SWEET CORN RESPONSE TO YARD WASTE COMPOST AND LUPIN HAY FERTILIZER TREATMENTS

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INTRODUCTION

The amount of municipal solid waste produced annually in Florida grew to approximately 50 million tons in 1992. This represents over 7.9 lb/resident/day and is twice the national average of about 4 lb/person/day (Smith, 1994). Biodegradable organic waste that could be composted comprises almost 60% of the total municipal solid waste. Compostable organic matter in municipal solid waste includes such things as yard trimmings, paper, fast foods, animal manure, crop residues and food processing residuals. Yard waste trimmings make up 7.4 million tons annually in Florida (Smith, 1994). Should all yard waste trimmings be composted, about 4 million tons of compost could be produced annually. In the U.S., federal law prohibited the use of unlined landfills by 1994 (Kidder, 1993). Florida law restricts the disposal of organic yard waste in lined landfills. These laws have encouraged a large industry to develop in Florida, whose objective is to produce wood chip mulch and compost from yard waste, often called yard waste compost (YWC). These products should be environmentally safe to apply to farmland and result in potential benefits not only to the farmer but also to society as a whole. For example, YWC can be applied in large quantities to farmland to help improve soil properties and crop yield (Gallaher and McSorley, 1994, 1995; Giordano et al., 1975; Kluchinski et al., 1993; Mays and Giordano, 1989; Mays et al., 1973; Wolley, 1995).

Nitrogen is the single-most-important fertilizer input and is required in the largest quantities for crop production (Olson and Sander, 1988). A sweet corn crop has a sufficient level of N if the concentration in the diagnostic ear leaf at full silking and tasseling is between 2.5 and 3.0% (Jones et al., 1991). Normal N fertilizer recommendations may differ significantly for crops grown on soils having received large quantities of YWC or other biodegradable organic waste product. Legumes are known to contain significant quantities of N and other fertilizer elements and can serve as sources of organic fertilizer (Wade et al., 1997; Wieland et al., 1997; Xiao et al., 1998). Soil K and Mg increased and diagnostic leaf N and P concentrations increased as cowpea (*Vigna unguiculata* L.) pod yield increased with increasing rates of lupin hay (Wieland et al., 1997). Studies showed that application of 2 to 3 tons of lupin (*Lupinus angustifolius* L.) hay/acre would maximize cowpea yield (Wieland et al., 1997; Xiao et al., 1998). In another study, bushbean pod yield reached maximum at 2 tons/acre crimson clover (*Trifolium incarnatum* L.) hay (Wade et al., 1997). The objective of this study was to investigate the changes in soil properties and impact on sweet corn (*Zea mays* L.) yield from use of YWC at five rates of lupin hay as an organic source of N and other nutrients.

MATERIALS AND METHODS

This research was conducted the fifth year (1997) following application of 120 ton YWC/acre each year for the previous four years (Table 1). A winter cover crop of ‘Tift Blue’ lupin was mowed closely just prior to planting sweet corn. ‘Silver Queen’ sweet corn was planted at 28,000 plants/acre in four-row plots, 30 in. wide and 12 ft long using a Brown-Harden in-row subsoil no-till (strip-till) planter. Seeders on the planter were John Deere Flexie 71’s. The three main-plot treatments were residual YWC cumulative treatments (480 ton YWC/acre no-till; 480 ton YWC/acre conventional tillage; conventional tillage control) from the past four years. No additional YWC was applied in 1997 prior to planting this experiment. Subplots were five rates of lupin hay (0, 2, 4, 6, 8 ton/acre) as a source of organic fertilizer, either incorporated just prior to planting or side-dressed as a mulch immediately after planting. All treatment combinations were replicated four times. The crop was hand hoed for weed control as needed. Approximately 1 acre-in. of irrigation was applied six times. No chemical management inputs were made. Ear leaf samples were collected at early silking and analyzed for N concentrations (Gallaher et al., 1975). Soil samples were collected from the top 8 in. in February prior toplanting corn and in August following corn harvest. Soil samples were analyzed for extractable nutrients, pH, organic matter and cation exchange capacity. Soils were further analyzed for plant-parasitic nematodes using appropriate procedures (McSorley and Gallaher, 1997; and Jenkins, 1964). All data were analyzed by analysis of variance for a split-plot design, followed by mean separation by Duncan’s multiple-range test.

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RESULTS AND DISCUSSION

The residual impact of application of large quantities of YWC, including large quantities of plant nutrients and organic matter (Table 1), resulted in significant improvement in soil quality for the beginning of this investigation (Table 2). Little differences existed between the two YWC treatments, but both were several hundred percent greater in most properties than the control. This condition persisted throughout the duration of the experiment, as evidenced by the summer soil test that followed (Table 2). It is obvious that the previously applied YWC should have a significant impact on crops growing under these conditions.

