Fresenius Envir Bull 4: 232-237 (1995)

1018-4619/95/040232-06 $ 1.50+0.20/0

CORN FERTILIZATION WITH THREE (SUGARBEET) VINASSE COMPOSTS

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SUMMARY. Beet vinasse (desugared, beet molasses) was co-composted with each of three following solid agricultural residues: grape marc, olive press cake and the cotton gin trash. The composts were used to fertilize corn. A treatment of mineral fertilizer was used for comparison. Compost had no detrimental effects on the growth parameters and nutritional status of corn. Compost treatments produced yields (weight of grain) that were higher than those obtained for mineral fertilizers.

KEYWORDS: beet vinasse, compost, plant growth, nutritional status, corn

INTRODUCTION

An excessive use of inorganic fertilizers leads to a progressive impoverishment of soil organic matter. This is a problem affecting extensive zones in the world [1] including Andalusia [2]

Land application of organic wastes is recognized as an important alternative disposal method both in recycling nutrient essential for plant growth and in increasing soil fertility [3].

Beet vinasses are beet molasses almost completely biochemically desugarized, destilled and sometimes concentrated. The use of this waste as fertilizer is being studied at present [4, 5].

Vinasse has three major problems for direct application as fertilizer: (a) high salt content [6], (b) low P content (P_2O_5 0.012%) and (c) high density (1.23 g/cm^3). These problems may be overcome through the co-composting of vinasse with agricultural solid wastes, thus obtaining a compost which can be used as a substitute for mineral fertilizer [7].

In this paper, the effect of deep fertilization of three vinasse composts as an alternative to traditional mineral fertilizer in corn is considered. Growth parameters, nutritional status and yield of corn on soil amended with three vinasse composts and a mineral fertilizer were compared.

MATERIALS AND METHODS

Compost

Three mixtures of vinasse and agricultural solid wastes were co-composted in static piles with forced aeration during four months.The initial proportion of solid wastes and vinasse were: COMPOST G: Grape marc (90%) and vinasse (10%); COMPOST O: Olive pressed cake (75%), leonardite (10%) and vinasse (15%); COMPOST C: Cotton gin trash (50%), leonardite (10%) and vinasse (40%). The chemical analysis of the three composts is shown in Table 1.

Soil and fertilizer treatments

Some relevant characteristics of the soil at two different depths (20 and 40 cm) are given in Table 2. Field experiments were carried out in plots of 10 x 15 m, in which five treatments were tested. The following doses were applied in each treatment: TG 15000 kg ha^{-1} of G; TO 35000 kg ha^{-1} of O, TC 7500 kg ha^{-1} of C; TF 1000 kg ha^{-1} of a 9-18-27 N-P-K mineral fertilizer. A treatment, TB, without fertilization was used as control. All treatments, except TB, received two top dressings with 300 kg ha^{-1} of urea (46% N). The experiment was carried out in duplicate. The amounts of N, P_2O_5 and K_2O added to the soil in each treatment are shown in Table 3. Corn c.v. Dakar was the test variety used for the experiment.

Table 1: Chemical composition of composts used (Oven-dry basis).

		G	O	C
N	%	2.10	1.00	2.60
P_2O_5	%	1.37	0.26	0.56
K_2O	%	1.30	0.90	2.10
O.M.	%	50.0	69.5	50.6
Na	%	1.70	1.30	2.40
Ca	%	2.80	1.90	1.30
Mg	%	0.30	0.20	0.40
Moisture	%	31	25	18
C/N		12	34	8.2

Table 2: Analytical characteristics of soil.

		DEPTH (cm)	
		0-20	20-40
Sand	(%)	79.4	81.3
Silt	(%)	10.6	9.7
Clay	(%)	10	9
pH (H_2O)		8.1	8.2
O.M.	(%)	0.8	
Kjeldahl-N	mg kg^{-1}	676	675
Available-P	mg kg^{-1}	16	
Available-K	mg kg^{-1}	175	205

Growth parameters

At 108 days after sowing four complete plants were randomly selected from each plot. The leaf area was determined by the following equation:

$$A = 0.811443 * L * a - 955.963 \qquad (1)$$

where A= Area of one leaf (m^2); L= Value of the length of the leaf (m); a= Value of the width taken in the center of the leaf (m).

This relationship between A, a and L was obtained by calibration with measurements obtained by a SKYE leaf areameter for 300 leaves of the same variety of corn collected from a nearby plot [8]. The total plant area (TA, m^2) was calculated by summing the area of each leaf. The leaf area index (LAI, m^2) was estimated by using equation (2):

$$LAI= TA*b \qquad (2)$$

where b is the plant population (in our case 7.1 plants m^{-2}).

Table 3: Amounts of N, P_2O_5 y K_2O added to soils through treatments.

Treatments	*N** *kg ha⁻¹*	*P_2O_5* *kg ha⁻¹*	*K_2O* *kg ha⁻¹*
TG	*221*	*144*	*137*
TO	*263*	*68*	*236*
TC	*160*	*34*	*129*
TF	*90*	*180*	*270*

**Plus 2 x 138 kg ha^{-1} of N (top dressings with urea).*

Yield

To estimate the yield, four representative points were selected in each plot 136 days after the sowing. Ears of each sampling point (four ears per plot) were weighed and thrashed at kernel moisture (10%) [9]. The weight of a thousand kernels was measured per plot. Yield was also measured in the field.

Chemical analysis of plant material

Plant material was collected at 108 (leaves) and 136 days (kernels) after sowing. Leaves and kernels were dried at 70°C after decontamination by washing, and ground. Nitrogen was determined by Kjeldahl digestion. Mineral elements were determined according to Jones *et al.* [9] following dry ashing and ash solution by treatment with conc. HCl on a hot plate. Sodium and K were determined by flame photometry. Calcium and Mg were determined by atomic absorption spectrometry and P by colorimetric determination using the phosphovanadomolybdic complex.

