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Effect of Pig Litter Composted on Growth of Maize (*Zea maiz*) and Havanan Pepper (*Capsicum chinense*) Plants

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Abstract: The effect of pig litter composted on growth of Maize (M) and Havanan Pepper (HP) plants was evaluated. The compost were made of rice husk litter from pens where 3 stoking densities of pigs were fattening (3.5 (C1), 2.3 (C2) and 1.7 m^2pig^{-1} (C3)). There was a Control (C) treatment (without fertilizer) and a fertilized one with Vermicompost (V). The average height (48.8 cm), stalk thickness (8.8 mm) and dry matter weight of leaves (8.3 g) were greater in the M plants in the compost treatments at 51 days after planting ($p<0.05$) than in the control one (33.3 cm, 5.2 mm and 5.8 g, respectively). The Foliage Cover (FC) in the HP plants was greater in the compost treatments (363.7 cm) than in the C treatment (287.2 cm) ($p<0.05$). Height, dry matter weight of root and leaves in the M plants and the height and FC in the HP plants increased linearly ($p<0.05$) from C1-3. The M plants in treatment V had greater height (63.5 cm), stalk thickness (11.3 mm), dry matter weight of leaves (10.5 g) and total nitrogen in leaves (1.9 g) than the average in the composts treatments (48.8 cm, 8.8 mm and 8.3 g, respectively). The plants of HP in V treatment had greater FC (443.3 cm) than the average in composts treatments (363.7 cm) ($p<0.05$). Nevertheless, there were not differences between C3 and V treatment ($p>0.05$) for all the response variables. The results suggested that it is possible to obtain a good quality compost from pig litter of rice husk. The compost quality was positively associated with the stoking pig density in the pens.

Key words: Compost, maize, havanan pepper, litter, pigs, rice husk

INTRODUCTION

The pig production is one of the agricultural activities of greater importance in latinoamerican countries, in both the productive and social point of view. The commercial pig production is mainly of the intensive type, which has a number of disadvantages. One of them is the inadequate handling and disposal of the organics remainders, that are volume up when mixed with the effluents of washed pens. In order to reduce the amount of slurries coming from pig pens some of countries in latinamerica are using successfully the system of growing pigs in pens with straw litters. After, pig litters can be composted and used like organic fertilizer (Edelmann *et al*., 2005). During the composting process the organic material is decomposed and progressively transformed into mineral material (Alidadi *et al*., 2007).

The compost process could be defined as a biotechnology where microorganism, worms and insects participate to produce an innocuous product, chemically stable and utilizable to improve soil fertility and crop production. Compost had shown to increase crop production at green houses and under field conditions (Romero *et al*., 2000; Pool *et al*., 2000). The utilization of composts improved the porosity, aeration and water retention in the soil and the high nitrate content of the composts produced an increased uptake of nitrogen by the plant tissues, resulting in increased plant growth (Atiyeh *et al*., 2001).

Thus, the objective of this study was to evaluate the growth of maize and havanan pepper plants fertilized with compost made from rice husk litter used to rear pigs.

MATERIALS AND METHODS

The experimental study was carried out in the Faculty of Medicine Veterinary and animal science from the University of Yucatán, situated in Yucatán, México.

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Table 1: Chemical characteristics of the soil, compost made of litter from pens with 3 stoking pig densities and the Vermicompost (V) utilized in this experiment

	Treatments				
Variables	Soil	C1	C2	C3	V
Total Nitrogen (%)	0.5	1.4	1.4	1.3	1.2
Organic Carbon (%)	3.5	19.4	19.2	17.6	6.0
Rate of C/N	7.5	14.0	14.3	13.3	5.0
Total phosphorous (ppm)	229.1	1169.2	1784.3	1740.7	1694.2

C1 = Stoking density of 3.5 m^2 pig^{-1}; C2 = Stoking density of 2.3 m^2 pig^{-1}; C3 = Stoking density of 1.7 m^2 pig^{-1}

Two kg m^{-2} of rice husks was used as litter during 20 days in pens with 3 stoking pig densities (3.5, 2.3 and 1.7 m^2 pig^{-1} for treatments C1, C2 and C3, respectively). Then, the rice husk litter mixed with the pig manure was collected and composted during 60 days. The chemical composition of the composts made is shown in Table 1.

