholesterol, helps keep blood pressure low and is recommended especially for patients with cancer and cardiac problems. A pecan sustainable farming system intends to be productive but at the same time, to preserve environmental quality, favouring the use of biological practices over chemical inputs. Surface application of compost to pecan trees, is a common practice in organic orcharding. The objectives of the work were to compare compost and vermicompost with liquid fertilizer and a control without fertilization in a completely random block design with four replications, in a one-year crop with a planting frame of 8m x 8m. The application of organic amendments produced statistically significant changes in soil properties with reference to inorganic fertilizer, especially in the total carbon, microbial biomass carbon and phosphorus. Compost and vermicompost treatments produced statistically significant increases in factors related to production as tree height and diameter.

Key words: compost, pecan, sustainable cultivation

الإدارة المستدامة للزراعة في جوز البقان في الأرجنتين

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الملخص: جوز البقان "*Carya illinoensis*" موجود في الولايات المتحدة الأمريكية الوسطى والغربية ووصل إلى الأرجنتين في القرن التاسع عشر الفرق مع المكسرات الأخرى ووجد أنه يحتوي على 80 ٪ زيت الغير المشبعة الأحماض الدهنية أوميغا 3 و 6 التي تساعد على خفض نسبة الكوليسترول ومنع أيضا من مخاطر الإصابة بأمراض القلب والأوعية الدموية. إنها تحتوي على مضادات الأكسدة: فيتامين E ويحتوي على نسبة عالية من الألياف التي تساعد على الوقاية من سرطان القولون. يفصل الكوليسترول السيئ، ويساعد على الحفاظ على انخفاض ضغط الدم وينصح خصوصا لمرضى السرطان ومشاكل في القلب. نظام الزراعة الجوز المستدامة تعتمز على أن تكون منتجة ولكن في الوقت نفسه، للحفاظ على نوعية البيئة، وتفضيل استخدام الممارسات البيولوجية أكثر من المدخلات الكيماوية. الرش السطحي تطبيق السماد لأشجار الجوز ، هو ممارسة شائعة في orcharding العضوية. وكان الأهداف من العمل لمقارنة السماد vermicompost مع الأسمدة السائلة والتحكم بدون تسميد في تصميم كتلة عشوائي تماما مع أربعة مكررات، في محصول سنة واحدة مع الإطار زرع 8m x 8m أنتج تطبيق التعديلات العضوية تغييرات ذات دلالة إحصائية عضوية في خصائص التربة مع الإشارة إلى الأسمدة غير العضوية، ولا سيما في مجموع الكربون والكربون الكتلة الحيوية الميكروبية والفسفور. إنتاج السماد والمخلفات العضوية أدت إلى زيادة معنوية في انتاجية المعاملات المتصلة بارتفاع الاشجار وقطرها.

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Introduction

Pecan nut, "*Carya illinoensis*", native from central and western U.S.A., was introduced by Domingo Faustino Sarmiento in the nineteenth century in Argentina, and now is spreading in the country growing under different climatic and soil conditions.

Besides being part of the culinary culture of Middle Eastern and European countries, has highly nutritious properties. The doctors recommend it for children with nutritional problems due to its constituents (protein, phosphorus, calcium, iron, potassium and vitamins A, B1, B2, B3, C, E and monounsaturated fatty acids). It reduces bad cholesterol, helps keep blood pressure low and is recommended especially for patients with cancer and cardiac problems (Marín and Boretti, 2008).

With regard to nutrition and pecan production, there is controversy regarding the strategy of using inorganic and organic fertilizers. Inorganic fertilizers are easy to handle, and organics have the advantage of lower costs and environmental benefits (Gosh, 2004).

The nutrients in compost are released slowly and steadily, which provides adequate nutrition from the roots, and prevents nutrient losses into the environment. In recent years there was a growing interest in the use of compost, because of the possibility of recycling of organic materials of high environmental

priority, however, the application needs proper management to avoid risks of over-fertilization and nutrient pollution, such as nitrate leaching groundwater and transport of phosphorus in surface water.

In the case of pecan nut, an excess of nitrogen can stimulate vegetative growth and affect the emission of fruitful shoots (Figueroa Viramontes, 2007). There is little information about research on the effect of compost in pecan orchards.

The objectives of the work were to compare organic amendments compost and vermicompost, with liquid fertilizer and a control without fertilization in a one-year crop, and their effects on soil and plant development.

