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EFFECT OF PHYSICAL BARRIERS ON SWEET POTATO WEEVIL CONTROL

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ABSTRACT

Two studies were conducted to determine the effect of physical barriers (black plastic, weed barrier and grass mulch) and a bare soil treatment on sweet potato weevil (SPW) infestation of "Viola" and "Sunny" sweet potato cultivars. Harvested roots were individually inspected and rated on a SPW damage index (DI) of 1-6 (1 - no damage, 6 - most severe damage). A mean damage index (MDI) was also calculated. All medium-sized storage roots with a DI rating _ 2 were considered as marketable yield. The yield of medium-sized roots for the "Sunny" cultivar was significantly higher under plastic mulch than on bare soil. The grass mulch treatment produced a higher percentage of storage roots rated DI-1 than plots with synthetic mulches (plastic or weed barrier). The grass mulch treatment also produced a higher percentage of medium-sized marketable roots than the weed barrier treatment. Sweet potatoes from the weed barrier plots had a higher MDI than those in the grass mulch plots. In the "Viola" study, the grass mulch treatment produced the highest total and marketable yields. The weed barrier treatment had a higher MDI, a lower percentage of roots rated DI-1 and a higher percentage of roots rated DI-6 than all the other treatments. These trials have demonstrated that grass mulch has more potential than weed barrier for controlling SPW.

INTRODUCTION

Sweet potato (*Ipomoea batatas* (L) Lam) is a crop of major economic importance in the Caribbean. The crop is grown year-round and the fresh storage roots are used for home consumption and commerce. Roots and foliage of the crop are also utilized as feed for farm animals.

Various insect pests and rodents attack sweet potato in the U.S. Virgin Islands. However, the sweet potato weevil (SPW), *Cylas formicarius elegantulus* (Summers), is the most economically important. High populations of SPW are present throughout the year in the Virgin Islands (PROSHOLD, 1986).

The SPW attacks nearly all parts of the sweet potato plant and can develop successfully on mature stems as well as storage roots (VASQUEZ and GAPASIN, 1980). When storage roots are available, a greater percentage of the SPW population is found in this plant part than in the vines of most cultivars (JANSSON *et al.*, 1990a). The SPW can cause severe damage, which reduces quality and marketable yield. Even low-level infestations can render sweet potato roots unfit for human consumption (PROSHOLD, 1983), because of toxic substances produced in the roots in response to SPW feeding (URITANI *et al.*, 1975). These chemicals impart a bitter taste to the storage roots.

Adult SPW make small superficial feeding holes on storage roots. Such damage, however, is considered minor compared with that caused by larval feeding in the roots (TALEKAR, 1991). Because of their concealed feeding habit, especially that of the larvae, SPW can be difficult to control with conventional insecticide applications, after the infestation has been initiated. During the latter part of the growing season, the large leaf canopy inhibits the effectiveness of foliar-applied insecticides. The chemical is intercepted by the foliage and does not come into contact with adults, which crawl over the soil or stay around the crown in search of exposed roots for feeding and oviposition. These factors do not favor the use of conventional insecticides, which was an early approach to SPW control. This method requires frequent applications in order to kill adults that might migrate from other areas (TALEKAR, 1991). Frequent spraying of insecticides is not cost-effective for sweet potato, especially in developing countries (TALEKAR, 1991).

Because of its limited flight activity (Sherman and Tamashiro, 1954), host specificity to genus *Ipomoea*, and the characteristic mode of damage to the roots and crowns, the SPW may be vulnerable to suppression by cultural practices. These include crop rotation, use of SPW-free cuttings, proper field sanitation, irrigation and mulching, all of which may have the potential to give consistent SPW control.

Soil cracks are a major route for SPW to access storage roots, especially for cultivars that set roots near the soil surface (TALEKAR, 1991). The enlargement of roots and soil moisture stress, especially in clay soils, can produce soil- cracks and increase exposure of storage roots to SPW. Absence of soil-cracks denies the weevil an access to the roots (TALEKAR, 1991). High-yielding cultivars tend to create more cracks in the soil than low-yielding cultivars and are thus more predisposed to SPW damage. Higher numbers of SPW have been found in clay than in sandy soil due to the greater number of cracks in the clay soil (HAHN and LEUSCHNER, 1982). Earthing up and closing of cracks in the soil serves the purpose of preventing easy entry of the SPW into soil to infest the storage roots (SHERMAN and TAMASHIRO, 1954). This is not an ideal practice because of the prostrate growth habit of the sweet potato plant.

