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Utilization of Leaf Compost as a Soil Amendment in Cut Flower Production

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ABSTRACT
For three consecutive years (1999-2001), 1-inch (50 T/A) of leaf compost was applied to plots on a sandy terrace soil (Windsor, CT) and a loamy upland soil (Mt. Carmel, CT). The compost-amended plots were fertilized with 10-10-10 (N-P2O5-K2O) at three rates: 0, 650 (half), 1300 (full) lb/A. Yields of snapdragon (Antirrhinum majus L.), black-eyed Susan (Rudbeckia hirta L.), zinnia (Zinnia elegans Jacq.), and cosmos (Cosmos bipinnatus Cav.) from compost-amended plots were compared to yields from control plots without compost that were fertilized with 1300 lb 10-10-10/A. For snapdragons, there were no significant differences in yield between treatments at either site in any of the three years. For the other species, there were no significant differences between treatments in any of the three years at Mt. Carmel and in two of three years in Windsor. This indicated that, for most years, leaf compost could replace inorganic fertilizer in cut flower production. In 2000, however, a year with greater than average rainfall, plots amended only with compost on a sandy soil at Windsor had significantly lower yields of black-eyed Susan, cosmos, and zinnia compared to yield in plots with compost and inorganic fertilizer. Thus, in wetter than average years on a sandy soil, a combination of half the inorganic fertilizer and compost was required to achieve optimum yields. In 2000, at Mt. Carmel, black-eyed Susans had slightly reduced yields and necrotic foliar symptoms in plots amended with immature compost but the lower yields were not statistically significant. Yield of cosmos decreased insignificantly at Windsor in 2001 when the full rate of fertilizer was used on a soil amended with compost for three years.

INTRODUCTION
With over 95 municipalities composting their leaves, leaf compost is now the most abundant type of compost in Connecticut. With no restrictions on its use in Connecticut (personal communication, Connecticut Department of Environmental Protection), growers appear more likely to consider using leaf compost as a soil amendment than other solid waste composts. In addition, an aquifer protection plan in Connecticut limits and monitors activities on designated aquifers. Thus, it is important for growers on these aquifers to develop management practices that minimize leaching of nitrate without decreasing crop yields. Most of the naturally occurring nutrients in compost are not immediately available to plants, but are released slowly so that plants can use them throughout the growing season. In addition, soil microbes release more nutrients from compost when temperatures are warm and crops are actively growing. Previous work showed that nitrate levels in ground water beneath compost-amended plots remained below the 10 ppm drinking standard, while nitrate levels in ground water beneath the inorganically fertilized control plots rose to almost 15 ppm (Maynard 1993). Brinton (1985) reported lower soil nitrate levels in composted manure treatments compared to treatments amended with fresh manure and inorganic fertilizer. Wuest et al. (1995) found that spent mushroom compost at the rate of 220 T/A for corn production had little effect on the water quality. In comparison to highly available sources of N, the potential for nitrate leaching losses was minimized by the gradual N release from the spent mushroom compost.

Applications of leaf compost have long been known to improve the physical conditions of many soils. Maynard and Hill (1994) found that the bulk density of compost-amended soil was lowered from 1.21 g/cc to 0.91 g/cc after 7 years of annual additions. These additions also increased the organic matter from 7.5 to 12.6%, promoted aggregation of fine soil particles, and reduced crusting following summer rains. Most importantly, higher organic matter content increased the water holding capacity of the soil from 1.3 to 1.9 inches of water in the plow layer. Similar results have been found by Dick and McCoy (1993). Gallaher and McSorley (1994) and Kostewicz (1993) showed a number of agronomic benefits to yard waste compost amendments, especially increased soil organic matter and improved water-holding capacity.

Utilization of leaf compost as a soil amendment has been shown to reduce the need for commercial inorganic fertilizers. In an unreplicated study, Hill (1984) found that annual amendments of leaf compost sustained higher yields of most vegetables when compared to unamended soil and reduced fertilizer needs by 1/3 and 2/3 the normal rate. In a 3-year study, Maynard (2000) found that on both loamy and sandy soils, one-inch of leaf compost incorporated into the soil annually can be substituted for inorganic 10-10-10 fertilizer and equivalent tomato yields could be expected in the first year of compost application. A combination of compost and 10-10-10 fertilizer produced optimum yields but the full rate of fertilizer was not necessary in all years.

