NOTE

Whitefringed Beetle (Coleoptera: Curculionidae) Impact on Growth and Yield of Burley Tobacco in Virginia[1]

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Whitefringed beetles, *Naupactus* (=*Graphognathus*) spp., are pests of tobacco, *Nicotiana tabacum* L, in the southeastern United States (Manley 1997, Tobacco Sci. 41: 103-108; Tappan et al. 1985, Tobacco Sci. 29: 6-7). In 1988 and 1999, whitefringed beetle grubs caused severe damage resulting in stand reductions of >50% in some burley tobacco fields in extreme southwest Virginia. Three species of *Naupactus* have invaded the United States from South America, and two of these are pests of tobacco in Virginia (Lanteri and Marvaldi, 1995, Coleopt. Bull. 49: 206-228; Warner 1975, U.S. Dep. Agric. Bur. Entomol. Plant Quar. E-464). *Naupactus leucoloma* occurs on burley tobacco in southwestern Virginia, and *N. leucoloma* and *N. peregrinus* are pests of flue-cured tobacco in south-central Virginia (Warner 1975).

Whitefringed beetles occur sporadically throughout the southeastern U.S. feeding on many species of field, forage, vegetable, and ornamental plants (Young et al. 1950, U.S. Dep. Agric. Circ. 850; Warner 1975). The soil-inhabiting grubs feed on the cortical tissue of roots, often causing severe damage that kills or stunts affected plants. The adults are flightless females that feed on the leaf margins of their hosts rarely causing economic injury (Young et al. 1950). Whitefringed beetles overwinter in the soil as partially grown larvae, feed voraciously on roots in spring, and pupate in early summer.

Whitefringed beetle grubs are most damaging during the first 4 to 6 wk after transplanting. Currently, no insecticides are registered for their control on tobacco, but soil, transplant water or transplant drenches may prevent serious injury. Manley (1997) and Tappan et al. (1985) obtained moderate control of whitefringed beetles with soil applications of chlorpyrifos (Lorsban®). This study was conducted to evaluate various insecticides for managing whitefringed beetle grubs on burley tobacco and to assess the impact of the grubs on plant growth, uniformity, and green biomass yield.

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This study was conducted on a farm near Jonesville, Lee Co., VA in 1999. The test site had been planted in burley tobacco in midMay. By early June, >50% of the plants in the field were wilting, yellowing, stunted, or dead. The affected plants had extensive damage to the cortical tissue of the taproots. The injury was so severe that it killed some of the plants. Almost every plant checked had medium-sized, white, legless grubs feeding on their roots and in the soil around the roots. The grubs were identified as *Naupactus* (=*Graphognathus*) spp. (Anderson and Anderson 1973, U.S. Dep. Agric. Coop. Econ. Inst. Rep. 23:797-800). Adult beetles collected from this field and at a nearby home on 13 August were identified as *N. leucoloma* (Lanteri and Marvaldi 1995; Warner 1975). Voucher specimens are stored at the Entomology Museum, Department of Entomology, VA Tech, Blacksburg, VA. Plant survival and uniformity was so poor that the field was disked for replanting. The field contained a sandy-loam soil and had been planted in a mixture of white clover, *Trifolium repens* L., and tall fescue, *Festuca arundinacea* Schreb, for at least 3 yr before the study.

The experiment was arranged in a randomized complete block design with nine treatments and four replications (Table 1). Plots were 2.2 by 16 m (2 rows by 35 plants) without guard rows. Blocks were separated by 1.7 m vacant alleys. On 22 June, 1 d before transplanting, the two chlorpyrifos (Lorsban® 4E, DowAgrosciences, INpolis, IN) broadcast treatments were applied with a CO_2-pressurized backpack sprayer that delivered 327 L/ha through 8004 flat fan tips at 207 kPa pressure. The

Table 1. Influence of treatments with various insecticides applied as soil, transplant drench, and transplant water treatments on the numbers of plants with symptoms of WFB damage, the percentages of dead or missing plants, and plant growth ratings on burley tobacco, Lee Co., VA, 1999

