SYNTHETIC PYRETHROIDS AND OTHER INSECTICIDES FOR CONTROL OF INSECTS ON FLUE-CURED TOBACCO

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Freel experiments were conducted in North Carolina during 1976-77 to evaluate the effectiveness of different dosages, formulations, and combinations of 16 insecticides applied as sprays to flue-cured tobacco for control of the tobacco budworm, Heliothis virescens (F.), tobacco hornworm, Manduca sexta (L.), tomato hornworm, M. quinquemaculata (Haworth), tobacco flea beetle, Epitrix hirtipennis (Melsheimer), and green peach aphid, Myzus persicae (Sulzer). Performance of the various treatments was compared with that of a standard treatment of 56 kg/ha Al of methomyl and a nontreated check.

Compared with methomyl, similar or superior control of budworms, hornworms, and flea beetles was obtained with the following experimental insecticide treatments: .011 kg/ha Al of FMC-45498 (S-(cyano)(3-phenoxyphenyl) methyl 1 R-CIS-3, 2, 2-dibromoethenyl).2, 2-dimethylcyclopropane-1-carboxylate). .11 kg of Ambush® (permethrin, cis/trans 40/60), Pounce® (permethrin, cis/trans 40/60), and Pydrin® (Benzeneacetic acid, 4-chloro-α-methyl n-methylcyano), cyan (3-phenoxv-phenyl) methyl ester); 56 kg of Curacron® (O-(4-bromo-2-chlorophenyl) O-ethyl S-propyl phosphorothioate); and 1.12 kg of Bolstar® (O-ethyl O-[4-(methylthio) phenyl] S-propyl phosphorothioate) and Monitor® (O, S-dimethyl phosphoramidothioate). Most of the organophosphates tested against aphids were superior to methomyl in reducing aphid damage. The pyrethroids tested against aphids increased aphid damage over that of nontreated checks.

INTRODUCTION

The efficacy of new experimental insecticides against the tobacco budworm, Heliothis virescens (F.), tobacco hornworm, Manduca sexta (L.), tomato flea beetle, Epitrix hirtipennis (Melsheimer), and green peach aphid, Myzus persicae (Sulzer) on flue-cured tobacco was reported recently (2). The most effective materials tested were CGA-15324 or Curacron® (O-(4-bromo-2-chlorophenyl) O-ethyl S-propyl phosphorothioate), N-2596 (S-(p-chlorophenyl) O-ethyl ethanephosphonodithioate), and FMC 33297 or Pounce® (permethrin). Research with N-2596 on tobacco has been temporarily discontinued by the manufacturer. This report presents additional information on certain registered products, Curacron, and Pounce and new information on other experimental insecticides used for control of the 4 insects mentioned earlier and the tomato hornworm, M. quinquemaculata (Haworth).

METHODS AND MATERIALS

Small-plot field experiments were conducted near Clayton, NC during 1976-77 to evaluate the effectiveness of certain insecticides applied with a self-propelled, high-clearance sprayer to 'Coker 319' flue-cured tobacco for control of artificial infestations of tobacco budworms and natural infestations of tobacco flea beetles, green peach aphids, tobacco hornworms, and a mixture of tobacco and tomato hornworms. Larvae occurring naturally on artificially infested plants were included in the tests. The experiments consisted of a variable number of insecticidal treatments, a standard treatment of methomyl SP at 56 kg/ha Al, and a nontreated check replicated 3 times in a randomized block design. Records were made on adult flea beetles and all stages of budworm larvae, hornworm larvae, and apterous aphids. Leaf consumption by budworm and hornworm larvae was also recorded. Plant damage ratings ranging from 0 (none) to 5 (very heavy) were used in evaluating hornworm and aphid injury to tobacco several weeks after treatment. Other experimental procedures were similar to those reported earlier (1).

