Cardoon (*Cynara cardunculus L.*) biomass production in a calcareous soil amended with sewage sludge compost and irrigated with sewage water

Lag A. , Gómez I. , Navarro-Pedreño J. , Pérez A. , Meléndez I. , Soriano-Disla J.M.

GEA – Environmental Soil Science Group. Department of Agrochemistry and Environment. Miguel Hernández University. Avda. de la Universidad s/n. 03202, Elche, Alicante, SPAIN (Tel.: +34-966658338, Fax: +34-966658340) alag@umh.es

INTRODUCTION

Energy demand is one of the most important current global issues which needs to be discuss among all the sectors involved, searching for an solution which should be as much environmentally compatible as possible. Fossil fuels resources are limited and its use generate or enhance environmental problems, i.e. Global Warming, thus it is necessary to find alternative ways to produce energy. Energy crops represent one step towards sustainability but it must be coupled with appropriate land use and management adapted to local conditions. Moreover, positive effects like soil conservation; economical improvement of rural areas and CO_2 storage could be achieved. In addition, if fertilization and irrigation requirements can be supplied with residues and its management is appropriate, energy consumption is reduced and economical and environmental benefits are obtain. The present study join all the previous ideas, using treated sewage water and sewage sludge compost as low-cost inputs for irrigation and nutrition of cardoon (*Cynara cardunculus* L.), a perennial Mediterranean crop. **The main aim of the present field experiment was to ascertain the optimum dose of compost application to obtain maximum biomass production.**

MATERIALS AND METHODS

In a calcareous soil under semi-arid conditions, located in the South East of Spain, four compost treatments (D_1=0; D_2=30; D_3=50; D_4=70 ton/ha) were applied by triplicate and forty eight cardoon plants were placed in each plot, 12 per treatment,. The experiment was developed for one cardoon productive cycle (one year aproximately), starting the first week of October and ending at the end of July. Soil was sampled three times (October, April and July) from the top 5-10 cm layer. Soil, compost and irrigation water analyzed parameters are shown in Table 1,2 and 3 respectively. Stalk, capitula and leave weight as well as height and total biomass production were the parameters determined for cardoon samples (Table 3). Analyses of variance (ANOVA) at p=0,05 significance level were performed to detect differences among treatments for each sampling/plot and to study soil parameters evolution and biomass production for each plot/dose.

Figure 1.- Evolution of *Cynara cardunculus L.* crop throughout production cycle. a) Compost application in October; b) Growth status in April; c) Inflorescence blooming in June; d) Leaves drying during the first week of July; e) In situ aerial biomass drying at the end of July.

Table 1. Mean ± standard deviation of soil parameters.

Clay (%)	38±4
Lime (%)	39±4
Sand (%)	23±4
CO_3^{-2} (%)	52±2
Reactive CO_3^{-2} (‰)	194±56
Cd (mg.Kg $^{-1}$)	0,37±0,02
Cr (mg.Kg $^{-1}$)	24±2
Ni (mg.Kg $^{-1}$)	13±1
Pb (mg.Kg $^{-1}$)	12±1

Table 2. Mean ± standard deviation of compost parameters.

pH	5,1±0,1
OM (g.kg^{-1})	73,6±0,2
Nk (g.kg^{-1})	2,185±0,003
P (g.kg^{-1})	0,0074±0,0002
EC (mS.cm^{-1})	5,75±0,01
Ca (mg.kg^{-1})	6948±624
Mg (mg.kg^{-1})	3926±20
K (mg.kg^{-1})	5173±154
Na (mg.kg^{-1})	2417±59
Cu (mg.kg^{-1})	221±1
Fe (mg.kg^{-1})	4781±359
Mn (mg.kg^{-1})	92±4
Zn (mg.kg^{-1})	575±2
Cd (mg.kg^{-1})	0,6±0,1
Cr (mg.kg^{-1})	24±4
Ni (mg.kg^{-1})	10±1
Pb (mg.kg^{-1})	29±1

EC - Electrical Conductivity; Nk - Kjeldahl Nitrogen; OC - Organic carbon

Table 3. Mean ± standard deviation of irrigation water parameters.

pH	7,9±0,3
EC (mS.cm^{-1})	2,1±0,1
Cl^- (mg.l^{-1})	681±53
BOD_5 (mg O_2.l^{-1})	14±3
Nk (mg.l^{-1})	28±17
NO_3^- (mg.l^{-1})	3±1
P (mg.l^{-1})	4±3
Ca (mg.l^{-1})	39±5
Mg (mg.l^{-1})	37±2
Na (mg.l^{-1})	281±36
K (mg.l^{-1})	29±4

