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# Soil amendment effects on crop-weed interactions

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**Budget:**
$18,430 for year one
$18,766 for year two
$19,115 for year three

***Abstract:*** *The used bedding from hooped hog production structures can be composted and spread on farm fields as a soil amendment. Researchers studied how this composted material affects crop yields, weed growth, and soil components.*

## Background

Deep-bedded hoop structures are becoming more popular with hog producers because they require less capital investment and pose fewer water contamination risks than some types of conventional operations. Because raising swine in deep-bedded hoop structures is a relatively new practice in Iowa, little is known about how compost produced from bedding/manure mixtures affects agroecosystem components and their interactions. Several factors led project investigators to hypothesize that field application of composted swine manure was likely to affect weed and crop performance.

First, composted swine manure is a concentrated source of nutrients that can increase soil nutrient availability, and improve corn nutrient content and grain yield. Second, manure and compost function as sources of non-nutrient compounds that can affect plant growth. Some of these compounds are growth inhibiting (fresh manure and newly made compost), while others are growth promoting (well-aged manure and mature compost). Third, composted manures can alter physical and biological characteristics of the soil environment in ways that can affect plant performance. Compost can augment soil moisture content and alter soil thermal regimes. It also can increase soil microbial biomass and activity.

Specific objectives of the project were to evaluate the impacts of composted swine manure on selected soil characteristics and on the nutritional status, height growth, competitive relations, and biomass and seed production of corn, giant foxtail, velvetleaf, and common waterhemp.

***Corn at silking, Struthers Farm, July 2000. Graduate student Terry Loecke takes samples of corn ear leaves to determine crop's nitrogen status.***

## Approach and methods

The experiment was conducted at the Iowa State University Agronomy and Agricultural Engineering Farm near Boone. Field plot testing was done from 1998 to 2001 to determine soil, corn, and weed responses to compost made from swine manure and corn stalks. Compost was applied at a rate of 8 metric tons of carbon (C) per hectare six months before corn and weeds were planted. (The application rate was three to six times higher than that normally used on Iowa's commercial grain farms. This was to ensure that the changes in soil conditions occurred rapidly and to maximize chances of detecting an effect of compost on weeds.)

Three weed species (giant foxtail, velvetleaf, and common waterhemp) were hand sown near cornrows, thinned to fixed densities, and allowed to compete with corn for the entire growing season. Nitrogen (N) fertilizer applications for corn production are were made in response to results from late spring soil nitrate-N tests with (-) compost plots receiving an average of 143 kg N fertilizer per hectare and (+) compost plots receiving an average of 118 kg N fertilizer per hectare.

## Results and discussion

Weather—Air temperatures from April through October were generally similar among years and did not differ markedly from long-term records. In contrast, there was considerable year-to-year variation in precipitation patterns.

Compost characteristics and effects on soil—Concentrations of N and C were highest in 2000, lowest in 1999, and intermediate in 1998. The compost used in this study was at least six months old at the time of application, and its maturity and longer decomposition time probably resulted in lower N and D concentrations than in some earlier studies.

Soil samples taken in the spring prior to the start of corn production indicated that compost application increased soil organic mater significantly, but had no effect on soil pH. Soil samples collected after corn emergence, but before N fertilizer was applied, indicated that compost significantly increased soil $NO_3$-N concentration. However, despite the large quantities of N applied in the compost, soil $NO_3$-N levels in (+) compost plots were well-below the threshold indicating that additional N was required for corn to reach its yield potential.

Weed and corn densities—The timing of crop and weed emergence was not a primary focus of the present study. However, it was noted that the interval between corn and weed emergence differed considerably among years. These differences in emergence times likely played a role in determining the outcome of weed-crop interactions.

Stand counts taken in late June of each year indicated that there were no significant differences in corn population density among treatments, although there was a significant difference among years, probably due to wet conditions around planting time.

Investigators were successful in establishing similar weed population densities in both (+) and (-) compost plots. Counts of weed seedlings made after thinning operations had been completed indicated that compost did not affect weed density in any given year. Velvetleaf and common waterhemp densities did differ among years.

Studies of weed density-corn yield loss relationships indicated that the impacts of foxtail species and velvetleaf on corn could vary substantially among sites and years.

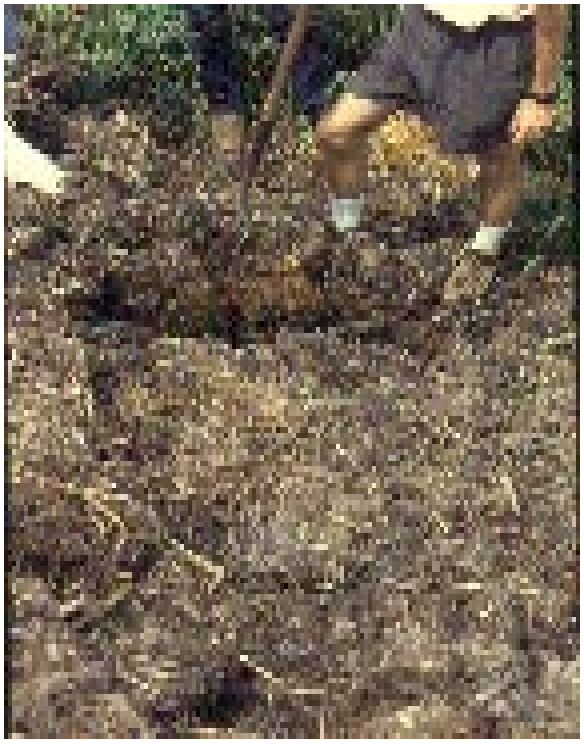
Weed nutrient concentrations—In general, compost increased N and phosphorus (P) con-

*The used bedding from hooped hog production structures can be composted and spread on farm fields as a soil amendment. Researchers studied how this composted material affects crop yields, weed growth, and soil components. Results indicate that composted swine manure can serve as an important source of organic matter, phosphorus, and potassium for soil improvement. Despite these benefits, composted swine manure also can have a stronger positive effect on the nutrient status, growth, seed production, and competitive ability of certain weed species, such as common waterhemp and velvetleaf, than it does on corn. Producers need to pursue efficient weed management practices if composted swine manure is applied to cornfields.*

centrations in the shoot tissue of each weed species, although this trend was not significant in every case. This was consistent with earlier work that observed that many weed species are more effective at absorbing nutrients than are the crops they infest, particularly under fertilized conditions.