The application of physical barriers can reduce SPW infestation levels by preventing the SPW from getting to the soil surface, covering cracks in the soil, and conserving soil moisture, thereby reducing the number of cracks in the soil caused by moisture stress. The objective of this study was to determine the effectiveness of physical barriers in reducing infestation levels of sweet potato roots by SPW.

MATERIALS AND METHODS

The studies were conducted at the University of the Virgin Islands - Agricultural Experiment Station on St. Croix. The soil is Fredensborg loamy, fine, carbonatic, isohyperthermic, shallow, typic Calciustoll (LUGO-LOPEZ and RIVERA, 1980).

Two trials were conducted evaluating physical barriers (grass mulch, black plastic mulch and weed barrier) and a bare soil treatment for their effectiveness on SPW infestation levels. One trial utilized the cultivar `Viola', and the other, cultivar `Sunny'. Field plots were established using 0.3 - 0.4 m terminal vine cuttings as the planting material. Plots were 3 m x 3.7 m and consisted of 3 rows (ridges), spaced 1 m apart. Plants were spaced 0.3 m within rows. The experimental design was a randomized complete block with four replications.

A drip irrigation system was installed consisting of Drip Strip Plus tubing (Hardie Irrigation) as the laterals, with laser drilled orifices 0.3 m apart. The irrigation system was used to facilitate crop establishment. The physical barriers were applied to the soil surface prior to planting. Holes were cut at 0.3 m spacings along the rows in the weed barrier (De Witt Pro 5) and plastic mulch (2 mil, polyethylene) to allow for the planting of the vine cuttings. The grass mulch was applied to the soil surface in a 0.13 m layer. During the early period of crop establishment, a number of plants had to be replaced in the plastic mulch treatment, particularly for the `Sunny' cultivar. This was due to cuttings becoming scorched when in contact with the plastic mulch, which became hot during the periods of high solar radiation.

At maturity (120 days after planting), 10 plants from the center row of each plot were harvested. The weight and number of all storage roots were recorded. Storage roots were divided into three size categories: small (< 2.5 cm dia.), medium (marketable size) and jumbo (> 12.5 cm dia. or longer than 25 cm). Each root was then inspected and rated on an SPW damage index (DI) scale of 1-6 (JANSSON *et al.*, 1990b): 1 - no damage; 2 - up to 25% of root surface area (RSA) has feeding punctures (FP) but no adult exit holes (EH); 3 - 26-50% of RSA has FP but no EH; 4 - > 50% of RSA has FP or 1-3 EH present (or both); 5 - 4-6 EH; and 6 - > 6 EH. The percentage of the total root biomass (all storage roots) in each damage category was recorded. The mean damage index (MDI) for each plot was calculated using the following formula, as described by Jansson et al. (1990b):

$$\mathbf{MDI = \_[(s_i) \times (i) + (m_i) \times (i) + (j_i) \times (i)]/trb}$$

$$\mathbf{i = 1,6}$$

where **s**, **m** and **j** are the biomass (kg) of small, medium and jumbo-sized storage roots, respectively; **trb** is the total root biomass; and **i** is the damage category. Marketable yield were all medium-sized roots with a rating of _ 2.

Yield data and percentages of total root weight were transformed to square root and arcsin, respectively. Statistical analysis of all data was performed using SAS General Linear Models procedure (SAS Institute, 1988). Treatment means were separated by the LSD procedure.

RESULTS

"Sunny" Cultivar

The application of physical barriers to "Sunny" sweet potato plants produced a higher total root biomass (Fig. 1) than the bare soil treatment. Plants grown with the plastic mulch treatment had a higher yield of medium-sized storage roots than plants grown with the bare soil (Fig. 1). This indicates that the increase in biomass caused by the application of plastic mulch was accompanied by an increase of medium-sized roots. Storage roots from the weed barrier plots had a higher mean damage index than roots from the grass mulch plots (Table 1). A higher percentage of storage roots from the grass mulch plots was rated in the DI-1 (clean roots) category than either of the synthetic mulch (plastic and weed barrier) treatments (Fig. 2). The data in Fig. 2 also shows that only a small percentage of storage roots from each treatment were rated in the categories with severe damage (DI 4-6). However, there was a trend towards higher percentages in these categories from the weed barrier treatment. The total percentages for DI 4-6 were 1.1, 4.8, 9.7 and 23.4 for the grass, plastic, bare soil and weed barrier, respectively. Fairly high percentages (> 20 %) were in the DI-3 category for the bare soil, plastic and weed barrier treatments (Fig. 2). This is an unmarketable category with the least SPW damage. Therefore, a little improvement in the level of SPW control, perhaps by the inclusion of other biological/cultural practices (eg. irrigation or pheromone) may cause a substantial improvement in the quantity of marketable yield. These practices need to be investigated.
The grass mulch plots produced a higher percentage of the total root biomass with a DI rating of _ 2 (marketable quality) than did the weed