In two 3-year studies where the full rate of fertilizer was used, Maynard (1996, 1997) found the greatest eggplant, pepper, and tomato yields were from plots amended with leaf compost compared to yields from plots amended with undecomposed leaves and unamended control plots. Stoffella (1995) and Gallaher and McSorley had similar results utilizing yard waste compost with corn, peppers, and cucumbers. In another study using the full rate of fertilizer, Maynard and Hill (2000) found that leaf compost reduced year-to-year variability in onion yields, increased the yields of most onion cultivars and, in two of three years, produced a higher percentage of the preferred colossal and jumbo sized onions.

Compost also has been shown to reduce the incidence of disease. The ornamental plant industry relies heavily on composted tree bark for control of diseases caused by Phytophthora root rots (Hardy and Sivasithamparam 1991; Hoitink et al. 1991). Composts have replaced methyl bromide in this industry (Quarles and Grossman 1995). Grebus et al. (1994) found that yard waste compost is naturally suppressive to soilborne plant pathogens. Maynard and Hill (2000) showed that annual additions of leaf compost reduced the incidence of soft rot disease in onions. Maynard (2000) reported that tomato plots amended only with compost had less blossom-end rot in years when this disorder was prevalent.

Cut flowers can be one of the most profitable crops on the farm. Byczynski (1997) reported that the potential gross revenue per acre in the Northeast is about $25,000. Total acreage of field-grown flowers in Connecticut has grown from 78 acres in 1989 to 1169 acres in 2005 (Anon. 2007). The wholesale value of cut flowers in 2002 was $913,000 (Anon. 2004). Most growers use conventional inorganic fertilizer or an organic system using compost. However, other growers wish to use a combination of the two methods but do not know the best ratio of fertilizer and compost to produce optimum yields (personal communications).

Most flower production studies have utilized compost as a replacement for peat in potting soil mixtures. Very few studies have utilized compost in field production of cut flowers. In one study, four different composts, including leaf, were evaluated in the production of wildflower sods on plastic (O'Brien and Barker 1997). Wildflowers were seeded on a 5-cm layer of compost or soil on top of plastic, which served as a weed barrier. Fresh leaf compost limited growth in the first year because of its low N content. Wildflower growth in leaf compost improved in the second year, but agricultural manure-based compost produced the highest quality wildflower stands. Similar results were found in another experiment in which a one-inch-thick layer of compost was either raked into the top two inches of soil or left as a surface mulch (O'Brien and Barker 1995). There were no differences in wildflower growth between the two methods. In the first summer after seeding, all compost-amended plots were dominated by weeds, which inhibited wildflower growth and flowering. In the second year, flowering in the leaf compost was diverse and dense with black-eyed Susan dominating by July. In both of these studies, the wildflowers were direct seeded unlike the present study in which transplants were used.

The objective of this study was to determine whether leaf compost could eliminate or reduce the need for inorganic fertilizer in cut flower production.

METHODS AND MATERIALS

Experiments were conducted at the Valley Laboratory, Windsor, Connecticut on Merrimac sandy loam (Entic Haplorthod), a sandy terrace soil with somewhat limited moisture holding capacity (Shearin and Hill 1962); and at Lockwood Farm, Mt. Carmel, Connecticut on Cheshire fine sandy loam (Typic Dystrochrept), a loamy upland soil with moderate moisture holding capacity (Reynolds 1979).

Unscreened leaf compost was applied to plots at both sites in April 1999, 2000, and 2001 at the rate of 50 T/A (dry weight basis) (1 inch on the surface) and rototilled into the soil to a depth of 6 inches. The compost was produced in a passive pile turned four or five times yearly for two years. Organic carbon in the unscreened compost was determined by loss on ignition (Ball 1964), total nitrogen content by the Kjehldahl method (Bremner 1965), pH by glass electrode (Lunt et al. 1950), and soluble salts by the electrical conductivity of a saturated paste extract (Bower and Wilcox 1965). The pH (1:1 suspension) was 6.5 and the soluble salts were 0.6 mmhos/cm. The nutrient values, determined by the Morgan test (Lunt et al. 1950), were 3 ppm NO3-N, 80 ppm NH4-N, 100 ppm P, 250 ppm K, 1200 ppm Ca, and 125 ppm Mg. Carbon content was 22.4% and total nitrogen was 0.8% for a C:N ratio of 28. Solvita (Woods End Research Laboratory, Mount Vernon, ME) maturity index was 7.

