APPLICATION OF COMPOSTED MUNICIPAL SOLID WASTE IN COTTON PRODUCTION

A. Khalilian, M. J. Sullivan, J. D. Mueller
Edisto Research & Education Center
F. J. Wolak and R. K. White
Agricultural & Biological Engineering Department
R. M. Lippert, Agronomy Dept.
Clemson University
Clemson, SC

Abstract

Municipalities are facing a growing problem of how to safely dispose of their solid waste. A possible solution to this problem is composting the organic fraction of municipal solid waste (MSW). The compost could then be used for agricultural purposes. Equipment was developed and tested for broadcast and band application of MSW compost at selected rates to agricultural lands for cotton production. Replicated tests were conducted to determine the effects of compost on soil parameters (organic matter, soil compaction, soil fertility and additive effects over years) and plant responses (yield, nutrition and insect density).

Application of 15 ton/acre of MSW compost (broadcast or banded) resulted in a 167 lb/acre increase in seed cotton yield in 1995. In 1996 the increase was 444 lbs. (23% more) seed cotton at 15 tons/acre compared to no compost application. The yield increase was proportional to application rate. All rates of compost increased soil organic matter content and soil nitrogen content 6 weeks after planting. However, compost did not affect the leaf nitrogen content during the same sampling period. Except for 5 ton/acre banded application rate, MSW compost significantly increased soil organic matter 14 weeks after planting. Only application of 15/acre compost (broadcast or banded) statistically increased soil nitrogen content during this period. There were very little carry over effects on soil organic matter and soil nitrogen for both 6 and 14 weeks after planting and seed cotton yield.

Introduction

Composting continues to gain acceptance as a solid waste management treatment technique. However, little effort has been undertaken towards development of a market for the final product, compost. The largest potential user of MSW compost is the agricultural industry (Parr and Hornick, 1992; Slivka et al., 1992). Application of MSW compost usually increases yields of agronomic and horticultural crops, under both field and greenhouse conditions. Agricultural uses of composted MSW have shown promise for a variety of field crops (sorghum, maize, forage grasses) and also vegetables sold for human consumption (lettuce, cabbage, beans, potatoes). Responses by plant systems have ranged from none to over twofold increases in yield (Shiralipour et al., 1992). According to research conducted by scientists with Louisiana State University (Hallmark et al., 1994) application of 10 tons/acre of composted MSW to opened sugarcane rows prior to planting resulted in a 720 lbs/acre increase in sugarcane yields. Addition of 6.7 tons/acre compost increased ryegrass yields compared to untreated plots but did not excessively increase the trace metal concentration in the soil (Bauduin et al., 1987).

Application of 3.5, 7, 14, or 28 tons/acre to a sandy soil increased heights and weights of two successive sorghum crops (Hortenstine and Rothwell, 19730). Addition of 28 tons/acre of compost resulted in an equal or greater sorghum yield than soils treated with 0.9 tons/acre of 10-4.4-8.3 (N-P-K) fertilizer. Application of 4, 8, or 12 tons/acre composted MSW to common bermudagrass increased yield the first year by 13.7, 17.2, or 20.6%, respectively. The addition of 12, 24, or 36 tons/acre in the second year increased the yields by 25, 30, or 40%, respectively (Terman et al., 1973). There is no published data on utilization of composted MSW in cotton production.

There is a need for research to determine whether compost can be used economically to replace or supplement commercial fertilizer for cotton production. Quantitative data on the effects of compost on soil and plant characteristics are needed as a means of understanding benefits and problems associated with utilization of composted municipal solid waste in coastal plain soils. Determination of the best methods of applying MSW composts to land (broadcast, banded, etc.) is needed. Also the effects of compost on pest management needs to be determined.

Objectives

The objectives of this project are to develop and test equipment for broadcast or band application of composted municipal solid waste at selected rates to agricultural lands for cotton production, determine the effects of compost on soil parameters (organic matter, soil compaction, soil fertility and additive effects over years) and plant responses (yield, nutrition and insect density).