Yield of fresh and dry sweet corn ears shows that YWC was effective in increasing yield as evidenced by the intercept for the three YWC treatments (Fig. 1). Yield was highest for the YWC treatment when corn was grown under no-tillage management, intermediate for YWC conventional tillage and least for the control. These differences among the three YWC treatments were consistent across all five lupin hay rates (Fig. 1). Data show that maximum fresh ear yield was achieved at about 2 ton lupin hay/acre for YWC no-till treatment, about 4 ton lupin hay/acre for YWC conventional tillage treatment and about 6 ton lupin hay/acre for the conventional tillage control treatment. One possible explanation for the higher yields for YWC no-till treatment is the likely conservation of soil water from the lack of soil disturbance as well as lupin hay mulch benefits. Lupin hay on the soil surface would also result in slower release of plant nutrients in the hay, and thus reduce the potential for excessive leaching of nutrients out of the root zone during heavy rainfall events, as compared to incorporation.

Nitrogen concentration in the ear leaf (Table 3) was highly correlated with ear yield (Fig. 1) and was directly caused by increasing rates of lupin hay (Table 3). Sufficiency levels (Jones et al., 1991) for N in the ear leaf were achieved for both YWC treatments at 2 ton YWC/acre but required 6 ton YWC/acre for the control. This evidence, along with yield data, further supports the fact that residual effects of YWC not only improve soil quality but also provide an environment for increased crop yield and leaf quality. It also indicates that lupin hay is a possible source of organic fertilizer in all of the YWC treatments.

Nematodes were not affected either by YWC treatments or by the application of lupin hay (Table 4). Significant quantities of ring and root-knot nematodes were present, and both increased in numbers by the end of the crop season. Therefore, yield differences in this study were not the result of the nematodes measured.

ACKNOWLEDGMENTS

The authors thank Jim Chichester, Howard Palmer, Walter Davis and John Frederick for technical support and Mr. Tom Fulmer of Enviro-Comp Services, Inc., Jacksonville, Florida, for providing the yard waste compost used in this study.

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Table 1. Analysis of yard waste compost used on the Green Acres Agronomy Field Laboratory research plots.

	Year			
Analysis	1993	1994	1995	1996
DM %[1]	45.1	49.8	50.7	57.7
OM %	48.2	59.2	42.2	52.2
C %	33.5	31.3	33.5	32.0
N %	0.81	0.91	0.98	0.63
C:N ratio	41.7	34.4	36.4	50.8
pH chopped	6.2	7.5	---	6.5
pH ground	6.3	7.1	7.0	6.2
Ca %	3.43	3.41	1.14	1.47
Mg %	0.18	0.19	0.07	0.17
K %	0.22	0.29	0.14	0.31
P %	0.17	0.18	0.08	0.15
Cu ppm	23.0	18.0	18.0	22.0
Fe ppm	1953.0	1825.0	2608.0	2615.0
Mn ppm	180.0	188.0	75.0	97.0
Zn ppm	102.0	118.0	138.0	148.0

[1]DM % = dry matter; OM % = organic matter in DM; chopped = compost samples were chopped into coarse particles using a grinder; ground = sub-samples of the chopped samples were ground with a Wiley mill to pass a 2-mm stainless steel screen. Values are the average of four replications. The source of the compost was Wood Resource Recovery, Gainesville, Florida, from 1993 to 1995 and Enviro-Comp Services Inc., Jacksonville, FL in 1996.

Table 2. Mehlich I extractable elements, Kjeldahl N and other soil analyses after yearly application of 120 ton yard waste compost/acre/year from 1993 to 1996.