Three sets of the compost-amended plots were fertilized with commercial grade 10-10-10 (N-P2O5-K2O) at three rates: 0, 650 (half rate), and 1300 lb/A (full rate). Yields from these plots were compared to unamended control plots fertilized with 10-10-10 at a rate of 1300 lb/A (full rate). The full rate was determined from analysis of soil from both sites before the addition of compost. Soil fertility at both sites was low. Three-foot aisles separated each 15 x 10 foot plot and each treatment was replicated four times in a Latin square design.

Four varieties of cut flowers were grown: snapdragon cv. Rocket (Antirrhinum majus L.), black-eyed Susan cv. Indian summer (Rudbeckia hirta L.), zinnia cv. Benary's giant (Zinnia elegans Jacq.), and cosmos cv. Versailles (Cosmos bipinnatus Cav.).

Each year, snapdragons and black-eyed Susans were seeded in a greenhouse on March 19-20, cosmos on April 12, and zinnias on April 25-26. The seedlings were grown in Promix BX (Premier, Red Hill PA) in standard plastic pots (3601 insert) measuring 2 5/8 X 2 ¼ X 2 5/8 inches (volume 15.5 cubic inches). The seedlings were fertilized with water soluble 20-20-20 (N-P2O5-K2O) (0.5 oz/gal) four weeks after germination. After hardening in a cold frame, the seedlings were transplanted on May 24-June 7 at both sites. Seedlings of each species were spaced one foot within the row with a population of 10 plants per plot in rows four feet apart. The snapdragons were pinched back to half their size on June 15 to promote branching. Marketable flowers with 8-inch stems were harvested weekly until frost. Weeds were controlled by cultivation. Overhead irrigation was used as necessary. Plants were removed from all plots at the end of the growing season and the plots fallowed over winter.

Soil samples were collected at the end of each growing season. Available soil nutrients were measured using the Morgan soil test (Lunt et al. 1950). Organic carbon was determined by loss on ignition (Ball 1964), pH by glass electrode (Lunt et al. 1950), and soluble salts by the electrical conductivity of a saturated paste extract (Bower and Wilcox 1965).

All yield data from replicated plots were analyzed by analysis of variance (ANOVA) at p=0.05 with Tukey's multiple range test for comparisons.

RESULTS AND DISCUSSION

BLACK-EYED SUSANS

Comparing like treatments, total yields from Windsor were up to 54% greater than those from Mt. Carmel in all three years (Table 1). The only statistically significant difference in yields within a site occurred in 2000 at Windsor where yields from the full-fertilized compost-amended plots and the full-fertilized control plots were greater than plots amended only with compost. The summer of 2000 was cool and wet with rainfall 6.9 inches above normal during the growing season. These conditions inhibited nitrification and increased leaching, so less nitrogen was available during the growing season on the compost-only plots. At Windsor, in 1999 and 2001, and every year at Mt. Carmel, all yields were statistically equivalent.

In 2001, after three years of compost amendments, the greatest yields of black-eyed Susans at both sites were from plots amended with both compost and the full rate of inorganic fertilizer (Table 1). Yields at Mt. Carmel from plots amended with compost and the full rate of fertilizer were 54% greater compared to the unamended control plots and 28% greater at Windsor. Yields of compost-amended plots with half the rate of fertilizer were 40% greater than the unamended full-fertilized control plots at Mt. Carmel and 17% greater at Windsor.

It appears that the full rate of inorganic fertilizer did not always produce optimum yields, but greater yields were attained when inorganic fertilizer was used with compost. There appeared to be a cumulative effect of the compost amendments as the percent increase in yields on all compost-amended plots, compared to no-compost control plots at both sites, was greatest in 2001.

