

**Annual Report**

**Soil Amendments for  
Roadside Flower Plantings in  
Virginia**

**July 1, 2000-June 30, 2001**

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## **I. Introduction**

The establishment and maintenance of roadside wildflower stands are dependent both upon the inherent productivity of roadside soils and on management practices. Roadside soils are usually highly disturbed relics of the road construction process and vary significantly from soils that have formed in place. In particular, roadside soils are generally compacted, high in soil strength, acidic, and low in organic matter and plant-available nutrients. Additionally, roadside soils are quite variable laterally due to their disturbed (cut/fill) nature coupled with the normal soil and geologic irregularities encountered when a road corridor slices linearly through what is typically a curvilinear surficial soil/parent material sequence.

The combined influence of adverse soil properties and soil variability in roadside soils has led to irregularities in wildflower growth and bloom display and, in certain instances, to complete stand failures (W. Watson and R. Dove, personal communication). Management practices such as tillage, liming, and fertilization have mitigated these problems only to a limited extent. Land reclamation studies have proven conclusively that the lack of organic matter and organically bound nutrients is the primary property that differentiates drastically disturbed soils from their natural counterparts (Daniels and Haering, 1994; Haering et al., 2000).

Numerous investigations in Virginia and nationally have demonstrated that composts produced from a wide variety of organic materials such as biosolids (sewage sludge), animal manure, and yard wastes can improve soil physical, chemical, and biological properties (Shiralipour et al., 1992; Brosius et al., 1998). The use of organic amendments can reduce or eliminate the need for periodic conventional fertilization and is typically less costly. Finally, and perhaps most importantly, organic amendments can ameliorate local irregularities in surface soil properties. In Virginia, many potentially useful organic amendments are available in each Department of Transportation (VDOT) district. Regulatory guidance and financial incentives promote utilization of these amendments.

The primary goal of this research was to develop a soil amendment strategy that will insure uniform and consistent roadside flower growth, quality, and bloom display from year-to-year. This goal will be accomplished by the use of organic soil amendments that will reduce soil moisture fluctuations, stabilize the physical/chemical soil environment, provide a slow-release source of N, P, and other essential nutrients, and provide a number of other known benefits such as pathogen suppression and enhanced root/shoot growth. The overall goal of this program is to measure the performance of several species of flowers grown in typical Virginia roadside soils amended with various available organic amendments. The specific objectives of the research program were:

- 1) To compare and evaluate different organic amendments for their relative *long-term* effectiveness at improving roadside soil properties and at enhancing wildflower growth and quality,

- 2) To evaluate the effect of non-composted (fresh) wood chips and hardwood tree leaves incorporated into roadside soils on flower growth and soil properties, and
- 3) To compare the use of organic amendments and a promising new foam soil amendment with conventional roadside practices (e.g. the use of inorganic fertilizers/mulch).

This report addresses the specific results of two field studies that were established between the fall of 1998 and the spring of 1999. The field studies were designed to evaluate the long-term effects of the organic materials that were selected. These organic materials included biosolids compost, yard waste compost, cotton gin waste compost, papermill sludge compost, and processed poultry-based fertilizer.



## **II) Effect of Compost Amendments on Performance of Roadside Flowers – Culpeper and Staunton – Initiated Fall, 1998.**

*Objective:* The objective of this ongoing study was to determine the effect of amending roadside soils with organic products, such as composted biosolids, composted yardwaste, cotton gin waste compost, composted papermill sludge, and processed poultry-based fertilizer, on the long-term performance of roadside flower plantings in Virginia.

*Justification:* These four organic products are available to most of the VDOT districts, but limited information is available about the effect of these products on roadside flowers. Two flower species, one perennial and one annual, were selected. Tall fescue was included in the design to represent the typical roadside vegetation used by VDOT.

*Materials and Methods:* In August 1998, two nearly level sites were selected in Culpeper and Staunton, Virginia. The Culpeper site is located near the exit ramp to Route 522/3 North off Highway 29 in Culpeper County within the Northern Piedmont soil physiographic region. The soil at this site has a clay loam surface texture with a high concentration of coarse fragments. The Staunton site is located in the median of I-81 near Buffalo Creek in Augusta County within the Appalachian Ridge and Valley soil physiographic region. This surface soil texture is also clay loam.

Initial soil chemical properties (Table 1) were determined using established procedures for southern U.S. soils (Donohue, 1992). VDOT staff had previously limed the soils, which made the soil pH, Ca and Mg adequate for establishment of vegetation. Soils at both sites contained lower than optimum levels of P for plant growth. Soil K levels were adequate at Culpeper, but lower than required for optimum plant growth at Staunton.

Table 1. Chemical properties of the soils used in the study.

Location	pH	P (ppm)	K (ppm)	Ca (ppm)	Mg (ppm)	Soluble Salts (ppm)
Culpeper	5.8	8	101	816	120	141
Staunton	6.1	10	25	840	117	90

The study design was a two-way factorial experiment consisting of three plant species and six soil treatments. Plant species were lanceleaf coreopsis (*Coreopsis lanceolata*), corn poppy (*Papaver rhoeas*), and tall fescue (*Festuca arundinaceae*). The soil treatments were composts from four unrelated sources, an NPK fertilizer applied according to soil test results, a poultry litter-based fertilizer, AgriCell™ foam, and an unamended control. The composts were produced from: 1) biosolids (+ wood chips), 2) yard waste (+ poultry litter), 3) papermill sludge, and 4) cotton gin trash. The amendment sources are listed in Table 2. Each treatment was replicated four times. The experimental treatments were applied as a randomized complete block at Culpeper and Staunton. Individual plots were 100 ft<sup>2</sup>.

Table 2. Sources of amendments applied in Culpeper and Staunton in August 1998.

Treatment or Amendment	Source
Biosolids compost (BC)	Harrisonburg-Rockingham Regional Sewage Authority, Mount Crawford, 540-434-1053
Yard waste compost (YWC)	Panorama Farms, Earleysville, 804-989-3846
Papermill sludge compost (PMSC)	Greif Bros., Amherst, 804-933-4182
Cotton gin trash compost (CGTC)	Commonwealth Gin, Windsor, 757-242-3566
Pelleted poultry-derived fertilizer (PPF)	Harmony Products, Chesapeake, 800-343-6343
AgriCell™ Foam	Enviro Tek Corp, Waterford, 540-882-3630

Existing vegetation at the sites was sprayed with glyphosate (2 gal/acre) two weeks prior to seeding. Soil at each site was then roto-tilled six to eight inches deep. The amendments were tilled into the top three to four inches of soil on 8/26/98 at Culpeper and 8/28/98 at Staunton. The laboratory analysis of the properties of each amendment is presented in Table 3.

Table 3. Analyses of soil amendments used in the study.