Plants of maize (*Zea maiz*) and Havanan pepper (*Capsicum chinense*) were planted in pots (45×45 cm wide and 35 cm height) with approximately 8 kg of soil from the central area of Yucatan, México (luvisol type). The plants fertilized with the composts C1, C2 and C3. In addition, other plants of Maize (M) and Havanan Pepper (HP) were fertilized with a commercial vermicompost or without any (control). The plants were fertilized with a proportion equivalent to 0.5 kg of compost m^{-2}. The plants were kept in a green house during the experiment. Table 1 shows the chemical characteristics of the soil and composts used.

The treatments, in each crop (M or HP), were distributed in a completely randomised design, with 3 replicates per treatment.

Height (H) and Stalk Thickness (ST) of M plants at 37, 44 and 51 days of age were measured. The root, stalk and leaves of the M plants were dried in an oven at 60°C during 2 days to estimate the dry matter at 51 days after planting. Nitrogen was measured by Kjedahl method also at 51 days after planting in roots, stalks and leaves of the M plants.

Height at 35, 70 and 105 days after planting and foliage cover at 86 days after planting were registered in HP plants.

The response variables were analysed using one way analysis of variance. Treatment means were compared using pre-planned contrasts. Multiple regression analysis were carried out to estimate the height, stalk thickness and dry matter yield of leaves in the M plants at 51 days after planting in response to the dry matter root yield and the phosphorus content in the compost.

RESULTS AND DISCUSSION

The results on height and stalk thickness in the M plants are shown in Table 2. The M plants in control treatment had a lower growth ($p<0.05$) than the average of the M plants in the compost treatments and the V treatment. Stalk thickness of the M plants were better for the compost and V treatment as compared to the control treatment ($p<0.05$). A significant positive linear response was observed as the stoking pig density increased ($p<0.05$). The H and ST of the M plants were better for the V treatment in comparison with the average of the compost treatments ($p<0.05$). However, not significant differences were observed between C3 and V treatment for H and ST ($p>0.05$). These results can be associated to the phosphorous content in the composts evaluated (Table 1). Phosphorus serves various basic cellular functions, in the activation of metabolic intermediates and also, in the regulation of enzymes and as a structural element in nucleic acids and phospholipids (Atiyeh *et al*., 2002; Bucher, 2007). The increase in concentration of phosphorous in the compost from the pig litter was associated to the concentration of phosphorous in form of phytates in the pig diets utilized. The major part of the phosphorous in the crops used to fed the pigs (sorghum and soyabean meal) where the rice husk litter was obtained to be composted, is in form of phytates, so, phosphorous in form of phytates have a low availability for the animals and increase its concentration in the faeces (Liu *et al*., 1998; Wienhold and Miller, 2004).

Table 2: Height and stalk thickness of maize plants, fertilized with Vermicompost (V), with compost made of litter from pens with three stoking pig densities and a control treatment (without compost)

	Days after planting					
	Height (cm)			Stalk thickness (mm)		
Treatment	37	44	51	37	44	51
Control	16.80	23.50	33.3	4.80	5.20	5.20
C1	14.80	23.30	41.0	6.00	6.30	7.20
C2	15.80	28.50	45.5	7.30	7.70	8.20
C3	17.20	33.80	60.0	9.80	10.70	11.00
V	18.30	35.20	63.5	9.80	11.20	11.30
SE	0.40	0.60	1.4	0.30	0.35	0.36
Contrasts	p-values					
Control vs C1, C2 and C3	ns	0.003	0.001	0.001	0.002	0.001
Linear response in C1, C2 and C3	ns	0.001	0.001	0.001	0.001	0.002
C1, C2 and C3 vs V	0.028	0.001	0.001	0.011	0.003	0.010
C3 vs V	ns	ns	ns	ns	ns	ns

C1= Stoking density of 3.5 m^2 pig^{-1}; C2= Stoking density of 2.3 m^2 pig^{-1}; C3= Stoking density of 1.7 m^2 pig^{-1}; ns: no significant difference ($p>0.05$)

The H, ST and Dry Matter weight of Leaves (DML) in the M plants at 51 days after planting was explained ($p<0.05$) by the phosphorous added through the compost and by the Root Dry Matter Weight (RDMW) in the M plants. The regression equations and coefficients of determination (R^2) were:

H = -10.89 + 55845.1 (Phosphorous)+ 6.48 (RDMW)
R^2 = 99.96%
ST = -1.98 + 0.0018 (Phosphorous) + 1.31 (RDMW)
R^2 = 99.98%
DML = 0.07 + 0.0016 (Phosphorous) + 0.96 (RDMW)
R^2 = 84.41%

The increases of H, ST and dry matter weight of leaves in the M plants from compost treatments in comparison to the control treatment agrees with the findings of Pool *et al.* (2000) who reported that the utilization of poultry manure as source of phosphorous increased the yield in the crops evaluated by them.

The dry matter weight and total nitrogen in the root, stalk and leaves of the M plants at 51 days after planting are shown in Table 3. A linear increases ($p<0.05$) in dry matter weight of root and leaves in the M plants was observed as stoking pig density increased from C1-3 treatments. In general, the M plants in the control treatment tended to have lower dry matter or total nitrogen as compared to the compost treatments ($p<0.05$). No differences ($p>0.05$) were observed between the compost treatments for total nitrogen content in the M plants. The dry matter weight and nitrogen in the stalk and leaves of the M plants were higher in vermicompost treatment than in the compost treatments. However, it is relevant to mention that no differences between V and C3 treatments were observed in nitrogen content in the M plants ($p>0.05$). These results agree with those of other research studies where compost and vermicompost were evaluated (Atiyeh *et al*., 2002; Levy and Taylor, 2003; Odongo *et al*., 2007; Bachman and Metzger, 2008). The plant growth enhancement by utilization of composts and vermicomposts seemed to be related to the improvement in physical characteristic of the soil and an increased uptake of nitrogen by the plant tissues, resulting in increased plant growth (Atiyeh *et al*., 2001).

The height and foliage cover in the HP plants are shown in Table 4. No differences were observed in those variables in HP plants between the control and the compost treatments ($p>0.05$). However, a significant linear response ($p<0.05$) was observed for both traits when the stoking pig density increased from C1-3 treatments. There was no difference between V and C3 treatment in any of the variables evaluated ($p>0.05$).

In this experiment, the plants of HP in V treatment showed the highest heights in comparison with the plants in the compost treatments at 35 and 70 days after planting ($p<0.05$). These results agree with Hernandez *et al.* (1999), Pool *et al.* (2000) and Santamaría *et al.* (2001), who found a better growth and production in several crops when fertilized with a vermicompost. However, at 105 days after planting there was no differences between the V and the compost treatments ($p>0.05$).

The increased of height observed in the HP plants as stoking pig density increased from C1-3 at 35, 70 and 105 days after planting, could be associated with the amount of phosphorus in the compost (Muñoz, 1999; Bucher, 2007). These results can be confirmed by what happened in that experiment, where the important factor which explains the increased in growth of the M plants had associated to the phosphorus content in the compost treatments.

Table 3: Dry matter weight and total nitrogen of maize plants, fertilized with Vermicompost (V), with compost made of litter from pens with three stoking pig densities and a control treatment (without compost) at 51 days after planting

	Dry matter (g)			Total nitrogen (g)		
Treatment	Root	Stalk	Leaves	Root	Stalk	Leaves
Control	5.20	4.90	5.80	0.50	0.80	1.10
C1	5.30	5.30	6.50	0.40	0.80	1.40
C2	5.30	6.60	7.90	0.30	0.80	1.40
C3	7.50	9.30	10.40	0.60	0.90	1.60
V	7.10	12.10	10.50	0.60	1.40	1.90
SE	0.27	0.65	0.28	0.03	0.09	0.08
Contrasts	p-values					
Control vs C1, C2 and C3	ns	ns	0.01	ns	ns	ns
Linear response form C1-3	0.03	ns	0.01	ns	ns	ns
C1, C2 and C3 vs V	ns	0.01	0.01	ns	0.04	0.05
C3 vs V	ns	ns	ns	ns	ns	ns

C1 = Stoking density of 3.5 m^2 pig^{-1}; C2 = Stoking density of 2.3 m^2 pig^{-1}; C3 = Stoking density of 1.7 m^2 pig^{-1}; ns: no significant ($p>0.05$)

