DEVELOPMENT OF SAMPLING METHODS FOR THE SLASH PINE FLOWER THRIPS *Gnophothrips fuscus* (Morgan), (THYSANOPTERA: PHLAEOTHRIPIDAE)

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Abstract

Slash pine flower thrips typically destroy about 24% of the flowers (cones) present in slash pine seed orchards. The seasonal distribution and abundance of slash pine flower thrips are being investigated and methods for sampling field populations of the insect are being evaluated for potential use in integrated pest management strategies. The efficacies of several sampling methods, including Berlese funnel extractions of host plant materials, suction apparatus, scouting, flight traps, and soil emergence samplers are reported.

Introduction

There are 5.18 million hectares (12.8 milllion acres) of slash pine, *Pinus elliottii* Engem. var. *elliottii*, in the southern United States (Sheffield et al. 1983). Genetically improved seeds for regeneration and reforestation of this species are produced largely in more than 75 southern pine seed orchards encompassing about 1,214 hectares (3,000 acres) (Department of Agriculture 1982). Through intensive management, these orchards are expected to yield over 50 pounds of seeds per acre per year (van Buijtenen & Hanover 1986). In the absence of pest management, however, total losses of slash pine cone crops average about 55% (Fatzinger et al. 1980).

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The slash pine flower thrips (SPFT), *Gnophothrips fuscus* (Morgan), (Thysanoptera: Phlaeothripidae), is a major pest of slash pine in southern pine seed orchards. The insect has been reported to damage pine in eastern Canada (MacNay 1957), Rhode Island and New York (nursery stock of Austrian pine, *P. nigra* Arnold) (Crawford 1938), and Florida and has been collected in Massachusetts and Virginia (O'Neill 1965). Thrips-like damage has been observed on loblolly pine, *P. taeda* L., in Louisiana (Goyer & Nachod 1976) and on sand pine, *P. clausa* (Chapm. ex Engelm.) Vasey ex Sarg, in Florida.

Life History and Biology of SPFT

Ranasinghe (1981) estimated that in north Florida the SPFT has three overlapping generations a year with an average generation time of 46 days at 22°C. Ranasinghe & Wilkinson (1988) found all stages of the insect on young slash pine seedlings during the spring and summer; insect numbers decreased during the fall. They found macropterous adults in the crowns of mature pines during warm weather.

Damage Caused by SPFT

Damage caused by the SPFT is not readily observed in the field because it occurs in the upper crown during the early stages of flower development (DeBarr 1969). Infestations appear to be more prevalent on young female strobili (flowers) of open-grown trees than on those in forest stands (Ebel 1963). Differences in susceptibility to attack between clones of seed orchard trees have been observed (DeBarr et al. 1972).

SPFT feed externally on flowers for a period of about 1 month when the flowers are succulent (bud stage until pollination) (Ebel 1965). Little damage occurs after pollination because the flowers quickly become leathery enough to resist additional feeding (Merkel & Ebel 1961, DeBarr 1969, Ebel et al. 1975). Feeding sites are marked with

small beads (exudates) of oleoresin (Ebel 1961, 1965) (Fig. 1). Severe feeding activity results in the destruction of scales and bracts (Ebel 1961). When feeding is severe, the flowers are killed, dry rapidly, and fall from the trees (DeBarr 1969). Feeding activity that does not kill flowers does kill scales, causing cone distortion due to asymmetrical growth; seed yields are only about one-third those of healthy cones (DeBarr & Williams 1971).

Figure 1. Adult slash pine flower thrips on female strobilus (flower) of slash pine. Small beads of oleoresin mark feeding sites.

SPFT damage an average of 24% (range 2-46%) of the flowers initially present in slash pine seed orchards (Fatzinger et al. 1980). The maximum SPFT damage we have observed was 90% of the flowers initiated during 1988 in an area of a slash pine orchard in northwest Florida that was not treated with insecticide.

Control of SPFT

Two insecticides (Cythion and acephate) are currently registered for control of SPFT. Since SPFT damage levels cannot be predicted, an insecticide is routinely applied twice during the early stages of flower development to reduce SPFT damage. Applications are timed by repeatedly observing development of female strobili: the first application is made when flowers are in the twig-bud stage and the second application is made about 2 weeks prior to maximum flower receptivity to pollen.