Insecticides used in these experiments were: Ambush® (permethrin, cis/trans 40/60), Bolstar® (O-ethyl O-[4-(methylthio) phenyl] S-propyl phosphorothioate), Curacron® (O-(4-bromo-2-chlorophenyl) O-ethyl S-propyl phosphorothioate), Dipel® (Bacillus thuringiensis Berliner), Elcar® (Heliothis nuclear-polyhedrosis virus), endosulfan, fenitrothion, FMC 41655.
(permethrin, cis/trans 25/75, I MC-45498 (S-cyano) (3-phenoxypyphenyl) methyl 1 R-cis-3, 2-dibromoethenyl)-2, 2-dimethylcyclopropene-1-carboxylate, methomyl, Monitor\(^\text{TM}\) (O, S-dimethyl phosphoramide dithioate). Pennycap-L\(^\text{TM}\) (encapsulated methyl parathion), Pennycap-M\(^\text{TM}\) (encapsulated methyl parathion), Pounce\(^\text{TM}\) (permethrin, cis/rans 40/60), and Pydrin\(^\text{TM}\) (Benzenearacetic acid, 3-chloro-alpha-(1-methylethyl)-cyano (3-phenoxy-phenyl)methyl ester).

RESULTS

**Tobacco Budworm:** Initially, methomyl SP at .56 kg/ha reduced budworm larval infestations at 3 days in the 6 experiments conducted (Table 1). At 3 days, the other treatments were as effective as methomyl SP with the following exceptions. Pennycap-E F at 1.12 kg and FMC-41655 EC at .11 kg were inferior, Dipel WP at .56 kg was inferior to ineffective, and Elixir WP at .56 kg and Pennycap-MX F and encapsulated fenitrothion F at 1.12 kg were ineffective. In addition, Ambush EC, Pydrin EC, and Pounce EC at rates of .11 kg or less were sometimes inferior or ineffective.

The original infestations of 30 budworm larvae/30 plants decreased considerably by the 10th day in the check plots, indicating little or no occurrence of wild larvae during the test periods. Thus, the residual effectiveness of the treatments was not adequately measured. In Experiment 1, methomyl SP and other treatments were ineffective at 10 days, due mainly to the rapid decline of the infestation in the check plots. In the other experiments, all treatments were as effective as methomyl SP at 10 days with the following exceptions. Ambush EC at .34 and .22 kg was superior, Dipel WP at .56 kg was inferior, and Pennycap-E F at 1.12 kg was ineffective.

Methomyl SP reduced budworm damage 48 to 73\% by the 12th day in 5 of the 6 experiments. Ambush EC at .34 and .22 kg reduced damage in Experiment 2 where methomyl SP was ineffective. Other ineffective treatments in this experiment were Ambush EC at .11 and .06 kg and Pydrin EC at .22, .11, and .06 kg. Where methomyl SP reduced damage, similar reductions were obtained with Bolstar EC and Monitor EC at 1.12 kg, Curacron EC at .84 and .56 kg, methomyl L and Elixir WP at .56 kg, endosulfan EC at .42 kg, Pounce 3.2 EC + endosulfan EC at .08 + .42 and .06 + .42 kg, Ambush EC and Pounce EC with Volck oil at .22 and .11 kg, Pounce 3.2 EC at .22, .11, and .08 kg, Pydrin EC at .17 and .08 kg, Pounce .8 EC and FMC-41655 EC at .11 kg, and FMC-45498 EC at .022, .017, and .011 kg. Similar to no protection was provided by Pennycap-F at 1.12 kg, and inferior to no protection was obtained with Dipel WP at .56 kg. Ineffective treatments included fenitrothion EC at 2.24 and 1.12 kg and encapsulated fenitrothion I, Pennycap-MX F, and Pennycap-E F at 1.12 kg.

**Tobacco Hornworm and Tomato Hornworm:** Methomyl SP at .56 kg/ha reduced tobacco hornworm larval infestations at 3 and 10 days in the 3 experiments conducted in 1976 (Table 2). At 3 days, all treatments provided control similar to that of methomyl SP. Larval infestations in the check plots increased between the 3rd and 10th days, providing pressure for determining the residual effectiveness of the treatments. Treatments superior to methomyl SP at 10 days included Ambush EC at .34, .22, .11, and .06 kg, Pydrin EC at .22, .11, and .06 kg, Pounce 3.2 EC and .8 EC with Volck oil at .22 and .11 kg, and Pounce .8 EC and FMC-41655 EC at .11 kg. Treatments similar to

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**Table 1. Insecticidal control of the tobacco budworm, tobacco flea beetle, and a 40:60 mixture of the tobacco hornworm and tomato hornworm on true-cured tobacco, Clayton, NC.**

<table>
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<tr>
<th>Treatment</th>
<th>Date of Application</th>
<th>Tobacco Budworm/10 plants</th>
<th>Tobacco Flea Beetle/10 plants</th>
<th>Tobacco Hornworm/10 plants</th>
<th>Tomato Hornworm/10 plants</th>
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<td>Early + Later Period</td>
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<td>Early + Later Period</td>
<td>Early + Later Period</td>
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Tobacco Science, 1979, 23(4), 193-208, ISSN 0082-4523.
methomyl SP were Penncap-M F, Penncap-MX F, and encapsulated fenitrothion F at 1.12 kg and methomyl L and Dipel WP at .56 kg. Fenitrothion EC at 2.24 and 1.12 kg was ineffective.