Compost	Solids (%)	Org C (%)	C:N	TKN* (%)	Org-N (%)	NH <sub>4</sub> -N (%)***	P (%)	K (%)	EC** (dS/m)	pH
Biosolids	70	37.8	9.6	3.95	3.14	0.81	2.9	0.25	10.74	6.8
Yard Waste	32	30.3	16.0	1.89	1.88	0.02	0.6	0.65	1.48	7.6
Paper Sludge	58	37.8	22.8	1.66	1.66	0.01	0.6	0.44	1.78	7.4
Cotton Gin	58	23.0	10.5	2.20	2.19	0.01	0.2	0.97	1.50	7.9
Poultry Fertilizer	90	40.98	9.4	4.36	3.96	0.04	1.8	2.79	22.70	7.5

\*TKN = Total Kjeldahl Nitrogen

\*\* EC = Electrical Conductivity (dS/m = mmhos/cm)

\*\*\*NH<sub>4</sub>-N (%) = Ammonium form of nitrogen

Amendments were applied at rates designed to supply 45 lbs/acre of first-year Plant Available N (PAN), which is the estimated annual N requirement of wildflowers. Tall fescue N needs are higher than those of wildflowers, but the same amendment rates were applied to all three species to provide consistent compost application rates. This equation was used to estimate PAN from the various organic amendments:

PAN = (X \* Org-N) + (NH<sub>4</sub>-N), where:

PAN = lbs of plant available nitrogen per dry ton of amendment,

Org-N = lbs of organic nitrogen per dry ton of amendment, determined as TKN - NH<sub>4</sub>-N,

NH<sub>4</sub>-N = lbs of (ammonia + ammonium) nitrogen per dry ton of amendment, and

X = estimated availability coefficient for organic N (x=0.10 for compost).

Nutrient application rates were estimated based on the actual composition of the composts (Table 4). Phosphorus and K rates were variable due to differences in the N:P and N:K composts ratios. The level of wildflower P and K needs are unknown, but tall fescue establishment required 140 lbs P<sub>2</sub>O<sub>5</sub>/acre at both sites and 160 and 75 lbs K<sub>2</sub>O/acre at Staunton and Culpeper, respectively.

Table 4. Applied plant available nutrients for the first year.

Treatment	Amendment Rate	Estimated Plant Available Nutrients (lbs/acre)		
		Total N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O
Biosolids	3 tons/acre (fresh wt)	49	280	12
Yard Waste	33 tons/acre (fresh wt)	54	292	164
Paper Sludge	22 tons/acre (fresh wt)	47	352	134
Cotton Gin	13 tons/acre (fresh wt)	34	69	175
Poultry Fertilizer	3 tons/acre (fresh wt)	44	222	133
AgriCell™ Foam <sup>1</sup>	3 inches	Not Documented	Not Documented	Not Documented
15-30-15	300 lbs/acre	45	90	45
Control	Not amended			

The three plant species selected have different characteristics. Corn poppy is a biennial that is seeded each year in the fall, coreopsis is a perennial that often requires two years to become fully established, and tall fescue is a perennial grass that is widely planted along Virginia roadsides. Corn poppy and fescue have higher N demands than coreopsis. Corn poppy and coreopsis were expected to be more sensitive to phytotoxicity produced by under-matured compost than fescue. Seeding rates were 20 lbs/acre of coreopsis, 18 lbs/acre of corn poppy, and 100 lbs/acre of tall fescue, respectively. The plots were rolled after seeding to increase seed-soil contact.

Weeds were controlled with periodic use of 2,4-D (1.4 gal/acre), imazapic (Plateau™, 4 oz/acre), and pendimethalin (Pendulum™, 1 gal/acre). Imazapic was applied to the poppies and coreopsis in the spring of 1999 and 2000. Pendimethalin was applied to the grass and coreopsis in August 1999. In June 1999, vegetation at both sites was mowed to eight inches to control weeds. By this time, the corn poppy had senesced, the tall fescue seed heads had fully expanded, and the coreopsis was not yet tall enough to be damaged by mowing. The plots were sprayed with glyphosate then roto-tilled to a depth of three inches. The corn poppy was replanted in early September 1999 and 2000. The plots were rolled after seeding and imazapic was then applied.

A visual rating system, employed frequently by turfgrass researchers, was used to measure living plant ground coverage density. The performance of the vegetation was evaluated through the spring of 2001 (2.5 years). In November 2000, the tall fescue plots at both sites were mowed and the clippings (biomass) were collected and dried. Soil from each plot was sampled to a depth of 3-4 inches, 18 months after soil amendments were applied (March 2000), for determination of pH; Bray-1 P; exchangeable Ca, Mg, K, and acidity; and base saturation.

*Results and Discussion:*

### Compost

There was considerable variation among the N levels of the composts. The biosolids compost (BC) contained almost double the percent of N in comparison to the other composts (Table 3). The BC had a low C:N ratio and a high proportion (i.e., >20%) of N in the NH<sub>4</sub> form, indicating that the compost was not totally stabilized at the time of application. The BC also contained (not unexpectedly) a higher concentration of P and a lower concentration of K than the other composts. The P and K concentrations in the yard waste (YWC) and the cotton gin trash (CGTC) composts were typical for composts derived from such feedstocks (Brosius et al., 1998). The papermill sludge compost (PMSC) also contained concentrations of P and K that were consistent with published values, but the total-N concentration of the PMSC used in our study was considerably higher than typical values (Campbell et al., 1995; Jackson and Line, 1997). The PMSC used in this study was produced from a combined primary and secondary sludge that had received additions of NH<sub>4</sub>OH during the digestion process to stimulate microbial decomposition (Evanylo and Daniels, 1999). The use of this PMSC produced resulted in a high initial C:N ratio of the sludge (40:1).

### Other Amendments

The levels of N, P and K in the poultry fertilizer were similar to YWC and PMSC. Both the poultry fertilizer and the 15-30-15 fertilizers had similar N concentrations, but P and K concentrations in the poultry fertilizer were nearly three times greater than in the 15-30-15 fertilizer. The AgriCell foam provided some N but also significantly increased soil water holding capacity (Beck et al, 1999). The potential for long-term N release has been documented for this product, but the amount and duration of N release was not clear. We have seen positive effects from the foam amendment on tall fescue performance for more than two years beyond establishment treatment (Beck, M., personal comm..).

### Corn poppy

Eight months after seeding (May 1999), the stand density of the corn poppy at Culpeper increased in the order: Foam = PPF ≥ Fertilizer ≥ PMSC = BC ≥ YWC ≥ CGTC ≥ control (Figure 1). Differences in corn poppy density with soil amendment treatments were observed in Staunton by the following spring (March 2000), the ground cover averaged 61% at Culpeper and 74% at Staunton. The poppy seed that was planted in Culpeper on September 1, 2000 and in Staunton on September 6, 2000 germinated but it did not establish sufficiently for a fair evaluation. Almost an inch of rain fell shortly after seeding at both sites, but afterward the plots received only trace amounts of rain during the next eight weeks. No data were taken in the spring of 2001.

