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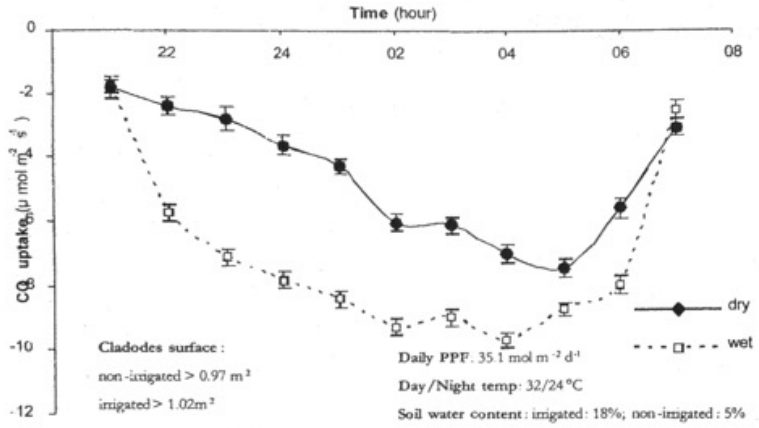

Fig. 2. CO_2 fluxes in irrigated and non-irrigated *Opuntia ficus-indica* trees. Each value is a mean (±SE) of 60 minutes measurements for each time lapse (14-21 July 2010).

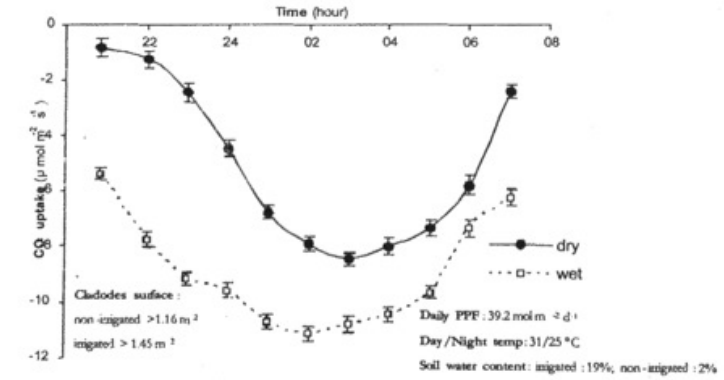

Fig. 3. CO_2 fluxes in irrigated and non-irrigated *Opuntia ficus-indica* trees. Each value is a mean (±SE) of 60 minutes measurements for each time lapse (1-5 August 2010).

Effect of Organic Fertilization on Green Cladodes (*Opuntia ficus-indica* (L.) Mill.) Yield in Lerma Valley, Salta, Argentina. Second Year

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Keywords: young cladodes, manure, production

Abstract

The tender cladodes of prickly pear cactus (*Opuntia ficus-indica* (L.) Mill.) commonly called "nopalitos" are widely consumed in Mexico, whereas in Argentina they are scantily used vegetables. The aim of the present work was to evaluate the effects of the application of three organic manures (hen, cow and sheep) to the production of young cladodes (nopalitos) of prickly pear cactus. The experimental design was a complete randomized block with six replications per treatment. Each experimental unit contained two mother cladodes. They were planted on 4 September 2008, at the beginning of spring. The different treatments (plus an untreated control) were applied a single time at 5 kg per plot at the moment of planting. "Nopalitos" were harvested and weighed when they measured 15 cm, from 1 September 2009 until 30 April 2010. Two components of the yield were analyzed: number and weight of the pruned buds. Organic fertilization increased the nopalito production in both weight (p=0.042) and number (p=0.025). The greatest total harvested weight was obtained in the plots fertilized with cow manure (Me= 1961.6 g/plot; RIC=464.5 g/plot), differing statistically from the control plots (Me=1517,7 g/plot; RIC=460,5). The greatest number of harvested nopalitos was obtained in the plots fertilized with cow manure (Me=43 nopalitos/plot; RIC=14.5) and hen manure (Me=44 nopalitos/plot; RIC=14.5 nopalitos/plot), significantly surpassing those found in the control plots (Me=35 nopalitos/plot; RIC= 11.2 nopalitos/plot). This study suggests that the greater benefit of cow manure fertilization also prevails in the second year of the experiment.

INTRODUCTION

Tuna or nopal (*Opuntia ficus-indica*) is an endemic native plant of Latin America with promising use potential. In some countries like Mexico, the cradle of cactus diversity, the species is put to a variety of uses. Its principal uses are human consumption as food (fruit and cladodes), cochineal production for natural pigments, livestock fodder, cosmetics, medicinal uses, and energy (alcohol and bio-gas) among others (Guevara et al., 1997). Apart from all these uses, cultivation of the species attains special importance for the success of sustainable agricultural systems in arid and semiarid areas (Guevara et al., 1997; Ramos and Quintana, 2004).

