

## STEWARD™: A NEW CONTROL OPTION FOR TARNISHED PLANT BUG

R. E. Seay, E. P. Castner and R. M. Edmund  
DuPont Agricultural Products  
Greenville, MS  
Lafayette, LA  
Little Rock, AR

### Abstract

Steward™ is a new insect control product developed by DuPont Agricultural Products that has proven to be highly effective on Lepidoptera pests in cotton and other crops. Steward™ has also demonstrated good activity on tarnished plant bug (*Lygus lineolaris*) while preserving a wide range of beneficial insects and spiders. Field and laboratory studies were conducted in 1997 and 1998 to evaluate Steward™ for the control of tarnished plant bug in cotton. Contact and residual activity of Steward™ on tarnished plant bugs, beneficial insects, and parasitic wasps was evaluated in the laboratory by applying Steward™ at use rates of 0.065 to 0.11 lb ai/A directly to the insects as well as by introducing the insects to treated leaf tissue. In small-plot, field studies, Steward™ was evaluated at rates of 0.065 to 0.11 lb ai/A and compared to oxamyl (Vydate® CLV), spinosad (Tracer®), acephate (Orthene®), and chlorfenapyr (Pirate®). In the laboratory studies which evaluated contact activity, Steward™ at use rates of 0.09 and 0.11 lb ai/A provided 82-86% control of tarnished plant bug adults and 33 to 43% control of plant bug nymphs. Residual studies conducted in the laboratory indicated poor control of tarnished plant bug nymphs and adults at all rates of Steward™. In the field studies, Steward™ applied at rates of 0.09-0.11 lb ai/A provided tarnished plant bug (adult) control that was equal to and often superior to the commercial standards.

### Introduction

Indoxacarb, the active ingredient in the insecticide Steward™, is a broad-spectrum lepidoptera insect control agent. The major insect pests controlled by this new product include many species of *Heliothines*, *Spodoptera*, *Plutella*, *Trichoplusia*, *Lobesia*, and *Cydia*. In addition to control of numerous other lepidoptera species, recent data also suggests control of selected sucking insect pests, including tarnished plant bugs (*Lygus lineolaris*).

The primary route of entry into the target insects is both by ingestion and contact activity. Indoxacarb has a novel mode of action and acts by inhibiting sodium ion entry into nerve cells, resulting in paralysis and death of the target pest species.

Indoxacarb has an excellent toxicological and ecotoxicological profile. This low use rate material will reduce environmental loading, particularly when compared to organophosphates and carbamates. It provides a safer alternative to pyrethroids from the standpoint of aquatic safety. The relatively low mammalian toxicity offered with this product provides improved safety to workers, as well as terrestrial mammals and birds when compared to organophosphates and carbamates.

Moreover, the novel mode of action, together with the lack of cross-resistance to existing insect control products and its safety to beneficial insects and spiders, makes indoxacarb an excellent candidate for IPM programs.

Tarnished plant bugs have become a major insect problem in much of the cotton belt resulting in an estimated crop loss of 1.6% annually in cotton. They overwinter as adults in ground trash and fall hosts. The insects complete one or more generations in spring hosts such as vetch, clover, primrose, and curly dock prior to moving into cotton. They initially infest the field margins and eventually migrate across the entire cotton field. Implementation of control measures vary depending on fruit retention, yield potential and environmental conditions. Consistent control of tarnished plant bugs has proved to be difficult due to the uneven distribution, mobility, and reinfestation potential of the pest.

Initial field and laboratory studies with Steward™ demonstrated good control of tarnished plant bug. Based on these results, additional studies were initiated in 1997 and 1998 to better quantify the activity of Steward™ on tarnished plant bugs as well as to document the impact on beneficial insects and spiders. Research efforts have included both laboratory and field trials conducted throughout Arkansas, Louisiana, and Mississippi.

### Materials and Methods

Laboratory studies were conducted on tarnished plant bugs to evaluate both contact and residual activity of Steward™. A laboratory spray chamber was used to topically treat the insects which were then moved to clean petri dishes. To measure contact activity, percent mortality was evaluated at 48 hours after application. To measure residual effects of Steward™, applications were made to cotton leaves with insects introduced to the treated plant material at 2 hours post treatment. Percent mortality was determined at 48 hours after application. For both studies, the spray chamber was calibrated to deliver a spray volume of 10 gallons per acre.