In 2000, there was a slight, insignificant decrease in yields of all the compost-amended plots, compared to the control plots at Mt. Carmel and two of the three treatments at Windsor (Table 1). In 1999 and 2001, the compost pile was turned regularly over the winter so that all portions of the pile were well-composted (Solvita maturity of 6-7) by the spring application. In 2000, however, the compost pile was not turned in winter. Uneven decomposition within the pile was evident by dry clumps of uncomposted leaves. Although portions of the pile had compost with a Solvita maturity of 6, other portions had leaves that were virtually unchanged (species of leaves could be determined). Within days of planting in the compost-amended plots, the leaves of black-eyed Susan seedlings became necrotic, deformed, and stunted. Many necrotic leaves eventually turned brown and fell. The plants recovered after several weeks but the total yields decreased. Increasing the fertilizer on the compost-amended plots did not improve yields at Mt. Carmel (Table 1), but did at Windsor as the fertilizer rate increased from 0 to 1300 lbs/A. Seedlings in the no-compost control plots did not show necrotic symptoms. These symptoms did not occur in the other species or in other years for black-eyed Susans.

There are two possible explanations as to the development of necrotic symptoms and the reduction in yield. First is nitrogen immobilization in the immature compost. This would explain why yields were greater at Windsor as the fertilizer rate increased. Increased yields did not occur at Mt. Carmel and soil tests taken at the time at both sites revealed adequate nutrient levels. In addition, the plants did not show classic nitrogen deficiency symptoms (yellowing of leaves). Instead, the leaves turned brown, especially around the edges and were stunted and deformed. Also, the other species in the same plots did not display foliar symptoms or reduction in yield, which one would expect if nitrogen were limiting. Another possibility that could explain the reduction in yield and the foliar symptoms is an undetected phytotoxic substance in the compost or undecomposed leaves. In another study at the same site (Maynard 1996, 1997), yields of eggplant and peppers were reduced in plots amended with undecomposed leaves but without foliar symptoms. Tomatoes grown in the same plots did not have reduced yields (Maynard 1997). Nutrient analyses of the soil also showed that reduced yields were unrelated to nitrogen immobilization.

SNAPDRAGONS

There were no significant differences between any of the treatments at either site in any year (Table 2). Snapdragon yields from plots amended only with leaf compost were equal to yields from plots amended with the full rate of fertilizer. Adding inorganic fertilizer to compost-amended plots did not significantly increase yields. Like the black-eyed Susans, the greatest yields were from plots in the sandy terrace soil of Windsor. Unlike the black-eyed Susans, however, there was little cumulative effect after three years of compost additions.

COSMOS

In 2000 at Windsor, yields from compost-amended plots fertilized with the full rate of inorganic fertilizer were greater than plots amended only with compost (Table 3). As noted above, reduced yields in the compost only plots can probably be explained by low mineralization rates of organic matter or increased leaching during the cool, wet summer. As with the other species, there were no significant differences between the compost-only plots and the full-fertilized control plots in any year, indicating that compost can be substituted for inorganic fertilizer in sandy terrace soil. There also appeared to be a slight cumulative effect of the annual compost additions. Yields from compost-amended plots averaged 9% greater than the control plots in 1999, 7% greater in 2000, and 16% greater in 2001.

At Windsor, decreased yield in 2001 was noted in compost-amended plots fertilized with the full rate of fertilizer. Although it was not statistically significant, yields from these plots were 13% lower than yields from the control plots, while compost-amended plots fertilized at half the rate had yields 29% greater and yields from the compost only plots averaged 30% greater than the full-fertilized control plots. Soil tests taken in September revealed very high nitrate levels in the full-fertilized compost-amended plots, averaging 44 ppm compared to 38 and 31 ppm from the other compost-amended plots and control plots. The high nitrate levels probably encouraged vegetative growth at the expense of flower production. This effect was not observed in the other flower species growing in the same plots or at Mt. Carmel where the nitrate levels ranged from 17 to 25 ppm. Thus, it appeared that cosmos might be uniquely sensitive to high nitrate levels in the soil and the full rate of inorganic fertilizer is unnecessary when compost is applied annually.

At Mt. Carmel, there were no significant differences in yield of cosmos among any treatments in any year (Table 3). As yields from the compost-only plots were equivalent to the full-fertilized controls, it appeared that compost could substitute for inorganic fertilizer in cosmos production in a loamy upland soil. There also appeared to be a cumulative effect to the yearly compost additions. Yields from compost-amended plots averaged 40% greater than the unamended control plots in 2001 compared to 5% greater in 1999 and 2% greater in 2000.

