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THE COBY PROCESS: BEDDING MULCH STUDY RESULTS

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Abstract

One of the potential uses of processed cotton gin byproducts (gin waste or gin trash) is mulch in bedding plant applications. A value-added technique known as the COBY Process was used to produce three mulches for different types of gin waste (Arizona picker trash, ground Texas stripper trash, and Texas stripper trash). This study investigated the effectiveness of the COBY products compared to cottonseed hulls, conventional wood mulch, lint cleaner waste (motes), and the raw gin trash used to make the COBY mulches for weed suppression and plant growth. Three application rates were used for all mulches, 300, 600, and 900 lb/ 1000ft^2. The outcome of the study showed mixed results in the performance of the COBY product. Overall, the COBY products performed equal to or better than the other mulches in suppressing weeds. However, six of the nine COBY treatments had lower flower quality ratings at the end of the study period (eight weeks) than they did initially. One of the problems discovered was the high soluble salt content (1450 to 2100 ppm) of the COBY product, which caused reduced plant growth compared to the other mulches evaluated. A majority of the soluble salts (1245 to 1575 ppm) were in the raw material initially. However, two of the COBY products exhibited higher soluble salt concentrations than the parent material from which they were produced. Possible causes for the increased salt concentrations are being investigated and could include the water and/or color dyes used in the process.

Introduction

The use of cotton gin byproducts (CGB), also known as gin trash or gin waste, as a soil amendment has been the focus of various research efforts over the past several decades (Box and Walker, 1959; Yau and Chang, 1972; Huitink, 2002). Studies evaluating the use of CGB as a soil amendment have included treating soil with the raw material (Fryrear and Koshi, 1974) or composted CGB (Seiber et al., 1982; Williams et al. 1982). Using raw CGB as a soil amendment can result in weed infestation (Fryrear, 1979) due to the weed seed gathered with the raw material during the harvesting process. Composting CGB has been shown to destroy various weed seeds (Hills et al., 1981) but it can be costly, labor intensive and take from 3 to 7 weeks to manufacture the desired product (Alberson and Hurst, 1964; Hills et al., 1981; Hills, 1982).

The COBY process (Holt and Laird, 2002) developed at the USDA-ARS, Cotton Production and Processing Research Unit in Lubbock., Texas, is a method of adding value to waste byproducts from cotton processing facilities. One of the potential products produced from the COBY process is bedding mulch for use in flowerbeds or other related landscaping applications. When the process is used to produce mulch, an extruder is utilized to aide in the sterilization of the raw material. The raw material is pressure-cooked at temperatures around 230 deg. F and ground within a 20 to 30 second timeframe. This research is a follow up of the initial study performed to evaluate the effectiveness of COBY for dry-applied bedding mulch applications (Holt et al., 2003). The objectives of this study were two-fold: 1) evaluate the COBY products effectiveness at suppressing weeds compared to a conventional wood mulch and 2) determine if the product adversely affects plant growth.

Materials and Methods

Plot Layout and Treatment Application

All treatments were evaluated at Summit Seed, Inc. Manteno, IL facility. Experiments were established on May 15, 2003 and evaluated for eight weeks. Prior to establishment, the flowerbeds plots were treated with glyphosate (500 mL/L) to kill all existing vegetation. After 10 days, the soil was tilled to a depth of 4 inches using a roto-tiller. The ground was graded smooth using a gill bar to ensure a firm soil for establishing ornamental plants. The plot size for each treatment was 5 ft x 5 ft = 25ft^2. The mulch treatments were applied by hand to establish a uniform distribution of material in each plot. Ageratum (*Ageratum houstonianum*), also known as Floss Flower (cultivar 'Hawaiian Blue'), were started in a greenhouse potting mix and transplanted into the plots when the plants were about 4 inches tall (about 6 weeks from seeding). Ageratum plants were established on 1 ft centers, i.e., 25 plants per plot. The plants were established in the plots by digging a shallow hole (3 inches deep) and gently firming the soil around the stem of the plants. The mulch treatments were moved aside prior to planting the Ageratum and then the mulch was relocated around the base of each plant. Immediately following the planting of the Ageratums, the entire experimental area was watered using an irrigation system in such a manner as to saturate the soil and ensure complete uniform coverage of all plots. All planting beds received an average of 0.98-inches of water per week for the eight-week study period. Figure 1 shows a picture of the final layout of the plots prior to testing.