### Coreopsis

Two years after seeding, none of the amendments significantly increased coreopsis density above the control at Culpeper or Staunton (November 2000; Figure 2). Coreopsis density averaged 84% at Culpeper and 65% at Staunton. Coreopsis density was suppressed in the poultry fertilizer plots at Culpeper and in the poultry fertilizer and cotton gin plots in Staunton. In Culpeper, the density was improved in the order: YWC ≥ Control ≥ CGTC ≥ Foam ≥ PMSC ≥ BC ≥ Fertilizer ≥

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<sup>1</sup> The amount of nutrients delivered by this product is not known. The product is sold as a soil conditioner, not a fertilizer. However, AgriCell does release significant N and P over time.

Poultry. In Staunton, the density was enhanced in the order: Foam  $\geq$  PMSC  $\geq$  YWC  $\geq$  Control  $\geq$  Fertilizer  $\geq$  BC  $\geq$  CGTC  $\geq$  Poultry.

Data were not collected in the spring of 2001 because road crews at both sites had sprayed the coreopsis with a broadleaf herbicide, and the plots in Culpeper were inadvertently mowed. Unfortunately, these events can and do occur in our research program when plots are situated on the roadside. The only prevention of this would be to work within the safer confines of experimental stations.

### Tall fescue

Two years after seeding, tall fescue grass clippings were collected from the plots. There were no significant differences among amendment treatments at each site (Table 5). Overall, the biomass from Culpeper was greater than from Staunton. This result was probably due to greater rainfall in Culpeper.

Tall fescue height was also recorded when clippings were collected. There were no significant differences in the Culpeper tall fescue height but in Staunton, there were slight differences (Table 6). In Staunton, the control treatment grass was as tall as all the other treatments; however, the biosolid grass was taller than the fertilizer, papermill or cotton gin composts. The Culpeper grass was generally taller than the grass at Staunton. This outcome may also be a reflection of greater rainfall in Culpeper.

Tall fescue density was also evaluated when clippings and height measurements were collected (Figure 3). In Culpeper there were no differences among the treatments in November 2000; in contrast, there were treatment differences in Staunton. All amendments except foam produced denser grass than the control. The average grass density at both sites was 76%.

Table 5. Dry weight (kg/ha) of tall fescue clipping taken on November 2, 2000 at Culpeper and Staunton. For each site, the dry weight values are not significantly different.

Amendment	Culpeper	Staunton
BC	1065	767
YWC	1099	822
PMSC	1128	808
CGTC	1082	741
Poultry Fertilizer	1060	739
AgriCell™ Foam	1000	678
Fertilizer	877	696
Control	1021	831
Mean	1041	758

Table 6. Height (cm) of tall fescue taken on November 2, 2000 at Culpeper and Staunton. The heights recorded at Staunton are significantly different. Means for treatments with the same letter are not significantly different at the 5% level according to Student, Newman and Kuels test.

Amendment	Culpeper	Staunton
BC	19.4a	14.0a
YWC	18.5a	11.7ab
PMSC	18.4a	11.2b
CGTC	18.4a	11.0b
Poultry Fertilizer	19.6a	12.7ab
AgriCell™ Foam	19.0a	12.2ab
Fertilizer	19.1a	10.7b
Control	20.6a	12.0ab
Mean	19.0	11.9

The following spring, grass density coverage was evaluated at the two sites. In Culpeper none of the amendments improved the grass density when compared to the control (Figure 3, June 2001). However, in Staunton, the foam, biosolid and yardwaste amendments produced slightly denser grass than the control. At that time, the average density at both sites was the same, 74%.

### Soil Properties

At both locations, the greatest increases in soil extractable P concentration were associated with yard waste compost, biosolids composts, and poultry fertilizer (Table 7,8), each of which supplied nearly 300 lbs P<sub>2</sub>O<sub>5</sub> per acre (Table 4). Surprisingly, the papermill sludge compost, which supplied the greatest amount of total P (352 lbs P<sub>2</sub>O<sub>5</sub> per acre), did not raise soil P concentration above that of the control, fertilizer or CGTC treatments. The P in the PMSC was apparently not readily extractable. Composts had little effect on the soil pH values, which were already adequate, but the soil pH values tended to be higher with the PMSC and YWC than with

the control and/or fertilizer treatments at either location (Table 7 and 8). This effect was likely due to the higher base saturation and lower exchangeable acidity of the PMSC and YWC plots compared to the control and fertilizer treatments. PMSC and YWC increased the soil Ca above the control and fertilizer treatments at both locations. YWC treatment increased K above the control or fertilizer treatments at both locations; but the poultry fertilizer increased the K above the control in Staunton only. The YWC increased the Mg above all other treatments at both locations. Only the YWC increased soil cation exchange capacity at either site. The lower C:N ratios of the BC and the CGTC when compared with the PMSC and YWC may have resulted in greater N-mineralization and subsequent acidifying nitrification reactions in the BC and CGTC soils. This outcome may have, in turn, reduced the buffering effectiveness of the organic matter in the BC and CGTC. The foam product did not increase the amount of extractable soil P, K, Ca or Mg when compared to the control. The pH of foam-amended plots was significantly lower than that of the controls due to the acidifying effect of the foam. Therefore, if foam is used as a soil amendment, appropriate lime additions are recommended. Percent base saturation was adequate for all treatments. The YWC and PMSC alone significantly increased percent base saturation above the control.

Table 7. Effects of amendments on soil properties sampled at Culpeper in March 2000, averaged across species. Treatment means followed by the same letter are not significantly different at the 5% level according to Student Newman Kuels test.

Treatment	pH	CEC*	ppm P	ppm K	ppm Mg	ppm Ca	% Base Saturation*
BC	6.0b	9.1b	24bc	207bc	178b	1151bc	85b
YWC	6.3a	11.5a	34a	299a	249a	1517a	90a
PMSC	6.4a	9.9b	14cd	185c	191b	1417ab	92a
CGTC	6.1b	9.3b	14cd	247abc	204b	1137bc	86b
Poultry Fertilizer	6.1b	8.9b	29ab	282ab	184b	1097c	86b
AgriCell™ Foam	5.8c	9.9b	17cd	234abc	187b	1141bc	79c
Fertilizer	6.0b	9.0b	16cd	209bc	183b	1116bc	84b
Control	6.0b	9.1b	12d	205bc	187b	1140bc	85b

\*CEC=Cation Exchange Capacity. The higher the CEC the more likely the soil is able to hold onto positive ions such as Ca<sup>2+</sup>, Mg<sup>2+</sup>,K<sup>+</sup>, Al<sup>3+</sup>, and Na<sup>+</sup>.

\*\*% Base Saturation = (K + Mg + Ca)/CEC. The base saturation indicates the percent of CEC sites that are occupied by basic cations. An approximate base saturation of 60% or higher is desirable.

Table 8. Effects of amendments on soil properties sampled at Staunton in March 2000, averaged across species. Means for all treatments followed by the same letter are not significantly different at the 5% level according to Student Newman Kuels test.