				Cumulative Yard Waste Compost-YWC (120 ton/acre/year)		
				No-till	Conv-till	Conv-till
Analysis	Unit	LSD	CV	480 ton/acre	480 ton/acre	0 ton/acre
Winter 1997, no YWC added in 1997, test prior to planting sweet corn						
N	ppm	448	21.7%	1613	1530	442
P	ppm	12	6.3%	140	132	67
K	ppm	15	20.0%	52	49	25
Na	ppm	4.3	15.2%	20	19	10
Ca	ppm	566	21.4%	2163	2042	374
Mg	ppm	36	17.7%	158	151	46
Cu	ppm	0.14	19.6%	0.30	0.33	0.61
Fe	ppm	1.03	14.3%	3.8	4.5	4.1
Mn	ppm	1.74	13.0%	10.5	9.9	2.8
Zn	ppm	2.57	13.6%	14.6	14.1	4.0
pH		0.15	1.3%	6.9	6.8	6.6
BpH		NS	0.3%	7.88	7.86	7.86
OM	%	1.21	21.4%	4.38	4.18	1.31
CEC	meq/100g	3.18	18.6%	13.35	12.80	3.5
Summer 1997, test following sweet corn harvest						
N	ppm	440	23.2%	1063	1123	428
P	ppm	22	11.6%	122	126	84
K	ppm	NS	41.6%	40	32	37
Na	ppm	9.6	15.1%	44	37	30
Ca	ppm	676	30.2%	1709	1834	336
Mg	ppm	45	28.7%	115	121	39
Cu	ppm	0.20	31.2%	0.30	0.33	0.52
Fe	ppm	2.47	16.1%	7.3	8.5	10.8
Mn	ppm	3.29	22.1%	10.1	11.2	4.5
Zn	ppm	4.05	23.6%	12.2	13.4	4.1
pH		0.20	2.2%	6.8	6.7	6.2
BpH		NS	0.3%	7.83	7.82	7.79
OM	%	0.64	21.5%	4.14	3.82	1.26
CEC	meq/100g	3.96	25.5%	11.15	11.86	3.89

Table 3. Nitrogen concentration in ear leaf of 'Silver Queen' sweet corn from yard waste compost and lupin treatments.

	Yard Waste Compost Treatments		
Lupin Hay	No-Till	Conv-Till	Control
tons/acre		% N	
0	2.40 L	2.49 L	1.87 L
2	2.51 S	2.62 S	2.43 L
4	2.71 S	2.73 S	2.49 L
6	2.82 S	2.83 S	2.74 S
8	2.74 S	2.70 S	2.74 S

LSD (P = 0.05) = 0.28; CV = 7.4%; No-till and Conv-till treatments received a cumulative total of 480 tons yard waste compost/acre in 120 ton/acre/year increments from 1993 to 1996. No compost was applied in 1997. L = low and S = sufficient levels of N in ear leaf according to Jones et al., 1991.

Table 4. Effect of yard-waste compost on nematode population levels in plots of 'Silver Queen' sweet corn, 1997.

	Sampling Date	
Compost Treatment	6 March	28 July
	Nematodes per 100 cm^3 soil	
	Ring (*Criconemella* spp.)	
Mulch, No-till	66	143
Incorporated, Conventional-till	66	399
Control, Conventional-till	105	328
	Root-knot (*Meloidogyne incognita*)	
Mulch, No-till	24	222
Incorporated, Conventional-till	10	172
Control, Conventional-till	10	172
	Stubby-root (*Paratrichodorus minor*)	
Mulch, No-till	1	1
Incorporated, Conventional-till	0	4
Control, Conventional-till	2	3
	Lesion (*Pratylenchus* spp.)	
Mulch, No-till	12	11
Incorporated, Conventional-till	20	24
Control, Conventional-till	31	25

Data are means of four replications. No significant treatment effects at P < 0.10.

Compost applied as mulch or incorporated, both treatments at 480 ton/acre.

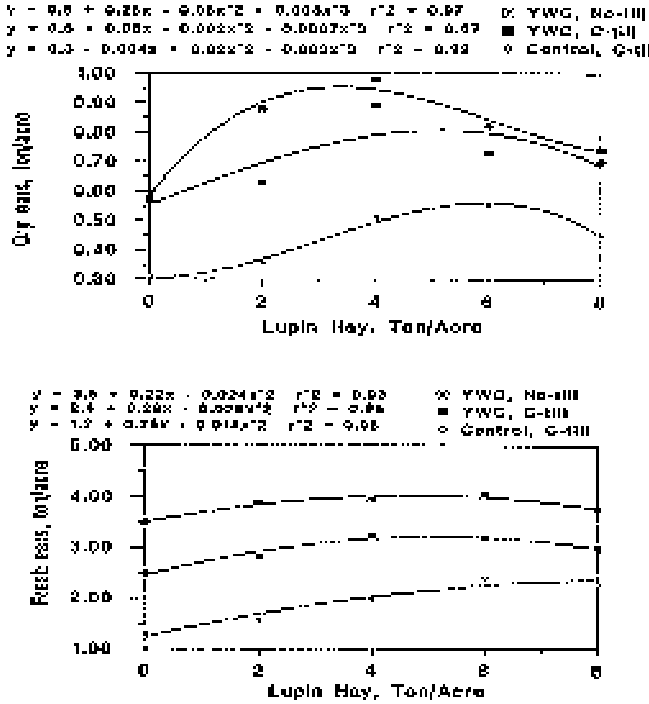

Fig. 1. Silver Queen sweet corn, fresh and dry ear weights; YWC = yard waste compost; No-till = strip-till; C-till = conventional tillage; the YWC treatmenst were from residual applications from the previous four years.