The COBY Product

The raw material used for the COBY Yellow and COBY Green product was acquired from two commercial gins whereas the COBY Red, which included gin lint cleaner waste (motes), was obtained from the Lubbock Ginning Laboratory. The picker trash (COBY Yellow) was obtained from a gin in Arizona. The COBY Green product was stripper trash from a gin located within three miles of the Ginning Laboratory that had been ground through a tub grinder. All the gin byproducts were processed, using the COBY Process, at the USDA-ARS, Cotton Production and Processing Research Unit in Lubbock, TX.

Figure 2 shows a schematic of the process used to produce the COBY material. The raw material was loaded using a pneumatic conveyer into a live-bottom bulk feed bin with five 9-inch augers. Upon exiting the feed bin, the gin byproducts were sprayed with either a gelatinized starch solution containing a red, green, or yellow dye for coloring, depending on the raw material being processed. The sprayed material was conveyed, in twin 12-inch cut-and-fold mixing augers, to a side-feeder that force-fed the byproduct slurry mix into an Insta-Pro model 2000 (Insta-Pro International, Des Moines, IA) extruder. The product exiting the extruder was conveyed to a belt dryer where the product was exposed to 275 deg. F. Upon exiting the dryer, the material was conveyed to nylon tote bags for storage.

The gelatinized starch slurry consisted of 1 lb of starch to every gallon of water in the cook tank. The starch slurry was applied at a consistent rate via a piston pump driven by a 0.75 Hp DC motor regulated by a closed-loop control system. The control system was comprised of flow meter with a 0-10 VDC output signal to the DC drive regulating the speed of the motor driving the starch pump. The amount of starch added to the byproducts was 5% by weight of the products (i.e. 15 lbs/min of byproducts had 0.75 lbs/min of starch added).

Feed rate from the bulk feed bin was determined from a mathematical relationship established prior to producing the mulch. A DC drive connected to a 1 Hp DC motor regulated the output from the bulk feed bin. The DC motor powered the feed bin augers through a 64 to 1 gear and sprocket reducer. Prior to processing the mulch, the raw material was loaded into the bulk feed bin and emptied, at four different drive settings, into a collection bin placed on a scale. The amount of material emptied during 15 minutes of operation was recorded for each of the four settings. This procedure was repeated three times for each setting in order to develop the mathematical formula necessary to determine the raw material output of the bulk feed bin at various intermediate settings on the DC drive. Temperatures of the extruder were recorded from two type-K thermocouples placed within the thermocouple wells located on the extruder barrel.

Experimental Design and Data Collection

There were twenty-eight treatments consisting of nine mulches (COBY green, COBY yellow, COBY red, Texas stripper trash, ground Texas stripper trash, Arizona picker trash, cottonseed hulls, motes, and a conventional wood mulch) at three application rates (300, 600, and 900 lb/1000ft^2), plus a control (i.e. bare soil).

The experiment was arranged using a completely randomized design with three replications. Standard analysis of variance techniques were used to analyze the data to determine statistically significant differences among the twenty-eight treatments by the Student-Newman-Keuls Multiple Range Test at the 99% confidence interval. The first ratings for each trial began one week after the planting date. All plots at both locations were evaluated weekly for: 1) flower quality of the Ageratum; and 2) number of weeds.

Results

The effects of the treatments on flower quality are shown in Table 1 for the second and eighth week. No significant difference was noted in flower quality for any of the treatments after two weeks. However, after the eight weeks there were significant differences noted for the various treatments. The treatment with the lowest flower quality was COBY Yellow 900 with an average value of 4.0 for the three plots. The highest numerical flower quality rating was 7.67 and was observed in three of the treatments (Hulls 600, Texas stripper trash 300, and Wood 900). Overall, six of the nine COBY treatments had lower average ratings for the final week than they did in the second week. This is opposite of what was noted in a previous study (Holt et al., 2003). In the previous study, all treatments evaluated had higher final flower quality grades at the two locations evaluated. The COBY treatments that yielded significantly lower flower quality ratings than 7.67 were COBY Green 900, COBY Red 900, COBY Yellow 600, and COBY Yellow 900. Flower quality ratings for all other treatments were not significantly different than 7.67 at the 99% confidence limit.