barrier plots. Marketable yields of 18.4, 17.0, 9.3 and 7.8 t/ha were obtained from the grass, plastic, weed barrier and bare soil treatments, respectively (Fig. 1). More than half (56 %) of the medium-sized storage roots from the weed barrier treatment were rendered unmarketable due to SPW damage. In comparison, 85 % of the marketable-sized storage roots from the grass mulch treatment were observed to be marketable (Table 1). This indicates that the weed barrier is not a very effective physical barrier to SPW, when growing the "Sunny" sweet potato.

"Viola" Cultivar

In the trial using cultivar "Viola", the grass mulch treatment produced the highest yield of total root biomass and medium-sized roots (Fig. 3). The plastic mulch treatment had the lowest yield, in contrast to the results for the "Sunny" cultivar, where the yield from the plastic mulch was highest for both parameters. Storage roots from the weed barrier treatment had a significantly higher MDI (Table 2) and a lower percentage (22.3) of roots in the DI-1 category, than all the other treatments (Fig. 4). There was a trend for the weed barrier treatment to produce the highest percentage of roots in the unmarketable categories, DI 3-6 (Fig. 4). Plants grown with weed barrier produced storage roots of which 23.7 percent were rated in the most severe damage category (DI-6). A lower percentage (52.5) of roots from these plants was in the categories considered marketable (DI _ 2), compared to the other treatments, which ranged from 79.8 to 89 %. Marketable yields of 16.5, 15.5, 10.4 and 9.5 t/ha were obtained from the grass, bare soil, plastic and weed barrier, respectively (Fig. 3). The percentage (50.7) of medium-sized storage roots from the weed barrier treatment which were marketable (Table 2), was significantly lower than all the other treatments (77.6 - 87.9 %).

DISCUSSION

These trials have shown that a differential response to the various soil physical barriers exists between the two cultivars of sweet potato. Generally, there was an increased yield response from the "Sunny" cultivar to all physical barriers, which resulted in increased marketable yield. The MDI tended to be higher for "Sunny" than for "Viola", indicating that "Sunny" is probably more susceptible to SPW infestation. Regarding the enhancement of marketable yield, the application of a grass mulch tends to be beneficial to both cultivars.

In the weed barrier treatment, for both cultivars, SPW damage was more severe than for the bare soil treatment. When the weed barrier was removed from the soil surface during harvesting, the number of weevils present made it obvious that this treatment was not effective. It appears that the weed barrier created a micro-environment that was favorable to the SPW.

Plastic mulch increased the total yield of "Sunny", but not "Viola". HOCHMUTH and HOWELL (1983) have reported higher yields from black plastic mulch, similar to the results obtained for "Sunny". Plastic mulch did not, however, reduce the SPW infestation levels for any of the two cultivars, compared to the bare soil treatment. Similar findings have been reported in Florida by JANSSON *et al.* (1987) where no difference in SPW damage was found for four cultivars between plots with and without plastic mulch barrier. Conversely, TALEKAR (1987) reported that the application of plastic film to plots reduced SPW infestations compared to plots without mulch.

The grass mulch treatment appears to have more potential for controlling SPW, particularly for "Sunny" cultivar. This is in agreement with results obtained in Taiwan by TALEKAR (1987), where the application of rice straw mulch was found to reduce SPW infestations compared to nonmulched plots.

This finding has special implication to the Virgin Islands and the other Caribbean countries, where grass is easily and inexpensively obtainable.

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Table 1. Effect of physical barriers on SPW infestation of "Sunny" sweet potato.

Treatment	MDI	% Medium-sized marketable
Weed barrier	2.84 a[z]	43.9[y]
Plastic mulch	2.25 ab	51.3
Grass mulch	1.51 b	85.2
Bare soil	2.10 ab	62.6

[z] Means separation in columns by LSD, P _ 0.05.

[y] Data arcsin transformed before statistical analysis was performed.

Table 2. Effect of physical barriers on SPW infestation of "Viola" sweet potato.

Treatment	MDI	% Medium-sized marketable
Weed barrier	3.1 a[z]	50.7.b[y]
Plastic mulch	1.4 b	87.9 a
Grass mulch	1.9 b	77.6 a
Bare soil	1.6 b	87.8 a

[z] Means separation in columns by LSD, P _ 0.05.

[y] Data arcsin transformed before statistical analysis was performed.