

**Toxicity of commonly used pesticides in staked tomato production in North Carolina to the natural predators *P. persimilis* and *Orius* spp.**

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**Table 1:** List of commonly used insecticides and fungicides in fruiting vegetables in North Carolina and their relative toxicity to the predatory mite *Phytoseiulus persimilis* and a hemipteran predator, minute pirate bug, *Orius* spp. Toxicity is rated according to degree of mortality: little to no toxicity (<25% mortality), slightly toxic (25-50%), moderately toxic (50-75%), or highly toxic (>75%).

Data were compiled from research experience and personal observations in North Carolina, in addition to various peer-reviewed publications and data reported in the side effects manuals provided online by Koppert Biological Systems and Biobest Sustainable Crop Management, two major distributors of commercial biological control agents.

| Name       | Active Ingredient                | MOA group | Application Type | Toxicity to <i>Orius</i> spp. |                  | Toxicity to <i>P. persimilis</i> |
|------------|----------------------------------|-----------|------------------|-------------------------------|------------------|----------------------------------|
|            |                                  |           |                  | <i>Nymph</i>                  | <i>Adult</i>     | <i>Nymph/adult</i>               |
| Lannate    | Methomyl                         | 1A        | Foliar           | Highly toxic                  | Highly toxic     | Highly toxic                     |
| Lannate    | Methomyl                         | 1A        | Soil             | Moderately toxic              | Slightly toxic   | Highly toxic                     |
| Sevin      | Carbaryl                         | 1A        | Foliar           | Highly toxic                  | Highly toxic     | Moderately toxic                 |
| Dimethoate | Dimethoate                       | 1B        | Foliar           | Highly toxic                  | Highly toxic     | Highly toxic                     |
| Excel      | Acephate                         | 1B        | Foliar           | Highly toxic                  | Highly toxic     | Highly toxic                     |
| Diazin     | Diazinon                         | 1B        | Foliar           | Slightly toxic                | Moderately toxic | Slightly toxic                   |
| Danitol    | Fenpropathrin                    | 3A        | Foliar           | Highly toxic                  | Highly toxic     | Highly toxic                     |
| Steed      | zeta-cypermethrin and bifenthrin | 3A        | Foliar           | Highly toxic                  | Highly toxic     | Moderately toxic                 |
| Asana      | Esfenvalerate                    | 3A        | Foliar           | Highly toxic                  | Highly toxic     | Highly toxic                     |
| Perm-UP    | Permethrin                       | 3A        | Foliar           | Highly toxic                  | Highly toxic     | Moderately toxic                 |
| Admire Pro | Imidacloprid                     | 4A        | Foliar           | Highly toxic                  | Highly toxic     | Highly toxic                     |
| Admire Pro | Imidacloprid                     | 4A        | Soil             | Highly toxic                  | Highly toxic     | Slightly toxic                   |
| Assail     | Acetamiprid                      | 4A        | Foliar           | Highly toxic                  | Highly toxic     | Moderately toxic                 |