Materials and methods

The experiment was developed in Villanueva, General Paz, Buenos Aires (S Latitude 35° 45' and Longitude W 58° 26'), on a soil classified as Thapto-argic Hapludoll (Soil Survey Staff, 1999). The test was performed on a staggered distribution with 8m x 8m planting distance, (Figure 1) with a randomized block design with four replications to compare the liquid fertilizer treatments (15 cm³ / 2 litres of water per hole), compost (5 litres / hole), vermicompost (5 litres / hole) and control without fertilization, in three applications dates: 11/12/09, 03/14/2010, and 19/09/2010.



Figure 1. The Pecan nut (*Carya illinoensis*) cultivation site.

The liquid fertilizer presented the following formulation: N (total nitrogen): 8.5%, 4.5% of P (soluble phosphorus) and 7% K (soluble K), with traces of chelated minor elements: Mn, Mg, S, Fe, Co, B, Zn, and Cu. The compost had: C (total carbon: 9.56%, P: 55 ppm, NO₃- (nitrates): 75 ppm, K: 203 ppm, pH: 6, EC (electrical conductivity): 1.55, 12.64% ash. The vermicompost showed 23.55% C, 295 ppm P, 491 ppm NO₃-, 689 ppm K, pH: 7.86, EC: 3.56, 56.87% ash.

Two sampling dates were considered: initial (14/09/2009) and the following year: (11/25/2010) to analyze soil C (Nelson and Sommers, 1982), pH (Page, 1982), EC (Rhoades, 1982), Bray-P (Bray and Kurtz, 1945) and microbial biomass carbon (MBC) by the fumigation extraction method by Vance et al. (1987). Determinations to assess the growth of pecan plants were plant height and stem diameter.

Data were processed using the *Infostat* statistics program (2007). The analyzed parameters were firstly checked for normality and then subjected to analysis of variance (ANOVA). The separation of treatments means was carried out by the Rienzo, Guzmán and Casanoves test (Di Rienzo et al., 2002).

Results and discussion

Main results of soil and plant response are shown in Figure 2.

The addition of vermicompost (V) produced a significant increase (5%) of soil pH compared to other treatments, but its value was close to neutral. It also produced a significant increase in electrical conductivity (EC), which may be related to its salt content. Romaniuk et al. (2010), in their field work on addition of V, observed a significant increase in pH, but the electrical conductivity of soil was not significantly affected.

The control treatment (T) and the liquid fertilizer (FL) differed significantly (5%) from the other situations, showing a lower value of organic carbon (Cox) than C and V. This also coincides with Romaniuk et al. (2010), whose

results showed a significant increase in total organic carbon content by applying V, which favors the increase of soil organic matter in soil.

Bray phosphorus (P) showed a significantly lower value for T, whereas there was a significant difference for the V, with the highest value among all treatments. Both Cox and P-Bray's results are related to the composition of V.

According to Marinari et al. (2000), organic fertilizers provide phosphates to the soil, with a greater nutritional balance than mineral fertilizers. In their agricultural use, the more restrictive factors in the use of compost have been the presence of heavy metals, excess nutrient, salt content, and organic pollutants (Madrid et al., 2000, Marbán et al., 2008), so that the organic materials must be properly analyzed and carefully monitored to observe their effects on soil properties.

With respect to the results for microbial biomass carbon (MBC) it's highlighted the effect of vermicompost and compost compared to other treatments. This coincides with the results of Romaniuk et al. (2010), the field application of vermicompost to an Hapludoll also produced a significant increase in microbial biomass carbon.

The use of vermicompost produced an augmentation in the population of microorganisms in soils due to increased C available as an energy source, which allows populations of microbes multiply rapidly after the implementation of the amendment (Sastre et al., 1996). In the study carried out by Gai and Naim (2006), were reported higher contents of microbial biomass in soils amended with vermicompost compared to those receiving only inorganic fertilizers.

Higher differences in height of the pecan trees were statistically significant for V and C, while the T value was significantly lower for the increase in diameter, compared to treatments C and V.

