Table 5. Summary of economically important thrips collected from ornamentals in Charlotte and Lee Counties, 1986-90.

| Growing season (Aug.-July) | Number of collections | Number of hosts | *Frankliniella bispinosa* | *F. fusca* | *F. occidentalis* | *Other* |
|---|---|---|---|---|---|---|
| 1986-87 | 16 | 8 | 112[z] (81.2)[y] | 1 (0.7) | 0 (0) | 25 (18.1) |
| 1987-88 | 1 | 1 | 1 (9.1) | 0 (0) | 0 (0) | 10 (90.9) |
| 1988-89 | 3 | 1 | 41 (93.2) | 0 (0) | 0 (0) | 3 (6.8) |
| 1989-90 | 12 | 6 | 228 (80.6) | 0 (0) | 30 (10.6) | 25 (8.8) |

[z]Number collected
[y]% of total for the season

Other notable collections from ornamentals include *Echinothrips americanus* which was an occasional pest in greenhouses. *Hercinothrips femoralis* was collected from dooryard *Crinum* lilies which annually suffered significant foliage damage caused by high numbers of these thrips.

Collections from weeds showed the same pattern as cultivated crops, with *F. bispinosa* the most common thrips present. Unfortunately, to save time in processing large samples, *F. bispinosa* was not separated from *F. cephalica* in collections from *Bidens pilosa* made on 5 July 1989 and in some April and May collections of that year. However, it was observed that WFT were found in weeds at the same time that they were present in nearby crops.

These observations show WFT to be present in readily detectable numbers in Palm Beach County, and sporadically present in other south Florida growing areas. This survey was beneficial in that WFT was found in southwest Florida before overwhelming numbers had developed; thus, growers can anticipate well founded information for their crop management plans regarding thrips and the Tomato Spotted Wilt Virus disease. The survey also demonstrated that during Apr. and May 1990 WFT had effectively displaced *F. bispinosa* as the dominant flower thrips in some east coast areas. Furthermore, important relationships were observed regarding movement of plant pests with plant material. Finally, TSWV was observed in a situation that suggested *F. fusca* was the more important of the 2 vectors present.

In addition to collecting directly from host material, the survey work was recently expanded to include water pan trapping in an effort to eliminate sample bias and to provide a more continuous record.

### Literature Cited


1. Denmark, H. A. 1986. The western flower thrips, *Frankliniella occidentalis* (Pergande). Florida Entomological Soc. Newsletter. December, 1986.
2. Funderburk, J. E. and V. E. Salguero, 1989. Biology and mangement of thrips and tomato spotted wilt virus. Proc. Florida Tomato Inst. Vegetable Crops. Special Series SS-VEC-901, 34-41.
3. McRitchie, J. J. 1986. Tomato spotted wilt. Florida Depart. of Agr. and Consumer Services, Plant Pathology Cir. No. 287, 2 pp.
4. Quaintance, A. L. 1898. The Strawberry Thrips and the Onion Thrips. Florida Agr. Expt. Sta. Bul. 46, 75-114.
5. Sakimura, K. 1963. *Frankliniella fusca*, an additional vector for the tomato spotted wilt virus, with notes on *Thrips tabaci*, another vector. Phytopathology, 53(4):412-415.
6. Schuster, D. J. and J. F. Price. 1987. New pests and possible new insecticides for use on tomatoes. Proc. Florida Tomato Inst. pp. 34-42.
7. Stannard, L. J. 1968. The Thrips, or Thysanoptera of Illinois. Bul. Illinois Natural History Survey. 29(4):215-552.
8. Watson, J. R. 1912. Tomato insects, root knot and "white mold". Florida Agr. Expt. Sta. Bul. 112:21-39.
9. Watson, J. R. 1922. The flower thrips. Florida Agr. Expt. Sta. Bul. 162:27-49.


