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Effect of selected and non-selected urban waste compost on the initial growth of corn

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Abstract

Brazil produces approximately 242,000 t of waste per day, 76% of it being dumped outdoors and only 0.9% recycled, including composting, which is an alternative still little known in Brazil. In search of a better destination for residues produced by domestic activities, composting stands as a feasible alternative. Organic compost from waste may be used for various purposes, among which are soil recovery, commercial production, pastures, lawns and reforestry and agriculture. However, the quality of the compost determines the growth and the development of plants. The effect of compost made from urban waste on corn plant (*Zea mays* L.) growth was investigated. Two types of compost were used: the selected compost (SC), produced from organic waste selectively collected; and the non-selected compost (NSC), taken from a 15-year-old cell from the Canabrava land-fill, located in Salvador, Bahia, Brazil (altitude 51 m, 12°22′–13°08′S, 38°08′–38°47′W). Corn was seeded in polyethylene pots, with soil-compost mixing substrate in the proportion of 0, 15, 30, 45 and 60 t ha^{-1} equivalent doses. Chemical analyses of the compost and growth properties of the plant like chlorophyll content; height and stem diameter; aerial and radicular dry biomasses, were used to evaluate compost quality. Plants cultivated with SC presented a superior gain, being of 52.5% in stem diameter, 71.1 and 81.2% in root and stem biomasses, respectively. Chlorophyl content alterations were observed in plants from treatments using 30 t compost ha^{-1} dose onwards. Conventional and multivariate statistical methods were used to evaluate these results. The beneficial action of organic compost in plant growth was confirmed with this research.

Keywords: Corn; Organic compost; Plant development; Urban waste; *Zea mays* L.

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1. Introduction

Brazil produces approximately 242,000 t of waste per day, 76% of it being dumped outdoors and only 0.9% recycled (EMBRAPA, 1996), including composting, which is an alternative still little known in Brazil. The volume of organic waste produced in the big cities is so great (above 50% of the total amount) that the natural systems cannot satisfactorily decompose it. For this reason, waste turns out to be considered as one of the greatest causes of environmental pollution (Scarlato and Pontin, 1995).

Recycling of urban solid residues contributes to the reduction of its volume, economy of natural resources, environmental protection, reduction of pathologies, economical development, besides other benefits to the community and the environment (Pereira Neto, 1994; Scarlato and Pontin, 1995). In search of a better destination for residues produced by both domestic and industrial activities, composting stands as a feasible alternative. This technique emphasizes recycling, contributes meaningfully to the reduction of the original volume, does not degrade the environment and eliminates pathogens (Escosteguy et al., 1993). Furthermore, it produces fertilizers (Scarlato and Pontin, 1995).

Since ancient times, the addition of organic matter has benefited soils and contributed to the productivity of plants. The use of solid residues for the rational production of compost has started about a century ago and ever since, many methods have been studied (Espinoza, 1997). According to Pereira Neto (1994), an accessible and low cost way to produce compost basically consists of the formation of piles of residues with periodical revolving to improve mass aeration and homogenization and accelerate the decomposition process.

According to Costa (1986), the effect of compost from organic residues goes beyond the purely chemical action of industrialized fertilizers, as it benefits both physical and biological mechanisms of the soil. Researches conducted by Lima et al. (1997a,b,c) proved the beneficial action of compost on the physical–chemical properties of the soil and on the plant development.

For Espinoza (1997), organic compost from waste may be used for various purposes, among which are soil recovery, commercial production, pastures, lawns and reforestry.

This work was developed with the purpose of evaluating the effect of organic compost from urban waste, both selected and non-selected, on the growth of corn plants (*Zea mays* L.).

2. Material and methods

The experiment was carried out at the Green House of the Biology Institute of Federal University of Bahia State, in Salvador, Bahia, Brazil. The experiment out-line was entirely casualized in a factorial $2 \times 4 + 1$, with five repetitions.

Two types of composts were used, one selectively collected (SC) and the other, non-selectively collected (NSC), mixed into the soil, collected in a forest area in Ituberá, Bahia, Brazil, and classified as Red Yellow Latosol, in equivalent doses at 15, 30, 45 and 60 t ha^{-1}. For the purpose of comparison, there was a control treatment (C) using only the soil specified above. The physical analysis of this soil shows the predominance of clay fractions (560 g kg^{-1}), while silt, fine and thick sands occurred with 120, 90 and 230 g kg^{-1}, respectively. The physical–chemical characteristics of the soil may be found in Table 1. Table 2 shows the chemical characteristics of selected and non-selected compost.

