Rev. Int. Contam. Ambie. 28 (3) 259-263, 2012

SHORT COMUNICATION

RESPONSE OF CHRYSANTHEMUM PLANT TO ADDITION OF BROILER MANURE AS A SUBSTITUTE FOR COMMERCIAL SUBSTRATE

Francisco ALONSO[1*], Rosario MIRALLES DE IMPERIAL[2], José Valero MARTÍN[2], Carmen RODRÍGUEZ[2] and María del Mar DELGADO[2]

[1] GI. Instalaciones Agroganaderas y Medioambiente. Universidad Politécnica de Madrid, Ciudad Universitaria s/n, 28040 Madrid, España.
[2] Departamento de Medioambiente, INIA, Ctra. La Coruña Km 7.5, 28040 Madrid España.
*Corresponding author; paco.alonso.peralta@upm.es

(Recibido septiembre 2011, aceptado abril 2012)

Key words: poultry manure, substrate, chrysanthemum, growth

ABSTRACT

Two different broiler manure types mixed with bedding material (straw and sawdust) were added at rates of 0 and 10% to two commercial peat substrates (black peat and sphagnum peat) to study the chrysanthemum plant growth. In all cases, the quality and size of the plants was better with the mixtures of black peat substrates. The number of flowers per plant increased significantly with the mixtures of black peat with broiler manure, but the size of the plants did not improve. The addition of broiler manure to sphagnum peat improved significantly the studied growth parameters, because substrate pH was more suitable for cultivation. There was no plant mortality with the mixtures tested, but when the percentage of broiler manure in the substrate mixture increased the plant mortality was remarkable.

Palabras clave: gallinaza, substrato, crisantemo, crecimiento

RESUMEN

Dos tipos diferentes de pollinaza mezclados con el material de cama (paja o serrín) añadidas en tasas de 0 y 10% más dos substratos comerciales de turba (turba negra y turba rubia) se usaron para estudiar el crecimiento de crisantemo en maceta. En todos los casos, la calidad y el tamaño de las plantas fue mejor con las mezclas de substratos de turba negra que con las mezclas de turba rubia. Con las mezclas de turba negra con pollinaza hubo un aumento significativo del número de flores sin que hubiese un aumento en el tamaño de las plantas. También se pudo observar que con la adición de pollinaza, el substrato de turba rubia mejoró significativamente los parámetros de crecimiento estudiados, esto fue debido a que el pH del substrato fue más adecuado para el cultivo. Por último, no hubo mortalidad de plantas con las mezclas experimentadas, pero cuando la cantidad de gallinaza aumentó en la mezcla fue más notable la mortalidad de plantas.

INTRODUCTION

The production of ornamental plants is a great consumer of organic waste and many studies have investigated the use of agricultural wastes (Evans *et al.* 1996, Wang *et al.* 1990) as substitutes for peatmoss. Almost all these plants are grown and marketed in containers, and more than 70 % of the substrates contain mixtures with organic materials (López *et al.* 2006). The use of substrates with lower content of peat adding poultry manure could help to recycle these subproducts, due to their high nutrient content.

Chrysanthemum (*Dendrathema grandiflorum* (Ramat.) Kitam) cultivation as a potted plant is one of the most important worldwide (AIPH 2006). In Spain, its demand as seasonal gardening plant has increased recently in last years. The amount of broiler litter manure to manage is very high, 12 kg/broiler/year (European Commission 2004), and traditionally have been applied to improve the fertility of soils.

The objective of this experiment was to evaluate the responses of pot plant chrysanthemum growth by using of two separated types of peat substrates growing media and mixed with by broiler litter manure. Growing parameters studied were: stem length (SL), flower numbers (FN) and dry weight final biomass (DWG).

MATERIALS AND METHODS

Materials

The experiment was carried out with chrysanthemum (*D. gandiflorum* (Ramat.) Kitam) cv. Albanor Yellow in the Instituto Nacional de Investigaciones Agronómicas (National Institute for Agriculture Research) in Madrid, Spain. It was carried out in a greenhouse for seventeen weeks, under controlled conditions of temperature and humidity. The chrysanthemum plants were bought directly from the producer; they were produced by in vitro culture (Hodson *et al.* 2008).