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# PEST DAMAGE TO MICRO-IRRIGATION TUBING: CAUSES AND PREVENTION

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*Abstract.* **Chewing activity by insects and mammals has been reported as a major cause of leaks in micro-irrigation tubing. The present study was undertaken to determine both the source of leaks occurring on a drip irrigation system in a tomato (*Lycopersicum esculentum* Mill.) field and the effect of tube thickness on the frequency of leak occurrence. For the latter objective, three thicknesses of tubing were used, 4, 8 and 15 mil. Forty seven leaks were sustained during the course of the study (2 months), with 45 of the leaks being attributed to rats and mice. Over half the damage occurred on 4 mil tubing, whereas 15 mil tubing sustained only 11% of the damage. Information is provided to aid in identification of the type of pest causing damage, and possible control practices are suggested.**

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Micro-irrigation systems can deliver water and nutrients in precise amounts at controlled frequencies directly to the plant's root zone. Realization of these advantages depends on uniformity of application, which can be compromised by emitter plugging (6), or leaks due to damaged irrigation tubing. Damage may be mechanical in origin (often occurring during the installation process) or it may be caused by a variety of insects or mammals including crickets (Gryllidae), mole crickets (Gryllotalpidae), wireworms (Elateridae), earwigs (Dermaptera), black beetles and white grubs (Scarabaeidae), certain caterpillars (Noctuidae), millipedes, field mice, and rabbits (R. M. Bull, Rhône-Poulenc Rural, P. O. Box 335, Hamilton Central Australia 4007, unpublished data). Various ant species (Formicidae) (2), and a variety of mammals including coyotes (J. Viarengo, T-Systems Int. Inc., personal communication), have also been cited.

During a tomato drip irrigation field study conducted on 2 acres at the Southwest Florida Research and Education Center (SWFREC) in Immokalee during the fall of 1989, 64 leaks were detected in the plastic tubing (drip tape) over the course of the season. A number of these leaks consisted of one or more V-shaped cuts on the edge of the tape which are initially interpreted to be caused by the scissor-like action of the mandibles of either crickets or white grubs. A field experiment was conducted during the spring of 1990 to determine the effect of tube thickness on the occurrence of these types of leaks.

## Materials and Methods

A randomized complete block design was used with 3 treatments and 18 replications. The treatments were 4, 8, and 15 mil drip tape ('Turbo Tape, T-Systems). Each plot was 30 ft long, the whole experiment consisting of six, 270 ft beds. Tomato seedlings (cultivar Sunny) were transplanted into the beds on 24 Jan. Field layout and irrigation system management were given by Pitts et al. (7).

Each day during an irrigation cycle the drip tubing on the 6 beds was checked for leaks by walking the beds while listening for streams of water striking the polyethylene mulch. Leaks were tagged, repaired, and the damaged sections removed for examination under a stereoscopic dissecting microscope.

A chi-square test (8) was used to test the significance of differences between observed and expected frequencies with which damage occurred in the three thicknesses of tubing tested over all replications and dates.

## Results

Leaks began occurring 2 weeks after transplanting. Forty-seven leaks had been observed by the time the experiment was concluded on 4 May, with 21 occurring between 29 Mar. and 10 Apr., an average of 2 leaks per day. Because the leaks appeared to be caused by rodents rather than insects, we began trapping rodents on 11 Apr., and put out a rodenticide (brodifacoum) on 26 Apr. Subsequently, we observed a decrease in the rate of new leaks to approximately 1 per day. The overall rate for leaks for the 2 month period from 2 February to 4 May approached 1 leak per day per 2000 feet of tape.

Live traps were set near damaged sections of tubing in or on the polyethylene mulch and 4 species of rodent (8 individuals) were captured: the house mouse *Mus musculus* (2), the cotton mouse *Peromyscus gossypinus* (1), the rice rat *Oryzomys palustris* (4), and the hispid cotton rat, *Sigmodon hispidus* (1). These animals were segregated in individual cages where they were denied access to water except for 3 sealed, water-filled pieces of irrigation tubing, one of each thickness. The house mouse failed to damage tubing, the cotton mouse and cotton rat damaged only the 4 mil tubing, while the rice rats damaged all 3 tubing thicknesses. The experiment was repeated except that water was also made available in a dish. Similar results were obtained in the rat cages, but under these conditions the mice did not cause damage.