Current Studies

The objectives of studies we have underway are:

1) to evaluate the use of estimated SPFT populations to predict subsequent damage in slash pine seed orchards;

2) to determine the seasonal distributions and abundances of SPFT in mature and young pines;

3) to distinguish similar damage symptoms caused by other factors;

4) to simplify techniques for identifying the insect;

5) to develop degree-day models for timing of insecticide applications.

Methods for sampling field populations of SPFT were needed to achieve these objectives. We began evaluating several methods for collecting SPFT that are flying, on branch tips of slash pine, and in soil samples under infested trees. Techniques evaluated included Berlese funnels, a suction apparatus, scouting, beating branch tips, flight traps, and soil emergence samplers.

Berlese Funnels for Extraction of SPFT from Branch Tips and Soil Samples

Commercially available Berlese funnels were modified to hold 10 slash pine branch tips (about 25 cm long). A sheet metal cylinder (76 cm long) was used to extend the distance from the funnel to the light source (70 watt incandescent lamp). Preliminary studies, conducted during 1987 and 1988, indicated that the majority of thrips, including *Frankliniella bispinosa* (Morgan), *F. tritici* (Fitch), *Leptothrips pini* (Watson), *Oxythrips pini* (Watson), *O. pallidiventris* Hood, and SPFT were extricated from branch tips within 2 weeks (Fig. 2). During this period, we recovered up to 26 thrips per sample of 10 branch tips. Inspections of the surface soil and litter for presence of SPFT will begin this year. The seasonal distribution and abundance of SPFT are being investigated by estimating the population densities of the insect at 2-week intervals for 2 years. Population densities are estimated by counting SPFT present on 10 branch tips collected from the upper crowns of 10 mature pines, on 10 tips collected from the entire crown of 10 young pines (less than 1.8 m tall), and in 10 soil samples collected beneath the crown of infested trees.

Scouting for SPFT on Young and Mature Pines

SPFT were counted visually on intact branch tips of young and mature pines throughout 1988 using magnifying lenses and the unaided eye. Once SPFT were observed on a branch, it was collected and placed in a Berlese funnel for extraction. The results varied widely with weather conditions and with differences in observers' abilities to locate SPFT on host plant material. SPFT often crawl under bark scales, inside needle fascicles, and into bud scales during cold or rainy weather and are difficult to locate. The scouting method appears to be suitable for determining the presence or absence of SPFT in various habitats, but it is unsuitable for quantitative measures of the insect's population.

Beating Branches

Thrips were dislodged from host plants by striking branches with a stick while the branches were held over the inner surface of a white dissection tray. The majority of thrips collected were *L. pini*; only a few SPFT were dislodged from the branches.

Flight Traps

Flight traps described by Ranasinghe (1981) and Ranasinghe & Wilkinson (1988) were tested during the summer and winter of 1988 and spring of 1989 at four heights in the crowns of orchard trees (Fig. 4). Each trap consisted of four white plastic discs (15-cm-diam, coffee can lids) suspended on a piece of string at intervals of about 10 ft. Each disc was sprayed on one side with Tanglefoot (Tanglefoot Co., Grand Rapids, Mich.). Sixteen traps were deployed by tying one end of the trap string to the center of a second string attached between the tops of two adjacent trees; the other end of the trap string was fastened to a stake in the ground. Captures of macropterous adults averaged less than one per trap. Total SPFT captured by the 64 traps ranged from 2 to 39.

