APPLICATION OF PIG SLURRIES IN THE GUADALENTIN VALLEY FOR BROCCOLI AND WATERMELON PRODUCTION: INFLUENCE ON SOME SOIL CHEMICAL CHARACTERISTICS

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ABSTRACT

This paper is aimed to determine the effects of application of pig slurries (PS) to the soil as a fertiliser in SE Spain. The main interest is to find out the optimum dose that can be added to the soil as an organic fertiliser. The study will enable to determine the potential agronomic use of these pig residues, which are a high-priority issue for the Guadalentin Valley. This paper reports the results obtained, after two consecutive years application, to fertilise broccoli and watermelon plantations. A 2100 m^2 plot has been prepared for both, broccoli and watermelon. Different dose, residual and accumulative effects, are also considered.

As regards to the characteristics of the pig slurries, they are similar to others, although both, total nitrogen and heavy metals are lower, as those parameters are strongly influenced by the feeding of the animals and the cycle of production.

The influence of the PS on soil chemical characteristics and on production is less notorious in watermelon experiences. Metals Cu, Zn, Mn and Fe, in general, increase for both plantations, however, these contents are not above those established by law. In both crops, the content of nitrate is not influenced by PS after two years of experiment. These contents are below those established by law.

INTRODUCTION

Nowadays pig slurry constitutes a very serious environmental problem mainly due to the change in the pig production system, bound to its intensivity. Diverse studies coincide in affirming that the most effective and economic method of confronting the problem of the accumulation of this waste of organic type is through its application to the soil.

The Region of Murcia the fifth near the 2 million heads, and the second after Cataluña in number of heads per surface unit. Inside the Region of Murcia, the Municipality of Lorca is the one that possesses higher number of exploitations; with 2657 (43%), producing near 4 millions pig slurry m^3 a year (M.A.P.Y.A, 2000).

The objective of this work was to determine the effects of application of pig slurry to the soil as an organic fertiliser in SE Spain. The main interest is to find out the optimum amount of this residue that can be added to the soil as an organic fertiliser. The study will enable to determine the potential agronomic use of pig residues, which is a high-priority issue for the Guadalentin Valley.

This paper reports the results of the second year application of pig slurry for broccoli and watermelon plantations, carried out between February and May and April and August of the year 2003.

MATERIALS AND METHODS

The study was carried out in the alluvial plain of Guadalentin Valley (Lorca, Murcia, southern Spain). The soils developed in this area are classified as Calcaric Fluvisols (FAO-ISRIC-ISSS, 1998). The experiment is planned to be for 3 years, using broccoli and watermelon. Four blocks of plots have been selected, each one with 630 m^2, using different doses of pig slurry: blank, 4.86 L m^2, 11.05 L m^2 and 14.86 L m^2; residual (R) and accumulative (A) effects are considered. Soil samples were obtained from the surface (0-30 cm). These soil samples were taken after the harvest while plants gathered before the harvest. Slurries were applied during the plant growth.

The following analysis were carried out: pH (Peech, 1965); electrical conductivity of the saturation extract (E.C.) (Bower and Wilcox, 1965); total organic carbon (T.O.C.) (Duchaufour, 1970); total nitrogen (T.N.) (Duchaufour, 1970); available phosphorus (Pa) (Watanabe and Olsen, 1965); available potassium (Ka) (Pratt, 1965); bioavailable Cu, Zn Fe and Mn (Lindsay y Norvell,1969).

The parameters studied in the plants were: NO_3^-, Cu, Zn, Fe and Mn contents (Madrid *et al.*,1996) and weighted to determine the quantity of broccoli and watermelon production. In pig slurry were determined: pH, electrical conductivity (E.C.), total organic carbon (T.O.C.), total nitrogen (T.N.), NH_4-N, NO_3^-, K, PO_4^{-3} , Cu, Zn, Fe and Mn contents; moisture, density, dry matter, methods used were according to M.A.P.Y.A. (1998).

Statistical analyses were carried out according to ANOVA (Casella and Berger, 1990).

RESULTS AND DISCUSSION

As regards to the characteristics of the pig slurries, they are similar to others (Bernal y Roig 1993), although both, total nitrogen and heavy metals, are lower; as those parameters are strongly influenced by the feeding of the animals and the cycle of production. However, there are some differences between the one applied to the broccoli and that of the watermelon, although they come from the same slurry pit: pH is higher in the slurry used for the watermelon cultivation, while total organic carbon and PO_4^{-3} are lower; in relation to the physical characteristics dry matter is also lower in the slurry used for watermelon (Table 3).

