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Qualité, économie, progrès social, environnement”**

**“What is the future of Agriculture in the Caribbean ?
Quality, Economy, Social Progress, Environment”**

**“¿ Cuál es el futuro de la Agricultura en el Caribe ?
Cualidad, Economía, Progreso Social, Medio ambiente”**



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EFFECTIVENESS OF NEEM (*AZADIRACHTA INDICA*) AS AN ORGANIC PESTICIDE IN VEGETABLE PRODUCTION

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RESUME

Le Neem offre le potentiel d'un insecticide biologique disponible localement avec la possibilité d'améliorer l'industrie agricole dans les Îles Vierges. Le Neem est un arbre qui pousse facilement avec une croissance rapide et ses feuilles et ses fruits peuvent rentrer dans la composition d'une variété de produits. Non seulement cela réduirait les dépenses des agriculteurs en réduisant leur dépendance aux produits chimiques coûteux importés, mais le Neem est davantage sécurisant pour l'environnement. Le développement agricole avec le souci de non pollution de l'espace sont rapidement en train de devenir des préoccupations majeures aux Îles Vierges. Ce projet adresse directement ces préoccupations en testant deux solides méthodes pour l'environnement de lutte biologique contre les insectes sur une grande étendue de culture de patate douce.

Quatre traitements (la pulvérisation traditionnelle, l'extrait de Neem commercialement disponible, paillage au Neem, traitement et contrôle) étaient comparés pour leur effet sur le rendement des cultures et l'incidence des dégâts des insectes. Le charançon de la patate douce est le premier problème d'insecte sur cette culture. Les données étaient collectées conformément avec les études précédentes sur le charançon de la patate douce dans les Îles Vierges (Crossman 1993). Des mesures de taille et d'étalement de la végétation ont été faites et le temps pris pour former une canopée rapprochée était enregistré ainsi que l'incidence des insectes foliaires. Les racines récoltées entreposées étaient divisées en trois catégories de taille (petit, moyen et grand), pesées avec évaluation de la présence des dégâts du charançon. La pulvérisation traditionnelle produisait le plus grand nombre de racines commercialisables entreposées. Le traitement au paillage de Neem a eu la plus forte moyenne de poids par racine entreposée et la récolte totale la plus forte. La pulvérisation au Neem était la plus affectée par le charançon de la patate douce, mais le niveau global en l'occurrence était si bas, que c'est probablement peu concluant.

ABSTRACT

Neem trees offer the potential of a locally available biological insecticide and the possibility of improving agriculture in the Virgin Islands. Neem is a hardy tree with rapid growth whose leaves and fruits can be made into a variety of products with insecticidal properties. Producing and utilizing such products would not only reduce farmers' expenses through decreased dependence on costly imported chemicals, but would also be more environmentally sound. Agricultural run-off and non point source pollution are quickly becoming major concerns in the Virgin Islands. This project directly addresses these concerns by testing two environmentally sound methods of organic insect control on a widely grown crop, sweet potato.

Four treatments (traditional spraying, commercially available neem extract, neem mulch treatment and no input) were compared for their effect on crop yield and incidence of pest damage. Sweet potato weevil (SPW) is the primary pest problem with this crop. Data was collected in accordance with previous SPW studies in the Virgin Islands (Crossman *et al.* 1993). Additional measurements were taken on the height and spread of vegetative material, crop canopy closure and incidence of foliar pests. Harvested storage roots were divided into three size categories (below market, medium and jumbo), weighed and percent infestation and damage of SPW recorded. Traditional spraying produced the greatest number of marketable storage roots. Neem mulch treatment had the highest average weight/storage root and greatest total yield. The Neem spray was the most effected by SPW, however results may have been influenced by the minimal infestation of

INTRODUCTION

Neem has been used for centuries in India and elsewhere for its medicinal and insecticidal properties. Although the leaves themselves have been used as an insect repellent since ancient times, scientific proof of their efficacy did not come until 1937 and individual compounds were first isolated in 1942 (Naqvi 1986). In recent years, neem has increasingly been studied for its potential as a biological control or organic pesticide.