All field studies were planted to upland cotton varieties on 38-40 inch row centers. Plot sizes ranged from 2 to 4 rows by 40 to 50 feet. The tests were conducted as a randomized complete block design with 4 replications. Insecticide treatments were applied when tarnished plant bug

populations reached local threshold levels. Applications were made with CO<sub>2</sub> plot sprayers, either hand held or tractor mounted, with spray volumes that ranged from 7 to 14 gallons per acre. Plant bug sampling methods consisted of 15 to 50 sweeps per plot using a standard 15 inch sweep net or insect counts using a standard beat sheet. Counts were taken for tarnished plant bug adults, nymphs, and beneficial insects.

Laboratory studies were conducted on lepidopteran parasites to evaluate the residual activity of Steward™. A John Deere high-cycle sprayer was used to apply the insecticide treatments to cotton in small field plots. Each treatment was replicated 4 times. Ten treated leaves per replicate were collected immediately after application and placed in petri dishes. Laboratory bioassays were then conducted by introducing one insect into each petri dish. Survival was determined after 24 hours of exposure.

### **Results and Discussion**

Results from laboratory studies indicated that topical applications of Steward™ at rates of 0.09 to 0.11 lb ai/A provided 82 to 86% adult tarnished plant bug mortality at 48 hours after treatment (Table 1). In comparison, contact mortality for the commercial standard insecticides ranged from 97% for Vydate® CLV to 100% for Karate®, Provado®, Bidrin®, and Orthene®. At 48 hours, Steward™ at rates of 0.09 to 0.11 lb ai/A provided for 33 to 43% mortality of tarnished plant bug nymphs. Karate®, Provado®, Bidrin®, and Orthene® applications resulted in 95 to 100% insect mortality with Vydate® CLV resulting in a 56% reduction in the number of tarnished plant bug nymphs. Evaluations of residual efficacy indicated a reduction in tarnished plant bug control for all insecticides except Bidrin® (Table 2).

In seven field trials conducted across the Mid-South, Steward™ at 0.09 and 0.11 lb ai/A provided 60 to 86% control of adult tarnished plant bug at 3 days after treatment (Table 3). Steward™ at these rates provided superior control when compared to Vydate® CLV, Tracer®, Orthene®, and Pirate®. All products were less efficacious on tarnished plant bug nymphs as compared to adults. Steward™ at rates of 0.09 and 0.11 lb ai/A resulted in 10 to 18.3 tarnished plant bug nymphs per 100 sweeps as compared to 17, 27, 40.3, and 47.3 for Vydate® CLV, Orthene®, Tracer®, and Pirate®, respectively.

Additional field studies confirmed that Steward™ at rates 0.09-0.11 lb ai/A provided tarnished plant bug control that was equal to and often superior to commercial standard insecticides including Orthene®, Provado®, Tracer®, Karate®, and Baythroid® (Tables 4, 5, 6). Steward™ at 0.11 lb ai/A resulted in fewer tarnished plant bugs when compared to tank-mixtures of Orthene® plus Provado® as well as Bidrin® plus Provado®.

Beneficial insect data collected from 16 field trials indicate that Steward™ at rates of 0.065 - 0.11 lb ai/A has a minimal impact on beneficial insects such as *geocorids*, *orions*, *nabids*, and *chrysopids* with survival rates of 72 to 100% at 3-5 days after treatment (Table 7). *Hippodamia* had the lowest survival rate which ranged from 52 to 60%.

Additional laboratory studies which evaluated Steward™ at rates of 0.055-0.065 lb ai/A indicated a high degree of safety to two important parasitic wasps of lepidopteran insects, *Cardiochiles nigriceps* and *Microplitis croceipes* (Table 8). At 48 hours after exposure to insecticide residues, Steward™ had survival rates of 92.7 to 100% for both species of parasitic wasp. In comparison, Karate® at 0.025 lb ai/A resulted in 32.5 and 60% survival for *Microplitis croceipes* and *Cardiochiles nigriceps*, respectively.

### **Tarnished Plant Bug, *Lygus Lineolaris***

**Identification and Developmental Stages** — The adult tarnished plant bug is approximately 0.25 in (6 mm) in length, the body is relatively flat, and reddish brown in color with a conspicuous yellow-brown triangle between the wings. The head is small, with a long proboscis that is carried under the body when at rest.

The first and second instar nymphs are pale green in color, have reddish tips on their antennae and are quite mobile.

Older nymphs have five black spots on their backs - two on the first segment of the thorax, two on the next segment and the remaining spot on the center of the abdomen.

The average time to complete one generation is about 30 days depending on climatic conditions.