Treatment	Rate kg AI/ha	Application method*	Plants with symptoms of WFB damage (%)**,† 26 July	Plants dead or missing (%)** 26 July	Relative growth rating (0-10)**,† 13 August
Imidacloprid 2F	0.15	TD	27cd	4cd	8.0ab
Imidacloprid 2F	0.29	TD	15d	3d	8.5a
Imidacloprid 2F	0.15	TPW	40bc	10bcd	6.5bc
Imidacloprid 2F	0.29	TPW	12d	1d	8.5a
Thiamethoxam 2F	0.13	TD	28cd	4cd	8.0ab
Acephate 97PE	1.68	TPW	71a	17b	3.0d
Chlorpyrifos 4E	2.24	PPI	52b	13bc	5.8c
Chlorpyrifos 4E	4.48	PPI	41bc	8bc	6.8bc
Untreated check			79a	35a	2.3d

* TD = transplant drench, application on 22 June; TPW = transplant water application on 23 June; PPI = Preplant broadcast and incorporated on 22 June.

** Means within a column not followed by the same letter(s) are significantly different as indicated by Student-Neuman-Kuels multiple range test ($P = 0.05$).

† Relative growth was rated on a scale of 0 to 10 where highest values are best on 13 August, 7 wk after transplanting.

treatments were incorporated with a rotary tiller. On 22 June, tray drench (TD) applications of imidacloprid (Admire® 2F, Bayer AG, Agricultural Division, KS City, MO) and thiamethoxam (Platinum® 2SC, Syngenta Corp., Research Triangle Park, NC) were applied to greenhouse transplants in 288-plant trays. Treatments were applied with a CO_2-pressurized backpack sprayer that delivered 400 mL of water per tray through 8003LP tips at 207 kPa pressure. To enhance imidacloprid uptake by the roots, additional water was applied to rinse the residues off the leaves and into the media. 'Tennessee 90' burley tobacco was transplanted into the experimental plots on 23 June, and the imidacloprid and acephate (Orthene® 97PE, Valent USA Corp. Walnut Creek, CA) transplant water (TPW) treatments were applied at 118 mL of solution per plant (1730 L/ha). Normal production practices were followed for fertilization, weed and disease control, and topping. No soil-borne diseases were found in the field and populations of insect pests feeding on tobacco foliage were very low.

Plant stands were counted, and growth ratings were made on 26 July and 13 August, 33 and 51 d respectively after transplanting. On each date, several plants were dug and the roots and the adjacent soil were examined for whitefringed beetle grubs. On 26 July, the total number of plants and the numbers of stunted (< one-half of normal height), missing, and dead plants were counted in both rows of each plot. In addition, plant growth was rated on a scale of 0-10, where 0 = all plants dead, 5 = fair growth and uniformity; and 10 = excellent growth and uniformity. On 20 September, 20 plants in each plot (10 consecutive plants in each row) were stalk cut and weighed. Very small, dead, and missing plants were not sampled. The lengths and widths of the harvested sections of each row were measured to determine the harvested area for each plot. The areas and plant weights were then used to estimate green biomass yields in kg/ha. Immediately after harvest, the root systems of five of the 10 harvested plants in each row were selected at random and dug. Soil and other debris were removed, and the roots were weighed. Grub feeding injury to each root system was rated on a scale of 0 to10, where 0 = roots completely destroyed, 5 = medium sized roots with moderate damage, and 10 = large roots with no injury. Data were analyzed by analysis of variance, and significantly different means were separated by Student-Newman-Kuels (P = 0.05) test (SAS Institute 1989, SAS/STAT Users Guide, Cary, NC). Before analysis, proportions for total damaged and total dead and missing plants were determined for each plot, and Barrett's test for normality was performed on the data. Because distributions were not normal, the proportion (pr) data were transformed to arsine $\sqrt{pr}$ before analysis. Proportion data were converted to the actual percentages (% = pr × 100) after analysis.

Whitefringed beetle grubs seriously impacted tobacco in the untreated check (Tables 1, 2). On 26 July, 79% of the plants in the untreated check exhibited symptoms of feeding injury including reduced growth, stunting, dead, and missing plants compared with 12% and 15% of the plants with symptoms in the most effective imidacloprid treatments (Table 1). Thirty-five percent of the plants in the untreated check were either dead or missing compared with only 2 to 4% for thiamethoxam and the most effective imidacloprid treatments and 8% for the highest rate of chlorpyrifos (Table 1). On 26 July, the average vigor rating in the untreated check was 2.3 on a scale of 0-10 compared with ratings of ≥8.0 for tobacco treated with thiamethoxam and the most effective imidacloprid treatments (Table 1). The green biomass weights of 20 plants in the untreated check averaged 6.4 ± 1.4 kg/20 plants compared with 12.7 ± 0.8-13.8 ± 1.4 kg/20 plants for the most effective treatments (Table 2). When