Table 1
Physical–chemical characteristics of red Yellow Latosol Soil

Physical characteristics (g kg^{-1})	
Thick sand	230.0
Fine sand	90.0
Silt	120.0
Clay	560.0
Chemical characteristics ($mmol_c$ kg^{-1})	
pH in water (1:2.5)	5.0
CEC	16.0
Aluminum	7.3
Calcium	5.3
Magnesium	3.3
Potassium	0.6
Phosphorus (mg kg^{-1})	0.3
Carbon (g kg^{-1})	22.2
Nitrogen (g kg^{-1})	1.7
Organic matter (g kg^{-1})	38.9

The experimental units consisted of hard polyethylene pots, containing 3 dm^3 soil and the different doses of SC and NSC, depending on the treatments. After setting the treatments (soils and soil/compost mixtures), the substrate was incubated for 15 days with humidity around 80% field capacity. Demineralized water was used for watering the pots.

The hybrid corn (Agroceres-405) was used as test-plant. Five days after planting, a thinning was made, in order to leave two plants per pot. During the experiment, the substrate humidity was kept near field capacity.

Table 2
Chemical characteristics of selected compost and non-selected compost

Parameter	SC	NSC	Brazil	Germany[a]
Ph in water (1:2.5)	8.1	7.7	6.9[b]	7.5
CEC ($mmol_c$ kg^{-1})	288	324	252[b]	–
Aluminum ($mmol_c$ kg^{-1})	0.0	0.0	0.0[b]	–
Calcium ($mmol_c$ kg^{-1})	86	120	30[c]	39
Magnesium ($mmol_c$ kg^{-1})	6	16	12[c]	8
Potassium (g kg^{-1})	11.7	1.7	15[c]	10
Phosphorus (g kg^{-1})	4.5	1.5	15[c]	6.2
Nitrogen (g kg^{-1})	17.5	5.3	9[c]	11.5
Carbon (g kg^{-1})	325	62	178[b]	–
Organic matter (g kg^{-1})	560	106	360[c]	330
Cd (mg kg^{-1})	<DL	1.9		
Cu (mg kg^{-1})	25	65		
Cr (mg kg^{-1})	23	51		
Ni (mg kg^{-1})	5	8.6		
Zn (mg kg^{-1})	58	151		
Pb (mg kg^{-1})	5.6	53		

[a] Cited by Vogtmann et al. (1993).
[b] Cited by Trindade et al. (1996).
[c] Cited by Kiehl (1985).

By the end of the experimental period, which took 35 days, stem height and diameter of the collected plants were measured. Right after, root and stem were separated and put into paper bags for drying in the stove at 60 °C until constant weight was reached. After 7 days, samples were weighed for the determination of dry biomass. One completely developed leaf (third leaf from top to base) was collected for the determination of chlorophyll *a*, *b*, *a*/*b* *e* $a+b$, using a spectrophotometer Micronal with wave lengths of 645 and 663 nm, according to Mackinney's equation (1941) and the methodology described by Arnon (1949).

The results were analyzed using the statistical package SAS (SAS Institute, 1982). Data were submitted to the variance analysis. The effect of qualitative factors (compost) was separated by the Tukey's test at the 5% level of significance.

3. Results

Tables 3 and 4 show values relative to the parameters height of the plants, stem diameter, root and aerial dry biomasses and a and b chlorophyll contents. Values found in plants cultivated in SC were significantly greater ($P > 0.05$), when compared to the ones of the plants cultivated in C and NSC treatments. Between these two treatments, significant differences were observed from 30 t ha^{-1} dose onwards for the height and 60 t ha^{-1} dose onwards for stem diameter. The addition of increasing doses of NSC did not influence significantly on the gain of dry matter either of the root or of the aerial part.

Plants cultivated with SC presented, even in the treatment with lower compost dose (15 t ha^{-1}), a gain of 54% in height, 52.5% in stem diameter, 71.1 and 81.2% in root and aerial biomasses, respectively, in relation to control treatment (C).

When comparing the corn cultivated in doses of 15 t ha^{-1} SC and 60 t ha^{-1} NSC, e.g., four times more NSC, it was observed that in 15 t ha^{-1} SC treatment, the height of plants

Table 3
Average value of parameters related to the growth of corn plants cultivated in urban waste selected compost and non-selected compost

Treatment	Height (cm)	Diameter (cm)	Biomass root (g)	Biomass aerial part (g)
Control (C)	29.35 a	0.37 a	0.52 a	0.42 a
15 t ha^{-1}				
SC	64.78 d	0.78 c	1.80 b	2.24 b
NSC	29.68 a	0.38 a	0.55 a	0.56 a
30 t ha^{-1}				
SC	75.71 e	1.18 de	3.04 c	5.50 c
NSC	39.82 b	0.45 ab	0.49 a	0.65 a
45 t ha^{-1}				
SC	78.62 e	1.26 e	3.67 d	7.2 d
NSC	47.81 bc	0.46 ab	0.64 a	0.75 a
60 t ha^{-1}				
SC	82.12 e	1.40 f	3.88 d	8.07 e
NSC	50.16 c	0.53 b	0.68 a	0.94 a

Columns with the same letter are not statistically different; Tukey's test 5%.

