# Effects of Band Width and Timing of Chlorpyrifos Granule Applications on Stem Rot Incidence and Wireworm Damage to Irrigated Peanut

S. L. Brown*, T. B. Brenneman, and R. C. Layton[1]

**ABSTRACT**

The objective of this study was to determine if band width and timing affected the insecticidal and fungitoxic activity of chlorpyrifos granules applied to irrigated peanut. At two locations and in 3 yr, chlorpyrifos granules were applied to flowering-stage or pegging-stage peanuts of the cultivar Florunner through a drop-tube or in 23-cm or 46-cm-wide bands centered over the row. At midseason, all chlorpyrifos treatments, except the widest band width applied at pegging significantly reduced the incidence of stem rot, but no differences were found at harvest. Wireworm populations were highly variable among tests but, when numbers were sufficient for evaluation, all chlorpyrifos treatments reduced wireworm populations and numbers of damaged pods. Application method and timing had little effect on the efficacy of chlorpyrifos as an insecticide. Even though all chlorpyrifos treatments reduced wireworm damage to peanut pods and at least delayed the onset of stem rot, only the drop-tube application at flowering resulted in increased yield at one location. Orthogonal contrasts of flowering-stage applications versus pegging-stage applications indicated that the flowering-stage applications resulted in higher yields and values per hectare.

Key Words: Wireworms, *Conoderus* spp., southern stem rot, chlorpyrifos, band width, *Sclerotium rolfsii*.

Thirty-eight percent of the U.S. peanut acreage (approximately 250,607 ha) is treated with chlorpyrifos (O,O-diethyl-O-[3,5,6,-trichloro-2-pyridinyl] phosphorothioate) granules and the loss of chlorpyrifos would cost peanut growers approximately $30 million annually (Witkowski *et al.*, 1994). As an insecticide, chlorpyrifos can reduce lesser cornstalk borer [*Elasmopalpus* lignosellus (Zeller)], southern corn rootworm (*Diabrotica undecimpunctata howardi* Barber), and wireworm (*Conoderus* spp.) damage and increase yield when one or more of these insects are present (Gilreath *et al.*, 1989; Mack *et al.*, 1989, 1991; Brandenburg and Herbert, 1991). In addition to its insecticidal value, chlorpyrifos has been shown to have fungitoxic properties (Csinos, 1984, 1985).

Suppression of stem rot (*Sclerotium rolfsii* Sacc.), a major disease of peanut in the Southeastern U.S., influences growers' decisions to use chlorpyrifos and may be the primary reason for its use in many cases. Although stem rot suppression with chlorpyrifos can be erratic, it is often significant, particularly when applied in combination with other fungicides such as PCNB (pentachloronitrobenzene) (Csinos, 1984; Bowen *et al.*, 1992; Brenneman *et al.*, 1994). Chapin and Thomas (1993) found the economic value of chlorpyrifos on peanut to be predominately due to stem rot suppression and to be greatly reduced where the more effective stem rot fungicide tebuconazole was used. Yield response to chlorpyrifos is highly variable depending on stem rot and insect pressure, and weather conditions which can impact the longevity of chlorpyrifos in the soil (Getsin, 1985; Mack, 1990).

The time and method of application can affect the activity of any pesticide. However, due to the insecticidal and fungitoxic value of chlorpyrifos on peanut, a specific time of application or application technique can potentially favor one role while negatively impacting the other. Csinos (1989) found that various fungicides applied at half their recommended rates in narrow bands (10 or 15 cm) centered over the row resulted in significant increases in yield and disease control over the untreated control and were not significantly different from the recommended rates applied in wider bands (30 or 41 cm). Our hypothesis was that, since stem rot infections generally occur near the crown of the peanut plant (Csinos, 1989), maximizing the concentration of chlorpyrifos in this area may increase stem rot suppression at the expense of insect control which may require a wider distribution to protect pods throughout the fruiting zone. Likewise, since stem rot is usually not active until midseason, a later application of chlorpyrifos may be more effective in reducing stem rot. Insect damage to peanut pods can occur at any time after pods begin to form. The purpose of this study was to determine if band width and timing affected the insecticidal

[1]Ext. Entomologist and Assoc. Prof., Entomology Dept., Assoc. Prof., Plant Pathology Dept., and Agric. Res. Statistician, Statistical and Computer Services, respectively, Univ. of Georgia, Tifton, GA 31793.