Methods and Materials

Tests were conducted at the Edisto Research and Education Center at Blackville, SC on a Faceville loamy sand soil. A randomized complete block design with four replications was the statistical model selected for comparing different treatments. Two application methods (broadcast and banded), three application rates (5, 10, and 15 tons/acre), and a control (no compost) were used in 1995 (Table 1). The same treatments were used in 1996, except the broadcast application plots were split in half to determine

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the additive effects of compost over the years. No additional compost was applied to one half while the other half received the same rate as in 1995. Cotton was planted and carried to yield using recommended practices for seedbed preparations, seeding, fertilization, insect and weed control. Plot size were 12 rows (38 ft. X 100 ft.). The two middle rows of each plot were machine harvested for yield determinations using a JD9900 spindle picker.

A commercially available spreader (Knight Pro Twin Slinger, model 8024) was used for broadcast application of compost in 1995. The spreader was adjusted to apply different rates of compost (5, 10 and 15 tons/acre). With this system, swinging hammers deliver the material to the side resulting in a uniform coverage over 25 ft width of the test plots. A 4-shank subsoiler-bedder was used to disrupt the hardpan and incorporate the composted material. Drift was a problem with this spreader under windy conditions. In 1996, a conventional flat-bed, chain conveyer type manure spreader was used for broadcast application to eliminate drift problem associated with the side delivering system. An adjustable gate was added to the spreader to control the application rates.

A 4-row device for band application of the MSW compost was developed and mounted behind a John Deere MaxEmerge2 cotton planter. The unit consisted of two fiberglass hoppers with two fluted-wheel metering devices at the bottom of each hopper. A hydraulic motor was used to run the metering system. Compost application rates were adjusted by changing speed of the motor using a flow control valve. This system dispensed the material, 8-in wide, behind the cotton planter.

Each plot was sampled for soil organic matter, ammonium and nitrate contents at planting, 6-weeks-after planting and 14-weeks-after planting. Twelve cores 8 inches deep and one inch in diameter were taken from each plot on each date. Soil ammonium and nitrate were determined colormetrically after extraction with 2 M KCI. Plant tissues (35 leaves/plot) were collected and analyzed for nitrogen.

Discussion

Table 1 shows seed cotton yields for the 1995 test. Application of 15 ton/acre of MSW compost (broadcast or banded) significantly increased seed cotton yield (167 lb/acre) compared to no compost application. There were no significant differences in yield among the rest of the treatments. In 1996, application of MSW compost (all rates) significantly increased the soil organic matter content 6 weeks after planting (Figure 1). The amount of organic matter in soil was proportional to application rate. Similar results were obtained with the soil nitrogen content 6 weeks after planting (Figure 2). However, these differences did not affect the leaf nitrogen content of cotton plant during the same sampling period (figure 3).

Figure 4 shows soil organic matter content 14 weeks after planting. Except for 5 ton/acre banded application rate, MSW compost significantly increased soil organic matter compared to compost application. Only application of 15/acre compost (broadcast or banded) statistically increased soil nitrogen content averaged over top 8 inches of the soil (Figure 5).

In 1996, all rates of MSW compost significantly increased seed cotton yield (Table 2). Yield increase was proportional to application rate. For 15 ton/acre broadcast application treatment, yield increase was 444 lb/acre or 23% more compared to no compost application.

Table 3 shows carry over and additive effects of compost on soil organic matter and soil nitrogen for both 6 and 14 weeks after planting and seed cotton yield. There were very little carry over effects with all of these parameters except for soil organic matter contents 6 weeks after planting at 15 ton/acre application rate (treatment 3b, Table 3). Based on two years data, it is obvious that compost must be applied every year to achieve maximum crop performance. Additive effects of compost were significant on soil organic matter, nitrogen contents and seed cotton yields (treatments 1a, 2a and 3a as compared to 1b, 2b and 3b). Increased soil organic matter and nitrogen content combined with the potential increase in soil water holding capacity and decrease in soil density associated with MSW compost, could be the contributing factors to yield increase.

Summary

Equipment was developed and tested for broadcast or band application of MSW compost at selected rates to agricultural land for cotton production. Replicated tests were conducted to determine the effects of compost on soil parameters (organic matter, soil compaction, soil fertility and additive effects over years) and plant responses (yield, nutrition and insect density).