In Argentina, while the species is widespread in many provinces, it is only used for fruit and cochineal production for natural dyes (Ortín et al., 2007a,b; Boldrini et al., 2007). Horticultural production of tuna plants, principally for 'nopalitos' is not generally practised. However, a wide range of sweet and savoury preparations (very popular in Mexico) can be made from the young cladodes of the plant. A tasting study carried out in Universidad Nacional de Salta showed very promising acceptability results (Lozano et al., 2008).

Great quantities of fertilizer, generally of bovine origin, are applied every two or three years to increase production. Chemical fertilisers (urea or ammonium sulphate) are also used, with annual applications in intensive systems (Guevara et al., 1997; Ramos and Quintana, 2004).

The benefits of manuring on nopal production are evident in the encouragement

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and increase of young cladodes (nopalitos), improvement in fruit quality and extension of the plant's productive life in both systems. The use of manure on tuna plants is economically viable and environmentally sustainable. Synthetic fertilizers can also be applied by drip watering. In both cases the dosage depends on soil fertility, cactus type and phenological stage of the crop (Vazquez Alvarado et al., 2006).

Fertilization has a positive effect on production and other variables related to nopalitos harvest yield, the best results being obtained from a mixture of soil, compost and fish flour (Murillo Amador et al., 2005).

The best effects found in the application of high doses of cow manure (200, 400 and 600 t/ha) on cultivars destined for nopalitos production were evident in the second year, perhaps due to incomplete mineralization of the organic matter in the first year of the cultivation cycle (Valdez-Cepeda et al., 2009).

The fact that both producers and researchers in Mexico generally acknowledge the favourable response of nopal to the application of organic and chemical fertilizers (Valdez-Cepeda et al., 2009), has prompted us to carry out the present work with a view to evaluate the effect of application of three types of manure (cow, sheep and hen) on the number and weight of nopalitos harvested in an experimental parcel in Lerma Valley, province of Salta, Argentina.

MATERIAL AND METHODS

Object of the Study

Opuntia ficus-indica is a bush like plant, 3 to 5 m high with a woody trunk. Its pulpy stems or cladodes can be from 30 to 60 cm long by 20 to 40 cm wide, with a thickness of 2 to 3 cm. It produces yellow flowers 7 to 10 cm long, and the oval fruit of varying colours is 5 to 10 cm long by 4 to 8 cm diameter, with abundant sweet, fleshy pulp (Ramos and Quintana, 2004).

Experimental Design

The study site was located at the Experimental Campus of the Salta National University, Salta Province, Argentina. The area has an annual rainfall of 695,1 mm and an average temperature of 16,7°C. The field trial was established as a randomized block design with four treatments (three organic manures and control) and six replications per treatment (Fig. 1). Each experimental unit contained two mother cladodes. They were planted on 4 September 2008, at the beginning of spring. The different treatments (cow, sheep, hen manure and a control) were applied at 5 kg per plot at the moment of planting. The buds ("nopalitos") were harvested and weighed when they measured 15 cm, from 1 September 2009 until 30 April 2010. The variables analyzed were total number of buds harvested (15 cm long) and total weight harvested per experimental unit over the period from 1 September 2009 to 30 April 2010.

Data Analysis

As the variables analyzed did not match the ANOVA assumptions, the data were analyzed with a non-parametric test for a randomized block design (Friedman test) with a 5% significance level (Zar, 1999; Siegel and Castellan, 2001). Due to the asymmetry of the variable distributions studied, the central tendency and the dispersion were summarized with the median (Me) and de interquartile rank (IQR) respectively.

RESULTS AND DISCUSSION

Throughout the total harvest period (7 months), organic fertilization increased the yield of nopalitos both in the number of sprouts gathered (T2=4.17; p=0.025) and in total weight harvested (T2=3.39; p=0.042).

Number of Nopalitos Harvested

The greatest number of nopalitos harvested was found in the plots fertilized with

cow manure (Me=43 nopalitos/plot; IQR=14.5) and hen manure (Me=44 nopalitos/plot; IQR=14.5 nopalitos/plot), significantly surpassing the numbers for the control plots (Me=35 nopalitos/plot; IQR=11.2 nopalitos/plot) (Fig. 2).