*Corresponding author.

and fungitoxic activity of chlorpyrifos against soil insect pests and stem rot in irrigated peanuts.

## Materials and Methods

Tests were conducted in 1992-1994 at the Southwest Georgia Experiment Station near Plains, GA and at the Coastal Plain Experiment Station (Gibbs Farm) near Tifton, GA. The soil at Plains was a Greenville sandy clay loam and at Tifton was a Tifton loamy sand. The test sites had been planted in continuous peanuts for at least 10 yr and are known to be heavily infested with *S. rolfsii*. All plots were irrigated as necessary to maintain adequate soil moisture.

A bicycle-type pushcart mounted with a granule applicator was used to apply chlorpyrifos granules (Lorsban 15G, DowElanco Corp.) to Florunner peanuts through a drop tube centered over the row or in a 23- or 46-cm wide band either at the flowering or pegging growth stage. All chlorpyrifos applications were made at the rate of 0.91 kg. ai (6.0 kg. of Lorsban 15G) per acre. Untreated peanuts were used as a control.

All tests utilized a completely randomized block design with six blocks at the Plains location and five blocks at the Tifton location. Peanuts were planted on a raised bed with two rows per bed. Plots were 3.6 m wide (four rows, spaced 0.91 m apart) and 7.6 m long. The first and second rows in each plot were used for stem rot and yield evaluations. Destructive sampling for insects and insect damage was confined to the third row of each plot.

Planting dates at Plains were 5 May 1992, 11 May 1993, and 29 April 1994. Flowering-stage applications were made 44, 41 and 34 d after planting (DAP), respectively. Pegging-stage applications were made 58, 64 and 62 DAP, respectively. At Tifton, peanuts were planted on 21 May 1992, 20 May 1993, and 11 May 1994. Flowering-stage applications were made 36, 37 and 41 DAP, respectively, while pegging-stage applications were made 71, 65 and 69 DAP.

All tests were evaluated for stem rot during mid- to late August. Stem rot incidence was determined by counting the number of 30-cm-long row segments with symptomatic plants (Rodrequez-Kabana *et al.*, 1975). Additional stem rot evaluations were made by examining inverted plants immediately after digging.

Sample dates for insects and insect damage can be classified as either early pod-set (<100 DAP), late pod-set (>100 DAP), or post digging. At Plains, insect and insect damage measurements were made at 93 and 128 DAP in 1992, 85 and 120 DAP in 1993, and 101 DAP in 1994. At Tifton, the same measurements were made at 75 and 113 DAP in 1992, 88 and 124 DAP in 1993, and 82 DAP in 1994. Post-digging evaluations of insect damage to peanut pods were made at Tifton only in 1993 and 1994.

To collect early pod-set and late pod-set insect and insect damage samples, a shovel was used to remove a 0.6-m section of row in each plot. Sample sites were arbitrarily selected but excluded areas with noticeably dead or diseased plants. The shovel blade was used to trim the row sections to a 0.6-m length. All peanut plants, including pods, in the 0.6-m section of row were removed and placed in a polyethylene bag. Within the 0.6-m sample site, soil was removed to a depth of approximately 10 cm and a width of approximately 46 cm and placed in the same bag with the plants.

Each sample, containing plants and soil, was then placed on a stack of four screens. Screens were made by attaching 1.3, 0.6, and 0.3-cm mesh hardware cloth and 2-mm mesh window screening on 0.6 $m^2$ wooden frames. All pods were removed from the plants and the plants were discarded. Pods were rinsed, examined, and classified as having either no insect damage, superficial insect damage, or one or more feeding sites that penetrated the pod. The total number of pods in each category was recorded.

Next, pressurized water (approximately 30 psi) was used to wash the soil through each successively finer mesh screen. After all soil passed through the screens, the number of lesser cornstalk borers, southern corn rootworms, and wireworms retained were counted. The 1.3 and 0.6-cm mesh screens served primarily to remove rocks and other large debris, while most insects were found on the 0.3-cm and 2-mm size screens.

Post-digging pod samples were collected by removing four or five randomly selected plants from the windrow after plants were dug and inverted and placing them in polyethylene bags. To evaluate insect damage, pods were removed, rinsed, and rated as described above. Because post-digging pod samples were collected randomly from the windrow and did not represent a known portion of the total plot, percent damage was reported rather than numbers of damaged pods per sample.