Treatment	pH	CEC*	ppm P	ppm K	ppm Mg	ppm Ca	% Base Saturation**
BC	6.1ab	9.7b	40ab	68c	173b	1358bc	87ab
YWC	6.3ab	11.5a	46a	119a	225a	1625a	92a
PMSC	6.4a	9.9b	22c	72c	173b	1500ab	91a
CGTC	6.1ab	9.5b	27bc	99ab	175b	1308bc	87ab
Poultry Fertilizer	6.2ab	10.1b	52a	109a	170b	1417abc	87ab
AgriCell™ Foam	5.9b	9.2b	21c	66c	154b	1247bc	84b
Fertilizer	6.1ab	8.7b	28bc	88bc	157b	1194c	85ab
Control	6.2ab	9.3b	21c fix	69c	175b	1311bc	88ab

\*CEC=Cation Exchange Capacity. The higher the CEC the more likely the soil is able to hold onto positive ions such as Ca<sup>2+</sup>, Mg<sup>2+</sup>, K<sup>+</sup>, Al<sup>3+</sup>, and Na<sup>+</sup>.

\*\*% Base Saturation = (K + Mg + Ca)/CEC. The base saturation indicates the percent of CEC sites that are occupied by basic cations. An approximate base saturation of 60% or higher is desirable.

### Herbicides

In March 1999, 2,4-D (1.4 gal/A) was applied to the tall fescue and Plateau™ (4 oz/A) was applied to the corn poppy and coreopsis at both sites. One month later Plateau™ (same rate) was again applied to the flowers. The herbicides were used to kill henbit (*Lamium amplexicaule*) and purple deadnettle (*Lamium purpureum*) in Culpeper and Canada thistle (*Cirsium arvensis*) in Staunton. The Plateau™ reduced but did not eradicate the henbit and purple deadnettle populations in Culpeper. Unfortunately, Plateau™ did little to kill the thistle. The coreopsis appeared to be slightly stunted by the herbicide, but later recovered. The corn poppies were unaffected. In late August 1999, Pendulum™ (1 gal/A) was applied to the coreopsis and 2,4-D (1.4 gal/A) was applied to the grass in both areas in an attempt to prevent the germination of winter annual weeds. The following spring, the weed population in these plots was reasonable.

In early September 2000, Plateau™ (4 oz/A) was applied after poppy seeding in Culpeper and Staunton. Canada thistle was the only weed to return. This weed continued to be a major problem at both sites.

*Conclusions:* Compost has been demonstrated to be valuable for restoring the productivity of disturbed soils because it improves nutrient availability, water-holding capacity, and soil structure. In this study, the effect of the assorted composts on plant density was variable and often no different than the unamended control. Extreme drought conditions during the initial one and one-half years after plant establishment may have masked anticipated beneficial effects of the composts. In the first year, each plant species performed poorly with the CGTC compared with other compost treatments at same location and sampling time. The most noticeable difference in chemical composition between the CGTC and other composts was the lower rate of P supplied. Conversely, the YWC always resulted in plant densities that were among the best at each location and time of sampling. This result was also observed in the greenhouse study conducted last year (Booze-Daniels, et. al. 2000). The AgriCell™ foam had visually enhanced the foliage color and density of the three plant species two years after application. The growth enhancing effect of the foam was still evident after the second poppy crop. This trial thus demonstrates significant residual effect of the foam.

At the end of this study, two and one-half years after installation, several of the amendments appeared to slightly hinder the growth of the plants. The PMSC and fertilizer slightly hindered the tall fescue and the poultry fertilizer was not beneficial for coreopsis.

In field and greenhouse studies completed last year (Booze-Daniels, et al., 2000), several plants responded differently to the variety of amendments used. For example, poppy performance was strongly enhanced with the AgriCell™ foam and poultry fertilizer; however, poultry fertilizer reduced the density of the coreopsis. This response was also observed for the native warm-season grasses that were screened in the greenhouse. The Indiangrass performed better in soil amended with YWC but not PMSC. The switchgrass performed well in all compost treatments. This result can be explained by the fact that although similar biological processes create composts, the characteristics of each are greatly dependent on the feedstock employed, the maturity, and PAN of the finished material. A further complication is the difference between batches of composts. Making compost is similar to making wine, in that the end-result is never exactly the same. Thus, testing new sources of compost for maturity is important, and matching compost type to individual plant species is worthy of further investigation.

### **III) The Effect of Leaf Litter and Wood Chips on the Performance of Roadside Flowers – Culpeper – Initiated Spring, 1999.**

*Objective:* The objective was to determine the effect of incorporated leaf litter and wood chips on the performance of roadside flower species.

*Justification:* Wood chips and leaf litter are abundantly available and often end up in community landfills. Both have been used as soil amendments to increase soil organic matter levels (Christian and Evanylo, 1997, Heckman, 2000, King, 1979). The use of these inexpensive materials on the roadsides may be of benefit to roadside flower establishment.

*Procedures and Materials:* In the spring of 1999, a nearly level site adjacent to the previous study (section II) in Culpeper was selected. The soil properties were the same as described earlier. Leaves were collected in the fall of 1998 from Blacksburg residents and stored in black plastic bags. A mixture of hardwood and softwood wood chips that were less than six months old was acquired from VDOT, and this mixture was stored in a pile.

The site was sprayed with glyphosate (2 gal/A) to kill the existing vegetation two weeks prior to the amendment application. The soil was roto-tilled four to six inches deep in preparation for the applications of the chips and leaves. On March 24, 1999, dried leaves (5.5, 11.0 and 15.0 wet tons/A) and wood chips (13, 20, 27 wet tons/A) were applied at three rates. All treatments were replicated four times and arranged in a completely randomized design. The amendments were then tilled into the soil to a depth of six to eight inches where possible, although the high rate of leaves was physically difficult to incorporate into the soil. The treatments are described in Table 9.

Table 9. Description of leaf litter and wood chips applied in Culpeper in March 1999. Fertilizer was applied in a split application in March and September 1999.

Amendment Treatment	Rate of Amendment	Fertilizer Rate (lb/A)	
		March '99	Sept. '99
Unfertilized control	0	0	
Fertilized control	0	150 *	150
Low Leaf Rate (L-leaf)	5.5 tons/A (wet weight)	195 **	195
Medium Leaf Rate (M-leaf)	11 tons/A	343	343
High Leaf Rate (H-leaf)	15 tons/A	461	461
Low Wood Chip Rate (L-chip)	13 tons/A	758	758
Medium Wood Chip Rate (M-chip)	20 tons/A	1114	1114
High Wood Chip Rate (H-chip)	27 tons/A	1469	1469

\* 15-30-15 used

\*\* 46-0-0 was applied to all the leaf and chip treatments

Two split applications of urea were applied in March 1999 and in September 1999 to satisfy both plant N requirements and to provide the estimated rate of N required by microbes to decompose the carbon present in both leaves and wood chips without nitrogen immobilization. This was calculated by applying N to achieve a C:N ratio of 30:1<sup>2</sup>. Phosphorus and K were incorporated

<sup>2</sup> Example of calculation: For 1000 lb of leaves, N= 1% x 1000 =10lb; C= 54% x 1000 = 540 lb. To attain the desired 30:1 C:N ratio after *in situ* composting, Needed N= 540/30 = 18 lb N. Because the leaves contain 10 lb

in March 1999 (300 lb/A 0-30-15). These experimental N rates were applied to overcome the anticipated N immobilization from the high C-containing leaves and woodchips and to supply adequate plant available N.