By comparing tubing damaged in cages with tubing damaged in the field, it was possible to determine that all but 2 leaks of unknown origin were caused by either rats or mice. The 2 exceptions appeared to be mechanical punctures, probably occurring during tube installation. Some of the damage caused by mice were of the V-shaped type on the edge of the tape, similar to that which had previously been attributed to insects (Fig. 1). The width of incisor marks was less than 1 mm. Rat damage was easier to identify: the incisor marks were larger, ranging between 1.5 and 2.25 mm in width, and often large holes were chewed in the tubing.

Of 45 leaks observed in the field, 8 appeared to be caused by mice and 37 by rats (Table 1). Most leaks (56%) occurred in 4 mil tubing and least (11%) in the 15 mil tubing. Thus 4 mil tubing proved the most susceptible to rodent damage in the field as it had in the laboratory. The difference between observed and expected frequencies of rodent damage in the 3 tubing thicknesses was statistically significant at $P < 0.001$ ($X^2 = 13.3$, df = 2).

## Discussion

*Diagnosis of Insect and Rodent Damage.* Chewing damage is most likely to occur along the edge of drip tubing where it may be easily grasped when not inflated with water. Correct diagnosis of this damage depends on knowledge of the mouthparts of insects and rodents.

Rodents gnaw by the opposed action of paired incisors in the upper and lower jaw. Although the actual break was sometimes made by only one pair, close examination with a hand lens revealed the marks of the opposing pair, a total of 4 punctures or marks for each bite. Often scratches were seen leading up to the punctures where the incisors grazed the tube before penetrating. The first bite occurred

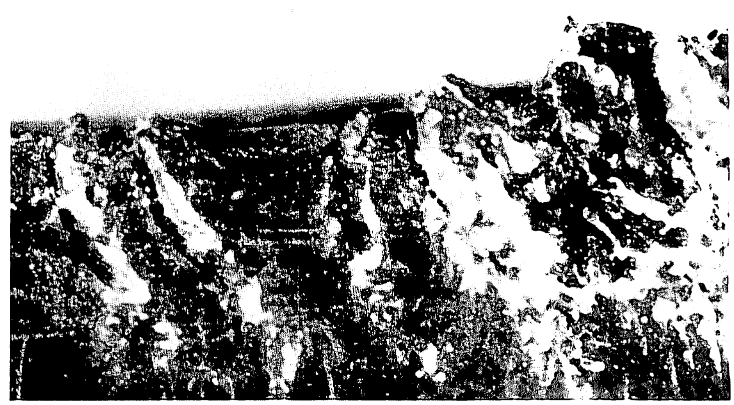

Fig. 1. "V-shaped" incision made by a mouse on the edge of drip irrigation tubing.

Table 1. Frequency of damage caused by rodents in 4, 8, and 15 mil tubing; differences between observed and expected frequencies statistically significant ($P < 0.001$, $X^2 = 13.3$, df = 2).

| | Damage frequency (no.) | | | | |
|---|---|---|---|---|---|
| | Tube thickness (mil) | | | | |
| Cause of damage | 4 | 8 | 15 | Total | |
| Mice | 6 | 2 | 0 | 8 | ( 18)[z] |
| Rats | 19 | 13 | 5 | 37 | ( 82) |
| Total | 25 | 15 | 5 | 45 | |
| | (56) | (33) | (11) | | (100) |

[z]Percent of total number.

at an angle, making a "V" with the edge of the tape. Succeeding bites tended to form a semi-circular arc, which when completed removed a circular piece of tube wall. Damage also originated along the flat side of the deflated drip tape rather than the folded edge, especially in the case of rats.

Insect mandibles work from side to side instead of up and down, but still depend on opposing action to cut, tear, or crush. Again, damage tended to occur along the edge of the tape, or in the case of some ant damage, around the periphery of the emitter orifice (2). Ant mandibles are small compared to the other insects considered here. Each bite leaves only a small mark resulting in an overall felt-like appearance at the edge of the damaged area (2). The larger mandibles of the field cricket give a shredded appearance to the damaged edge, with the shreds pointing outward. The holes are similar to but larger than those made by wireworms (R. M. Bull, unpublished data). White grubs and mole crickets tend to cut "V" shaped nicks along the edge of the tube, while earwigs and millipedes make round, relatively smooth holes (R. M. Bull, unpublished data).