In these 3 experiments, methomyl SP reduced tobacco hornworm damage 95 to 99% by the 12th day. With the exception of fenitrothion EC at 2.24 kg, all of the treatments just discussed provided plant protection for 12 days similar to that of methomyl SP. Based on hornworm damage ratings made 37, 30, and 21 days after application in Experiments 1, 2, and 3, respectively, reductions in damage were obtained with Dipel WP at .56 kg in Experiment 1 and with methomyl SP and all of the pyrethroid treatments tested in Experiments 2 and 3. In Experiments 2 and 3, the pyrethroid treatments were superior to methomyl SP in reducing damage 30 and 21 days after application.

In 1977, methomyl SP reduced mixed infestations of tobacco and tomato hornworm larvae by the 7th day in the 3 experiments conducted (Table 1). Compared with methomyl SP, superior control was provided by Monitor EC and Bolstar EC at 1.12 kg, Curacron EC at .84 and .56 kg, Ambush EC at .22 and .11 kg, and Pydrin EC at .08 and .06 kg. Similar control was obtained with Penncap-M F and Penncap-MX F at 1.12 kg, Methomyl L at .56 kg, and FMC-41655 EC at .022, .017, and .011 kg. Methomyl SP was highly effective in Experiment 1 and there was virtually no opportunity for the pyrethroids to exhibit superiority in this test.

Tobacco Flea Beetle: Methomyl SP at .56 kg/ha provided 87 to 98% control of flea beetles at 3 days and 40 to 80% control at 7 days in the 6 experiments conducted (Table 1). At 7 days, all treatments provided control similar to that of methomyl SP with the following exceptions. Fenitrothion EC at 1.12 kg, Endosulfan EC at .42 kg, and Pydrin EC at .06 kg were inferior. The infestation in the check plots of Experiment 4 decreased between the 3rd and 7th days; thus, the residual effectiveness of the treatments was not adequately measured in this test. Overall, treatments superior to methomyl SP at 7 days were Bolstar EC and Monitor EC at 1.12 kg, Ambush EC at .34 kg, Pydrin EC and Pounce 3.2 EC at .22 and .11 kg, Pounce .8 EC with Volck oil at .22 kg, FMC-41655 EC and Pounce .8 EC at .11 kg, Pounce 3.2 EC + endosulfan EC at .08 + .42 kg, and FMC-45498 EC at .022, .017, and .011 kg. Superior to similar control was provided by Ambush EC at .22 and .11 kg. Similar control was obtained with Penncap-M F, Penncap-MX F, Penncap-E F, and encapsulated fenitrothion F at 1.12 kg, Curacron EC at .84 and .56 kg, methomyl L at .56 kg, Pydrin EC at .08 and .06 kg, Pounce .8 EC with Volck oil at .11 kg, Pounce 3.2 EC at .08 kg, Pounce 3.2 EC + endosulfan EC at .06 + .42 kg, and Ambush EC at .06 kg. Endosulfan EC at .06 kg was inferior, and fenitrothion EC at .42 kg was inferior, and fenitrothion EC at .22 and 1.12 kg was ineffective.