Garden cosmos (*Cosmos bipinnatus*) (10 lb/A) was seeded in March 1999. In September 1999, the plots were re-seeded with corn poppy (18 lb/A). In April 2000 the poppy plots were inadvertently tilled by VDOT. We therefore were not able to collect the poppy data for those plots. Sulfur cosmos (*Cosmos sulphureus*, 10 lb/A) was sown by VDOT in June 2000 as one mass planting. In the tilling process identifying markers were temporarily hidden, thus data could not be collected. On June 12, 2001, the plots were once again seeded with garden cosmos (15 lb/A) after the plots were sprayed with glyphosate (2 gal/A), and individually roto-tilled. Data were collected in August 2001.

*Results and Discussion:* The first sowing of Cosmos resulted in a poor stand in all plots because of the drought during the summer of 1999. No data were collected. The corn poppy stand that was seeded in the fall of 1999 established successfully, but the stand was later destroyed by VDOT before the flower data could be taken.

Two months after sowing (November, 1999), the corn poppies growing on the two highest wood chip plots (M-chip and H-chip) were significantly less dense than those on the other treatments (Figure 4). However, six months after the corn poppies were sown (March, 2000), all rates of both the leaf and chip treatments were similar for plant density. The control and fertilizer plots out-performed the leaf and chip plots. At that time, no visual N-deficiency symptoms were detected in the poppy crop.

When the last crop of cosmos was planted in June 2001, it was difficult to see any evidence of intact wood chips or leaves. There were no significant differences in plant density two months after the cosmos was planted. However, all treatments reached an average density of 70%.

*Conclusions:* None of the treatments, even the highest rates of leaves and chips, suppressed cosmos density two years after the amendments were applied to the site. It is clear that if leaves and chips are used as soil amendments, additional N is needed for successful stand establishment. How much N to add is not known, especially with high rates of leaves and chips. Heckman (2000) reported that no additional N was required to grow corn. Further study would be required to determine exactly how much N would be necessary for successful stand establishment and to determine the least amount of N that would be required to satisfy the N requirement of both the plants and C decomposing microbes.

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N/1000 lb leaves, subtract 10 lb from 18 lb. Eight lb N is therefore needed to insure decomposition of the leaves without robbing N from the plants.

#### IV. Overall Conclusions: Fall 1998 to Spring 2001

The field studies that were installed two and half years ago have provided information, although mixed with unexpected results. There is little difference between the control and the amendments in the field studies. This indicates that either a) the soils were so variable that no differences could be statistically identified, b) the soil was not adverse enough for the amendments to make a real difference, c) the drought that has persisted over the course of this study have negated any striking differences in plant growth, d) we did not apply high enough amounts to generate a response, or e) the amendments are not needed to improve plant growth. The last possibility can be eliminated because we know from the copious amount of research done all over the World that organic amendments are beneficial to plant growth on adverse soils. A combination of a through d is a more probable explanation.

The three plants that we observed responded differently to various amendments. For example, the poppies and tall fescue perform well with AgriCell™ foam and poultry-derived fertilizer. Composted products did little to improve poppy density, but they did not reduce plant density relative to fertilized controls. The *Coreopsis* density was unaffected by the compost amendments. However, the poultry-derived fertilizer reduced the density of this plant when compared to the control. This effect was also observed in the greenhouse study that was reported by Booze-Daniels, et al (2000). This concept of matching compost type to individual plant species is new and should be considered seriously.

Compost amendments are now easily and abundantly available to VDOT, and they will become more accessible as the number of compost producers increase. We suggest that tested compost be applied to poor soils with little hesitation. Our experience with yardwaste use on the roadside in Mechanicsville in 1996 has proven to us that compost application was the key ingredient to the successful establishment and persistence of vegetation on this extremely acid site (Booze-Daniels, et al, 1998). To date, the roadside remains vegetated; however, the adjacent area that was not treated with compost is no longer vegetated.

Leaf and wood chip products are also abundantly available to VDOT and should be used on the roadsides. These materials can be incorporated into the soil and allowed to decompose *in situ* with the addition of fertilizer. This study showed that leaf and chip loading rates did not adversely affect the performance of cosmos two years after application. This is a positive indication that our loading rates of leave and chips are possible. The soil at the test site was adequate for cosmos growth so it was not expected that the amendments would enhance cosmos growth. If enhanced growth on poor soils is desired, this study should be repeated on a different site over more than two years. In addition, determining the appropriate fertilizer rate with these amendments would be beneficial.

Testing composted products before applying to the land is imperative. Composts are created according to certain guidelines, but that does not mean the product will be the same with each batch nor from different production facilities. In addition, compost maturity is one of the most important characteristics to consider when selecting a composted material for roadside use. A compost product is considered inferior if it has not totally matured to its final stable form. These

products should be used with caution because the by-products of incomplete compost decomposition can have negative effects on plant growth.

The last issue to discuss is the overall importance of controlling soil pH. We mentioned this in a previous report (Booze-Daniels, et al, 2000). We believe this is so important that it warranted mentioning again. Soil pH influences the effectiveness of added N and P on plant growth. Plants that are grown in extremely acid soils utilize both elements less efficiently than those grown in soils with higher pH. The VDOT manager may obtain a more favorable plant response when these roadside flower species are grown in soils that are limed to pH 6.0 to 7.0. Not only is plant-available N increased, other essential elements such as Ca and Mg are also more easily available to the plants. The other factor in this “liming effect” is that aluminum (Al) is rendered immobile in higher pH soils. Al is also bound by organic amendments. Al is toxic to many plants (except for Ericaceous plants) and N-transforming microbes.

## **V. References**

Beck, M.A., W.L. Daniels and J.N. Booze-Daniels. 1999. Effect of urea-formaldehyde foam on vegetation establishment. p. 343 *In: 1999 Annual Meeting Abstracts, ASA/CSSA/SSSA*, Madison, WI.

Booze-Daniels, J.N., G.K. Evanylo, W.L. Daniels, and K. Haering. 2000. Soil amendments of roadside flower plantings in Virginia. Annual Report. Virginia Dept. of Transportation, Environmental Division, 1401 East Broad Street, Richmond, VA, 23219. 32p.