**Biology** — Tarnished plant bugs overwinter as adults and may be active on green weeds in the winter. In early spring, they feed on legumes and weeds. Adults migrate to young cotton as the spring weed host senesce and becomes unattractive.

**Damage Symptoms** — Tarnished plant bugs are plant sap feeders and concentrate on developing squares, growing points and young bolls, particularly in the terminal portions of the cotton plant.

Symptoms of injury include square desiccation, damaged leaf petioles, damaged branches, malformation of leaf structures and lesions on main stems.

Cotton crop losses from insects and mites is estimated to be 7.7% of which 1.6% is attributable to *Lygus* spp.

## Conclusions

Field studies indicate that Steward™ provides tarnished plant bug control that is equal to and often superior to the current standard insecticides. In the laboratory, Steward™ exhibited contact activity that was slightly less than several standard insecticides; however, this trend was not observed in the field. Based on these results, Steward™ will offer an effective alternative to control tarnished plant bugs in cotton. Steward™ was shown to have minimal impact on several species of beneficial insects and parasitic wasps. Because of its preservation of beneficial insects and wasps, Steward™ will be a valuable component of an Integrated Pest Management Program.

Steward™ represents a novel mode of action with a low potential for cross resistance to existing insect control products and will be a valuable tool in managing insecticide resistance in cotton.

## References

Burriss, E. , J. H. Pankey, B. R. Leonard, and J. B. Graves, 1997. *Tarnished Plant Bugs in Cotton*. Louisiana State University, Agricultural Center, Louisiana Agricultural Experiment Station, Research Info. Sheet 101. Cotton Insects and Mites: Characterization and Management, The Cotton Foundation. Vol. 3, pp 26-28, pp 761-761.

Harder, H. H. , S. L. Riley and S. F. McCann, 1997, DPX-MP062: *A Novel Broad-Spectrum, Environmentally Soft, Insect Control Compound*, Proceedings Beltwide Cotton Conferences, National Cotton Council, Vol 1, pp 48-50.

Head, R. B. and M. R. Williams, 1993, *Pest, Thresholds and the Cotton Plant*, Mississippi State University, Cooperative Extension Service.

Table 1. Comparison of Contact Mortality of Indoxacarb vs. Commercial Standards on Tarnished Plant Bugs. % Contact Mortality of Tarnished Plant Bugs @ 48 Hours

| Treatment    | Rate (lb ai/A) | Adults | Nymphs |
|--------------|----------------|--------|--------|
| Water        | --             | 8.5    | 12     |
| Steward™     | 0.065          | 70     | 36     |
| Steward™     | 0.09           | 82     | 33     |
| Steward™     | 0.11           | 86     | 43     |
| Vydate® C-LV | 0.25           | 97     | 56     |
| Karate®      | 0.028          | 100    | 100    |
| Provado®     | 3.75           | 100    | 98     |
| Bidrin®      | 0.5            | 100    | 98     |
| Orthene®     | 0.5            | 100    | 95     |

Insects oversprayed in petri dish, then introduced to a clean dish.

Average of two studies.

\*Data source - Dr. Glynn Tillman, USDA, Tifton, GA, 1997 Study.

Table 2. Comparison of residual mortality of Indoxacarb vs. Commercial standards on tarnished plant bugs. % Residual Mortality of Tarnished Plant Bugs @ 48 Hours.

| Treatment    | Rate (lb ai/A) | Adults | Nymphs |
|--------------|----------------|--------|--------|
| Steward™     | 0.065          | 12     | 21     |
| Steward™     | 0.09           | 8      | 20     |
| Steward™     | 0.11           | 10     | 23     |
| Vydate® C-LV | 0.25           | 70     | 87     |
| Karate®      | 0.028          | 72     | 87     |
| Provado®     | 3.75           | 17     | 30     |
| Bidrin®      | 0.5            | 100    | 100    |
| Orthene®     | 0.5            | 78     | 90     |
| Control      |                | 5      | 12     |

Insects introduced to treated plant material 2 hours post-treatment

Average of two studies

\*Data source - Dr. Glynn Tillman, USDA, Tifton, GA, 1997 Study

Table 3. Field comparisons of Indoxacarb vs. Commercial standards on tarnished plant bugs. DuPont: Mid-South Field Studies.

| Treatment   | Rate (lb ai/A) | Adults/ 100 Sweeps | Nymphs/ 100 Sweeps | % Control Adults |
|-------------|----------------|--------------------|--------------------|------------------|
| Steward™    | 0.065          | 10.1               | 19.3               | 53               |
| Steward™    | 0.09           | 8.6                | 10                 | 60               |
| Steward™    | 0.11           | 3.1                | 18.3               | 86               |
| Vydate® CLV | 0.25           | 10.3               | 17                 | 53               |
| Tracer®     | 0.067          | 17.1               | 40.3               | 21               |
| Orthene®    | 0.5            | 12.9               | 27                 | 41               |
| Pirate®     | 0.35           | 23.1               | 47.3               | 0                |
| Control     | --             | 21.7               | 39                 | 0                |

\*Adults - average of 7 studies, Nymphs - average of 3 studies AR, LA, and MS, 1998 Studies.