The lower flower quality scores of some of the COBY treatments were puzzling. However, when the analytical results came back from the lab (Figures 3 and 4) it was noted that the soluble salt content of all three of the COBY mulches were high enough to either reduce plant growth and vigor (COBY Red and COBY Green) or cause severe salt injury symptoms (COBY Yellow). The parent material for each of the COBY treatments was the gin trash products used for some of the other mulches (i.e. COBY Red – Texas stripper trash, COBY Green – Ground Texas stripper trash, COBY Yellow – Arizona picker trash). Figure 3 shows that two of the COBY products (COBY Red and COBY Yellow) exhibited higher soluble salt contents than did the raw material from which they were produced. The increase in soluble salt prompted an inquiry as to whether the increase in salt is a result of the water used in the process or the dyes used for coloring. However, COBY Green had slightly lower soluble salt than did its parent material. It may be that a greater sample size (i.e. more replicated measurements) is needed to obtain a better understanding of the soluble salt content ranges that may exist in both the raw and COBY material. Currently, the answer to where the additional salt is coming from is being investigated. The only mulch evaluated with a soluble salt content closest to the "Desirable range for most established plants" was the wood mulch. Figure 4 shows the potential for Hydrogen (pH) values. Most of the mulches evaluated had acceptable pH values of 6.0 or greater. The lowest pH value (5.7) was seen in the motes.

One of the problems encountered in this study with flower quality was the subjective nature of the rating system. Flower quality is judged on a scale from zero to nine with nine indicating the healthiest most robust plant. The flower quality rating can be influenced by the color of the mulch (i.e. background for the plants), the number and size of the weeds in the plot, and the experience of the evaluator for the plant in question. An additional check of plant robustness was planned for this study by harvesting all the plants in each plot and obtaining a plant dry weight. However, due to unforeseen circumstances (i.e. half the samples were lost in shipping from Manteo, IL to Lubbock, TX) this data was not collected.

Table 2 shows the average number of weeds for each treatment. After the second week, significant differences in weed suppression were noted. The treatments with the highest average number of weeds were the control (18.3) and the Hulls 300 (13.3). The treatments with the lowest weed counts were Texas stripper 900 and all the Mote treatments with zero weeds. After eight weeks, differences in weed suppression were more pronounced than in week 2. The control had an average weed count of 43.3. The treatments that had significantly lower weed counts than the control were: COBY Green 900 (10.3), COBY Red 900 (12.0), COBY Yellow 900 (12.0), Ground Texas stripper 900 (13.3), Texas stripper 900 (9.6), and all of the Mote treatments (Mote 300 – 6.6, Mote 600 – 1.0, Mote 900 – 0.67). The highest three mean weed counts were observed in all three of the Arizona picker treatments (Arizona 300 - 56.3, Arizona 600 - 57.0, Arizona 900 - 66.6). The high weed counts in the Arizona treatments illustrate the weed problems that can results from weed seed in the raw material. Weed seed associated with the raw material is made evident when comparing the weed count in each mulch group based on application rate. The mean weed count in each mulch, with the exclusion of Wood 600, decreased with increasing application rates except for the Arizona treatments, which exhibited higher weed counts as the application rate increased. This if further illustrated when considering that the only COBY treatment that had lower significant weed counts from its parent material, on an application rate basis, was the COBY Yellow, which was produced from the Arizona picker trash. These results do not imply that Arizona picker trash has more weed seeds than Texas stripper trash. It is more likely that the quantity of raw material collected in Texas just happen to come from fields that were relatively weed free, whereas the Arizona material was not. Thus, even though the Texas trash performed well compared to its COBY counterpart it would not be advisable to rely on the material being weed free when trying to market the product commercially.