Booze-Daniels, J.N., R.E. Schmidt, and D.R. Chalmers. 1998. Evaluation and Management of Turfgrass on Virginia Roadsides. Annual Report. Virginia Dept. of Transportation, Environmental Division, 1401 East Broad Street, Richmond, VA, 23219. 58p.

Brosius, M.R., G.K. Evanylo, L.R. Bulluck, and J.B. Ristaino. 1998. Comparison of commercial fertilizer and organic by-products on soil chemical and biological properties and vegetable yields. pp. 195-202. *In: S. Brown, J.S. Angle, and L. Jacobs (ed.) Beneficial co-utilization of agricultural, municipal, and industrial by-products.* Beltsville Agricultural Research Center. Kluwer Academic Publishers, Dordrecht, Netherlands.

Campbell, A.G., X. Zhang, and R.R. Tripepi. 1995. Composting and evaluating a pulp and paper sludge for use as a soil amendment/mulch. *Compost Science & Utilization* 3:84-95.

Christian, A.H. and G. Evanylo. 1997. On-Farm leaf mulching: An option for farmers and municipalities. Virginia Cooperative Extension pub. #418-017, Virginia Tech, Blacksburg, VA 24061.

Daniels, W.L. and K.C. Haering. 1994. Use of sewage sludge for land reclamation in the Central Appalachians. pp. 105-121. In Clapp, C.E., W.E. Larson, and R.H. Dowdy (eds.) Sewage sludge: land utilization and the environment. Soil Science Society of America Miscellaneous Publ. ASA, CSSA, and SSSA, Madison, WI.

Donohue, S.J. 1992. Reference soil and media diagnostic procedures for the southern region of the United States. Southern Cooperative Series Bull. No. 374. 47 p.

Evanylo, G.K. and W.L. Daniels. 1999. Papermill sludge composting and compost utilization. *Compost Science & Utilization* 7:30-39.

Haering, K.C., W.L. Daniels, and S.E. Feagley. 2000. Reclaiming mined lands with biosolids, manures, and papermill sludges. P 615-644 *In* R.E. Barnhisel, et al., Reclamation of drastically disturbed lands, SSA Mono. 41, ASA/SSA Madison WI.

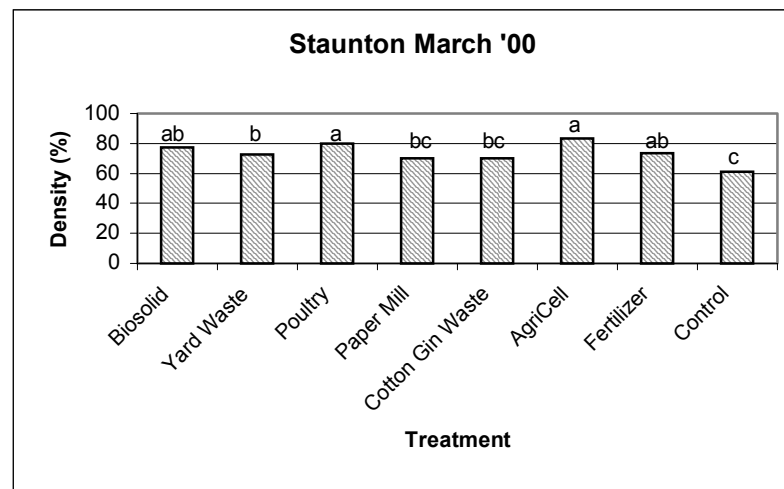
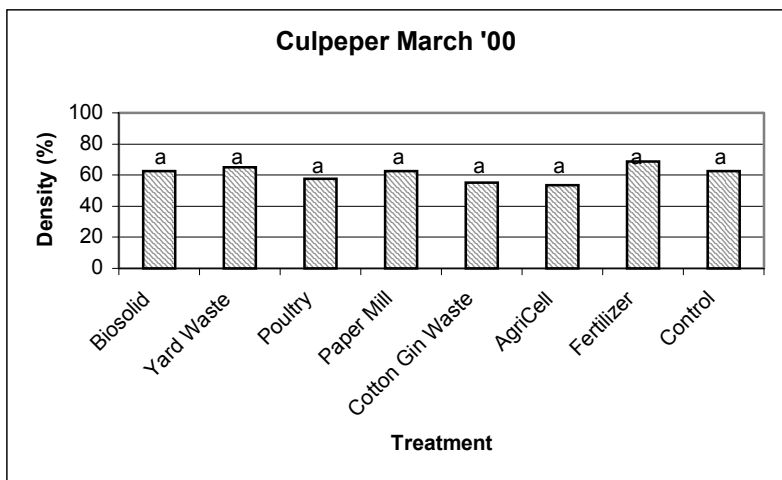
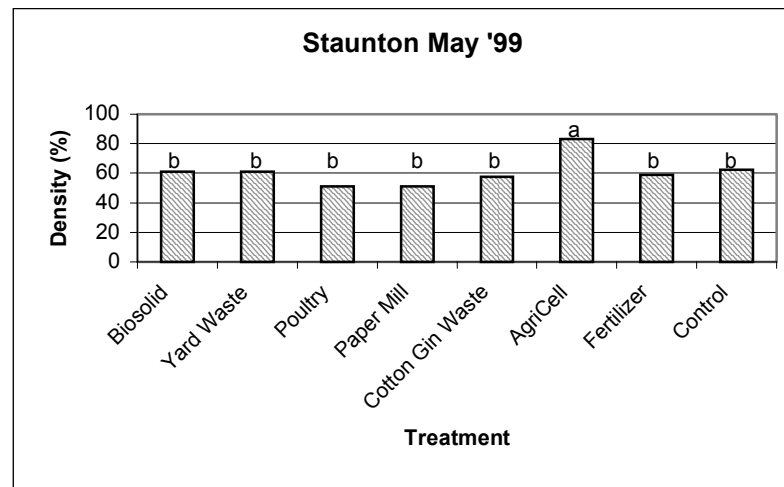
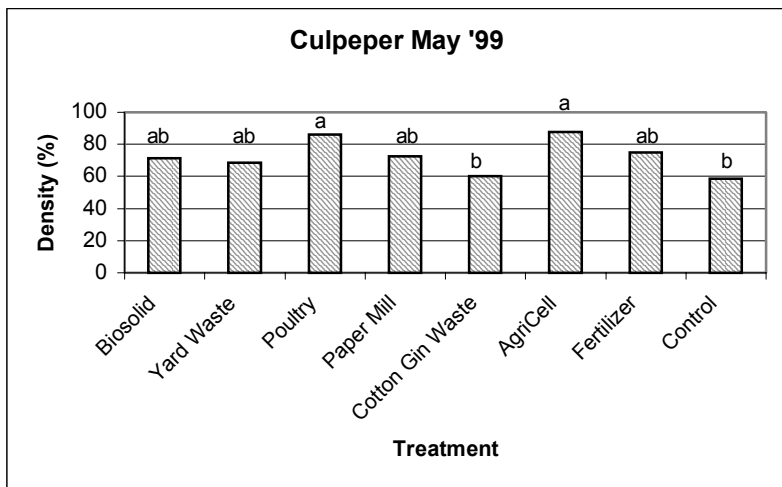
Heckman, Joseph R. Spring 2000. Leaves from city shade trees benefit soils. *The Soil Profile*. Vol 10, No. 1. Rutgers Cooperative Extension Service, Plant Sci Dept, Rutgers, 59 Dudley Rd, New Brunswick, NJ 08901.