EC - Electrical Conductivity; Nk - Kjeldahl Nitrogen; BOD_5 – Biological oxygen demand

RESULTS AND DISCUSSION

Several statistical differences in soil were found between treatments for extractable zinc, magnesium and phosphorus; as well as Kjeldahl nitrogen and organic carbon due to compost application, showing a gradual increase of nutrients from D_1 to D_4. However, considering the evolution of soil parameters along time, pH was the only with marked and significant decreasing trend from the first to the last sampling period (Figure 2.)

Mean cardoon biomass production in D_1 subplot was 13 ton/ha which differed significantly from D_4 production, which was about 20 ton/ha. Hence, the maximum biomass production was obtained with the maximum compost dose.

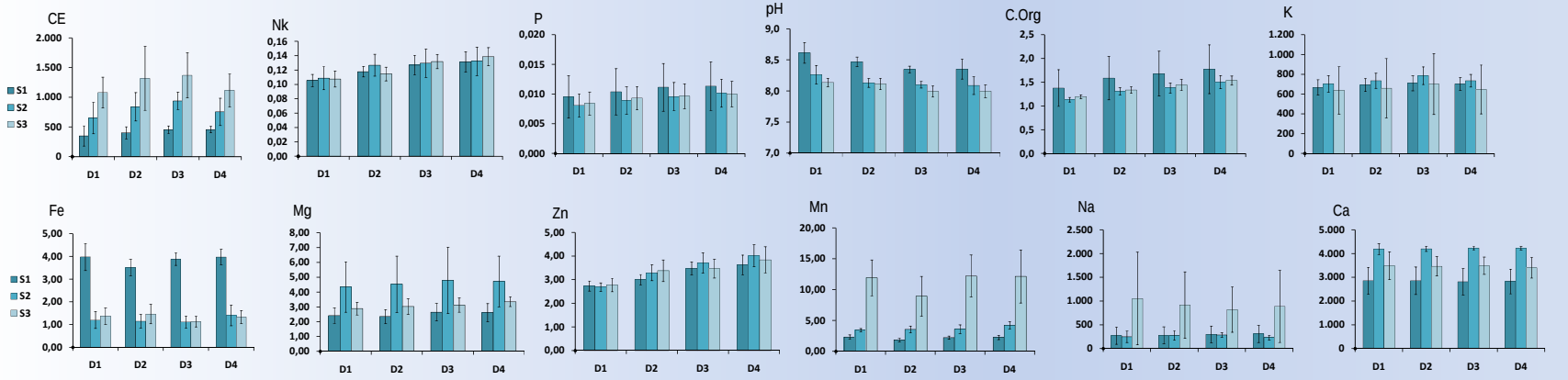

Figure 2.-Mean values (±) standard deviation of soil parameters for each compost dose. (S1-Fisrt soil sampling; S2- Second soil sampling; S3- Third soil sampling

Table 4. Mean ± standard deviation of plant parameters

Compost dose	LW (Kg)	IN	IW (Kg)	SW (Kg)	TBW (Kg)	PH
D_1	0,7±0,3a	19±7a	0,6±0,2a	0,5±0,2a	1,7±0,6a	175±16a
D_2	0,8±0,2a	24±10ab	0,7±0,3ab	0,6±0,2ab	2,1±0,6ab	191±14b
D_3	0,9±0,4a	21±9ab	0,7±0,3ab	0,6±0,2^a	2,1±0,7ab	187±15ab
D_4	1,0±0,3a	29±11b	0,9±0,3b	0,8±0,2b	2,7±0,7b	194±14b

LW – Leaves weight; IN – Inflorescence Numbre; IW – Inflorescence weight; SW – Stalks weight; TBW – Total biomass weight; PH – Plant Height

CONCLUSION

The results show that compost amendment increased cardoon biomass production, probably due to the improvement of soil properties, especially plant nutrient availability. No significant differences were found in soil parameters along time, with the exception of pH. However, longer test time is needed to evaluate long term effects in soil and to check the maintenance of biomass productivity.

Acknowledgements: The author gratefully acknowledges the Spanish Ministry of Innovation and Science for a research fellowship (AP2007-01641)

EGU 2010. European Geosciences Union. General Assembly 2010. Energy, Resources and Environment. Vienna Austria. 2-7 May 2010