| Name                       | Active Ingredient                                    | MOA group | Application Type | Toxicity to <i>Orius</i> spp. |                    | Toxicity to <i>P. persimilis</i> |
|----------------------------|--|-----------|------------------|-------------------------------|--------------------|----------------------------------|
|                            |  |           |                  | <i>Nymph</i>                  | <i>Adult</i>       | <i>Nymph/adult</i>               |
| Belay                      | Clothianidin   | 4A        | Foliar           | -                             | -                  | Highly toxic                     |
| Actara                     | Thiamethoxam   | 4A        | Foliar           | Highly toxic                  | Highly toxic       | Moderately toxic                 |
| Platinum                   | Thiamethoxam   | 4A        | Soil             | Highly toxic                  | Highly toxic       | Slightly toxic                   |
| Venom, Scorpion            | Dinotefuran  | 4A        | Foliar           | Highly toxic                  | Highly toxic       | Highly toxic                     |
| Closer                     | Sulfoxaflor  | 4C        | Foliar           | -                             | -                  | Moderately toxic                 |
| Sivanto                    | Flupyradifurone                                      | 4D        | Foliar           | -                             | -                  | Slightly toxic                   |
| Entrust <sup>1</sup>       | Spinosad   | 5         | Foliar           | Slightly toxic                | Slightly toxic     | Slightly toxic                   |
| Radiant                    | Spinetoram   | 5         | Foliar           | Slightly toxic                | Slightly toxic     | Moderately toxic                 |
| Agri-Mek and generics      | Abamectin  | 6         | Foliar           | Highly toxic                  | Highly toxic       | Highly toxic                     |
| Proclaim                   | Emamectin benzoate                                   | 6         | Foliar           | Highly toxic                  | Highly toxic       | Highly toxic                     |
| Knack                      | Pyriproxyfen   | 7C        | Foliar           | low to no toxicity            | low to no toxicity | Slightly toxic                   |
| PQZ                        | Pyrifluquinazon                                      | 9A        | Foliar           | -                             | -                  | -                                |
| Fulfill                    | Pymetrozine  | 9B        | Foliar           | Slightly toxic                | Slightly toxic     | Slightly toxic                   |
| Sefina                     | Afidopyropen   | 9D        | Foliar           | -                             | -                  | -                                |
| DiPel, Crymax <sup>1</sup> | <i>Bacillus thuringiensis</i> subsp. <i>kurstaki</i> | 11A       | Foliar           | low to no toxicity            | low to no toxicity | low to no toxicity               |
| Rimon                      | Novaluron  | 15        | Foliar           | Moderately toxic              | Slightly toxic     | Slightly toxic                   |
| Courier                    | Buprofezin   | 16        | Foliar           | Slightly toxic                | low to no toxicity | Slightly toxic                   |
| Trigard                    | Cyromazine   | 17        | Foliar           | Slightly toxic                | low to no toxicity | Slightly toxic                   |
| Intrepid                   | Methoxyfenozide                                      | 18        | Foliar           | Slightly toxic                | Slightly toxic     | low to no toxicity               |
| Kanemite                   | Acequinocyl  | 20B       | Foliar           | low to no toxicity            | low to no toxicity | low to no toxicity               |
| Acramite                   | Bifenazate   | 20D       | Foliar           | low to no toxicity            | low to no toxicity | low to no toxicity               |

| Name                | Active Ingredient              | MOA group       | Application Type | Toxicity to <i>Orius</i> spp. |                    | Toxicity to <i>P. persimilis</i> |
|---------------------|--------------------------------|-----------------|------------------|-------------------------------|--------------------|----------------------------------|
|                     |                                |                 |                  | <i>Nymph</i>                  | <i>Adult</i>       | <i>Nymph/adult</i>               |
| Portal              | Fenpyroximate                  | 21A             | Foliar           | Slightly toxic                | low to no toxicity | Highly toxic                     |
| Magister            | Fenazaquin                     | 21A             | Foliar           | Moderately toxic              | Slightly toxic     | Highly toxic                     |
| Avaunt              | Indoxacarb                     | 22              | Foliar           | Moderately toxic              | Moderately toxic   | low to no toxicity               |
| Oberon              | Spiromesifen                   | 23              | Foliar           | low to no toxicity            | low to no toxicity | Moderately toxic                 |
| Movento             | Spirotetramat                  | 23              | Foliar           | -                             | low to no toxicity | Slightly toxic                   |
| Nealta              | Cyflumetofen                   | 25              | Foliar           | -                             | -                  | Slightly toxic                   |
| Coragen             | Chlorantraniliprole            | 28 <sup>2</sup> | Foliar           | low to no toxicity            | low to no toxicity | low to no toxicity               |
| Harvanta            | Cyclaniliprole                 | 28 <sup>2</sup> | Foliar           | -                             | -                  | low to no toxicity               |
| Verimark, Exirel    | Cyantraniliprole               | 28 <sup>2</sup> | Foliar           | -                             | -                  | low to no toxicity               |
| Beleaf              | Flonicamid                     | 29 <sup>2</sup> | Foliar           | -                             | -                  | low to no toxicity               |
| M-Pede <sup>1</sup> | Potassium salts of fatty acids | -               | Foliar           | -                             | -                  | Highly toxic <sup>3</sup>        |
| Bravo               | Chlorothalonil                 |                 | Foliar           | low to no toxicity            | low to no toxicity | low to no toxicity               |
| Manzate             | Mancozeb                       |                 | Foliar           | low to no toxicity            | low to no toxicity | low to no toxicity               |
| Quadris Top         | Azoxystrobin                   |                 | Foliar           | low to no toxicity            | low to no toxicity | low to no toxicity               |

<sup>1</sup>OMRI-approved

<sup>2</sup>While data is limited for the diamides and flonicamid, their high degree of pest selectivity will likely result in low to no toxicity against these biocontrol agents.

<sup>3</sup>M-Pede and other insecticidal soaps have no residual activity once the foliar application has dried, and toxicity towards both pest and predator requires direct contact. Actual toxicity during field applications is likely to be moderate to none.

**Additional resources:**

<https://sideeffects.koppert.com/side-effects/>

<https://www.biobestgroup.com/en/side-effect-manual>

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