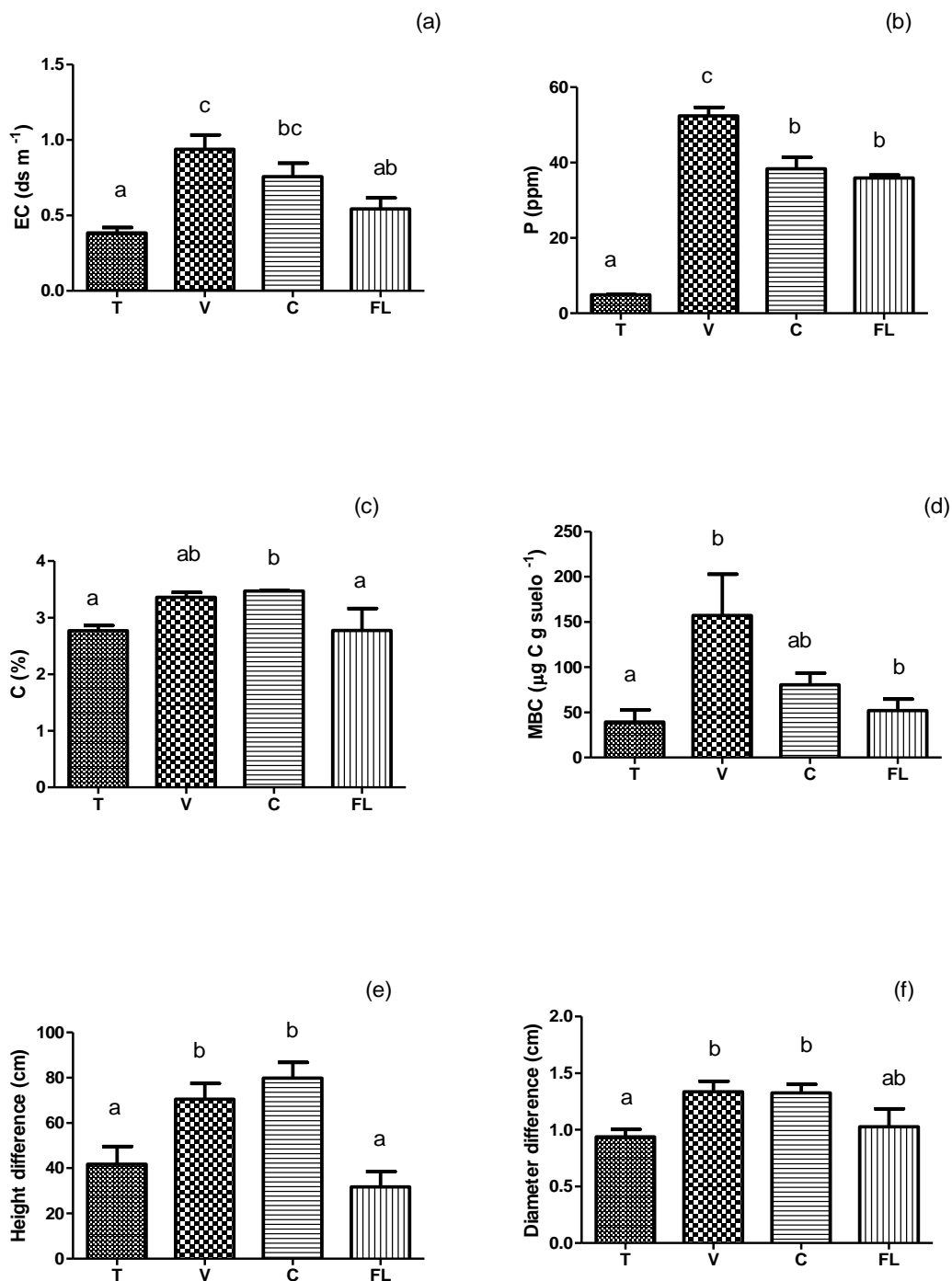


Figure 1. Mean values of (a) soil electrical conductivity (EC), (b) exchangeable phosphorous (P), (c) oxidable carbon (C), (d) microbial biomass carbon (MBC), (e) differences in plant height and (f) differences in plant diameter between two consecutive years.

Different letters denote significant differences between situations at $\alpha = 0.05$. T is the control, V is the vermicompost treatment, C is the compost treatment and FL is the liquid fertilizer treatment.

Mexico has initiated a scheme of pecan plantations in sustainable production, using the minor possible amounts of fertilizers and agrochemicals, in order to obtain highly nutritious and free of toxic residues fruit

(Ascencio Contreras, 2007). It is also important to consider, as suggested by Fortuna et al. (2003), that the use of compost can play an important role in optimizing the availability of nutrients and carbon sequestration potential of

the agroecosystem, as its continued addition increased the pool of resistant and labile soil carbon.

Conclusions

The application of organic amendments produced changes in soil properties and plant performance. The effects of C and V, with respect to pH values obtained are not worrying as this parameter remained close to neutrality. The electrical conductivity increased, so its effect should be monitored to prevent adverse effects on soil colloids. The increase of carbon is positive, but phosphorus enrichment, which can cause nutritional imbalances, should be taken into consideration. Organic amendments also produced significant increases in MBC, with statistically significant differences for the V. Both C and V presented statistically significant increases in tree height and diameter.

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