Jackson, M.J. and M.A. Line. 1997. Windrow composting of a pulp and papermill sludge: Process performance and assessment of product quality. *Compost Science & Utilization* 5:6-14.

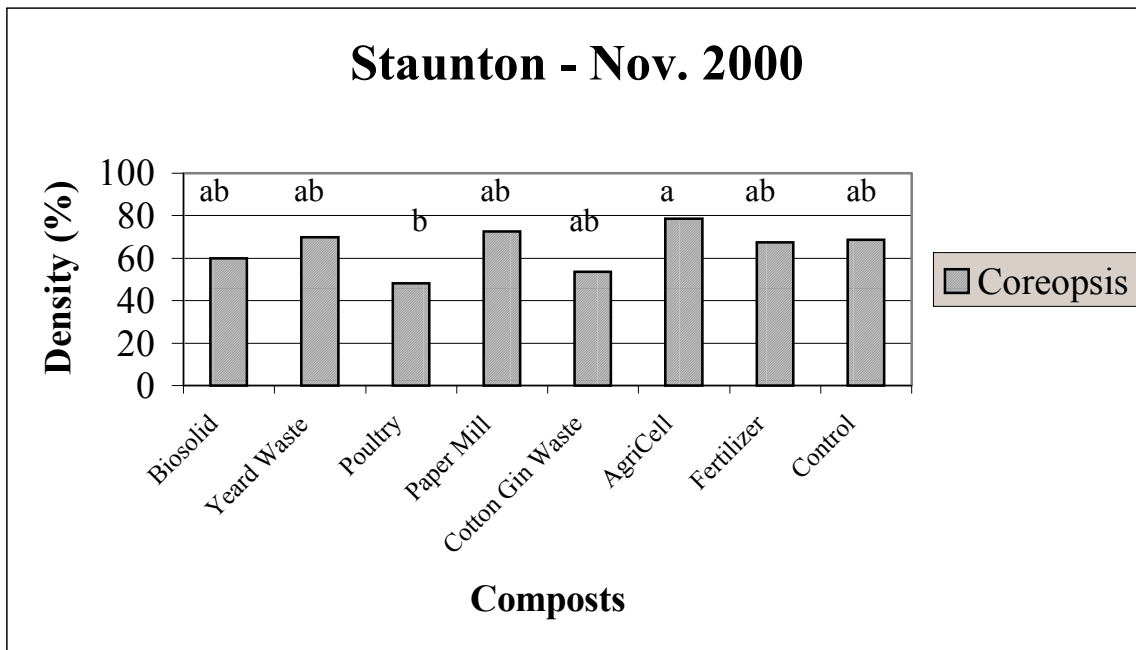
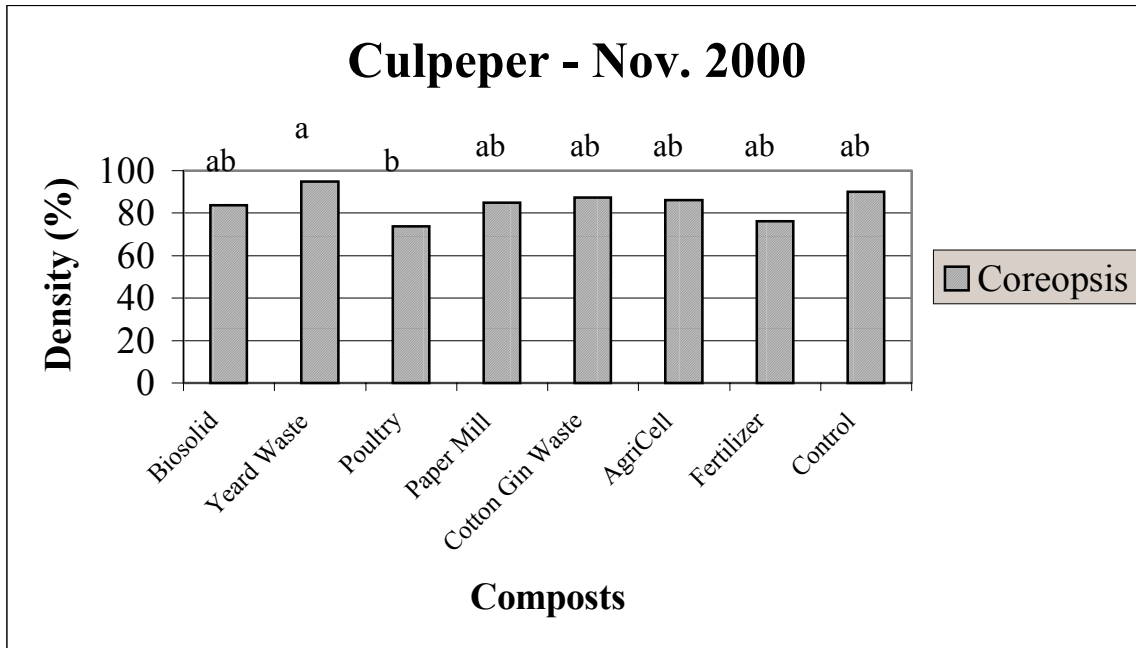
King, L.D. 1979. Waste wood fiber as a soil amendment. *Journal of Environ. Quality*. 8:1, pp. 91-95.

Shiralipour, A., D.B. McConnell, and W.H. Smith. 1992. Physical and chemical properties of soils as affected by municipal solid waste compost application. *Biomass and Bioenergy* 3:261-266.

**Figure 1. Corn Poppy Denisty in Culpeper and Staunton**  
 Different letters above treatment bars indicate significant differences at P<0.05.