Statistical analysis

The data were analyzed by ANOVA and the differences among treatments were compared using Tukey's test.

RESULTS AND DISCUSSION

Plant Growth and Production

Some parameters related to plant growth are shown in Table 4. Plant height (PH) did not show any significant differences ($P<0.05$) between various treatments.

However, there was an apparent treatment effect for LAIs. While LAI values for TG and TO treatments were not significantly different (P<0.05) from the control TB, LAIs increased significantly for TC and TF. These increases amounted to 29% and 16% respectively over TB. The LAI values for TG, TC and TF were within the usual range reported by Fernández *et al.*[10] The yields were not significantly different (P<0.05) for the five treatments (Fig. 1a). However, the estimated yield was significatly higher (P<0.05) for treatment TC (Fig. 1b).

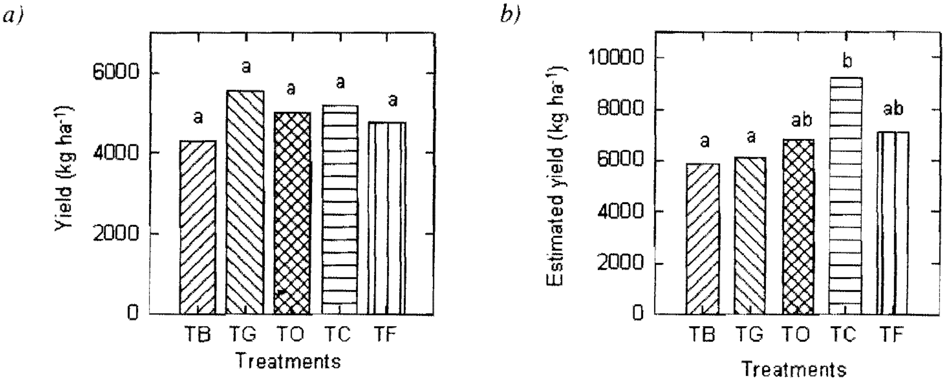
Table 4: Mean values of plant height (PH) and leaf area index (LAI) at 108 days after sowing.

Treatments	*PH (m)*	*LAI*
TB	*1.78 a*	*3.062 a*
TG	*1.91 a*	*3.537 abc*
TO	*1.79 a*	*3.237 ab*
TC	*1.88 a*	*3.959 c*
TF	*1.83 a*	*3.561 bc*

** Values followed by the same letter in the same column do not differ significantly (P<0.05).*

The effect of treatment on the 1000 kernel weights is shown in Fig. 2. The 1000 kernel weights for TO and TC treatments were significantly higher than that obtained for TB. Similar results have been reported by Murillo *et al.*[11]

Figure 1: Effect of treatments on yield (a) and on estimated yield (b). Means of data columns with same letters are not significantly different (P<0.05).



Plant nutrients

Nitrogen, P, K, Ca, Mg and Na concentrations in leaves are shown in Table 5. Nitrogen content did not differ significantly (P<0.05) between various treatments. However, the lowest values were obtained for TB and TO. For TO, the low N content in leaves could be due to the higher C/N ratio of compost O favouring immobilization phenomena [12]. Phosphorus and K contents in leaves were similar for the different treatments but TC displayed the lowest values. This could be due to the dilution phenomena resulting from the higher size of the plants.

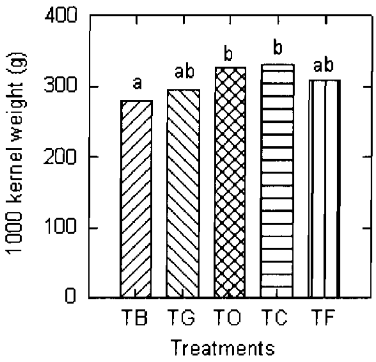
Table 5: Nutrient contents in the ear leaf at 108 days after sowing.

Treatments	*N* %	*P* %	*K* %	*Na* %	*Ca* %	*Mg* %
TB	*2.18 a*	*0.16 ab*	*1.27 a*	*0.075 ab*	*1.14 ab*	*0.35 a*
TG	*2.35 a*	*0.18 b*	*1.96 b*	*0.090 b*	*1.21 ab*	*0.49 bc*
TO	*2.14 a*	*0.17 b*	*1.82 b*	*0.075 ab*	*1.17 ab*	*0.44 abc*
TC	*2.28 a*	*0.15 a*	*1.16 a*	*0.060 a*	*1.28 b*	*0.52 c*
TF	*2.22 a*	*0.17 b*	*1.61 ab*	*0.080 b*	*1.10 a*	*0.42 ab*

* *Values followed by the same letter in the same column do not differ significantly (P<0.05).*

For all the compost treatments, the sodium contents in leaves were similar to that of the mineral treatment, despite the high Na content of the composts. All nutrient values were within the usual ranges [13].

Figure 2: Effect of treatments on 1000 kernel weight. Means of data columns with same letters are not significantly different (P<0.05).



CONCLUSIONS

Results highlighted the use of compost as an alternative to traditional mineral fertilizer. Composts made up of vinasse and agroindustrial wastes had no detrimental effects on the paremeters under evaluation (growth parameters, yield and nutritional status). Best results were observed for cotton gin trash with vinasse (compost C).

ACKNOWLEDGMENTS

The authors thank D. Teodoro Nogueras for supervising this project and Dr. D. Ron for her helpful comments on the manuscript.

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Accepted 16 December 1994