ZINNIAS

Yields from Windsor were greater than yields from Mt. Carmel in all three years with yields as much as 83% greater when comparing the same treatments (Table 4). In 2000, compost-amended plots fertilized at half the full rate had yields significantly greater than plots amended with compost and no fertilizer. Compared to the full-fertilized control plot, plots amended only with compost had statistically equivalent yields all three years showing that compost can replace inorganic fertilizer in zinnia production on sandy terrace soil. Even though the yields were not significantly greater, the addition of inorganic fertilizer on the compost-amended plots increased yields as much as 16% compared to the unamended control plots. There did not appear to be a cumulative effect of the annual compost additions.

At Mt. Carmel, there were no significant differences in zinnia yield between treatments in any year (Table 4). Compost effectively replaced fertilizer in a loamy upland soil in zinnia production as compost-amended plots with no additional inorganic fertilizer had yields equivalent to the full-fertilized control plots. Adding fertilizer to compost-amended plots did not significantly improve yields and there was no cumulative effect in compost additions.

SOIL CHARACTERISTICS

Amending soil with compost for three consecutive years affected the physical and chemical characteristics of the soil at both Mt. Carmel and Windsor. The pH of the soil amended with compost for three years ranged from 6.4 to 6.6 at both sites compared to 5.6 in the unamended controls at Mt. Carmel and 5.9 at Windsor. The initial pH of the compost-amended plots was the same as the pH of the unamended control plots. Thus, the compost had a liming effect and raised the pH into the range considered optimal (6.0-6.5) for both microbial activity and nutrient availability.

The addition of compost for three years increased the organic matter at Mt. Carmel from 4.7% on the unamended control to an average of 6.5% on the compost-amended plots and from 3.5% to 5.0% at Windsor. Increasing the organic matter of soils has been shown to improve the water holding capacity of soils (Maynard and Hill 1994).

Except for the nitrate values in 2001 described earlier, available soil nutrients were similar in compost-amended plots and the control plots at both sites in all years. Available soil nutrients for all treatments at both sites were “medium” to “high” according to the Morgan method (Lunt et al. 1950) and were not limiting for plant growth. In another study near the same sites, three years of amending leaf compost to soils increased the concentrations of calcium, magnesium, and nitrate-nitrogen in the amended soil compared to the unamended control (Maynard 1997).

SUMMARY

This study showed that, in most cases, cut flower yields from compost-amended plots were equivalent to unamended full-fertilized plots and these equivalent yields could be expected from the first year of compost application. The one exception was when the growing season was unusually cool and wet on a sandy soil. The sandy soil retained little residual nitrate and the cool, wet conditions inhibited nitrification and increased leaching to the extent that crops needs were not fully met. Under those conditions, inorganic fertilizer in addition to compost was required but the half-rate was sufficient to achieve optimum yields.

Black-eyed Susan was the only species to have increased yield when inorganic fertilizer was used in addition to compost but the increase was not statistically significant. This shows that, unlike most vegetables, optimum yields of these cut flowers can be attained in most years with leaf compost alone. Cosmos had decreased yields when the full rate of fertilizer was used on a soil amended for three years with compost but again the decrease was not statistically significant. Cumulative effects of the annual additions of compost were seen in black-eyed Susans and cosmos. Black-eyed Susans also had a negative response to immature compost. The slightly reduced yields, however, were not statistically significant.

REFERENCES

Anon. 2004. Floriculture Crops 2003 Summary. Agricultural Statistics Board. USDA.

Anon. 2007. Floriculture Crops 2005 Summary. Agricultural Statistics Board. USDA.

Ball, D.F. 1964. Loss-on-ignition as an estimate of organic matter and organic carbon in non-calcareous soils. J. Soil Sci. 15:84-91.

Bower, C.A. and L.V. Wilcox. 1965. Soluble Salts. In Methods of soil analysis, Part II. C.A. Black (ed.). Amer. Soc. Agron., Madison, WI. pp. 993-940.

Bremner, J.M. 1965. Total Nitrogen. In Methods of soil analysis, Part II. C.A. Black (ed.). Amer. Soc. Agron., Madison, WI. Pp. 1149-1178.

Brinton, W.F. 1985. Nitrogen response of maize to fresh and composted manure. Biological Agriculture and Horticulture 3:55-64.

Byczynski, L. 1997. The Flower Farmer. Chelsea Green Publishing Company. White River Junction, Vermont. 208 pp.