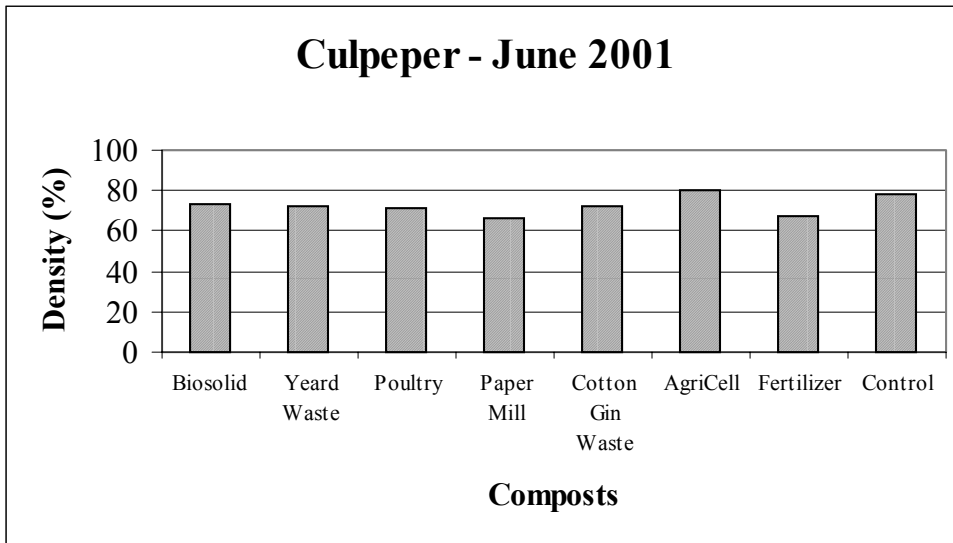
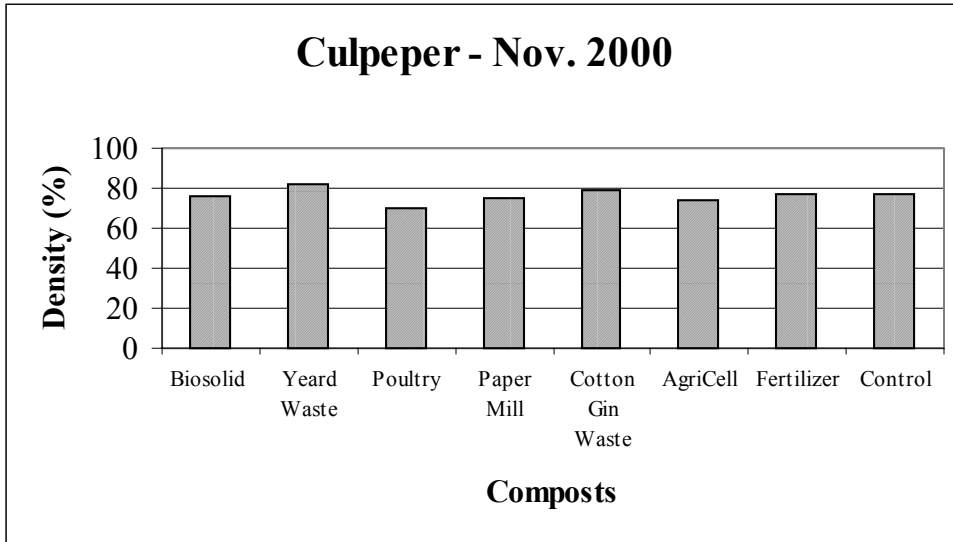


**Figure 2. Coreopsis Density in Culpeper and Staunton**  
 Different letters above treatment bars indicates significant differences at  $P < 0.05$ .



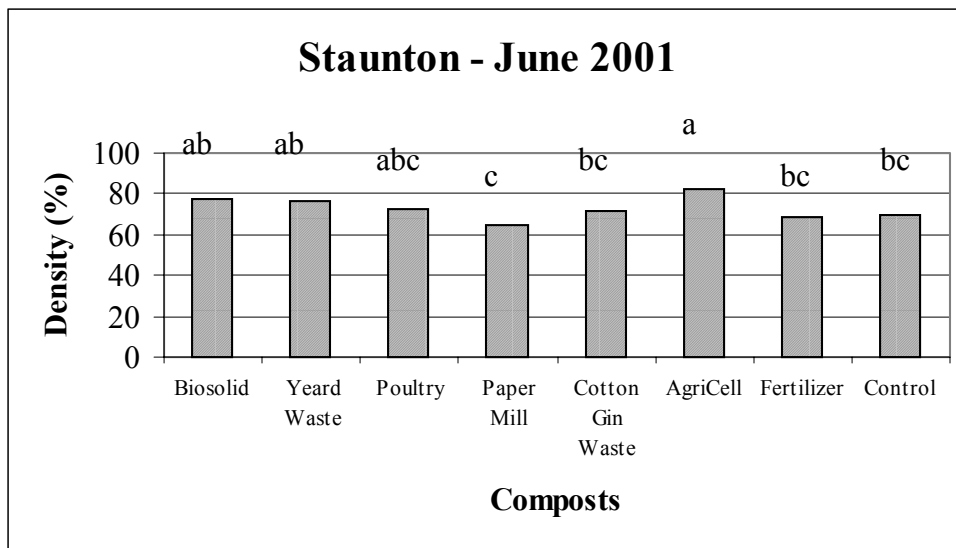
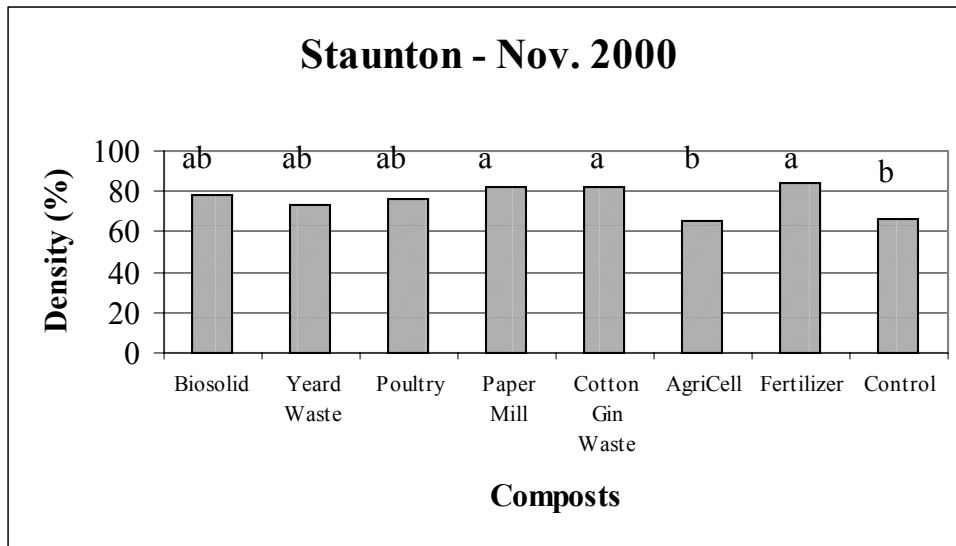
**Figure 3a. Tall Fescue Denisty in Culpeper**

No significant differences at  $P < 0.05$  exist for each date among treatments.



**Figure 3b. Tall Fescue Denisty in Staunton**

Different letters above treatment bars indicates significant differences at  $P < 0.05$ .



**Figure 4. Leaf and Wood Chip Study – Culpeper**

The percent density (ground coverage) of poppy and cosmos was sown in September 1999 is presented for two dates. Three rates of leaves (lf) and wood chips (chip) were applied in March 1999. Means for treatments with the same letter are not significantly different at the 5% level according to Student Newman Kuels test

