EFFECT OF NEEM-BASED (*AZADIRACHTA INDICA*) PEST CONTROL METHODS ON OKRA YIELDS IN THE U.S. VIRGIN ISLANDS

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ABSTRACT: Neem (*Azadirachta indica*) products have been used as organic pesticide against a wide variety of agricultural pests in tropical areas of the world. A study was conducted to determine the efficacy of various neem treatments on the pests effecting okra in the U.S. Virgin Islands. A field trial was conducted at the UVI Agricultural Experiment Station incorporating six pest control treatments: diazinon, azatin, neem mulch, neem tea, neem hedge, and control. Okra was harvested three times per week for nine weeks. Marketable fruit weights and number of fruit were recorded. The diazinon, azatin, and neem mulch treatments produced statistically similar numbers of fruit and had similar yields (9.93, 9.74, and 8.36 t ha⁻¹, respectively). All three treatments were significantly (P< 0.05) better than the control (6.76 t ha⁻¹). Total yield and number of fruit were significantly less than the control for the ‘home-made’ neem tea treatment made from leaves. Production from the neem hedgerow treatment was significantly lower than all other treatments, most likely due to competition for light and moisture. This study indicates that azatin and neem mulch are organic pest control options that produce okra yields similar to those achieved when using the synthetic commercial insecticide, diazinon.

INTRODUCTION

The neem tree (*Azadirachta indica*) is a member of the mahogany family native to south Asia and naturalized throughout semi-arid areas in Asia, Africa and the Caribbean (Parotta and Chaturvedo, 1994). Neem has been used for centuries for its insecticidal properties against a myriad of insect pests (Schmutterer and Ascher, 1986). The tree has the potential of improving agriculture in the Virgin Islands as it represents an economical biological insecticide that can be collected and produced locally by small scale farmers (Ahmed and Grainge, 1986; Daly and Zimmerman, in press). Insecticidal extracts are made from both leaves and seeds (Navqi, 1986). In the U.S. Virgin Islands, a number of small farmers spray a “neem tea” (made from steeped neem) leaves on their crops. Although leaf extracts are known to have lower levels of active ingredients, they are probably utilized instead of the seed extracts because they are both easy to make and leaves are available all year. This study examines the effect that neem tea and other neem-based insect control methods have on production levels of okra.

Okra (*Hibiscus esculentus*) is a member of the Malvaceae (Mallow) family believed to have been introduced to the Caribbean sometime during the 1500s. The immature fruits are used as a vegetable in many Caribbean dishes and are served fried, curried, with peppery sweet corn and in countless other recipes (Bourne et al., 1988). Today it is grown throughout the Caribbean region.

In the Virgin Islands, okra is one of the most common crops grown during the summer months by small farmers. According to the National Agricultural Statistics Service (NASS), 50 farms planted 15 acres of okra, producing 11,745 harvested pounds in the Virgin Islands in 1993. In 1998, the most recent date for which data is available, the number of farms producing okra
increased to 61 while total acreage decreased to 8 ac. and production fell to 8,156 (NASS, 1998). This data demonstrates the continued trend toward okra production on smaller farms and does not include the many other individuals producing okra in home gardens.

Large and small scale farmers alike in the Caribbean islands are heavily dependent on imported agrochemicals such as pesticides, which are not produced in the Virgin Islands. Shipping charges cause higher prices for Caribbean farmers and drive up operating expenses. In addition to being more costly, shipping is a process which often lasts several weeks from ordering to receiving goods. This makes farm management more complex by requiring accurate record keeping to ensure that materials are ordered well in advance. Although local farmers can ask a higher price for their produce and still remain competitive with imported goods, only $2.8 million of the $35 million expenditure on fresh agricultural products is locally met in the Virgin Islands (D’Souza, 2000). This fact can be partially explained by the expenses and complications associated with shipping agricultural products to the territory.