Green Peach Aphid: Methomyl SP at .56 kg/ha provided 97.1 to 99.7% control of aphids on the 10th day in the 3 experiments conducted (Table 2). Compared with methomyl SP, similar control was provided by fenitrothion EC at 2.24 and 1.12 kg, Penncap-M F and Penncap-MX F at 1.12 kg, methomyl L at .56 kg, and Pounce 3.2 EC at .22 and .11 kg. Inferior control was obtained with fenitrothion EC at 2.24 kg and FMC-45498 EC at .08 + .42 kg. Inferior treatments included Ambush EC at .34, .22, and .11 kg, Pydrin EC, Pounce 3.2 EC, and Pounce .8 EC with Volck oil at .22 and .11 kg, and Pounce .8 EC at .06 kg. Based on aphid damage ratings made 37, 30, and 21 days after application in Experiments 1, 2, 3, respectively, methomyl SP reduced damage in the 3 experiments. Compared with methomyl SP, similar control was provided by fenitrothion EC at 2.24 and 1.12 kg, Penncap-M F and Penncap-MX F at 1.12 kg, methomyl L at .56 kg, and Pounce 3.2 EC at .22 and .11 kg. Inferior control was obtained with fenitrothion EC at 2.24 kg and FMC-45498 EC at .08 + .42 kg. Inferior treatments included Ambush EC at .34, .22, and .11 kg, Pydrin EC, Pounce .8 EC with and without Volck oil, and FMC-41655 EC at .11 kg. Based on aphid damage ratings made 37, 30, and 21 days after application in Experiments 1, 2, 3, respectively, methomyl SP reduced damage in the 3 experiments. Compared with methomyl SP, similar control was provided by fenitrothion EC at 2.24 and 1.12 kg, Penncap-M F and Penncap-MX F at 1.12 kg. Similar protection was provided by fenitrothion EC at 1.12 kg, methomyl L at .56 kg, and Pydrin EC and Ambush EC at .06 kg. Treatments which increased aphid damage included Ambush EC at .34, .22, and .11 kg, Pydrin EC, Pounce 3.2 EC, and Pounce .8 EC with Volck oil at .22 and .11 kg, and Pounce .8 EC at .06 kg. FMC-41655 EC at .11 kg.
PHYTOTOXICITY

Pydrin EC was phytotoxic to tobacco in an early-season experiment in 1977. It was not phytotoxic in a late-season test in 1977 or in early-or-late-season experiments in 1976. Symptoms consisted of irregular, whitish spots over the apical half of leaves to grown. At .17 kg/ha of Pydrin EC, there were 2 to 4 leaves with moderate to heavy spotting on virtually every plant. At .08 kg, there were 2 to 4 leaves with light spotting on about 1/4 of the plants. No other phytotoxicity was noted in this study.

DISCUSSION

About .11 kg/ha of the pyrethroids Ambush, Pounce, and Pydrin was required to obtain budworm control similar to that provided by .56 kg of methomyl. Compared with methomyl, .11 kg of these pyrethroids gave superior control of hornworms and flea beetles, and .06 kg gave superior control of hornworms and similar control of flea beetles. Although neither dosage of these pyrethroids controlled aphids, initial reductions in aphids and subsequent increases in aphids over that of nontreated checks were greater at .11 kg than at .06 kg. The newer pyrethroid FC-45498 at .011 kg provided superior control of flea beetles and similar control of budworms and hornworms. It was not tested against aphids.

Compared with methomyl, .56 kg of Curacron provided superior control of hornworms and similar control of budworms and flea beetles. Bolstar and Monitor at 1.12 kg provided superior control of hornworms and flea beetles and similar control of budworms. These organophosphate insecticides were not tested against aphids, but Curacron was effective in previous tests (2) and the other materials are probably effective also.

Pounce with Volck oil and a 25/75 cis/trans ratio of permethrin (FMC-41655) were slightly less effective than Pounce (permethrin, cis/trans 40/60) against budworms, hornworms, and flea beetles and little different against aphids where all of these treatments were ineffective. Endosulfan + Pounce was slightly more effective than either material alone against budworms, hornworms, and flea beetles, with the exception that endosulfan alone performed poorly against flea beetles. This treatment was not tested against aphids where Pounce is ineffective and endosulfan is considered to be a fair aphicide.

Encapsulated fenitrothion was significantly less effective than fenitrothion against budworms and aphids and significantly more effective against hornworms and flea beetles. Little difference was noted between the effectiveness of Penncap-M and Penncap-MX against these 4 insects. Penncap-E was significantly less effective than Penncap-M against budworms and significantly more effective against hornworms and flea beetles.

LITERATURE CITED


Table 2. Insecticidal control of the tobacco hornworm and green peach aphid on flue-cured tobacco, Clayton, NC. 1976.

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a In each vertical column in each experiment, means having one or more letters in common are not significantly different at 5% level.
b kg/ha of formulation.