Plots were mechanically harvested and pods dried to approximately 10% (w/w) moisture prior to storage at room temperature. One 500-g sample per plot was removed and graded according to official Federal-State Inspection Service methods. Value per ton and per hectare were calculated using the ASCS loan schedule.

Data were analyzed using analysis of variance and, where appropriate, the Duncan Waller test for mean separation (SAS Institute, Inc., Cary, NC). Log transformations were performed on actual counts and arc sin square root transformations were performed on percentage data prior to analysis. Orthogonal contrasts were performed for selected groups of variables and Pearson correlation coefficients were calculated for all variables.

## Results

***Insects and Insect Damage.*** As expected with irrigated plots, very few lesser cornstalk borer larvae were collected in this study. While southern corn rootworm can be a serious pest of irrigated peanuts, particularly for clay soils such as that at Plains, very few were collected during the 3 yr of this study. Therefore, only wireworm data are reported.

The number of wireworms collected averaged over both locations was 0.05, 0.08, and 0.16 per sample in 1992, 1993, and 1994, respectively. During the 3-yr study, each sample collection averaged 0.16 and 0.04 wireworms at Tifton and Plains, respectively. The test with the highest population was at Tifton in 1994 where an average of 0.29 wireworms were collected per sample. These numbers are relatively low compared to populations in other tests where as many as four wireworms per sample have been collected (Brown, unpubl. data, 1993).

Numbers of wireworms collected during the early pod-set stage showed a significant interaction between year, location, and treatment. Soil samples collected during late pod-set were screened for insects only in 1993. Since there was no significant interaction between location and treatment, 1993 data were pooled from the two locations. The average numbers of wireworms collected per sample are shown in Table 1.

**Table 1. Average number of wireworms collected per sample during the early pod-set stage during 1992 to 1994 and the late pod-set stage in 1993.**

| Chlorpyrifos treatment | | Early pod-set | | | | | | Late pod-set |
|---|---|---|---|---|---|---|---|---|
| | | Plains | | | Tifton | | | Plains & Tifton |
| Applic. time | Band width[a] | 1992 | '93 | '94 | 1992 | '93 | '94 | 1993 |
| | | ---no.--- | | | ---no.--- | | | no. |
| Flowering | DT | 0.2 | 0 | 0 | 0 | 0.2 | 0.2 | 0.5 |
| Flowering | 23 cm | 0 | 0 | 0 | 0 | 0 | 0 | 0.2 |
| Flowering | 46 cm | 0 | 0 | 0 | 0 | 0.2 | 0.2 | 0.4 |
| Pegging | DT | 0 | 0.2 | 0 | 0.3 | 0.3 | 0 | 0.4 |
| Pegging | 23 cm | 0 | 0 | 0 | 0 | 0 | 0.7 | 0.5 |
| Pegging | 46 cm | 0 | 0 | 0 | 0 | 0 | 0.2 | 0.3 |
| Untreated | | 0.2 | 0.2 | 0 | 0 | 0 | 0.8 | 1.5 |
| LSD (0.05) | | NS[b] | NS | NS | NS | NS | 0.5 | 0.7 |

[a]DT= drop-tube centered over the row, 23 cm = 23-cm band centered over the row, 46 cm = 46-cm band centered over the row.
[b]NS = Not significant (P< 0.05).

Soil samples collected during the early pod-set stage contained significantly different numbers of wireworms in only the 1994 Tifton test. In that test, all chlorpyrifos treatments reduced wireworm populations below that found in untreated soil except the 23-cm band applied at pegging. At late pod-set, all treatments significantly reduced wireworm populations. Since wireworms were, by far, the most abundant insects, damage was presumed to be due almost entirely to wireworm feeding. On several occasions, wireworms were found inside damaged pods.

Average numbers of penetrated pods in early pod-set and late pod-set samples as well as the average percent of penetrated pods in post-digging samples are shown in Table 2. Data from early pod-set samples showed a significant interaction between year, location, and treatment (P≤0.0001). Data from late pod-set samples showed no significant treatment interactions, so data from all years and locations were pooled. Post-digging samples were collected only at Tifton in 1993 and 1994 and showed a significant interaction between year and treatment (P=0.0167).