Plants were homogeneous and had an average of 9 leaves and with a mean stalk length (from the neck of the plant) of 5.70 cm. Plastic pots of 14 cm diameter were used for the transplanting of chrysanthemum and filled up with the different substrates according with the treatments.

Six treatments with two types of broiler manure with different bedding material (straw and sawdust) at volumetric rates of 0 and 10 % mixed with two commercial substrates (peat substrates) were tested. Two treatments were performed with 100 % of two commercial types of substrate and other four treatments were mixtures with 90% of commercial substrate and 10 % of broiler manure (**Table I**). The uncomposted broiler manure was provided from two farms located in Castilla y León (Spain).

The peat substrate 1 was a commercial substrate which consisted of black peat and added nutrients, and it is commonly used in gardening. The peat substrate 2 was a sphagnum peat from the Baltic regions, and it was fertilized to suit the requirements of demanding gardening plants.

The broiler litter manure is a mixture of chicken droppings, bedding, and other materials generated during the broiler production (e.g. remaining food, water and feathers). Bedding material is used to absorb excreta. Broiler growing period is about 45 days long at the end of each period, broiler litter manure with bedding material was removed and replaced by another fresh bedding material. The most common broiler bedding materials used in Spain are barley straw and pine sawdust.

Chemical analyses

Before mixtures were performed, chemical analyses were conducted on the two peat substrates and

TABLE I. TREATMENTS OF PEAT SUBSTRATES 1 AND 2 AMENDED WITH BROILER MANURE (V/V)

Treatments	Substrates		Broiler manure	
	Peat Substrate 1 (%)	Peat substrate 2 (%)	Straw (%)	Sawdust (%)
T1	100	0	0	0
T2	90	0	10	0
T3	90	0	0	10
T4	0	100	0	0
T5	0	90	10	0
T6	0	90	0	10

TABLE II. CHEMICAL COMPOSITION OF THE PEAT SUBSTRATES AND BROILER MANURE

Chemical composition	Substrates		Broiler manure	
	Peat substrate 1	Peat substrate 2	Straw	Sawdust
NH^+_4–N (mg/kg)	58.93 (1.39)	61.26 (1.38)	8261 819.47 (381.62)	6 125.01 (696.26)
NO^-_3 –N (mg/kg)	1 602.82 (1.05)	1 311.58 (1.70)	235.58 (63.90)	203.50 (35.23)
Kjeldahl Nitrogen (%)	0.98 (0.33)	1.14 (0.34)	4.57 (0.86)	3.46 (0.03)
pH (H_2O)	5.87 (0.12)	3.52 (0.07)	7.66 (0.23)	8.47 (0.10)
E.C. (dS/m)	0.95 (0.24)	0.37 (0.08)	11.21 (3.85)	8.59 (1.11)
OM (%)	48.55 (2.57)	39.22 (2.29)	61.58 (2.95)	62.01 (1.07)
Total P (mg/kg)	0.93 (0.41)	0.95 (0.31)	9 478.50 (135.83)	9 299.75 (558.18)
Total K (mg/kg)	1.96 (1.21)	2.17 (1.22)	19 147.50 (557.88)	20 135.30 (1 886.58)

Standard deviations are in parentheses

the two types broiler manure samples (**Table II**). The following parameters were determined: pH was measured in a 1:2.5 (w/v), substrate water suspension with a glass electrode (pHmeter Basic20). The electrical conductivity was determined in a 1:5.0 (w/v), substrate: water suspension with a platinum electrode connected to a conductivimeter (CDM3 Radiometer, Copenhagen) at a reference temperature of 25 ºC. Total Kjedahl nitrogen was determined by the Kjedahl method (Hesse, 1971) and inorganic nitrogen (NH^+_4 –N and NO^-_3 –N) by the Bremner method, using airstream distillation (Bremner, 1965); P and K were extracted with acids (McGrath and Cubliffe 1985) and their concentrations determined using inductively coupled argon plasma emission spectrometry (ICPES) (Sims and Kline 1991).