Dick, W.A. and E.L. McCoy. 1993. Enhancing soil fertility by addition of compost. In: Science and Engineering of Composting: Design, Environmental, Microbiological, and Utilization Aspects, H.A.J. Hoitink and H.M. Keener (Eds.) Renaissance Publications. Worthington, Ohio, USA.

Gallaher, R.N. 1994. Management of yard waste compost for soil amendment and corn yield. Pp. 156-160 in P.J. Bauer and W.J. Busscher, eds. Proceedings of the 1994 Southern Conservation Tillage Conference for Sustainable Agriculture. USDA-ARS coastal Plains Soil, Water, and Plant Research Center, Florence, SC.

Gallaher, R.N. and R. McSorley. 1994. Management of yard waste compost for soil amendment and corn yield, p. 28-29. In: Composting Council's Fifth Annual Conference. Proc. Washington, D.C. 16-18 Nov.

Grebus, M.E. , M.E. Watson, and H.A.J. Hoitink. 1994. Biological, chemical and physical properties of composted yard trimmings as indicators of maturity and plant disease suppression. Compost Sci. Util. 1:57-71.

Hardy, G.E. St. J. and K Sivasithamparam. 1991. Suppression of Phytophthora Root Rot by a Composted Eucalyptus Bark Miz. Aust. J. Bot. 39:153-159.

Hill, D.E. 1984. Annual amendments of leaf mold sustain higher yields of vegetables. Frontiers of Plant Science 36(2):4-5.

Hoitink, H.A.J., Y. Inbar, and M.J. Boehm. 1991. Status of composted-amended potting mixes naturally suppressive to soilborne diseases of floricultural crops. Plant Dis. 75:869-873.

Kostewicz, S.R. 1993. Pole bean yield as influenced by composted yard waste soil amendments. Proceedings of the Florida State Horticultural Society 106:206-208.

Lunt, H.A., C.L.W. Swanson, and H.G.M. Jacobson. 1950. The Morgan soil testing system. Ct. Agric. Exp. Sta. Bull. 541. 60p.

Maynard, A.A. 1993. Nitrate leaching from compost-amended soils. Compost Science & Utilization 1(2):65-72.

Maynard, A.A. 1996. Cumulative effect of annual additions of undecomposed leaves and compost on the yield of field-grown peppers. Compost Science and Utilization 4(2):81-88.

Maynard, A.A. 1997. Cumulative effect of annual additions of undecomposed leaves and compost on the yield of eggplant and tomatoes. Compost Science & Utilization 5(1):38-48.

Maynard, A.A. 2000. Applying leaf compost to reduce fertilizer use in tomato production. Compost Science & Utilization 8(3): 203-209.

Maynard, A.A. and D.E. Hill. 1994. Impact of compost on vegetable yields. BioCycle 35(3):66-67.

Maynard, A.A. and D.E. Hill. 2000. Cumulative effect of leaf compost on yield and size distribution in onions. Compost Science & Utilization 8(1):12-18.

O'Brien, T.A. and A.V. Barker. 1995. Evaluation of field-applied fresh composts for production of sod crops. Compost Science & Utilization 3(3):53-65.

O'Brien, T.A. and A.V. Barker. 1997. Evaluating composts to produce wildflower sods on plastic. J. Amer. Soc. Hort. Sci. 122(3):445-451.

Quarles, W. and J. Grossman. 1995. Alternatives to methyl bromide in nurseries – Disease suppressive media. The IPM Practitioner 17(8):1-13.

Reynolds, C.A. 1979. Soil Survey of New Haven County, Connecticut. United States Department of Agriculture, Soil Conservation Service. 197 pp.

Shearin, A.E. and D.E. Hill. 1962. Soil Survey of Hartford County, Connecticut. United States Department of Agriculture, Soil Conservation Service. 126 pp.

Stoffella, P. 1995. Growth of vegetables, p.2-34. In W.H. Smith (ed.). Compost test program for the Palm Beach Solid Waste Authority Project. Final Rpt.

Wuest, P.J., H.K. Fahy and J. Fahy. 1995. Use of spent mushroom substrate (SMS) for corn (maize) production and its effect on surface water quality. Compost Science & Utilization 3:46-50.

Table 1. Average number (+SD) of stems/plant of black-eyed Susans as influenced by growing in sandy terrace soil (Windsor) or a loamy upland soil (Mt. Carmel) with 50 dry tons of leaf compost per acre in combination with two levels of inorganic fertilizer (10-10-10) and in no-compost soil following cut flower production fertilizer recommendations.

