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CARIBBEAN FOOD CROPS SOCIETY

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ORGANIC MULCHES: WEED CONTROL, MOISTURE RETENTION, SOIL TEMPERATURE, AND CROP YIELD

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ABSTRACT: This paper investigates the use of locally available organic mulch and organic fertilizer for the production of sweet corn in Barbados. It focuses primarily on the impact of locally produced coconut fiber, wood chip, and green waste mulches on sweet corn yield, weed control, moisture retention and soil temperature. The performance of these organic mulches is compared to synthetic mulch and a control (unmulched). The effect of the amendments and cropping density are also assessed. The variety of sweet corn grown was Golden Sweet 93. Organic pest management practices were utilized throughout the production period. The use of organic mulches did not significantly increase yields in comparison with the control. Cropping densities used in the trial had no significant impact on yield. Weed control among all organic mulches was significant. Coconut fiber and wood chip provided the best weed control among these organic mulches. Organic mulches had 5-10 times less weeds than the control before first weeding. Weeds such as *Commelina elegans*, *Euphorbia heterophylla* L., and *Mimosa* spp. persisted within organic mulch treatments but below economic damage threshold levels. All treatments lead to an increase in moisture retention when compared to the control. Coconut fiber and Wood chip performed the best among the amendments in relation to water retention. Soil Temperature was significantly reduced by all organic treatments, a reduction of 1.3-1.9 °C. The Green Waste treatment resulted in the lowest average soil temperature. The implications and details of these observations in relation to organic crop production, weed management, and soil fertility management are discussed.

Keywords: Organic mulch, sweet corn, weed control, moisture retention, soil temperature

INTRODUCTION

Mulch provides several benefits to agricultural production and these benefits become extremely important in the context of organic agriculture. Organic farming is defined by FAO as an agro-ecological production management system that promotes and enhances biodiversity, biological cycles and soil biological activity without the use of synthetic pesticides, herbicides, or fertilizers. It is based on minimal use of off-farm inputs and management practices that restore, maintain, and enhance agro-ecological harmony. Since synthetic herbicides are excluded from the system and there are no local organic herbicides that are very effective, it becomes of great importance to utilize mulch primarily for the benefit of weed control.

In its recycling efforts, the Sustainable Barbados Recycling Center (SBRC) has been producing several types of organic mulches. These mulches are expected to be used by local farmer mainly as a means of weed control. Organic mulch is a protective covering of organic material with the following internationally documented benefits: weed control, increased water retention, reduction in soil temperature, increased soil biological activity, and increased organic matter content. Depending on the mulch material used, application rate, and environmental factors these benefits are manifested to different degrees. Local research in this area is important since there

are significant economic and environmental benefits that could be derived if these mulches possess the characteristics to facilitate adoption by farmers on a national level.

OBJECTIVES

Major

- 1) To determine the suitability of locally available mulches for weed control.

Minor

- 1) To determine the impact of locally available mulches on soil moisture, temperature, and organism activity.
- 2) To determine the impact of local mulch on the yield of sweet corn.

MATERIALS AND METHODS

This research trial was conducted at the Central Agronomic Research Station, Ministry of Agriculture, Barbados. In the process of field preparation a representative soil sample was taken for chemical analysis. The soil sample was analyzed for soil texture, C.E.C, pH, organic matter, soluble salts and soil nutrients. The physico-chemical characteristics of the experimental site are as follows: Texture = B; Organic Matter = 0.8%; Nitrogen = 5 lbs/acre; P_2O_5 = 24 lbs/acre; K_2O = 353 lbs/acre; pH = 7.5; C.E.C = 79.4 meq/100 cm^3 ; Soluble Salts = 353 ppm. The nutrient analyses of the fertilizers used are as follows: Chicken manure: 1.1% N, 3.7% P_2O_5 , 2% K_2O ; Conventional fertilizer: 24% N, 23% P_2O_5 , 18% K_2O . Due to the varying concentration of nutrients within each amendment only one macro nutrient could have been held constant across all amendments. As a result, nitrogen was held constant at 150 lbs/acre.

The experiment was set up in a completely randomized design with three factors. The factors were mulch, soil amendment and crop spacing. The crop type selected was sweet corn Golden Sweeter 93. The two types of ameliorant treatments were chicken manure and inorganic fertilizer. The application rate was 150 lb N/acre. There were six mulch treatments: Wood Chip (WC), Coconut Fiber (CF), Green Waste (GW), and Un-mulched Soil/Control (CONT). This resulted in a total of 54 treatments that were replicated three times. The experimental area in total was 16000 sqft and the individual plot size of 600 sqft. Double row spacing was used with intra-row spacing of 10 inches and 12 inches. The inter-row spacing was held constant at 24 inches.