Conclusions

This research was undertaken as a follow up to a 5-week study performed in 2002 where the COBY material was evaluated for its effectiveness in dry-applied bedding mulch applications. In this study, three separate COBY products were produced using different gin trash samples. Texas stripper trash, ground Texas stripper trash, and Arizona picker trash were used to produce COBY Red, COBY Green, and COBY Yellow, respectively. The objectives of this study were two-fold: 1) access the effect of COBY on flower quality (plant robustness) and 2) evaluate weed suppression effectiveness. Nine mulches were evaluated at three application rates (300, 600, and 900 lb/1000ft^2) for a period of eight weeks.

Overall, flower quality ratings for six of the nine COBY treatments exhibited lower numerical averages after week eight than they did after week two. Analytical analyses of the mulches revealed the COBY and some of the raw gin waste material had soluble salt concentrations that were high enough to either reduce plant growth and vigor or cause severe salt injury symptoms. For two of the COBY mulches (COBY Red and COBY Yellow), the soluble salt content was higher (350 to 750 ppm) than that of the parent material from which it was made. The additional salts may be from the water used in the process or from the dyes used for coloring. An investigation into the cause of the additional salt is currently underway. Whatever the cause, the soluble salt content of both the raw material and process additives need to be understood to make sure that the final product has acceptable concentrations so as not adversely impact plant growth.

For twenty-three of the twenty-seven mulches, weed counts decreased as application rates increased. Treatments that were significantly different from the control, at the 99% confidence limit, were the 900-lb/1000ft^2 application rates of Hulls, all three COBY mulches, ground Texas stripper trash, Texas stripper trash, and all the Mote mulches. All Arizona treatments had significantly higher weed counts than the control. In addition to having higher weed counts than the control, the Arizona treatments displayed an increasing weed count as the application rate increased. This illustrates the problem of weed seed in the raw material and emphasizes the importance of sterilizing the material if it is to be marketed commercially.

The overall result from this study has prompted further investigation into the cause and remedy of reducing soluble salts in the raw and COBY material. Until the cause, and possible remediation techniques, of the soluble salt concentrations can be understood, it would not be prudent to use the COBY material for bedding mulch applications. Additional tests are being planned to refine the COBY material using other bedding plants at various locations having different soil types.

Acknowledgement

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Disclaimer

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Table 1. Mean flower quality results (9=robust plant) from the test plots for the second and eighth week.

Treatments [a]	**Second Week** [b]	**Eighth Week** [b]
COBY Green 300	6.00	5.67abcde
COBY Green 600	6.00	6.33abcd
COBY Green 900	6.00	5.00bcde
COBY Red 300	6.00	6.33abcd
COBY Red 600	6.00	5.67abcde
COBY Red 900	6.00	4.67cde
COBY Yellow 300	6.00	6.33abcd
COBY Yellow 600	6.00	4.33de
COBY Yellow 900	6.00	4.00e
Hulls 300	5.67	7.50a
Hulls 600	6.00	7.67a
Hulls 900	6.00	6.33abcd
AZ Picker 300	6.00	7.00ab
AZ Picker 600	6.00	7.33a
AZ Picker 900	6.00	6.00abcde
TX Ground 300	6.00	6.00abcde
TX Ground 600	6.00	6.33abcd
TX Ground 900	6.00	6.67abc
TX Stripper 300	6.00	7.67a
TX Stripper 600	6.00	7.33a
TX Stripper 900	6.00	6.67abc
Motes 300	6.00	6.00abcde
Motes 600	6.00	5.67abcde
Motes 900	6.00	5.67abcde
Wood 300	6.00	7.33a
Wood 600	6.00	7.00ab
Wood 900	6.00	7.67a
Control	6.00	7.33a

a) The numbers following the treatment names indicate the amount of product (lb) applied per 1000 ft^2 (i.e. COBY Green 300 was 300 lbs per 1000 ft^2).

b) Means within the same column that are followed by any letter that is the same are not significantly different at the 99% confidence limit.

Table 2. Mean number of weeds from the test plots for the second and eighth week.