MATERIALS AND METHODS

This trial evaluated differences among six insect control treatments on okra and their overall effect on number of marketable fruit and marketable yield. Each treatment plot was 3.6 m x 7.3 m or 26.3 m², consisting of three rows spaced 1.2 m apart. Plant spacing within rows was 0.6 m or a total of 24 plants per replication. The field was irrigated with drip emitters every 0.6 m. The experimental design was randomized block design with four replications per treatment.

The okra variety used in the trial was Clemson Spineless. Plants were direct seeded with three seeds per hole and thinned to one plant after two weeks. Seeds were planted in June 2002 and sprayed for the first time when pests were observed 22 days later. One of the primary pests affecting okra in the Virgin Islands is the aphid, but mealy bugs, whitefly and other pests are also a concern. The six pest control treatments tested in this study were traditional spraying (TS), neem-based spray (NS), neem mulch (NM), neem tea made from fresh cut leaves (NT), a neem hedge treatment (NH), and control.

Plants were sprayed as needed, usually once per week during initial stages and two times per week during the height of production. For the TS treatment either diazinon or malathion was applied only once per week. Azatin™ was used for NS treatment and was applied according to the label, usually twice per week. NT was made from fresh cut neem leaves (1kg leaves/7.6 L water) steeped in ambient temperature water for 48 hours, and then strained. The NT was applied as often as three times per week depending on the severity of the infestation. All commercial pesticides were applied in accordance with their labels. Spraying was conducted during early mornings to minimize drift and consequent cross contamination among treatments.

The non-spray treatments were NM, NH and control. The purpose of these treatments was to determine the insecticidal effect of un-processed green material from the neem tree. The hedge was comprised of neem seedlings planted 0.6 m apart in rows 10 m in length and 5 m between rows. The hedge rows were planted one year prior to the okra crop and were maintained at a height of 0.9 m and 0.6 m wide. The mulch for the NM treatment was applied green, in a 10-15 cm layer with woody stems over 3 cm removed. The mulch was applied only after the okra seedlings were tall enough (20 cm) to avoid being smothered.

The first harvest was 53 days after planting. Okra was harvested three times per week for 9 weeks for a total of 26 harvests. Field observations were recorded on the incidence of pests.
and diseases throughout the experiment. Data on number of fruit, fruit size and fruit yield were taken at each harvest. Data analysis was conducted by using the SAS System 8.00 for Windows. Analysis of variance was conducted for total number of fruits and total yield by using GLM procedure which indicated there was significant difference among treatments for both number of harvested fruits and total yield. Mean separation was completed using PDIF (SAS 2001).

RESULTS AND DISCUSSION

White fly, mealy bug and aphids were the primary pests observed on plants within all treatments during the course of the study. Aphids were the only pests that caused serious damage to the plants and reduced yields. Severely infested plants went through a several-week process of increasing aphid population, development of sooty mold, leaf loss and, in severe cases, plant failure.

During the first three weeks of okra harvest only NH was visibly different from the other treatments, with noticeably underdeveloped plants. Insect pests were present in isolated patches and appeared to be spreading. Spraying regimes were increased for all three spray treatments. By week four, aphids were causing severe damage to isolated plants in NT and control, reducing yield. Spraying in NT was increased to three times per week but the aphid population continued to increase.

Total plot production by weight, number of fruit and average fruit size per treatment is shown in Table 1. Total marketable production weights ranged from 1.63 t/ha⁻¹, to 10.09 t/ha⁻¹ (Figure 1). The results from the more productive treatments are in keeping with yields achieved in a previous variety trial conducted on an adjacent plot (Palada and Crossman, 1991). There were significant differences (P 0.01) in total marketable yield between all treatments except for TS and NM, which produced the highest total yields (10.09 t/ha⁻¹ and 9.90 t/ha⁻¹ respectively) and were the most successful treatments. The only other treatment that produced higher marketable yield than the control was NS.