Application of 15 ton/acre of MSW compost (broadcast or banded) significantly increased cotton yield (167 lb/acre) compared to no compost application in 1995. In 1996, all rates of compost significantly increased the soil organic matter content and soil nitrogen content 6 weeks after planting. The increase was proportional to application rate. However, compost did not affect the leaf nitrogen content of the cotton plant during the same sampling period.

Except for 5 ton/acre banded application rate, MSW compost significantly increased soil organic matter 14 weeks after planting. Only application of 15 ton/acre compost (broadcast or banded) statistically increased soil nitrogen content during this period.

In 1996, broadcast application of 15 ton/acre compost increased seed cotton yields by 23% compared to no compost application. There were very little carry over

effects on soil organic matter and soil nitrogen for both 6 and 14 weeks after planting and seed cotton yield. Based on two years data, it appears that compost must be applied every year to achieve maximum crop performance.

Acknowledgments

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References

Bauduin, M., E. Delcarte and R. Impens. 1987. Agronomic characterization and evaluation of two new municipal waste composts. In Compost: Production, Quality and Use (M. De Bertoldi, M. P. Ferranti et al.), pp. 479-486. Elsevier Applied Science, London.

Hallmark, W. B., S. E. Feagley, X. Wan and L. P. Brown. 1994. Effects of composted MSW on sugarcane production and fertilizer requirements. Compost Quality Documentation, Bedminster Bioconversion Corporation, Cherry Hill, NJ.

Hortenstine, C. C. and D. F. Rothwell. 1973. Pelletized municipal refuse compost as a soil amendment and nutrient source for sorghum. J. Environ. Qual. 2(3): 343 - 344.

Parr, J. F. And S. B. Hornick. 1992. Utilization of municipal wastes. In Soil Microbial Ecology: Application in Agriculture, Forestry, and Environmental Management (B. Metting). Marcel Dekker, New York.

Shiralipour, A., D. B. McConnell and W.H. Smith. 1992. Uses and benefits of MSW compost: a review and assessment. Biomass and Bioenergy, Pergamon Press, N.Y., 3(3-4):267-279.

Slivka, D. C., T. a. McClure, a. R. Buhr and R. Albrecht. 1992. Compost: United States supply and demand potential. Biomass and Bioenergy 3, 281- 299.

Terman, G. L., J. M. Soileau and S. E. Allen. 1973. Municipal waste compost: Effects on crop yields and nutrient content. J. Environ. Qual. 2(1), 84- 89.

Table 1. Effects of compost on seed cotton yield (preliminary test 1995). Clemson University, Edisto Research and Education Center, Blackville, SC.

Trt. No.	Compost (ton/acre)	Application Method	Yield (lb/acre)
1	5	Broadcast	1840 b
2	10	Broadcast	1974 b
3	15	Broadcast	2119 a
4	5	Band	1859 b
5	10	Band	1977 b
6	15	Band	2137 a
7	None	-------	1970 b

Values in a column followed with the same letter are not significantly different (values averaged over 4 replications).

Table 2. Effects of compost on seed cotton yield , 1996. Clemson University, Edisto Research and Education Center, Blackville, SC.

Trt. No.	Compost (ton/acre)	Application Method	Yield (lb/acre)
1	5	Broadcast	2072 c
2	10	Broadcast	2141 bc
3	15	Broadcast	2349 a
4	5	Band	2057 c
5	10	Band	2099 bc
6	15	Band	2226 ab
7	None	-------	1905 d

Values in a column followed with the same letter are not significantly different (values averaged over 4 replications).

Table 3. Carry over and additive effects of compost on soil nitrogen and organic matter contents and seed cotton yield , 1996.

Trt No	Comp. (ton/a)		No3-N (ppm)		O.M. (%)		Yield (lb/a)
	1995	1996	6 W*	14 W	6 W	14 W	
1a	5	5	12.7b	2.1ab	1.23b	1.15b	2072 b
1b	5	None	8.4c	1.6 b	0.95cd	0.95c	1901 c
2a	10	10	13.8b	2.4ab	1.38b	1.18b	2141 b
2b	10	None	7.2c	1.6 b	1.0cd	0.88c	1912 c
3a	15	15	16.4a	3.0 a	1.48a	1.35a	2349 a
3b	15	None	9.5c	2.0ab	1.05c	0.98c	1853 c
8	None (control)		7.7c	1.5 b	0.90d	0.93c	1906 c

* 6 W and 14 W = 6 and 14 weeks after planting.
Values in a column followed with the same letter are not significantly different (values averaged over 4 replications).