Treatment Compost T/A	Fertilizer lbs/acre	1999	2000	2001
Windsor				
50	1300	56 ±3 a	77 ±14 a	60 ±7 a
50	650	55 ±10 a	65 ±11 ab	55 ±7 a
50	0	49 ±5 a	47 ±2 b	49 ±6 a
0	1300	53 ±6 a	75 ±15 a	47 ±6 a
Mt. Carmel				
50	1300	40 ±4 a	57 ±9 a	48 ±10 a
50	650	46 ±9 a	54 ±6 a	44 ±6 a
50	0	39 ±8 a	51 ±6 a	43 ±6 a
0	1300	35 ±2 a	61 ±10 a	31 ±8 a

Means followed by the same letter within each column are not significantly different by Tukey's multiple range test at the five percent level.

Table 2. Average number (+SD) of stems/plant of snapdragons as influenced by growing in sandy terrace soil (Windsor) or a loamy upland soil (Mt. Carmel) with 50 dry tons of leaf compost per acre in combination with two levels of inorganic fertilizer (10-10-10) and in no-compost soil following cut flower production fertilizer recommendations.

Treatment Compost T/A	Fertilizer lbs/A	1999	2000	2001
Windsor				
50	1300	51 ±5 a	36 ±7 a	37 ±5 a
50	650	46 ±2 a	37 ±4 a	37 ±6 a
50	0	46 ±4 a	32 ±6 a	34 ±8 a
0	1300	43 ±8 a	34 ±3 a	35 ±6 a
Mt. Carmel				
50	1300	26 ±2 a	31 ±1 a	25 ±5 a
50	650	25 ±2 a	30 ±7 a	23 ±5 a
50	0	22 ±5 a	26 ±7 a	23 ±7 a
0	1300	25 ±5 a	27 ±8 a	25 ±5 a

Means followed by the same letter within each column are not significantly different by Tukey's multiple range test at the five percent level.

Table 3. Average number (+SD) of stems/plant of cosmos as influenced by growing in sandy terrace soil (Windsor) or a loamy upland soil (Mt. Carmel) with 50 dry tons of leaf compost per acre in combination with two levels of inorganic fertilizer (10-10-10) and in no-compost soil following cut flower production fertilizer recommendations.

Treatment Compost T/A	Fertilizer lbs/A	1999	2000	2001
Windsor				
50	1300	115 ±36 a	133 ±13 a	54 ±11 a
50	650	107 ±8 a	103 ±21 ab	80 ±18 a
50	0	118 ±8 a	90 ±18 b	81 ±23 a
0	1300	104 ±15 a	102 ±15 ab	62 ±17 a
Mt. Carmel				
50	1300	68 ±10 a	128 ±33 a	81 ±18 a
50	650	82 ±10 a	87 ±15 a	89 ±25 a
50	0	74 ±14 a	97 ±9 a	78 ±9 a
0	1300	71 ±19 a	102 ±21 a	59 ±10 a

Means followed by the same letter within each column are not significantly different by Tukey's multiple range test at the five percent level.

Table 4. Average number (+SD) of stems/plant of zinnias as influenced by growing in sandy terrace soil (Windsor) or a loamy upland soil (Mt. Carmel) with 50 dry tons of leaf compost per acre in combination with two levels of inorganic fertilizer (10-10-10) and in no-compost soil following cut flower production fertilizer recommendations.

Treatment Compost T/A	Fertilizer lbs/A	1999	2000	2001
Windsor				
50	1300	65 ±11 a	68 ±11 ab	75 ±12 a
50	650	66 ±9 a	76 ±11 a	76 ±13 a
50	0	57 ±6 a	52 ±5 b	55 ±9 a
0	1300	56 ±7 a	68 ±8 ab	68 ±5 a
Mt. Carmel				
50	1300	42 ±5 a	55 ±10 a	49 ±8 a
50	650	36 ±8 a	47 ±6 a	50 ±10 a
50	0	36 ±8 a	40 ±4 a	47 ±12 a
0	1300	39 ±2 a	50 ±6 a	49 ±8 a

Means followed by the same letter within each column are not significantly different by Tukey's multiple range test at the five percent level.

NOTES