Two treatments produced at significantly lower rates than the control (6.88 t/ha⁻¹). By far the lowest producer, NH (1.63 t/ha⁻¹) appeared to suffer from severe competition for moisture and nutrients from the hedgerow trees and produced well under the rate of the control (Figure 4). Plants in NH were the last to bear fruit and never reached the height of those from other treatments. Though this treatment was never sprayed, insect populations were not observed to be as great as in other treatments. NT (4.92 t/ha⁻¹) also had a negative effect on production as it produced significantly less than the control. It is not known why number of fruit and yield was reduced by this treatment, but the aphid infestation was observed to be more severe in this treatment than in any other.

In terms of number of marketable fruit produced per week, NS, TS and NM were not significantly (P 0.01) different. All three were significantly (P 0.01) better than control and were the top three producers (Figure 1). In terms of total production TS and NM were significantly (P 0.01) better than all other treatments, but were not different from one another (Figure 3).

SUMMARY AND CONCLUSIONS

This study has shown that okra production varied under the different pest treatments. Two treatments, NH and NT, had a negative effect, producing less than the control and, therefore, cannot be recommended. Three treatments, TS, NS and NM, had production levels
significantly higher than that of the control. Growers of okra should note that it was possible to increase marketable yields with one of these three methods. The two spray treatments, TS and NS, improved yield through reduced insect damage. NM is a non-spray treatment that improved yields either through improved water conservation, insect repellant effect or a combination of the two. Future research should examine the possibility of further improving yields by combining NM with spray treatments. Additionally NM should be compared with traditional hay mulching to discover whether the neem mulch provides significant insect protection.

These results indicate that okra growers in the Virgin Islands may be able to improve their production systems with one of these two treatments. Furthermore, using neem leaves as mulch is a locally available, inexpensive, organic practice that offers results similar to those of more expensive and time consuming chemical application.

Table 1. Okra spray treatments and production from 96 plants over 9 weeks.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Total yield (kg)</th>
<th>Total Number of Marketable Fruits</th>
<th>Average Marketable Fruit Weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neem Spray</td>
<td>60.53</td>
<td>5697</td>
<td>10.59</td>
</tr>
<tr>
<td>Traditional Spray</td>
<td>71.45</td>
<td>6918</td>
<td>10.33</td>
</tr>
<tr>
<td>Neem Mulch</td>
<td>70.41</td>
<td>6298</td>
<td>11.18</td>
</tr>
<tr>
<td>Neem Tea</td>
<td>34.56</td>
<td>3303</td>
<td>10.46</td>
</tr>
<tr>
<td>Neem Hedge</td>
<td>11.44</td>
<td>1174</td>
<td>9.75</td>
</tr>
<tr>
<td>Control</td>
<td>48.64</td>
<td>4589</td>
<td>10.6</td>
</tr>
</tbody>
</table>

Table 2. Marketable yield of okra as affected by treatment.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Marketable Yield (t/ha)</th>
<th>Average Number of Marketable Fruits per Plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical Spray</td>
<td>10.09 a</td>
<td>72.1 a</td>
</tr>
<tr>
<td>Neem Spray</td>
<td>8.50 b</td>
<td>59.3 b</td>
</tr>
<tr>
<td>Neem Mulch</td>
<td>9.90 a</td>
<td>65.6 ab</td>
</tr>
<tr>
<td>Neem Tea</td>
<td>4.92 d</td>
<td>34.4 d</td>
</tr>
<tr>
<td>Neem Hedge</td>
<td>1.63 e</td>
<td>12.2 e</td>
</tr>
<tr>
<td>Control</td>
<td>6.88 c</td>
<td>47.8 c</td>
</tr>
</tbody>
</table>
Figure 1. Total number of marketable okra produced per week with various insect control treatments over 9 week harvest.

Figure 2. Weekly marketable okra yield per plot for various insect control treatments.
Figure 3. Cumulative marketable okra yield for various insect control treatments (t/ha).


