The Combined Efficacy of Malathion and Spinetoram against Three Stored Product Insects
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ABSTRACT

The effectiveness of malathion and spinetoram alone and in binary combinations was investigated against the adults of *Sitophilus oryzae* (L.), *Rhizopertha dominica* F. and *Tribolium castaneum* (Herbst.). The obtained results showed that, the toxicity of each insecticide to the adults of the three insect species was concentration and exposure period - dependent. Adults of *S. oryzae* were highly susceptible to malathion alone but, *R. dominica* and *T. castaneum* adults were the least susceptible to the insecticide. While *R. dominica* adults were higher susceptible to spinetoram alone than the two other species. Co-toxicity values resulted from adding LC10 of spinetoram to various malathion concentrations showed a potentiating effects on the adults of *T. castaneum* at all concentrations of malathion, on *R. dominica* at the three lowest concentrations and at the lowest concentration (0.25 ppm) only on the adults of *S. oryzae*. Meanwhile an additive effect was achieved with other concentrations of malathion and LC10 of spinetoram against the three tested insect species. A complete protection for stored wheat seeds was achieved with the Six tested mixtures (Mix1 - Mix6) against adults of *S. oryzae* and *R. dominica* up to 6 months. Also, the same effect extended against *T. castaneum* adults to 5, 4 and 2 months with Mix6, each of (Mix3 and Mix4) and Mix1, resp. Contrarily, Mix1, Mix4 failed to give a complete mortality for *T. castaneum* adults at all various intervals (months). Data concluded that, stored wheat seeds treated with Mix1 (4ppmM+5ppmSm) or Mix4 (4ppm M+4ppm Sm) were protected against the three insects infestation for 3 months.

INTRODUCTION

Malathion is an organophosphorus (OP) insecticide is being used as a protectant against stored product insects during storage till now. Several insects now resistant to (Op) insecticides, the lesser grain borer *R. dominica*, adults were resistant to both malathion, pirimiphos-methyl (El-Lakwah et al., 2004). Therefore, alternative insecticides or pest management strategies are urgently needed to replace traditional insecticides.

Recently, spinetoram is a mixture of chemically modified spinosyns (spinosyn J and spinosyn L) produced by bacterium *Saccharopolyspora spinosa* colonies, has a unique mode of action on insect nervous system at the nicotinic acetylcholine receptor and GABA receptor cites (Dripps et al., 2011). It is an broad spectrum insecticide with low mammalian toxicity (Mertz and Yoo 1990). Two formulations of spinetoram, water dispersible granules (WG), and suspension concentrate (SC) were evaluated, *R. dominica*, *S. oryzae*, *T. confusum* adults in the laboratory. From the species tested, *R. dominica* was the most susceptible, given that immediate and delayed mortality and high reduction in F1 progeny (Vassilakos, et.al., 2012).

Synergism was shown between (OP) and pyrothriod combinations of insecticides and other substances were evaluated against stored product insects have developed resistance (Bengston et al., 1987).

The aims of the present study to make a combinations from malathion and spinetoram with high potentiality to control the main insect species of stored wheat seeds *Sitophilus oryzae* (L.), *Rhizopertha dominica* F. and *Tribolium castaneum* (Herbst.) for 3 months at least.

MATERIALS AND METHODS

Insects:

Adults of the rice weevil *S. oryzae*, the lesser grain borer *R. dominica*, and the red flour beetle *T. castaneum*, were used for investigations. All species were reared and maintained under laboratory conditions for several generations at 26 ± 2°C and 60 ± 5% RH.

Insecticides:

**Malathion1%dust:0,0dimethyl-s-(1-dicarboxyethyl) phosphodithioate**, produced by Kafr El-Zayat chemical and pesticides company, Egypt.

**Spinetoram(Radiant 12%SC):** Spinetoram is a mixture of (3-O-ethyl 5,6-dihydro spinosyn J and 3-O-ethyl spinosyn L), formulation was obtained from Shoura chemicals com. under license of Dow Agro Sciences UK.

Grain treatment:

The amount of malathion insecticide was added to jars of about 125 ml volume contains 50 g of media (sterilized and conditioned wheat kernels in case of the rice weevil and the lesser grain borer or wheat flour in case of the red flour beetle) to achieve malathion concentrations 8, 4, 2, 1, 0.5 and 0.25 ppm (toxicity of malathion alone), water solution (five ml from each concentration) were added to 50 g media to give 10, 5, 2.5, 1.25, 0.625 and 0.313 ppm for LC10 of spinetoram assessment, and left 24 hrs to evaporate the solvent.