Another kind of damage is caused by last instar larvae of *S. sueroides* migrating from their leguminous host plants (*Aeschynomene* spp. and *Sesbania* spp.) in search of pupation sites. The larvae have been shown to climb vertical "risers" of PVC "spaghetti" tubing to bore 2.5-3mm round holes (1). Round or oval scars of unsuccessful attempts were often observed on the tube as well. In contrast, rodent damage to spaghetti tubing was rough-edged and more irregular. Leaks caused by *Selenisa* were usually discovered when the water was turned on. The water pressure drove the larva or pupa against the emitter where it may not be seen unless the emitter is removed.

*Prevention of Insect and Rodent Damage.* The preference of rats and mice for thin tubing in this study indicated that much damage would probably have been avoided had 15 mil tube been used throughout, although without a choice available to the rodent, the attack on heavier tubing could have been greater than was actually observed. In spite of this uncertainty, the use of 15 mil tubing appears to be one means of preventing rodent damage. Ten mil tubing has been considered as sufficient to prevent most insect damage (5). However, tube thickness within the range commonly used did little to prevent the enlargement of emitter orifices by ants (2). A better solution to the ant problem may be the use of specially designed irrigation tape with the emitters protected between two parallel extruded ridges (3).

Chang and Ote (2) reported that ant damage was more prevalent in buried tubing than tubing placed on open ground. However, tube laid directly under polyethylene mulch was often damaged by rodents and also crickets. Experience has shown that most of this damage can be avoided by burying the tube under 2 to 3 inches of soil (4). The effect of burying on susceptibility to soil-inhabiting insects such as wireworms and white grubs requires investigation.

Sources of tube-damaging insects and/or rodents should be removed as much as possible before installation of the system. Populations of soil-inhabiting insects can often be greatly reduced by timely tillage or flooding. Trash and debris that serves as nesting sites for crickets and rodents around field margins should be removed. In this study, a nearby vegetable dump was determined to be a major source of rats and mice. Mowing of host plants in citrus groves has been suggested as a means of controlling *Selenisa* (1).

Chemical control has been reported in some cases to be effective in preventing damage to micro-irrigation systems. Possibilities include pre-plant applications of rodenticides, granular insecticides, fumigation, and chemigation. Naturally, uses are legally restricted to those specifically described on the pesticide label.

## Literature Cited


1. Brushwein, J. R., C. H. Matthews, and C. C. Childers. 1989. *Selenisa Sueroides* (Lepidoptera: Noctuidae): A pest of subcanopy irrigation systems in citrus in southwest Florida. Florida Entomol. 72(3):511-518.
2. Chang, V.C.S. and A. K. Ota. 1976. Fire ant damage to polyethylene tubing used in drip irrigation systems. J. Econ. Entomol. 69(4):447-450.
3. Chang, V.C.S., A. K. Ota, and D. Sanders. 1980. Parallel ridge barrier to control ant damage to orifices of drip irrigation tubes. J. Econ. Entomol. 1980. 73(3):403-406.
4. Hochmuth, G. H. 1990. Pepper fertilization recommendations. [IN] Proceedings of the Florida Pepper Institute, D. N. Maynard and W. M. Stall Eds. Special Series SSVEC-002, pp. 57-63. Vegetable Crops Dept. U. of Florida, Gainesville, FL.
5. Olsen, S. M. 1990. Personal communication. North Florida Research and Education Center, Rt 3, Box 4370, Quincy, FL 32351.
6. Pitts, D. J., D. Z. Haman, and A. G. Smajstrla. 1990. Causes and prevention of emitter plugging in micro irrigation systems. Florida Coop. Ext. Svc. Bull. 258.
7. Pitts, D. J., Y. J. Tsai, D. L. Myhre, and T. A. Obreza. 1991. Impact of a raised water table on drip-irrigated tomatoes. Proc. of the Fl. State Hort. Soc. 103: (paper N° 120, in press).
8. Sokal, R., and R. Rohlf. 1969. Biometry. W. H. Freeman and Company, San Francisco.