Broccoli

pH data increase as applications is higher (plot D, 14.86 L m^2), being more notorious for residual effect than for lowed the accumulative one in both cases (pV is inferior at 0.001); the same pattern follows the content of T.N., Pa and Kc, however in these three the value is higher for accumulative plots then in for residuals. In relation to the values of T.C.O., the highest value is for plot C (11.05 L m^2) with accumulative effect. The values of E.C. are

Table 1.*-Soil chemical characteristics at 0-30 cm depth, second years after application of pig slurry in plots broccoli and watermelon.*

Treatment	pH		E.C. dS m^{-1}		T.C.O. g kg^{-1}		T.N. g kg^{-1}		Pa mg kg^{-1}		Kc cmol kg^{-1}	
Broccoli	R	A	R	A	R	A	R	A	R	A	R	A
Blanck	7.8 a	7.8 ab	3.1 ab	3.1	10.3 a	10.9 a	1.3 c	1.2 a	1.1 a	1.1 a	0.9 c	1.0 b
B (4.86 L m^2)	7.8 a	7.8 a	3.0 b	3.0	9.6 a	11.6 a	1.1 a	1.2 a	1.1 a	1.1 a	0.6 a	0.8 a
C (11.05 L m^2)	7.8 a	7.8 b	3.1 b	2.7	10.5 a	15.8 b	1.2 b	1.4 b	1.5 b	3.2 b	0.7 b	0.9 ab
D (14.86 L m^2)	8.1 b	7.9 c	2.4 a	2.2	15.8 b	13.1 ab	1.4 d	1.5 c	2.1 c	4.7 c	0.8 c	1.0 b
pV	0.000***	0.001***	0.057NS	0.564NS	0.014*	0.034*	0.000***	0.000***	0.000***	0.000***	0.000***	0.029*
Watermelon												
Blanck	7.5 a	7.6 a	4.6 c	3.7 b	21.5 c	21.2	1.4 a	1.4	1.5 a	1.5 a	0.8 ab	0.8 a
B (4.86 L m^2)	7.8 b	7.7 b	3.5 bc	3.3 ab	16.3 a	23.0	1.5 b	1.5	2.2 b	2.5 a	0.7 a	0.9 a
C (11.05 L m^2)	7.9 c	7.8 b	3.0 b	2.8 a	17.9 b	23.0	1.6 c	1.5	2.6 c	4.2 b	0.8 a	1.0 ab
D (14.86 L m^2)	8.0 c	7.9 c	2.2 a	3.5 b	18.2 b	23.1	1.7 d	1.4	3.5 d	4.3 b	1.2 b	1.0 b
pV	0.003**	0.004**	0.008**	0.028*	0.000***	0.345NS	0.000***	0.371NS	0.000***	0.004**	0.054NS	0.054NS

lower when slurry treatment increases although pV indicates that those differences are not significant at level of probability of 0.05 (Table 1).

In relation to the plant chemical parameters it should be highlighted that values of NO_3^- increase considerably when we incorporate higher quantity of slurry; them this value reach up to 4011 mg kg^{-1}, being the maximum allowed by law of 4500 mg kg^{-1} (Reglamento C.E. 563/2002). pV indicates that are not significant at level of probability of 0.05 the values for Cu, Fe and Mn, however an increase is observed for the accumulative effect in relation to the residual, these values inside the normal ranges (Table 1).

The production in the second year of experiment surpasses the overage of the Valley of the Guadalentín in the plot with the higher treatment and accumulative effect, residual effect does not surpass 1 kg m^2 (Figure 1).

Watermelon

As happens to broccoli an increase of pH takes place in soil when the slurry application to higher for both residual and accumulative plots. This increase also takes place in Pa and T.N., reaching the last one the higher value for residual plots. It should be highlighted that regarding the content of T.C.O., the higher value is reached in the blank residual effect plot. In the case of Kc great variation is not observed between different treatments (Table 1).

For NO_3^-, Zn, Fe and Mn analysed in plants, pV indicates that they are not significant at level of probability of 0.05; however, an increase NO_3^- in accumulative effect is noticed being the higher value of 4306 mg kg^{-1} in the lowest treatment (B), even surpassing the values of broccoli. Cu shows a notorious increase in the treatment C and D (Table 2).