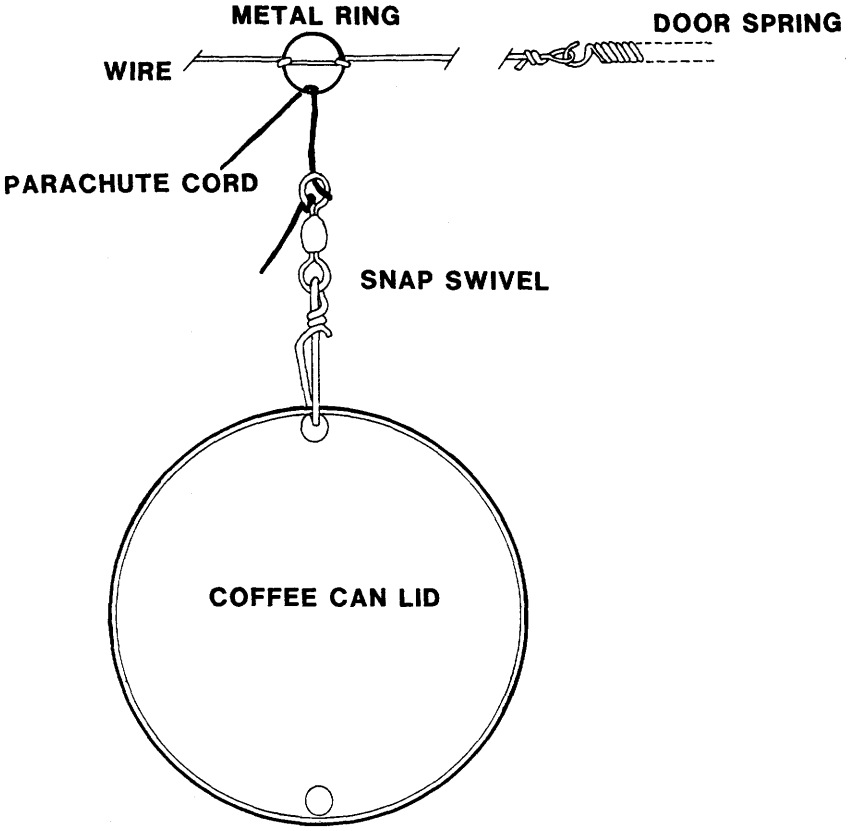

Figure 4. Components of flight trap used to collect winged adults of slash pine flower thrips.

Soil Emergence Samplers

It is currently unknown whether SPFT spend part of their life cycle in the soil or litter. Ranasinghe (1981), however, did not recover SPFT from the top layers (5.0 to 7.5 cm) of soil beneath three mature slash pines. In addition to Berlese funnel extractions of soil samples, we began using soil emergence traps for SPFT during February, 1989 (Fig. 5). The emergence traps were constructed by gluing the large end of a plastic funnel (10 cm diam) over a 9-cm-diameter hole cut in the bottom center of a plastic bucket (20 cm in height, 28 cm diameter at top, 23 cm diameter at bottom). The small end of the funnel (1.5 cm diam) was glued through a 1.5-cm-diameter hole cut in the lid of an inverted vial (140 ml) at the top of the trap. The traps are placed with their open ends on the ground beneath infested trees to collect insects emerging from the soil. The traps have been operated for only 2 weeks thus far, and no SPFT have been observed among the insects captured.

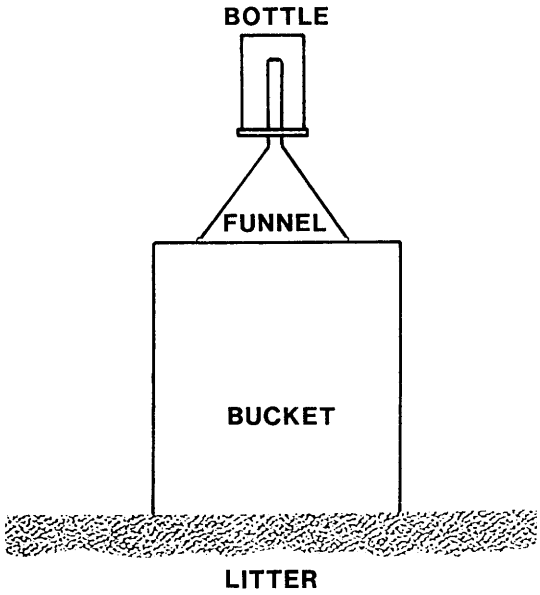

Figure 5. Soil emergence traps for collecting thrips and other insects.

Degree-Day Model

Our other sampling effort is concerned with the development and evaluation of a degree-day model for the timing of insecticide applications for control of SPFT. Three trees of each of four clones of slash pine known to be highly susceptible to SPFT attacks are being observed from late-November through early-March to determine the onset and end of SPFT feeding activity. These data will be used in conjunction with on-site temperature records to develop and evaluate a degree-day model for predicting SPFT feeding periods on female strobili in slash pine seed orchards.