Insects cause the greatest damage and loss of yield to agricultural crops. Prevention of pest damage usually represents the greatest single operating expense facing small farmers. In the Virgin Islands, as in other Caribbean nations, most farmers are heavily dependant on imported, synthetic pesticides. Shipping charges drive the costs yet higher as the chemicals are almost exclusively produced in the U.S. mainland and other developed nations. Imported food is more expensive the greater the distance from the food source and in the U.S. Virgin Islands that translates to prices between 17 – 29% higher than the mainland (Mills 1990). Despite this obvious incentive for local farmers to produce, only \$2.8 million of the annual \$35 million expenditure on fresh agricultural products is met locally due to the afore mentioned costs and challenges (D'Souza 2000).

The dangers of misusing synthetic agrochemicals have been well documented for decades. Contamination threat exists for both the farmer applying the chemical and to the environment at large. Effects can be immediate or a gradual build-up of toxins in the system over time. In small arid islands, the risk to the environment is more acutely realized as water resources are scarce and precious, and run-off from aquifers discharges directly to environmentally sensitive coral-lined seashores.

Utilizing locally produced, biologically sound pesticides offers Caribbean islands the chance to reduce their dependency on imported agrochemicals. Neem based products simultaneously offer the chance for improved personal and environmental safety. Several registration protocol tests have been conducted by USDA and all have shown that Azadirachtin causes no toxicity effects on test animals and tested negative for carcinogenicity (Cooper *et al.* 1999). Of course, one product can not solve all pest problems, but it can become a valuable tool in an integrated approach to crop production.

METHODS

The trial conducted evaluated differences between methods of insect control on sweet potato and their effect on total yield. The primary pest affecting the sweet potato is the sweet potato weevil (SPW), but several other pests damage the foliage and storage roots. The four treatments were traditional spraying (TS), neem-based spray (NS), neem mulch (NM) and no input.

The sweet potato used in the study, 98-022, is a promising new line from the University of Puerto Rico's sweet potato breeding project. It is white-fleshed and sweet with a deep purple skin color. Storage roots may be harvested 140 to 150 days after planting.

Raised beds approximately 30 cm in height were created before planting. Poly hose 1/2 inch in diameter was run to all plots and fitted with 1/2 inch diameter drip irrigation lines, which were laid on top of the beds. Plots consisted of three rows with 91 cm between rows and 61 cm between plants within rows. Rows were 7.31 m in length and contained 12 plants. The experimental design was a randomized block design with four replications per treatment.

Pesticide was applied as needed, roughly every three weeks. Spraying was conducted in the morning to minimize drift. TS treatment consisted of either Malathion or Diazanone, depending on the target pest. Azatin™ was applied in accordance with the label for NS. The neem mulch consisted of whole leaves and small twigs and was not shredded in order to prolong its life. It was applied 14 days after planting when the sweet potato was large enough to not be covered over. A 10 cm mulch layer was applied between rows and atop the raised beds, fully covering the ground between plants and between rows. The no input treatment was a bare soil treatment that received no pesticide treatment.

At maturity (140 days) 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 categories: small/unmarketable (<3 cm dia.), medium (normal marketable size), and jumbo (>12 cm dia. or longer than 25 cm). Each root was also inspected and rated on an SPW damage index scale of 1-6 in accordance with methods of Jansson *et al.*, (1990): 1 - no damage; 2 - up to 25% of root surface area (RSA) has feeding punctures (FP) but no adult exit holes; 3 - 26-50% of RSA has FP but to EH; 4 - >50% of RSA has FP or 1-3 EH present (or both); 5 - 4-5 EH; and 6 - > EH). Any other damage (rodents, fungus, worms) to storage roots was also recorded.

RESULTS

Total root biomass was greatest from the NM treatment and lowest from the no input treatment (Table 1). NM also produced the highest per plant average of marketable roots at 855.6 g (Table 2) and the highest marketable yield per hectare at 15.11 T/Ha (Table 3). It was the first treatment to form a closed foliar canopy. NS and TS averaged 759.55 and 727.18 g per plant respectively and no input produced the lowest yield. TS plots produced the greatest number of marketable storage roots, but with the lowest average weight per root at 146 g (Table 2). It also had the greatest amount of foliar spread, measuring from 1.3 – 1.5 m from the center of the raised beds. NS and traditional had nearly identical marketable root biomass totals, averaging 708 and 700 g per plant respectively, despite NS having a greater average root weight. Storage roots in NS plots were fewer and larger than TS.