Significant differences in the number of penetrated pods at early pod-set were found in three of the six tests. In 1992 and 1994 at Plains, all chlorpyrifos treatments had significantly fewer penetrated pods than the untreated check. In 1994 at Tifton, all chlorpyrifos treatments had fewer penetrated pods than the untreated check except for the drop-tube and 23-cm band treatments applied at pegging. For all years and locations, there was a significant correlation between number of wireworms and penetrated pods at early pod set (r=0.352, P=0.0001).

At late pod-set, all chlorpyrifos treatments had less penetrated pods than the untreated check. There was a significant correlation between number of wireworms and penetrated pods at late pod-set (r=0.356, P=0.0015).

After digging, the percentage of penetrated pods did not differ among treatments in 1993. In 1994, all chlorpyrifos treatments had fewer penetrated pods than the untreated check. For all years and both locations, there was a significant correlation between post-digging penetrated pods and number of wireworms at early pod-set (r=0.409, P≤0.0001), number of wireworms at late pod-set (r=0.375, P=0.014), damaged kernels (r=0.38, P=0.0004), and value per ton (r=-0.358, P=0.0008). At Tifton in 1994, where the greatest amount of wireworm damage occurred, the number of penetrated pods after digging, significantly correlated with yield (r=-0.309,

**Table 2. Average number of pods penetrated by wireworms per sample during the early pod-set stage and the late pod-set stage, and percent penetrated pods at post-digging, 1992-1994.**

| Chlorpyrifos treatment | | Penetrated pods | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | At early pod-set | | | | | | At late pod-set | At post-digging | |
| | | Plains | | | Tifton | | | Plains & Tifton | Tifton | |
| Application time | Band width[a] | 1992 | 1993 | 1994 | 1992 | 1993 | 1994 | 1992-1994 | 1993 | 1994 |
| | | ---no.--- | | | | | | ---no.--- | ---%--- | |
| Flowering | DT | 0.8 | 1.0 | 0 | 0 | 0.8 | 2.2 | 1.1 | 1.2 | 2.6 |
| Flowering | 23 cm | 0.6 | 0.4 | 0.2 | 0 | 0.8 | 1.7 | 1.7 | 1.1 | 1.3 |
| Flowering | 46 cm | 0.6 | 1.0 | 0 | 0 | 0.8 | 0.5 | 1.2 | 0.9 | 0.7 |
| Pegging | DT | 0.2 | 0.8 | 0 | 0.7 | 2.0 | 4.7 | 2.2 | 1.5 | 2.1 |
| Pegging | 23 cm | 0.8 | 0.8 | 0 | 0 | 1.3 | 5.2 | 1.4 | 0.8 | 2.5 |
| Pegging | 46 cm | 0 | 2.0 | 0 | 0 | 0.7 | 2.3 | 1.1 | 1.6 | 2.8 |
| Untreated | | 13.0 | 1.4 | 2.0 | 0.7 | 0.3 | 8.8 | 4.1 | 1.2 | 6.1 |
| LSD (0.05) | | 3.1 | NS[b] | 1.1 | NS | NS | 5.3 | 1.1 | NS | 2.4 |

[a]DT= drop-tube centered over the row, 23 cm = 23 cm-band centered over the row, 46 cm = 46-cm band centered over the row.
[b]NS = Not significant (P< 0.05).

P=0.046) and value per hectare (r=-0.306, P=0.048).

Average numbers of superficially damaged pods per early pod-set and late pod-set sample and the average percent superficially damaged pods in post-digging samples are shown in Table 3. There was a significant interaction between year, location, and treatment for superficial pod damage at early pod-set. Data on superficial pod damage at late pod-set was pooled across year and location, but for post-digging superficial damage there was a significant treatment x year interaction (P=0.0009).

At Plains in 1992 and 1994 all chlorpyrifos treatments had less superficial pod damage than the untreated check. In 1994, the 46-cm band treatment applied at pegging had less superficial damage than the 46-cm band treatment applied at flowering. At Tifton, no treatment differences were found in superficial pod damage at early pod-set. At late pod-set, all chlorpyrifos treatments had less superficial pod damage than the untreated check. In 1994 after digging, all chlorpyrifos treatments had a lower percentage of superficially damaged pods than the untreated check. There were no differences in the percentage of superficially damaged pods in 1993.

***Stem Rot Incidence.*** Results from midseason and post-digging stem rot ratings are shown in Table 4. Since there were no significant treatment interactions, data from all years and locations were pooled.