The experiment lasted 119 days (17 weeks); it ended when most of the flowers were open. The following parameters were evaluated at the end of the experiment: 1) final stem length (FSL), 2) biomass dry weight (BDW), 3) number of flowers per plant (FN) (open and unopened flowers), 4) dry matter content of the biomass (%DM), and 5) plant mortality. Also the ratio between BDW and FSL (BDW/FSL) was calculated.

Data analysis

Data obtained for the FSL, BDW, %DM, FN and ratio between BDW and FSL (BDW/FSL) of the plants were subjected to variance analysis by the ANOVA procedure of the Statgraphics Centurion (2010), after being subjected to the arcsine transformation $(\times/100)^{0.5}$ to guarantee a normal distribution. In all cases the variance analysis model included the factor treatment (T1, T2, T3, T4, T5, T6). The averages were separated using the LSD test ($P<0.05$).

RESULTS AND DISCUSSION

There was no mortality of plants in any of the studied treatments. When the percentage of broiler manure increased in the mixture of substrate plant mortality was higher (25 %, 50 %), therefore the parameters of crop growth were not studied. This may be because the electrical conductivity of the substrate was not suitable for chrysanthemum cultivation (Sonnevel 2000). **Table III** shows the results of quality and growth parameters in chrysanthemum.

In all cases, the results of growth and number of flowers were better with substrate mixtures of black peat than with mixtures of sphagnum peat substrate. The addition of poultry manure to black peat substrate did not improve significantly the growth of plants, but significantly increased the number of flowers per plant. This could be related to the increasing of plant-available nitrogen in the substrates with a mixture of poultry manure (Bugarín *et al.* 1998).

Plants grown in sphagnum peat substrate had lower growth and only survived. This could be due to the low pH of sphagnum peat substrate. This result is similar to that obtained by EunJoo *et al.* (2000) for chrysanthemum pot culture.

However, the growth and flower number of the plants were significantly increased with the addition of poultry manure to sphagnum peat substrate. These results are similar to those obtained by Carr *et al.* (1998); this might be due to increased substrate pH to values close to the optimum for cropping and higher amount plant-available nitrogen in the substrate.

Also, significant differences in BDW were observed, and the best results were obtained for Treatment 1. As for other parameters, the addition of broiler manure in sphagnum peat substrate improved the quality of the plant at the end of the growth season. Always

TABLE III. EFFECT OF TREATMENT TYPE ON GROWTH PARAMETERS AND QUALITY OF CHRYSANTHEMUM CULTIVATION

Treatments	N	FSL (cm)	BDW (g)	% DM	FN	BDW / FSL
T1	4	29.200^{a}	13.247^{a}	19.395^{a}	26.00^{b}	0.4536^{a}
T2	4	29.125^{a}	11.430^{b}	16.785^{b}	30.00^{a}	0.3908^{ab}
T3	4	26.250^{ab}	11.325^{b}	16.602^{b}	32.00^{a}	0.4345^{a}
T4	4	9.875^{c}	3.467^{d}	11.745^{d}	02.25^{d}	0.3571^{bc}
T5	4	26.125^{b}	7.973^{c}	13.591^{c}	20.00^{c}	0.3070^{c}
T6	4	26.250^{b}	8.461^{c}	13.194^{c}	27.50^{b}	0.3114^{c}
SEM		0.87543	0.5224	0.4601	1.8549	0.02362
p		<0.0001	<0.0001	<0.0001	<0.0001	0.0010

N = Observations number.
FSL = Stem length.
BDW = Biomass dry weight.
% DM = Dry matter content of the biomass.
FN = Number of flowers per plant
SEM = Standard error of mean.
p = Probability values resulting from the analysis of variance

the plants with mixtures of sphagnum peat substrate were of lower quality because the stem was weaker (the ratio between BDW and FSL was lower) (**Fig. 1**).

Plants grown with a mixture of black peat were more compact, forming a hemisphere in the container according to the desired quality in chrysanthemum plant pot.

Therefore, using broiler manure as an additional material to commercial substrate in chrysanthemum plant production is an interesting option when it is recycled avoiding it be an important source of contamination, and also it could be a way to reduce cultivation costs.