Table 4: Height and foliage cover of havanan pepper plants, fertilized with Vermicompost (V), with compost made of litter from pens with three stoking pig densities and a control treatment (without compost)

	Age (days)			
	Height (cm)			Cover (cm^2)
Treatment	35	70	105	86
Control	28.30	34.30	36.90	287.20
C1	28.70	34.10	35.90	317.60
C2	28.40	35.40	37.30	295.40
C3	30.70	39.00	41.30	478.10
V	33.40	40.10	42.00	443.30
Standard Error	0.27	0.53	0.59	15.73
Contrasts	p-values			
Control vs C1, C2 and C3	ns	ns	ns	0.06
Linear response from C1-3	0.01	0.01	0.01	0.01
C1, C2 and C3 vs V	0.01	0.05	ns	0.05
C3 vs V	ns	ns	ns	ns

C1 = Stoking density of 3.5 m^2 pig^{-1}; C2 = Stoking density of 2.3 m^2 pig^{-1}; C3 = Stoking density of 1.7 m^2 pig^{-1}; ns: no significant ($p>0.05$)

A superior foliage cover in the plants of HP in the compost treatments compared with those in the control treatment at 86 days after planting was observed ($p<0.06$). These results agree with those of Ranwa and Singh (1999), Sánchez *et al.* (2000) and Balbi *et al.* (2002), who found that the greater development of the aerial biomass was directly related to the growth of the plants. There was no differences between V and C3 treatment in any of the variables evaluated in the HP plants ($p>0.05$). These results point out that compost from pig litter of rice husk could support plants development in a very similar way to those of vermicompost.

CONCLUSION

The results of this study suggest that it is possible to obtain good quality compost from pig litter of rice husk. The quality of the compost was positively associated with the stoking pig density in the pens.

REFERENCES

Alidadi, H., A.R. Parvaresh, M.R. Shahmansouri, Pourmoghadas H. and A.A., 2007. Combined compost and vermicomposting process in the treatment and bioconversion of sludge. Pak. J. Biol. Sci., 10: 3944-3947. PMID: 19090260. http://www.scialert.net/pdfs/pjbs/2007/3944-3947.pdf.

Atiyeh, R.M., N.Q. Arancon, C.A. Edwards and J.D. Metzger, 2002. The influence of earthworm-processed pig manure on the growth and productivity of marigolds. Bioresour. Technol., 81: 103-108. DOI: 10.1016/S0960-8524(01)00122-5. PMID: 11762902. http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V24-444NGWV-K&_user=10&_coverDate=01%2F31%2F2002&_rdoc=1&_fmt=high&_orig=browse&_sort=d&view=c&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=738314bbba4cc50319fcbd10ceea2ac4.

Atiyeh, R.M., C.A. Edwards, S. Subler and J.D. Metzger, 2001. Pig manure vermicompost as a component of a horticultural bedding plant medium: Effects on physicochemical properties and plant growth. Bioresour. Technol., 78: 11-20. DOI: 10.1016/S0960-8524(00)00172-3. PMID: 11265782. http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V24-429XVVH-33&_user=10&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=321675897fe9bb340d14da6beadbeeb8.

Bachman, G.R. and J.D. Metzger, 2008. Growth of bedding plants in commercial potting substrate amended with vermicompost. Bioresour. Technol., 98: 3155-3161. DOI: 10.1016/j.biortech.2007.05.069. PMID: 17689243. http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V24-4PC4DMS-2&_user=10&_coverDate=05%2F31%2F2008&_rdoc=1&_fmt=high&_orig=browse&_sort=d&view=c&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=062e630fe78612c5eb79a29c630abadb.

Balbi, C.N., A.R. Ferrero and P.A.Garcia, 2002. Culture estructure, intercepted radiation and dry matter yield in Maize plants directly sowed. In: XIII Reunión de Comunicaciones Científicas and Técnicas. Facultad de Ciencias Agrarias-UNNE. Campo Experimental FCA. Argentina.

Bucher, M., 2007. Functional biology of plant phosphate uptake at root and mycorrhiza interfaces. New Phytol., 173: 11-26. DOI: 10.1111/j.1469-8137.2006.01935.x. PMID: 17176390. http://www3.interscience.wiley.com/cgi-bin/fulltext/118538973/PDFSTART.