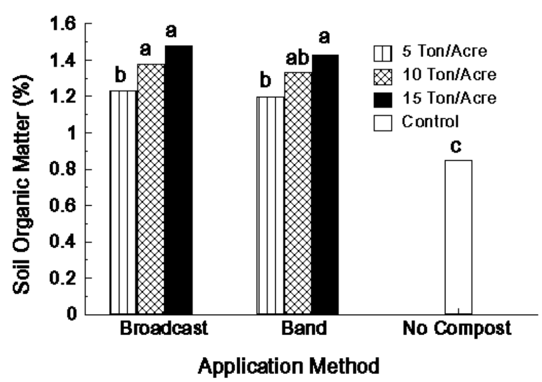

Figure 1. % Soil Organic Matter 6 Weeks after planting

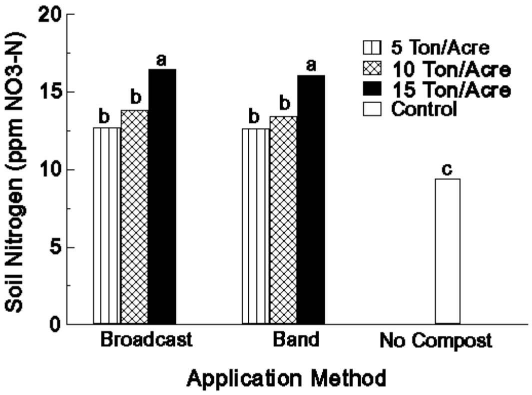

Figure 2. Soil Nitrogen Content 6 Weeks after planting

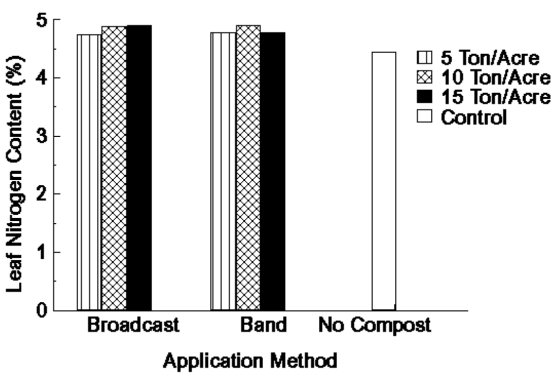

Figure 3. Leaf Nitrogen Content 6 Weeks after planting

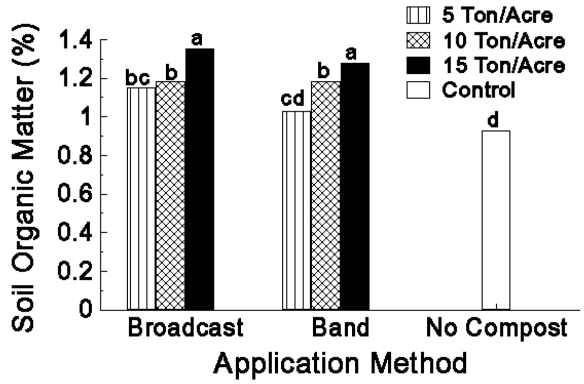

Figure 4. Soil Organic matter content 14 weeks after planting

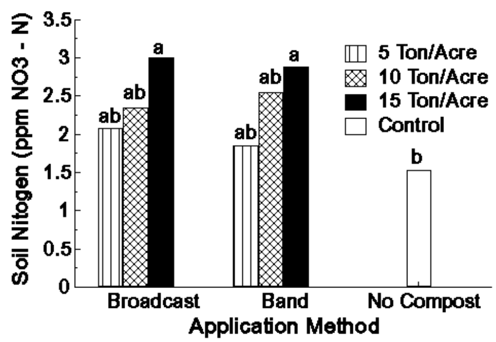

Figure 5. Soil nitrogen content 14 weeks after planting