Total Weight of Nopalitos Harvested

The greatest total weight harvested was obtained in the plots fertilized with cow manure (Me=1961.6 g/plot; IQR=464.5 g/plot), statistically different from the weight harvested in the control plots (Me=1517.7 g/plot; IQR=460.5) (Fig. 3).

In the conditions of Lerma Valley, province of Salta, this second year of experimentation allows us to verify that despite the fact that nopal is a rustic plant, it responds favourably to the application of organic fertilizers, particularly bovine manure (Valdez Cepeda et al., 2009). During the first production year of this test, cow manuring was the treatment that led to the greatest average harvest weight per plot (Me=2549 g; IQR=296.4 g) statistically different only to the harvested weight in the plots fertilized with hen manure (Me=1718 g; IQR=134 g) (Lozano et al., 2009). This new work (second production year) corroborates the results of the previous season, permitting us to recommend the use of cow manure in an area with important dairy activity. The number of nopalitos harvested during the first year of the experiment showed no significant difference between treatments (Lozano et al., 2009), but in the present period the greatest number of nopalitos harvested was in the plots fertilized with cow and hen manure; which leads to the advisability of a deeper study of processed fowl manure (to eliminate moisture and reduce particle size), as other works mention its superiority to cow manure for this yield variable (Martinez Lopez et al., 2009).

The following aspects should be taken into account for later studies: fertilize in the second year after planting, once the root system is developed and in the presence of moisture. Whenever possible, use decomposed manures with a more advanced mineralization process. Consider that both manures and chemical fertilizers show their effect one to two years after application, and the residual effect persists for over three years.

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Figures

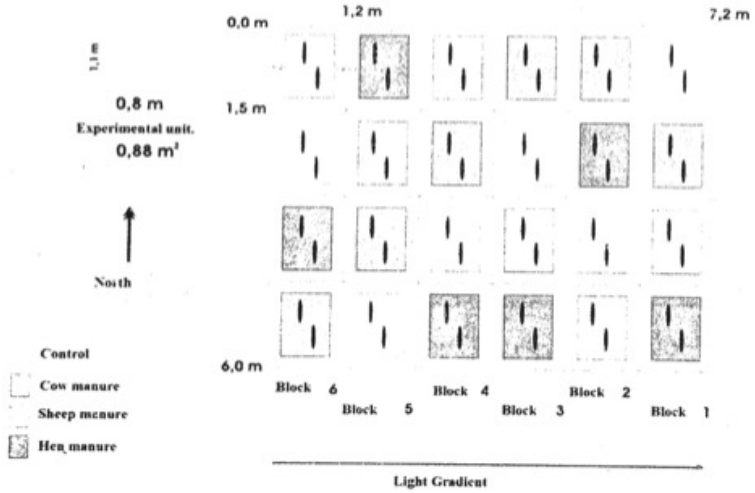

Fig. 1. Randomized block design with four treatments and six replication (blocks).

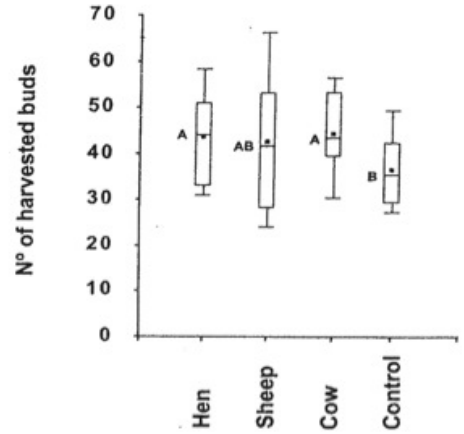

Fig. 2. Total number of buds (nopalitos) harvested per plot, in response to manure used as fertilizer in an experimental plot in Lerma Valley, province of Salta, Argentina.

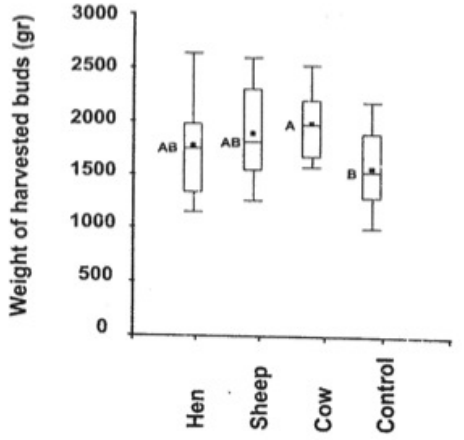

Fig. 3. Total weight of buds (nopalitos) harvested per plot in response to manure used as fertilizer in an experimental plot in Lerma Valley, province of Salta, Argentina.