The main treatments in the trial were broadcasted unto the beds and rotivated into the beds immediately after to allow for incorporation. Following incorporation, 12 inch spaced doubled row drip irrigation lines were placed into the field. The experimental area was then manually covered with two inches of the various mulch treatments. This coverage includes both rows and drains. The corn seeds were planted one per hole. Irrigation was regulated using a tensiometer, maintaining an average of 20 bars. Organic methods were used for pest control. The corn was harvested at the milk stage determined by destructive sampling. For determining corn ear weight, four plants were randomly selected and their ears were weighed to calculate the average head weight per plant. Heads were all check for damage by pest or disease. The data collected were subjected to analysis of variance (ANOVA) test. Depending on how the variance was distributed Tukey's honestly significance difference and Tahmane was applied for mean separation at a 0.05 level of significance.

RESULTS

Yield. No interactions or main effect within the experiment had a significant impact on sweet corn yield.

Soil Temperature. Mulch had a significant impact on soil temperature (sig 0.002). As expected the time of the day had a significant impact on soil temperature (sig 0.000). Therefore, soil temperatures in the afternoon were significantly higher than temperatures in the morning. There was no interaction between the mulch treatments and the time of the day. This result demonstrates that if any temperature reductions are achieved, the degree of reduction will be relatively consistent throughout the day.

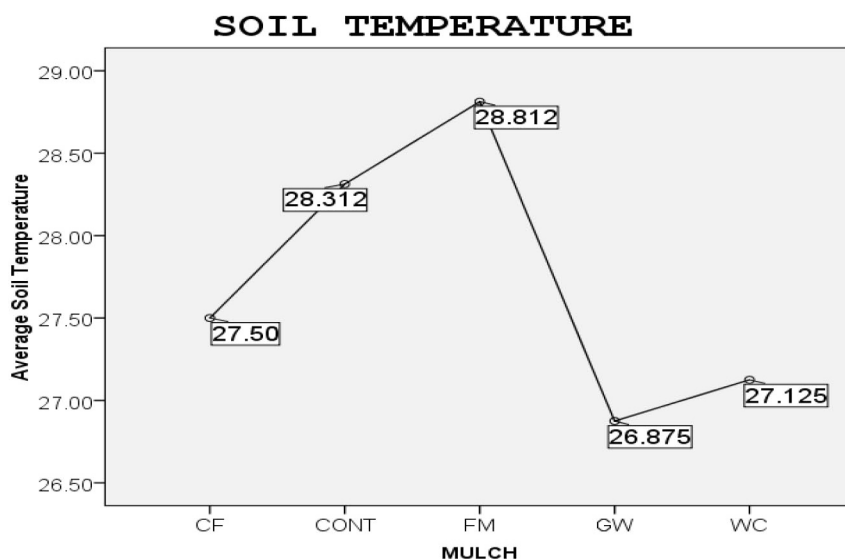


Figure 1. Soil temperature of different mulches.

Green Waste (1.9° C), Wood Chip (1.7° C) and Coconut Fiber (1.3° C) treatments resulted in significantly lower soil temperatures than Ground Cover/Fabric Mulch (see fig 1). This outcome was expected since the ground cover was black and had a tendency to trap heat (Ramakrishna et al., 2006). The mean difference between Green Waste and Fabric Mulch was approximately 2 °C. Only the Green Waste (1.4° C) and Wood Chip (1.18° C) had significantly lower soils temperature when compared to the control. It is possible that smaller particle size and resulting larger surface area of the Green Waste mulch accounted for the difference in temperature.

Weed Score. The main effect Mulch showed significance in relation to weed score (sig 0.000). All mulches lead to significantly lower weed scores when compared to the control (sig 0.000). Similar results were achieved by Kar and Kumar (2007). There was no significant difference between the organic mulches and the Ground Cover/Fabric mulch in terms of weed control.

Within the control, grass weeds dominated. The few weeds present within the organic mulches were mainly broadleaf weeds that could have been already present in the mulch as seeds. The weeds present were: *Commelina elegans* (Water Grass), *Euphorbia heterophylla* L. (Milk Weed), and *Mimosa pudica*. It was evident that the noxious weed *Cyperus rotundus* (Nut Grass) was not suppressed with three inches thick application of these organic mulches.