Weed height—Compost significantly increased the maximum observed height of velvetleaf and common waterhemp, but had no significant effect on giant foxtail height. Weed height differed significantly among years for each of the three weed species.

Weed biomass and seed production—Compost had no significant effect on the shoot biomass of giant foxtail in any year of the study, increased velvetleaf biomass significantly in one of three years, and increased common waterhemp biomass in all years. Weed biomass differed significantly among years for each of three weed species. Weed biomass was an effective predictor of weed seed production for each weed species in each compost treatment.



***Composted swine manure used in crop and weed experiments was produced at the ISU Rhodes Farm and on a commercial farm.***

Corn nutrient concentrations—Compost had no significant effect on corn ear leaf N or P concentrations, but it did increase potassium (K) concentrations by an average of 15 percent. Weeds had no significant effect on corn ear leaf N, P, and K concentrations, but the concentration of each element was significantly greater in 2000 and 2001. Regardless of compost or weed infestation treatments, corn macronutrient concentrations in both 2000 and 2001 were sufficient for high corn yields. Compost application also consistently increased corn height.

Corn grain yield—Corn grain yield was affected by a significant interaction among compost treatment, weed infestation treatment, and year. Compost had no effect on corn yield in the corn alone and corn with giant foxtail treatments. In contrast, compost significantly increased corn yield in the common waterhemp treatment in 2000, and significantly decreased corn yield in the velvetleaf treatment in 2001.

Comparing weed-free and weed-infested yields assessed competitive effects of weeds on corn grain yield. Both giant foxtail and velvetleaf reduced corn yield in the (-) compost treatment in 2000 and in the (+) compost treatment in 2001, but had no effect on corn yield in the other four year x compost treatment combinations. Common waterhemp competition decreased corn yield in the (-) compost treatment in 2000 and in the both the (-) and (+) compost treatments in 2001.

Compost-related shifts in competitive ability were detected for common waterhemp in 2000 and velvetleaf in 2001. Results indicated that

*Corn and weed responses to composted swine manure were tested within a three-year corn-soybean-wheat + red clover rotation system.*

the effect of compost on weed-crop interactions is species-specific, as well as variable among years.

Parts of the variation observed among years in weed growth and weed competitive ability may be explained by differences in the timing of weed and corn emergence. Researchers noted that little or no corn yield loss occurred when weeds emerged moderately late relative to the crop, whereas substantial yield loss occurred when weeds emerged just after the crop.

## Conclusions

Application of compost increased soil organic matter, P, K, and nitrate-N levels. Compost also increased the N concentration of velvetleaf shoots, the P concentration of giant foxtail and common waterhemp shoots, and the K concentration of shoots of each of the weed species. Compost increased velvetleaf and common waterhemp heights in each of the three years of the project and increased velvetleaf biomass in one of three years, but had no effect on giant foxtail biomass. Measurements of weed seed production in 2001 indicated that compost increased seed output by giant foxtail; compost consistently increased corn leaf K concentration and corn height, but had a variable response on corn grain yield. Overall, for 12 year x weed infestation treatment combinations, compost significantly increased corn grain yield in one comparison, had no effect in ten comparisons, and significantly reduced corn yield in one comparison. The latter case (corn infested with velvetleaf in 2001) indicated that compost was capable of increasing the strength of weed competition against corn.

In total, results of this project suggested that composted swine manure had beneficial effects on soil characteristics and corn K nutrition, but that it also could increase weed nutrient uptake, growth, seed production, and competitive ability against crops. The general lack of effect of compost on corn yield may have been because:

1. Available N, P, and K levels in both the (+) compost and the (-) compost treatments were adequate for high yields, and
2. Other effects of compost on soil conditions were relatively unimportant with regard to grain production.

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Project investigators hypothesize that the potential for compost to increase the competitive effects of weeds on corn is greatest when weeds emerge close to the time of crop emergence. Effective weed management strategies should be in place when composted swine manure is used as a soil amendment in corn production systems.

## Impact of results

This study adds to a small but growing body of knowledge concerning the impacts of composted swine manure on soils, crops, and weeds. Results indicate that composted swine manure can serve as an important source of organic matter, phosphorus, and potassium for soil improvement. Despite these benefits, composted swine manure also can have a stronger positive effect on the nutrient status, growth, seed production, and competitive ability of certain weed species, such as common waterhemp and velvetleaf, than it does on corn. Producers need to pursue efficient weed management practices if composted swine manure is applied to cornfields.

## Education and outreach

Researchers anticipate a minimum of four scientific journal articles to be published about this project; two are being circulated for review and two others will be reviewed by late 2003.

The questions and results generated by this study were presented at 28 meetings and invited lectures to a wide range of farmers, researchers, educators, and agricultural professionals.

***Graduate student Terry Loecke checks corn plant spacing in an experiment investigating corn growth and yield responses to composted swine manure.***