At midseason, all chlorpyrifos treatments significantly reduced stem rot incidence except for the 46-cm band treatment applied at pegging. However, at harvest time, none of the chlorpyrifos treatments resulted in a reduction in stem rot incidence.

Midseason incidence of stem rot was significantly correlated with stem rot incidence at harvest (r=0.583, P≤0.0001), yield (r=-0.317, P≤0.0001), grade (r= -0.364, P≤0.0001), damaged kernels (r=0.332, P≤0.0001,), value per ton (r=-0.422, P≤0.0001), and value per hectare (r= -0.379, P≤0.0001).

Stem rot incidence at harvest was significantly correlated with yield (r=-0.609, P≤0.0001), grade (r=-0.472, P≤0.0001), damaged kernels (r=0.494, P≤0.0001), value per ton (r=-0.564, P≤0.0001), and value per hectare (r= -0.657, P≤0.0001).

As with insect damage, orthogonal contrasts indicated there was significantly less stem rot (midseason and harvest) in chlorpyrifos treated plots than in untreated plots. However, there were no differences in flowering vs. pegging applications or in drop tube vs. band applications.

***Peanut Yield and Grade.*** Peanut yield and value per hectare for each treatment are shown in Table 5. Each of these variables had a significant location x treatment interaction (P = 0.02 and 0.05, respectively). No significant differences were found in peanut grade, value per ton, or damaged kernels.

At Tifton, only the drop-tube application at flowering significantly increased yields and value per hectare. Although there were treatment differences in yield and value per hectare at Plains, none of the chlorpyrifos treatments were significantly different from the untreated check. Orthogonal contrasts revealed that applications at flowering resulted in significantly greater yield (P=0.003) and value per hectare (P≤0.005) than those at pegging.

## Discussion

Results indicate that wireworm populations and numbers of wireworm-damaged pods vary by year and location. Where wireworm populations were sufficient for evaluation, chlorpyrifos significantly reduced wireworm populations in the soil as well as numbers of damaged pods.

Pearson correlation coefficients indicate that wireworm damage can have a negative impact on peanut yield, grade and value. Although wireworm damage was found in all six tests, a correlation with yield occurred only at Tifton in 1994. Peanut plots are probably able to compensate for minor pod loss with additional fruiting so

**Table 3. Average number of superficially damaged pods per sample during the early pod-set stage and the late pod-set stage, and percent superficially damaged pods at post-digging from 1992 to 1994.**

| Chlorpyrifos treatment | | Superficially damaged pods | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | At early pod-set | | | | | | At late pod-set | At post-digging | |
| | | Plains | | | Tifton | | | Plains & Tifton | Tifton | |
| Application time | Band width[a] | 1992 | 1993 | 1994 | 1992 | 1993 | 1994 | 1992-1994 | 1993 | 1994 |
| | | no. | | | | | | no. | % | |
| Flowering | DT | 1.4 | 0.2 | 0.2 | 0 | 0.7 | 4.2 | 0.9 | 1 | 3.7 |
| Flowering | 23 cm | 1.4 | 0 | 0.8 | 0.7 | 0.8 | 1.8 | 1.1 | 1.2 | 1.5 |
| Flowering | 46 cm | 0.4 | 0.2 | 1.0 | 0 | 0.5 | 2.5 | 1.0 | 1.3 | 1.3 |
| Pegging | DT | 1.0 | 0.2 | 0.2 | 0 | 1.5 | 6.5 | 0.9 | 2.2 | 3.2 |
| Pegging | 23 cm | 1.4 | 0 | 0.2 | 0 | 1.3 | 5.3 | 1.2 | 1.5 | 5.2 |
| Pegging | 46 cm | 0.6 | 0 | 0 | 0 | 0.7 | 3.3 | 1.1 | 3.2 | 2.5 |
| Untreated | | 15.2 | 0.8 | 4.0 | 0 | 0.2 | 5.2 | 2.6 | 2.3 | 13.5 |
| LSD (0.05) | | 3.9 | NS[b] | 0.9 | NS | NS | NS | 1.2 | NS | 5.1 |

[a]DT= drop-tube centered over the row, 23 cm = 23 cm-band centered over the row, 46 cm = 46-cm band centered over the row.

[b]NS = Not significant (P< 0.05).