In case of mixtures, at first the amount of LC10 of spinetoram was added to food and left 24 hrs to evaporate the solvent then mixed with the amount of malathion.

**Bioassay:**

Batches of 30 adult insects (1 weeks old) were introduced to the jars. Three replicates for each concentration were used, the jars were covered with muslin cloth and fixed with rubber band. All replicates of experiment were kept at 26 ± 2°C and 60 ± 5% RH. Mortalities were recorded after 2, 3, 5, 7 and 14 days from treatment. Mortalities were corrected using Abbot’s formula (1925).

The lethal concentrations of spinetoram after 7 days were estimated using EPA probit analysis program (version 1.5).

After 7 days from exposure the joint action caused by adding of LC10 of spinetoram to the various concentrations of malathion insecticide was determined according to the equation adopted by Mansour et.al. (1966):

\[ Co-toxicity \text{ factor} = \left[ \frac{\text{observed mortality} \% - \text{expected mortality} \%}{\text{expected mortality} \%} \right] \times 100 \]
Mix No. (Mix) Mixture Nasr, M. E. H. Effect of Malathion: gave 79.1, 100.0 and 45.1 % kill for three tested insects after 7 days from treatment were given in days of exposure to mixtures.

Susceptibility of adult insects to the insecticide: The obtained results are in harmony with the findings of other investigators (Vassilakos and Athanassiou, 2012; Athanassiou and Kavallieratos, 2014 and Nasr, 2015).

Persistence of binary mixtures: The efficacies of six binary mixtures of the two insecticides according (Table 1) were tested against the adults of above insect species for 6 months. Firstly, 30 adult insects were introduced to the treated or untreated samples that were taken monthly from wheat lots stored at 26 ± 2°C and 60 ± 5 RH and adults mortality was recorded after 7 days of exposure to mixtures.

Germination of wheat seeds: Every month, 25 seeds were cultivated in each of 4 Petri dishes (4 replicates) for 7 days and germination% was calculated.

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Table 1. Mixture levels and concentration of each insecticide

<table>
<thead>
<tr>
<th>Mixture</th>
<th>Malathion (M)</th>
<th>Spinetoram (Sm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mix₁</td>
<td>(M₁) = 5</td>
<td>(Sm₁) = 5</td>
</tr>
<tr>
<td>Mix₂</td>
<td>(M₂) = 5</td>
<td>(Sm₂) = 4</td>
</tr>
<tr>
<td>Mix₃</td>
<td>(M₃) = 4</td>
<td>(Sm₃) = 5</td>
</tr>
<tr>
<td>Mix₄</td>
<td>(M₄) = 4</td>
<td>(Sm₄) = 4</td>
</tr>
<tr>
<td>Mix₅</td>
<td>(M₅) = 4</td>
<td>(Sm₅) = 3</td>
</tr>
<tr>
<td>Mix₆</td>
<td>(M₆) = 4</td>
<td>(Sm₆) = 2</td>
</tr>
</tbody>
</table>

RESULTS AND DISCUSSION

Effect of Malathion:

Data illustration in Figure (1) showed that, the effects of malathion alone at different concentrations on mortalities of S. oryzae, R. dominica and T. castaneum adults after 7 days from treatment.

Results revealed that, malathion at 8, 4 and 2 ppm gave complete mortality for S. oryzae adults, While only 65.7% mortality was achieved at the lowest concentration (0.25 ppm). Meanwhile, mortality of R. dominica adults reached 62.3% at the highest concentration (8 ppm) and only 5.7% at 0.25 ppm. Adults of T. castaneum were relatively less susceptibility to malathion compared with the others species tested, the highest concentration (8 ppm) gave 45.7% only.

The obtained data revealed clearly that adults of S. oryzae were highly susceptible to malathion followed by R. dominica and T. castaneum adults which were the least susceptible to the insecticide.

Effect of Spinetoram:

Data of the spinetoram toxicity to the adults of the three tested insects after 7 days from treatment were given in Fig. (2). The results showed that, the highest concentration gave 79.1, 100.0 and 45.1% kill for S. oryzae, R. dominica and T. castaneum, respectively.

LC₁₀ from spinetoram after 7 days were 0.410, 0.032 and 3.18 ppm for the adults of S. oryzae, R. dominica and T. castaneum, respectively.