***Table 2**.-NO_3^-, Cu, Zn, Fe and Mn contents of leaf in broccoli and watermelon.*

Treatment	NO_3^- mg kg^{-1}		Cu mg kg^{-1}		Zn mg kg^{-1}		Fe mg kg^{-1}		Mn mg kg^{-1}	
Broccoli	R	A	R	A	R	A	R	A	R	A
Blanck	1236 a	1128 a	1.2	0.8	6.1 ab	7.6 a	14.1 a	17.7	12.5 ab	15.1
B (4.86 L m^2)	1692 ab	1712 a	0.9	1.4	5.6 a	9.7 ab	15.5 a	26.8	10.2 a	28.0
C (11.05 L m^2)	2142 ab	2988 b	1.1	2.4	6.3 a	10.0 ab	16.5 a	27.8	21.8 ab	28.2
D (14.86 L m^2)	2257 b	4011 c	1.5	1.3	8.3 b	11.6 b	24.0 b	26.6	25.1 ab	28.6
pV	0.114NS	0.000***	0.534NS	0.452NS	0.048*	0.120NS	0.041*	0.648NS	0.145NS	0.331NS
Watermelon										
Blanck	2861	2830 a	1.0 a	2.6	4.1	4.0	33	29	7.6	6.3
B (4.86 L m^2)	2649	4306 b	1.9 a	2.9	4.0	5.6	30	26	5.9	6.3
C (11.05 L m^2)	1975	3655 ab	3.6 b	3.0	3.4	5.8	31	27	6.1	6.8
D (14.86 L m^2)	2299	3743 ab	3.7 b	3.1	4.2	5.4	29	25	6.7	6.5
pV	0.339NS	0.179NS	0.016*	0.774NS	0.569NS	0.250NS	0.458NS	0.729NS	0.413NS	0.760NS

***Table 3**.-Composition of the pig slurry added to soil in broccoli and watermelon in second year*

Characteristic chemical	Broccoli	Watermelon
pH	7.3	7.7
E.C. dS m^{-1}	13.2	13.3
T. O. C. g L^{-1}	10.5	4.7
Total N g L^{-1}	2.2	1.9
NH_4-N g L^{-1}	1.8	1.4
NO_2^- mg L^{-1}	24.5	24.9
NO_3^- mg L^{-1}	20.5	18.5
K mg L^{-1}	1911	1791
PO_4^{-3} mg L^{-1}	1205	621
Cu mg L^{-1}	1.1	1.3
Zn mg L^{-1}	1.1	1.2
Fe mg L^{-1}	6.6	6.2
Mn mg L^{-1}	0.5	0.3
Characteristic physical		
Moisture %	96.1	97.8
Density mg mL^{-1}	1.0	1.0
Dry matter g L^{-1}	39.7	21.3

The production surpasses the media of the Guadalentín Valley for all the treatments, except the blank, being the treatment C and D (Figure 2).

CONCLUSIONS

Pig slurry is similar to others used for the same agronomic, except for the quantity of N and metals. Although the slurries used for both crop are extracted from the same pit, differences are observed mainly related to total organic carbon and PO_4^{-3}. The chemical parameters of the soil, tend to increase as the slurry dose higher being higher for the accumulative effect. This tendency takes place in both crops. being more notorious in broccoli cultivation . E.C. go lower when slurry treatment increases.

Plant analysis shows notorious increase in NO_3^-, being higher the accumulative effect. However, these values don't surpass that specified by law. The metals also present an increase, reaching the normal levels. The production has reached, for both crops the average in Guadalentín Valley. In the case of the broccoli, in the highest treatment of accumulative effect and for watermelon for all the treatments, in both residual and accumulative effects; being higher in the accumulative effect**.**

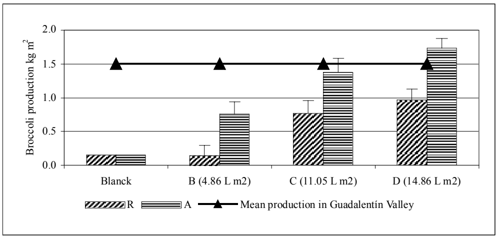

Figure 1.*-Production of broccoli in the second year (kg m²).*

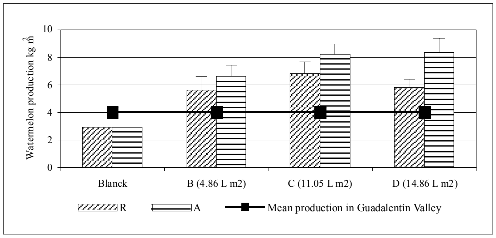

Figure 2.*-Production of watermelon in the second year (kg m²).*

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