Table 4
Average content ($g\,kg^{-1}$) of chlorophylls (*Chlo a*, *b*, *a/b*, $a + b$) of corn plants cultivated in selected compost and non-selected compost

Treatment	*Chlo a*	*Chlo b*	*Chlo a/b*	*Chlo* $a + b$
Control (C)	1.32 bc	0.49 ab	2.70 a	1.81 b
$15\,t\,ha^{-1}$				
SC	1.45 cd	0.49 ab	2.96 a	1.9 bc
NSC	1.30 bc	0.49 ab	2.62 a	1.80 b
$30\,t\,ha^{-1}$				
SC	1.65 de	0.58 b	2.84 a	2.2 cd
NSC	1.14 ab	0.42 a	2.70 a	1.5 ab
$45\,t\,ha^{-1}$				
SC	1.76 e	0.59 b	2.97 a	2.36 d
NSC	1.32 bc	0.48 ab	2.76 a	1.80 b
$60\,t\,ha^{-1}$				
SC	1.62 de	0.56 b	2.88 a	2.1 cd
NSC	1.00 a	0.41 a	2.45 a	1.41 a

Columns with the same letter are not statistically different; Tukey's test 5%.

was 22.56% greater than in $60\,t\,ha^{-1}$ NSC treatment, as well as the stem diameter (32.06%), root biomass (37.77%) and the aerial part biomass (58.06%).

Table 4 indicates that chlorophyll *a* and $a + b$ contents presented by plants cultivated with SC (dose $15\,t\,ha^{-1}$), and in both C and NSC treatments (doses 15, 30 and $45\,t\,ha^{-1}$) did not show significant differences. The SC application provoked an increase on *Chlo a* and $a + b$ contents with the use of $30\,t\,ha^{-1}$ dose onwards. The addition of $60\,t\,ha^{-1}$ NSC contributed to decrease *Chlo a* and $a + b$ contents in relation to both C and SC treatments.

4. Discussion

The results obtained in this study confirm the beneficial action of the organic compost on the plant development. They are similar to those previously obtained by Costa (1994) and Trindade et al. (1996), who concluded that the urban waste application contributes to increase the growth of corn plants. However, Vogtmann et al. (1993) state that compost quality determines the growth and the development of plants. In this investigation the corn cultivated with SC showed significantly higher development than the corn cultivated in NSC. The organic compost produced from organic residues previously selected presented a better result on the corn plant development than the organic compost from non-selected residues, although increase in the corn growth could be observed even when cultivated with compost produced from non-selected organic waste. Corn (*Z. mays* L.) plants cultivated in the selected compost treatment presented higher values for biomass production, as well as for all the other evaluated growth parameters.

In a similar way, Lima et al. (1997b), evaluating the behavior of vegetables cultivated in urban waste organic compost, observed an improvement in the soil fertility and an increase in vegetable production. According to Costa (1994), the application of urban waste compost to the soil, besides the improvement of physical–chemical characteristics, may reduce costs with chemical fertilizers. Studying the effect of this type of compost on the growth of lettuce and carrot (*Daucus carota*), the author concludes that the soil fertility with the urban waste compost influenced significantly on the production of dry matter of those cultures. Observations of this kind had already been made by Sganzerla (1983), who obtained an increase of 300 times more in the production of lettuce with compost application when compared to the conventional cultivation.

The contribution of urban waste compost to the development of plants was also referred to by Lopes et al. (1996) for “caupi” (*Vigna unguiculata* (L.) Walp), as well as by Lima et al. (1997a) for the radish (*Raphanus* sp.). Evaluating the effect of urban waste organic fertilizer on the radish physiology, these authors verified a significant increase of both leaf area and biomass production.

In this study the chlorophyll did not prove to be an efficient parameter to evaluate the effect of compost on the corn physiology, although a slight decrease in the chlorophyll concentration was observed in the NSC treatments. According to Wang (1986), a reduction of chlorophyll pigments may be a toxicity indicator. Oliveira et al. (1994), studying the effect of a heavy metal (Cd) on the chlorophyll content, observed that the increases of the metal concentration caused the decrease of *a* and *b* chlorophyll, the *a* chlorophyll being the most influenced.

The results indicate that an appropriate dose of compost for corn production during the initial growth would be 15 $t\,ha^{-1}$ NSC and 30 $t\,ha^{-1}$ SC. Considering that the corn plants gave different responses according to the investigated doses and analyzed parameters, it is recommended to investigate doses higher than 60 $t\,ha^{-1}$ SC to confirm up to which dose there is no different response. It is also clear that SC contains greater amount of nutrients N, P and K. This might be the major explaining factor for the differences found in plant growth rate.

5. Conclusion

This study confirms the beneficial action of the organic compost on the plant development. The organic compost produced from organic residues previously selected presented a better result on the corn plant development than the organic compost from non-selected residues, although increase in the corn growth could be observed even when cultivated with compost produced from non-selected organic waste.

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