Treatments [a]	Second Week [b]	Eighth Week [b]
COBY Green 300	5.67bcd	32.33cd
COBY Green 600	3.67bcd	21.33cdef
COBY Green 900	0.33d	10.33def
COBY Red 300	5.33bcd	38.33bc
COBY Red 600	3.67bcd	22.00cdef
COBY Red 900	0.33d	12.00def
COBY Yellow 300	8.67bcd	42.00bc
COBY Yellow 600	4.00bcd	29.00cde
COBY Yellow 900	1.00d	12.00def
Hulls 300	13.33ab	31.00cde
Hulls 600	3.33bcd	28.33cde
Hulls 900	2.00cd	19.00cdef
AZ Picker 300	9.00abc	56.33ab
AZ Picker 600	6.00bcd	57.00ab
AZ Picker 900	12.00abc	66.67a
TX Ground 300	5.67bcd	39.00bc
TX Ground 600	3.67bcd	21.33cdef
TX Ground 900	0.67d	13.33def
TX Stripper 300	5.00bcd	33.33cd
TX Stripper 600	0.33d	25.33cde
TX Stripper 900	0.00d	9.67def
Motes 300	0.00d	6.67ef
Motes 600	0.00d	1.00f
Motes 900	0.00d	0.67f
Wood 300	7.67bcd	37.33bc
Wood 600	6.00bcd	39.33bc
Wood 900	2.00cd	24.33cdef
Control	18.33a	43.33bc

a) The numbers following the treatment names indicate the amount of product (lb) applied per 1000 ft^2 (i.e. COBY Green 300 was 300 lbs per 1000 ft^2).

b) Means within the same column that are followed by any letter that is the same are not significantly different at the 99% confidence limit.

Figure 1. Layout picture of test plots evaluated in this study.

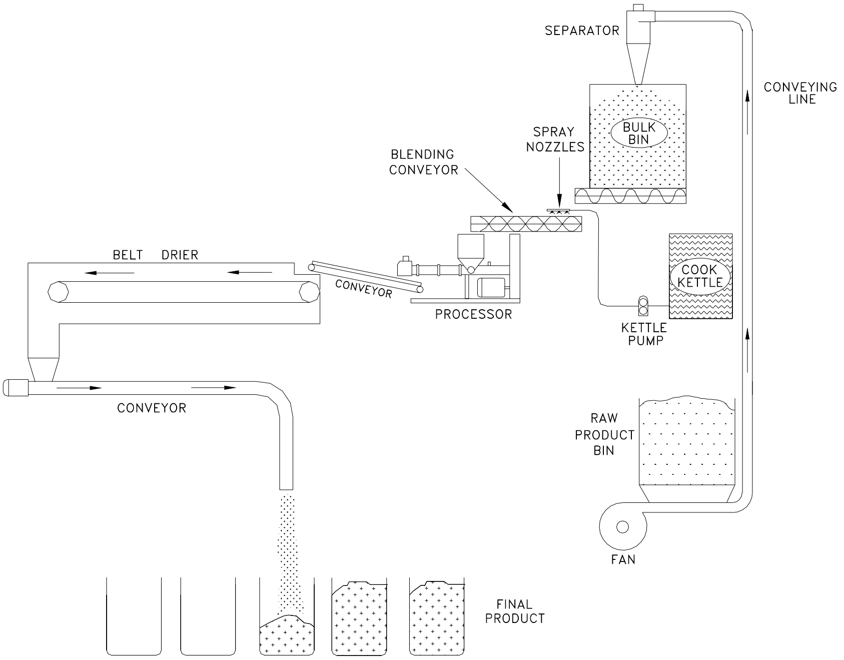

Figure 2. Schematic of the process used to produce the COBY mulch.