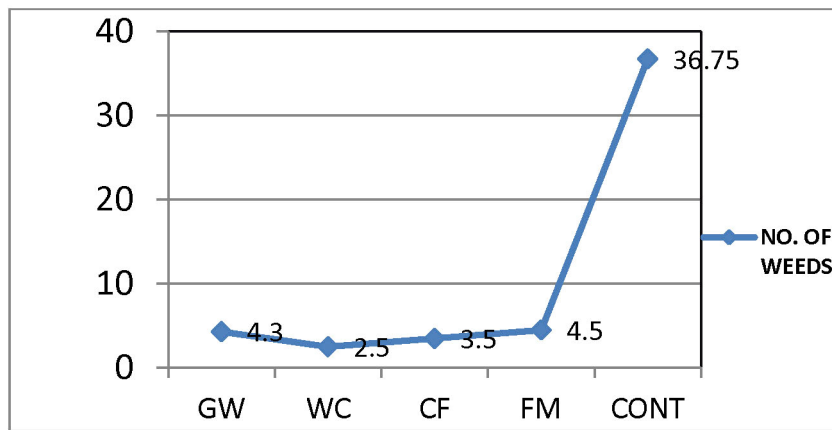


Figure 2. Number of weeds on different mulches.

All mulches led to significant increases in soil moisture content relative to the control. This was expected since mulching could decrease evaporation from the soil by 55% in comparison with non-mulched soil (Xie et al., 2005). Soil moisture content was not significantly different among Ground Cover, Coconut Fiber, and Wood Chip mulch. However, Wood Chip Mulch led to significantly more moisture retention than Green Waste (sig 0.003). The fine particle size of the green waste and its tendency to cling together could have reduced water permeability, increased runoff, thus limiting the amount of moisture entering the soil.

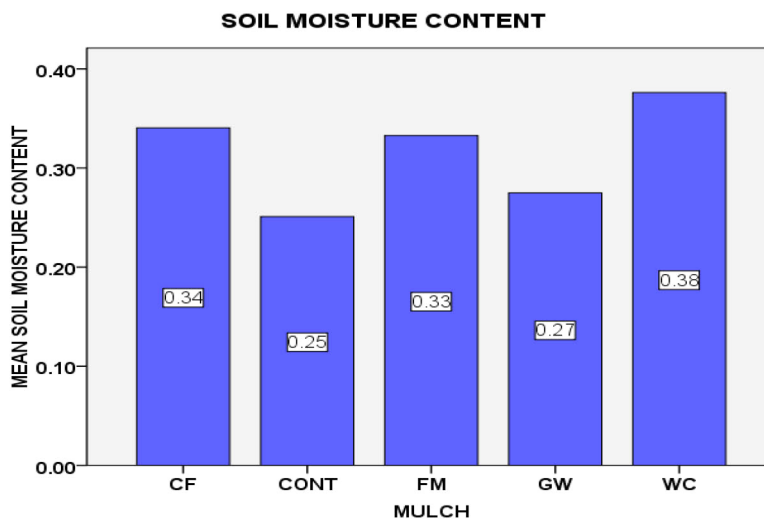


Figure 3. Soil moisture content of different mulches.

The most efficient and cost effective method of application is with a mulch/compost spreader. Application on soil should ideally be three inches thick to achieve appropriate weed control results. Table 1 demonstrates the vast difference in cost between the synthetic ground cover and the organic mulches.

Table 1. Yield, cost of mulch per acre, and cost of mulch applied per acre.

MULCH TYPE	TONS/ACRE	COST OF MULCH/ACRE	COST OF MULCH APPLIED/ACRE
COCONUT FIBER	19	\$744	\$1144
GREEN WASTE	37	\$1488	\$1888
WOOD CHIP	37	\$1488	\$1888
GROUND COVER	NIL	\$8750	\$8890

CONCLUSIONS

All organic mulches used in this field trial are adequate for use as weed controls. Green Waste and Wood Chip mulches are best suited for the purpose of soil temperature reduction. Wood Chip and Coconut Fiber mulches provide the greatest benefits in relation to soil moisture retention. Locally produced organic mulch can potentially provide a sustainable alternative to imported synthetic mulch given the agronomic benefits they provide and the low carbon footprint involved in the production of such organic mulches. Further research is required to determine the appropriate mulch thickness required to suppress the persistent noxious weed *Cyperus rotundus*.

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