Table 4. Field Comparisons of Indoxacarb vs Standards: Tarnished Plant Bug. Test 1: Early July.

| Treatment                     | Rate (lb ai/A) | Tarnished Plant Bugs /100 feet |
|-------------------------------|----------------|--------------------------------|
| Check                         | --             | 38.4                           |
| Orthene® 90 S                 | 0.5            | 16.7                           |
| Orthene® 90 S + Provado® 1.6F | 0.5 + 0.375    | 16.7                           |
| Provado® 1.6F                 | 0.0375         | 13.36                          |
| Bidrin® 8 + Provado® 1.6F     | 0.25 + 0.0125  | 13.36                          |
| Steward™ 1.25 SC              | 0.11           | 13.36                          |
| Steward™ 1.25 SC              | 0.09           | 8.36                           |

\*Data Source: Dr. Charles Allen, University of Arkansas, Monticello, AR, 1998.

Table 5. Field comparisons of Indoxacarb vs. Standards: Tarnished Plant Bugs. Test 2: Mid-August.

| Treatment        | Rate (lb ai/A) | Tarnished Plant Bugs/100 feet |
|------------------|----------------|-------------------------------|
| Check            | --             | 27.73                         |
| Orthene® AG 97   | 0.5            | 11.73                         |
| Steward™ 1.25 SC | 0.11           | 9.59                          |
| Steward™ 1.25 SC | 0.09           | 7.46                          |
| Regent® 2.5      | 0.05           | 6.4                           |

\*Data Source: Dr. Charles Allen, University of Arkansas, Monticello, AR, 1998.

Table 6. Field Comparisons of Indoxacarb vs. Standards: Tarnished Plant Bug. Test 3: August.

| Treatment        | Rate<br>(lb ai/A) | Tarnished Plant<br>Bugs/100 feet |
|------------------|-------------------|----------------------------------|
| Check            | --                | 17.2                             |
| Tracer® 4 SC     | 0.067             | 15.2                             |
| Baythroid® 2 E   | 0.033             | 12                               |
| Provado® 1.6 F   | 0.047             | 7.2                              |
| Karate® 1 E      | 0.03              | 6                                |
| Legend®          | 0.047 + 0.033     | 3.2                              |
| Steward™ 1.25 SC | 0.09              | 3.2                              |
| Steward™ 1.25 SC | 0.11              | 2                                |

\*Data Source: Dr. Charles Allen, University of Arkansas, Monticello, AR, 1998.

Table 7. Field Studies (16): Impact of Indoxacarb on Beneficial Insects. % Survival.

| Treatment | Rate<br>(lb ai/A) | Geocorids | Orius | Nabids | Hippodamia | Chrysopids |
|-----------|-------------------|-----------|-------|--------|------------|------------|
| Steward™  | 0.065             | 83        | 96    | 80     | 59         | 100        |
| Steward™  | 0.09              | 79        | 72    | 84     | 52         | 75         |
| Steward™  | 0.11              | 81        | 81    | 80     | 60         | 83         |

\*Average of 16 studies, DuPont and University, 1996 - 1998. Rated at 3-5 days after treatment.

Table 8. Survival of Parasitic Wasp Exposed to Residues of Indoxacarb vs. Commercial Standards 0 Hours after Spraying Cotton Leaves in Small Field Plots. % Survival.

| Treatment | Rate<br>(lb ai/A) | <i>Cardiochiles<br/>nigriceps</i> | <i>Microplitis<br/>croceipes</i> |
|-----------|-------------------|-----------------------------------|----------------------------------|
| Steward™  | 0.055             | 94.4                              | 100                              |
| Steward™  | 0.065             | 92.7                              | 94.7                             |
| Lannate®  | 0.25              | 100                               | 100                              |
| Karate®   | 0.025             | 60                                | 32.5                             |
| Control   | --                | 100                               | 100                              |

Rated at 48 hours after exposure to residue.

\*Data Source: Dr. Glynn Tillman, USDA, Tifton, GA, 1997 Study.