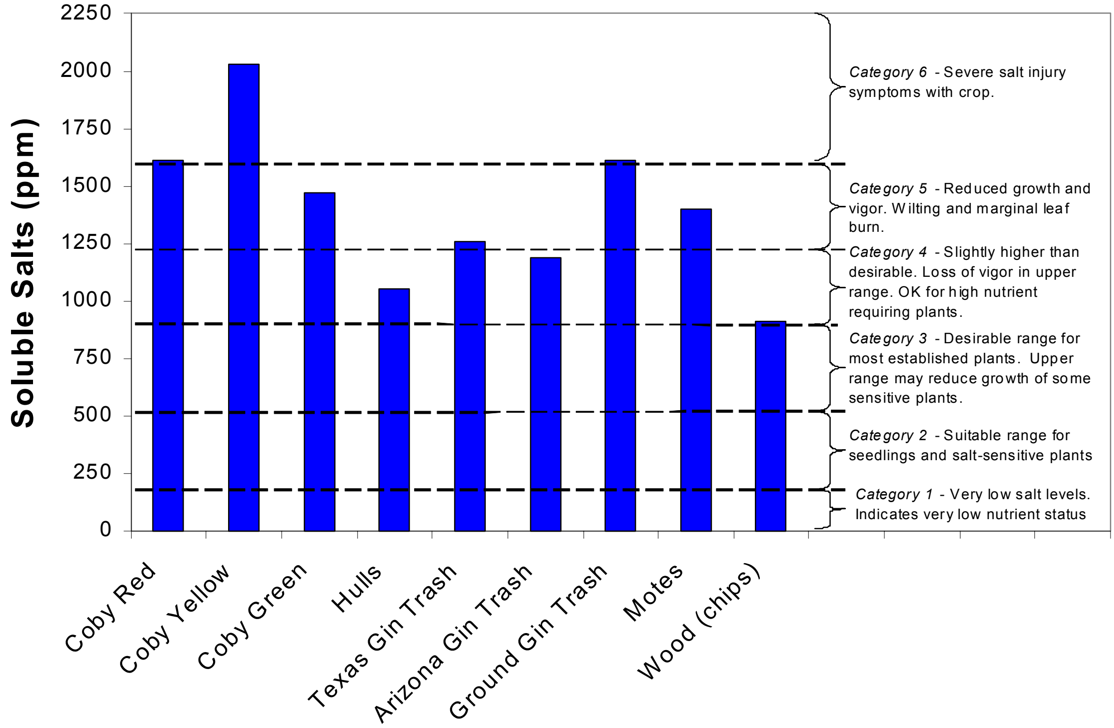

Figure 3. Soluble salt concentrations for the various mulches evaluated.

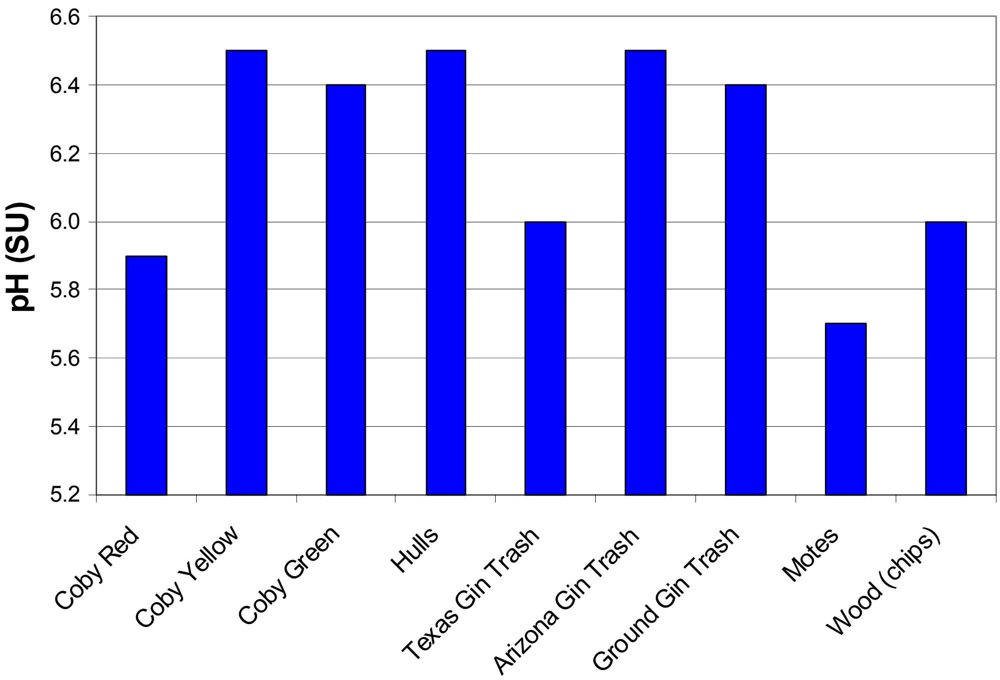

Figure 4. Potential of Hydrogen (pH) for the various mulches evaluated.