Table 2. Influence of various insecticides applied as soil, transplant drench, and transplant water treatments for whitefringed beetle control on the root damage rating, root weight, total green weight and green biomass yield of burley tobacco, Lee Co., VA, September 20, 1999

Treatment	Rate kg AI/ha	Application method*	Root damage rating (0-10)**	Root weight (g/10 plants)**	Weight (kg leaf & stalk/20 plants)**	Yield green leaf & stalk biomass (kg/ha)**
Imidacloprid 2F	0.15	TD	6.5abc	913a	12.3a	11,243abc
Imidacloprid 2F	0.29	TD	6.9abc	967a	12.8a	12,430a
Imidacloprid 2F	0.15	TPW	5.5cd	790ab	10.4ab	8,792c
Imidacloprid 2F	0.29	TPW	7.4a	1,085a	12.7a	11,405abc
Thiamethoxam 2F	0.13	TD	7.2ab	953a	13.8a	12,171ab
Acephate 97PE	1.68	TPW	3.7e	481c	6.2c	4,389e
Chlorpyrifos 4E	2.24	PPI	5.7bcd	572bc	8.5bc	6,559d
Chlorpyrifos 4E	4.48	PPI	6.6abc	854ab	11.7a	9,404bc
Untreated check			4.3de	481c	6.4c	3,263e

* TD = transplant drench; TPW = transplant water; PPI = Preplant incorporated.

** Means within a column not followed by the same letter(s) are significantly different ($P = 0.05$) as indicated by Student-Neuman-Keuls multiple range test.

adjusted for mortality and extremely small plants, green biomass yields of the check and the acephate treatments were >70% lower than the highest yielding treatments (Table 2). Root weight and root damage ratings followed similar trends (Table 2).

Imidacloprid and thiamethoxam applied as TD treatments and the highest rate of imidacloprid applied in the TPW supported the greatest improvements in plant growth rating, root damage rating, root + stalk weight, and green biomass yield (Tables 1, 2). Tobacco treated with the lowest rate of imidacloprid in the TPW and the chloropyrifos broadcast treatments generally had lower root ratings, and more damaged, dead, and missing plants than the best treatments, but they improved growth and root damage ratings compared with the acephate TPW treatment and the untreated check (Tables 1, 2). The acephate TPW treatment provided no protection against the grubs as biomass yield, root ratings, and most other variables were similar to the untreated check (Tables 1, 2).

Earlier studies (Manley 1997, Tappan et al. 1985) showed that chlorpyrifos provided moderate control of whitefringed beetle grubs on tobacco. Manley (1997) found that chlorpyrifos was more effective than imidacloprid applied as soil incorporated and TPW treatments, but he did not evaluate the imidacloprid TD treatments that were so effective in the current study. Manley (1997) obtained moderate control of the grubs with aldicarb and found that acephate was ineffective as soil and TPW treatments.

The neonicotinoids, imidacloprid and thiamethoxam, act as feeding inhibitors that may reduce early feeding damage caused by grubs that would normally feed on the roots of newly transplanted tobacco. The high rates of imidacloprid may cause some early-season phytotoxicity in the form of a mottled necrosis of leaves, but yield is usually not affected (Sorenson et al. 1999, Tobacco. Sci. 43: 7-14).

This study shows that high populations of whitefringed beetle grubs severely impact the growth and yield of burley tobacco. Tobacco, not protected with insecticides, had severe root injury, irregular stands, and much lower green biomass yields than that protected with TD and TPW applications of imidacloprid and TD applications of thiamethoxam. Chlorpyrifos also reduced whitefringed beetle injury, but yields were lower than for most imidacloprid and thiamethoxam treatments. The lowest rate of imidacloprid applied as a TD treatment is the most practical chemical treatment of managing whitefringed beetle grubs on burley tobacco. Crop rotation with unfavorable hosts for the whitefringed beetle may also be a good option for managing the grubs on tobacco. A simple way of scouting fields for the grubs before transplanting needs to be developed because the distribution of whitefringed beetles is sporadic

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