Clarification of SPFT Damage Symptoms on Host Plant Materials

Several other insects and certain abiotic factors are capable of causing damage symptoms similar to that caused by SPFT. In an effort to further elucidate the damage symptoms caused by SPFT on female flowers and other host plant materials, SPFT are being caged on individual clusters of female flowers in a slash pine seed orchard and on potted seedlings in a greenhouse. Cages containing up to six SPFT and other cages without thrips were installed on the orchard trees in January, 1989 during the twig-bud stage of female flower development. The flowers will be photographed weekly during the period of SPFT feeding activity and monthly thereafter until the cones mature in September, 1990. The photographs will be used to trace the development of damage symptoms caused by SPFT feeding activity and to further elucidate the effects of nonlethal feeding activity on seed production.

Acknowledgment

The authors thank Harold Denmark, Bureau of Entomology, Div. of Plant Industry, Fla. Dept. of Agriculture and Consumer Services, Gainesville, Florida, for identifications of SPFT, and Edward P. Merkel for valuable suggestions and technical assistance during the course of this study. This research is funded in part by the Integrated Forest Pest Management Cooperative, USDA Forest Service, and the Univ. of Fla.

References Cited

Crawford, J. C. 1938. Some new or little known Thysanoptera. Entomol. Soc. Wash. Proc. 40: 35-43.

DeBarr, G. L. 1969. The damage potential of a flower thrips in slash pine seed orchards. J. For. 68: 326-327.

DeBarr, G. L., E. P. Merkel, C. H. O'Gwynn & M. H. Zoerb, Jr. 1972. Differences in insect infestation in slash pine seed orchards due to phorate treatment and clonal variation. For. Sci. 18: 56-64.

DeBarr, G. L. & J. A. Williams. 1971. Nonlethal thrips damage to slash pine flowers reduces seed yields. Southeast. For. Exp. Stn., USDA Forest Service Res. Note SE-160. 4 pp.

Department of Agriculture. 1982. 1981 Directory of forest tree seed orchards in the United States. USDA For. Serv. FS-278, U. S. Gov. Printing Office. 48 pp.

Ebel, B. H. 1961. Thrips injure slash pine female flowers. J. For. 59: 374-375.

1963. Insects affecting seed production of slash and longleaf pines -- their identification and biological annotation. USDA For. Serv., Southeast. For. Exp. Stn., Res. Pap. SE-6. 24 pp.

1965. Control of thrips on slash pine female strobili. J. For. 63: 287-288.

Ebel, B. H., T. H. Flavell, L. E. Drake, H. O. Yates, III & G. L. DeBarr. 1975. Seed and cone insects of southern pines. USDA For. Serv., Gen. Tech. Rep. SE-898. Southeast. For. Exp. Stn., Asheville, N.C. and Southeast Area State and Priv. For., Atlanta, Ga. 40 pp.

Fatzinger, C. W., G. D. Hertel, E. P. Merkel, W. D. Pepper & R. S. Cameron. 1980. Identification and sequential occurrence of mortality factors affecting seed yields of southern pine seed orchards. USDA For. Serv. Res. Pap. SE-216. Southeast. For. Exp. Stn., Asheville, N.C. 43 pp.

Goyer, R. A. & L. H. Nachod. 1976. Loblolly pine conelet, cone, and seed losses to insects and other factors in a Louisiana seed orchard. For. Sci. 22: 286-391.

MacNay, C. C. 1957. Forest and shade tree insects. Can. Insect Pest Rev. 35: 133-140.

Merkel, E. P. & B. H. Ebel. 1961. Cone and seed insects and their control. Sixth Southern Conf. on Forest Tree Improvement Proc. 1961: 137-141.

O'Neill, K. 1965. The correct names of two phlaeothripids associated with pine (Thysanoptera). Proc. Entomol. Soc. Wash. 67: 58-59.

Ranasinghe, M. A. S. K. 1981. Bionomics of slash pine flower thrips, *Gnophothrips fuscus* (Morgan), in pine seed orchards of Florida. Ph.D. dissertation, University of Florida, Gainesville, Fla. 120 pp.

Ranasinghe, M. A. S. K. & R. C. Wilkinson. 1988. Seasonal occurrence of *Gnophothrips fuscus* (Thysanoptera:Phlaeothripidae) on slash pine in Florida. Florida Entomol. 71: 384-387.

Sheffield, R. M., H. A. Knight & J. P. McClure. 1983. The slash pine resource. *In* E. L. Stone [ed.], Proceedings of symposium on the managed slash pine ecosystem, 4-23. School of For. Res. and Cons., Univ. of Florida, Gainesville.

van Buijtenen, J. T. & J. W. Hanover. 1986. Designing for yield. J. For. 84: 28-31.