**Table 4. Midseason and post-digging stem rot incidence ratings for three different band widths of chlorpyrifos granules applied at flowering or at pegging at Tifton and Plains from 1992 to 1994.**

| Chlorpyrifos treatment | | Stem rot (hits/100) | |
|---|---|---|---|
| Application time | Band width[a] | Midseason | Post-digging |
| | | ----no.---- | |
| Flowering | DT | 12.2 | 36.8 |
| Flowering | 23 cm | 13.7 | 36.9 |
| Flowering | 46 cm | 14.5 | 33.1 |
| Pegging | DT | 14.9 | 38.6 |
| Pegging | 23 cm | 13.6 | 37.1 |
| Pegging | 46 cm | 16.7 | 37.0 |
| Untreated | | 20.3 | 42.5 |
| LSD (0.05) | | 5.3 | NS[b] |

[a]DT= drop-tube centered over the row, 23 cm = 23-cm band centered over the row, 46 cm = 46-cm band centered over the row.
[b]NS = Not significant (P< 0.05).

**Table 5. Yield and value per hectare for peanuts grown using various chlorpyrifos treatments.**

| Chlorpyrifos treatment | | Yield | | Value | |
|---|---|---|---|---|---|
| Application time | Band width[a] | Tifton | Plains | Tifton | Plains |
| | | -- kg/ha -- | | -- $/ha -- | |
| Flowering | DT | 4175 | 4249 | 3118 | 2984 |
| Flowering | 23 cm | 3939 | 3941 | 2884 | 2757 |
| Flowering | 46 cm | 3748 | 4306 | 2697 | 3070 |
| Pegging | DT | 3807 | 3783 | 2724 | 2713 |
| Pegging | 23 cm | 4025 | 3887 | 2873 | 2787 |
| Pegging | 46 cm | 3983 | 3666 | 2907 | 2668 |
| Untreated | | 3524 | 3979 | 2453 | 2788 |
| LSD (0.05) | | 572 | 358 | 512 | 291 |

[a]DT= drop-tube centered over the row, 23 cm = 23-cm band centered over the row, 46 cm = 46-cm band centered over the row.

that final yield is not affected. Irrigated peanuts with adequate soil moisture are probably capable of compensating for more pod loss than drought-stressed peanuts. In the one test where wireworm damage did impact yield, pod damage evaluated after digging was negatively correlated with yield, but there were no correlations in earlier evaluations. These results suggests that peanuts may be compensating for early pod loss, but plants do not have sufficient time to compensate for the loss of pods late in the growing season.

Application method and timing had little effect on the efficacy of chlorpyrifos as an insecticide for the control of wireworms. Orthogonal contrasts indicated chlorpyrifos-treated peanuts had fewer penetrated pods than untreated peanuts, but no differences were observed with regard to time or method of application.

Peanut pods that are only superficially damaged by insects such as wireworms may remain intact throughout the growing season and harvest. While it is possible that superficial damage may predispose some pods to fungal decay, such damage probably has little effect on yield. However, Lynch and Wilson (1991) found that pods superficially damaged by lesser cornstalk borers had higher levels of aflatoxin produced by *Aspergillus* spp., which greatly reduces the value of peanuts.

Pods that have been penetrated by insects are subject to rapid fungal decay. Only pods that were recently penetrated are likely to be available for harvest. Therefore, yield would more likely correlate with numbers of penetrated pods than with numbers of superficially damaged pods.

With the exception of the 46-cm band applied at pegging which was not significantly different from the untreated check, all chlorpyrifos treatments were equally effective at reducing the incidence of midseason stem rot. Although other studies (e.g., Chapin and Thomas, 1993) have shown small but significant reductions of stem rot at harvest, the effects that were evident in this study at midseason were not seen by harvest. Breakdown of chlorpyrifos in the soil may have been responsible for this loss of efficacy with time (Csinos, 1985).

Results indicated that time of application and band width have little effect on the insecticidal or fungistatic activity of chlorpyrifos. Even though all chlorpyrifos treatments reduced wireworm damage to peanut pods and at least delayed the onset of stem rot, only the drop-tube application at flowering at the Tifton location resulted in increased yield. That increase was not clearly explained by reduced stem rot incidence or insect damage to pods. However, results from the 1994 test at Tifton suggest that yield response may be greater in individual fields with higher wireworm populations. Better methods of predicting the risk of wireworm damage in individual fields would reduce losses and avoid unnecessary chlorpyrifos applications.

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