Results indicated that, the adults of R. dominica were highly susceptible to spinetoram than the two tested insects.
Table 2. Co-toxicity resulted from addition of LC_{10} of Spinetoram to different concentrations of malathion against three stored product insects

<table>
<thead>
<tr>
<th>(M) Conc. ppm</th>
<th>% mortality after 7(days) ± S.D.</th>
<th>S. oryzae</th>
<th>R. dominica</th>
<th>T. castaneum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>alone</td>
<td>M+</td>
<td>Co-toxic.&amp;</td>
<td>alone</td>
</tr>
<tr>
<td>100.0±0.0</td>
<td>8</td>
<td>100.0±0.0</td>
<td>-9.9d</td>
<td>62.3±0.5</td>
</tr>
<tr>
<td>100.0±0.0</td>
<td>4</td>
<td>100.0±0.0</td>
<td>-9.9d</td>
<td>59.0±0.5</td>
</tr>
<tr>
<td>0.00</td>
<td>1</td>
<td>0.0±0.0</td>
<td>-</td>
<td>100.0±0.0</td>
</tr>
</tbody>
</table>

a: antagonistic  d: additive effect  p: potentiation(synergistic) effect

Table 3. Persistence of the binary mixtures from malathion and spinetoram against three stored product insects

<table>
<thead>
<tr>
<th>Mix</th>
<th>% adult mortality after 7 days from exposure ± S.D. at various intervals (months)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>S. oryzae</td>
<td>100.0±0.0</td>
<td>100.0±0.0</td>
<td>100.0±0.0</td>
<td>100.0±0.0</td>
<td>100.0±0.0</td>
<td>100.0±0.0</td>
<td>100.0±0.0</td>
</tr>
<tr>
<td>R. dominica</td>
<td>100.0±0.0</td>
<td>100.0±0.0</td>
<td>100.0±0.0</td>
<td>100.0±0.0</td>
<td>100.0±0.0</td>
<td>100.0±0.0</td>
<td>100.0±0.0</td>
</tr>
<tr>
<td>T. castaneum</td>
<td>100.0±0.0</td>
<td>100.0±0.0</td>
<td>100.0±0.0</td>
<td>100.0±0.0</td>
<td>100.0±0.0</td>
<td>100.0±0.0</td>
<td>100.0±0.0</td>
</tr>
</tbody>
</table>

REFERENCES


الفعالية المشتركة لكل من الملايين والاسبيتورام ضد ثلاثة من حشرات المواد المخزونة

محمود السيد حسن نصر

تم دراسة فعالية كل من مبيد الملايين والإسبتيورام منفردين وكذلك مخلوطهما المختلط ضد الحشرات الكاملة لسوسة الأرز وتتابع الحشرة الصغرى وخنفساء الدقيق الكستانتية وقد أوضح النتائج أن نسبة أي من المبيدتين تتوقف على التركيز ومدة التعرض. وجد أن الحشرات الكاملة لسوسة الأرز كانت أكثر حساسية لمبيد الملايين منفردا بينما كانت حشرات ثانية النَّفَّازين حشرة الصغرى و خنفساء الدقيق الكستانتية أقل حساسية للمبيد. وكانت حشرة ثانية النَّفَّازين أكثر حساسية لمبيد الإسبتيورام منفردا. وأظهرت الدراسات المشتركة النتائج من إضافة LC10 من الإسبتيورام إلى تركيزات الملايين بالنسبة لسوسة الأرز وشم وسوس النَّفَّازين في مختبر. وقُل من الإسبتيورام لتركيزات الملايين المختلفة الأخرى. كما أعطي كل مخلوطة من المبيدتين (Mix1, Mix2) جرعة كاملة لحشرة الصغرى ضد حشرات ثانية النَّفَّازين سوسسة الأرز وحشرة الصغرى لعدة أشهر. واستمر على الانتفاض من إضافة LC10 من الإسبتيورام إلى تركيزات الملايين المختلفة الأخرى. كما أعطي كل Mıl (Mix1, Mix2) على التوالي. ولم يعط (Mix1, Mix1) نفس التأثير ضد خنفساء الدقيق الكستانتية لعدة أشهر. وقُل من الإسبتيورام من التأثيرات على الخفافيش في أي شهر من فترات الأخذ. ونستنتج أنه ببعض حالات حشرة الصغرى قد يتم حماية ضد الإصابة من Mıl (Mix1, Mix2) لعدة المتادات الثلاثة لعدة 3 شهور.

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