The no input treatment produced the greatest number of undersized roots as well and the greatest biomass of undersized storage roots per plant (Table 1). It was the last treatment to form a closed foliar canopy and had the least amount of spreading. All other treatments produced relatively few undersized roots. Undersized roots comprised 8.9% of the total biomass for no input while only 2-3% of total root biomass for all other treatments (Table 1). Only three storage roots from the 160 harvested plants were classified as jumbo. TS produced two totaling 1087 g and no input produced one weighing 629 g. Because jumbo size storage roots were so infrequent, they were simply lumped with the medium sized, marketable roots and not treated separately.

DISCUSSION

The NM treatment produced the highest yields of all treatments is considered the most successful of all treatments (Table 3). NM roots also had lower percentage of total damage than NS and TS. Previous results by Crossman *et al.* (1993) indicated that organic mulch has a high potential for controlling SPW and results from this study point to the same conclusion. However, the increased yield may not have resulted from decreased pest damage, as roots harvested from no input recorded no pest damage yet produced the lowest total yield.

Crossman *et al.* (1993) reported approximately 30% of storage roots with a damage index of 3-6 (most severe) for bare soil treatments. Bare soil treatments in the present study recorded SPW damage below 7%. This could be partially explained by the fact that insecticides were used in this study while they were not used for any treatment in the previous study. Another likely explanation for the low incidence of pest damage is the SPW were simply not present in large numbers. The planting site had been in fallow for some time previous to this study and the pests may not have remained in large numbers.

This variety either tends to produce smaller roots or requires more than the expected time to fully mature. Post-harvest observations indicate the latter may be the case. Crossman *et al.* (1993) also indicated that root enlargement causes soil cracking and thus increasing susceptibility to SPW. The overall moderate size of the roots harvested during this study and resulting low degree of soil cracking may also be a factor in low occurrence of SPW.

CONCLUSIONS

The preliminary findings of this study are encouraging for the potential of using neem as a biological control for the agricultural pests of the Virgin Islands. The NM plots gave the highest total yields for sweet potato and this treatment should be tried on other commonly planted agricultural crops in the US Virgin Islands to determine further validate results.

NS and TS produced nearly identical total yields and roughly 90% of both treatments yields were marketable quality. This offers the possibility of replacing traditional use of Malathion and Diazanone with more environmentally sound, neem based products without a decrease in yield. Commercial products must be imported to the Virgin Islands and can be prohibitively expensive for farmers. Future work should include testing the effectiveness of a locally produced, neem-based product and comparing it to commercial products.

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TABLES

Table 1. Breakdown of Total Harvested Roots by Type and Treatment

| | Total Weight* | Marketable | Undersized | Damaged |
|-------------|----------------------|-------------------|-------------------|----------------|
| No Input | 27182 g | 91.1% | 8.9% | 0.0% |
| Neem Spray | 31114 g | 91.1% | 2.4% | 6.6% |
| Neem Mulch | 34955 g | 96.0% | 2.1% | 1.9% |
| Traditional | 31087 g | 93.6% | 2.9% | 3.5% |

*This data is the cumulative total of all four replications, with 10 plants harvested per replication for a total of 40 plants.

All weights expressed in grams. Damaged roots include SPW and all other forms of damage combined.

Table 2. Weight, Quantity and Production of Marketable Roots

| | No input | Neem Spray | Neem Mulch | Traditional Spray |
|------------------------------|-----------------|-------------------|-------------------|--------------------------|
| Average Number of Root/Plant | 3.00 | 3.2 | 4.65 | 4.85 |
| Average Weight/Root | 206.34 g | 220.16 g | 184.00 g | 149.93 g |
| Average Root Weight/Plant | 619.03 g | 759.55 g | 855.60 g | 727.18 g |

Table 3. Root Yields by Treatment expressed in Tons/Hectare

| | No Input | Neem Spray | Neem Mulch | Traditional Spray |
|------------------|-----------------|-------------------|-------------------|--------------------------|
| Total Yield | 11.92 | 14 | 15.74 | 13.99 |
| Marketable Yield | 10.86 | 12.75 | 15.11 | 12.61 |