CONCLUSION

There was no plant mortality with the mixtures tested, but when the percentage of broiler manure in the substrate mixture increased, the plant mortality was remarkable.

The number of flowers per plant increased in all treatments when poultry manure was added to the substrate.

Plants grown with mixtures of sphagnum peat substrate had lower quality because the crown was less compact.

Fig. 1. Chrysanthemum cultivation: plants grown with substrate mixtures of peat substrate 1 (left picture) vs plants grown with substrate mixtures of peat substrate 2 (right picture)

ACKNOWLEDGEMENTS

This research was supported by the INIA-FEDER RTA2005-00120-CO2-01 and RTA2009-00074-00-00 projects. The authors wish to extend their sincere thanks to Mr. Jesús L. García for the agricultural labor and Mrs.Angela García and Mrs. Isabel González for their help with analytical work.

REFERENCES

AIPH. (2006). International Flowers and Plants 2006 International Association of Horticultural Producers and Union Fleurs. Florian Heinrichs. Institut für Gartenbauökonomie der Leibniz Universität Honnover. ISBN: 90.74486-15-0.

Bremner M.P., Paredes C., Sánchez-Monedero M.A., Cegarra J. (1965) Inorganic forms of nitrogen. Methods of Soil. Analysis Part 2. Am. Soc. of Agro, Wis. 9. pp. 1179-1237.

Bugarín M., Baca G., Martínez J., Tirado J.L., Martínez A. (1998). Amonio/nitrato y concentración iónica total de la solución nutritiva en crisantemo. I Crecimiento y floración. Terra Latinoamericana 16, 113-124.

Carr L.E., Brodie H.L., Bouwkamp J.C., Ku C. (1998). Poultry residual composts: Materials Balance and crop response. Compost Sci. Util. 6, 36-43.

EunJoo H., JongHyang B., YongBeom L. (2000). Growth and photosynthetic characteristics of chrysanthemum plantlets as affected by pH and EC of the nutrient solution in microponic culture. J. Korean Soc. Hort. Sci. 41, 12-15.

European Commission. (2004) Prevención y Control Integrado de la Contaminación (IPPC) Documento de referencia de mejores técnicas Disponibles en la Cría Intensiva de Aves de Corral y Cerdos. Documento BREF ILF. Ministerio de Medio Ambiente. Madrid, España.

Evans M.R., Konduru S., Stamps R.H. (1996). Source variation in physical and chemical properties of coconut coir dust. HortScience 31, 965-967.

Hodson E., Forero A., Cancino G., Moreno A., Monsalve L.E., Acero W. (2008). In vitro regeneration of three chrysanthemum (*Dendrathema grandiflora*) varieties "via" organogenesis and somatic embryogenesis. Universitas Scientiarum 13, 118-127.

Hesse P.R. (1971). *A Textbook of soil chemical analysis*, John Murray, 1971, 520 p.

López M.C., Ruiz J., Masaguer A.. (2006). Producción de planta ornamental en contenedor con sustrato alternativos a la turba. Ensayos en la Comunidad de Madrid. Consejería de Economía e Innovación Tecnológica. Comunidad de Madrid. Colección de Investigación 8, p. 176.

McGrath S.P., Cubliffe C.H. (1985). A simplified method for the extraction of metals Fe, Zn, Cu, Ni, Cd, Pb , Cr, Co and Mn from soils and sewage sludges. J. Sci. Food Agric. 36, 794-798.

Sims J.T. and Kline J.S. (1991). Chemical fractionation and plant uptake of heavy metals in solids amended with co-composted sewage sludge. J. Eviron. Qual. 20, 387-395.

Statgraphics Centurion (2010). StatPoint Technologies Inc. Corporate Headquarters: 560 Broadview Ave. Suite 201 Warrenton, VA 20186, USA.

Sonneveld C. (2000). Effects of salinity on substrate grown vegetables and ornamentals in greenhouse horticulture. Ph. D. Thesis, Wageningen University, Netherlands, p. 151.

Wang Y. and Blessington T.M. (1990) Growth of interior performance of poinsettia in media containing composted cotton burrs. HortScience. 25, 407-408.