Edelmann, W., U. Baier and H. Engeli, 2005. Environmental aspects of the anaerobic digestion of the organic fraction of municipal solid wastes and of solid agricultural wastes. Water Sci. Technol., 52: 203-208. PMID: 16180429. http://www.iwaponline.com/wst/05201/wst052010203.htm.

Hernández, D., C. Villalobos and M. Vega, 1999. Production of almácigos with lombriz humus. In: XI Congreso Nacional Agronómico y III Congreso Nacional de Suelos. Resumen 334. Escuela de Ciencias Agrarias. Universidad Nacional de Costa Rica, San José, Costa Rica. http://www.mag.go.cr/congreso_agronomico_XI/a50-6907-III_080.pdf.

Levy, J.S. and B.R. Taylor, 2003. Effects of pulp mill solids and three composts on early growth of tomatoes. Bioresour. Technol., 89: 297-305. DOI: 10.1016/S0960-8524(03)00065-8. PMID: 12798121. http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V24-488G3WK-6&_user=10&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=168bdd9a1d5919c7733d8e7446808e19.

Liu, J., D.W. Bollinger and T.L. Veum, 1998. Lowering the dietary calcium to total phosphorus ratio increase phosphorus utilization in low-phosphorus corn-soybean meal diets supplemented with microbial phytase for growing-finishing pigs. J. Anim. Sci., 76: 808-813. PMID: 9535341. http://jas.fass.org/cgi/reprint/76/3/808.pdf.

Muñoz, R., 1999. Effect of the saturation by bases, Ca: Mg relations in the ground and dose of phosphorus on the growth and mineral nutrition of the maize. In: XI Congreso Nacional Agronómico and III Congreso Nacional de Suelos. Escuela de Ciencias Agrarias. Universidad Nacional de Costa Rica, San José, Costa Rica. http://www.mag.go.cr/congreso_agronomico_XI/a50-6907-III_102.pdf.

Odongo, N.E., K. Hyoung-Ho, H.C. Choi, P. van Straaten, B.W. McBride and D.L. Romney, 2007. Improving rock phosphate availability through feeding, mixing and processing with composting manure. Bioresour. Technol., 98: 2911-2918. DOI: 10.1016/j.biortech.2006.10.015. PMID: 17150355. http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V24-4MH2BSJ-1&_user=10&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=378d24eaeb6d77db5f5dba6a4a940960.

Pool, N.L., S.A. Trinidad, B.J.D Echeverts, M.J. Pérez and G.A. Martínez, 2000. Mejoradores de la fertilidad del suelo en la agricultura de ladera de los altos Chiapas, México. Agrociencia, 34: 251-259. http://www.colpos.mx/agrocien/Bimestral/2000/may-jun/art-1.pdf.

Ranwa, R.S. and K.P. Singh, 1999. Effect of integrated nutrient management with vermicompost on productivity of wheat (*Triticum aestivum*). Ind. J. Agric., 44: 554-559. http://www.cababstractsplus.org/abstracts/Abstract.aspx?AcNo=20033066451.

Romero, M.R., S.A. Trinidad, E.R. García and C.R. Ferrera, 2000. Producción de papa y biomasa en suelos con abonos orgánicos y minerales. Agrociencia, 34: 261-269. http://www.colpos.mx/agrocien/Bimestral/2000/may-jun/art-2.pdf.

Sanchez, E.P., S.A. Larque, S.T. Nava, C. Trejo, 2000. Respuesta de plantas de maíz y frijol al enriquecimiento de dióxido de carbono. Agrociencia, 34: 311-320. http://www.colpos.mx/agrocien/Bimestral/2000/may-jun/art-7.pdf.

Santamaría, R.S., C.R. Ferrera, S.J.J. Almaraz, S.A. Galvis and B.I. Barois, 2001. Dinámica y relaciones de microorganismos, c-orgánico y n-total durante el composteo y vermicomposteo. Agrociencia, 35: 377-384. http://www.colpos.mx/agrocien/Bimestral/2001/jul-ago/art-1.pdf.

Wienhold, B.J. and P.S. Miller, 2004. Phosphorus fractionation in manure from swine fed traditional and low-phytate corn diets. J. Environ. Qual., 33: 389-393. PMID: 14964395. http://jeq.scijournals.org/cgi/reprint/33/1/389.