that would not be possible in commercial production and may interfere with mowing. Netting with coarser mesh could be used when seeding a coarse textured grass like tall fescue at high rates.

Our studies indicate that monostands of tall fescue sod can be harvested after 4.5 to 9 months when using netting. Netting increased sod-tensile strength 5-6 fold compared to no netting. Higher seeding rates result in a denser turf; however, excessive plant competition may result during periods of the growing season.

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HortScience 15(6):820–821. 1980.

Synthetic Pyrethroid Insecticides, Resmethrin and Permethrin, for Tropical Foliage Plant Protection[1]

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Additional index words. insect control, phytotoxicity, aphids, *Myzus persicae*, thrips, *Echinothrips americanus*

Abstract. **Applications of resmethrin at 0.6 g/liter and permethrin at 0.3 g/liter concentrations did not satisfactorily control green peach aphid, *Myzus persicae* (Sulzer). One application of permethrin at 0.15 g/liter controlled thrips, *Echinothrips americanus* Morgan, but repeated applications of resmethrin were necessary. Only *Brassaia actinophylla* Endl. showed significant phytotoxicity to resmethrin, but permethrin caused excessive injury to *B. actinophylla*, *Epipremnum aureum* (Linden & Andre) Bunt., *Maranta leuconeura* E. Morr. and *Nephrolepis exaltata* (L.) Schott.**

Insects are economically important pests of tropical foliage (2,3). Under commercial conditions losses occur as a result of direct feeding activity, reduced aesthetic value and by quarantine actions. Subsequently, there is considerable demand for efficacious and nonphytotoxic chemical controls. The synthetic pyrethroid, resmethrin, is available for whitefly control on floral crops while the experimental pyrethroid, permethrin, has been noted for its effectiveness against ornamental plant pests (1,7). As aphids and thrips are common economic pests in commercial production of tropical foliage, this study was established to evaluate the efficacy and potential phytotoxicity of resmethrin and permethrin on selected tropical foliage plants.

In efficacy tests *Aphelandra squarrosa* Nees. 'Dania', 20 cm high, were maintained in the greenhouse under 6 klx max, at 22°–37°C in 15 cm containers in a medium of 3 parts of Florida peat and 1 part mason's sand (by volume) plus 4 kg dolomite, 2 kg Perk (minor element supplement; Estech General Chemicals Corp., Chicago, Illinois) and 6 kg 1.4N-6.2P-11.6K Osmocote (Sierra Chemical Co., Newark, California)/m^3. *Dieffenbachia maculata* (Lodd.) G. Don, 37 cm high, were potted in the same medium and maintained under 15 klx max at 21°–35°C. Resmethrin 2EC or permethrin 1 TEC was applied once or 3 times weekly at concentrations listed in Table 1 and at a volume of 1900 liters/ha with a compressed-air-sprayer at 3 kg/cm^2 and equipped with an 8002 nozzle. *Aphelandra squarrosa* were infested with green peach aphids, *Myzus persicae* and *D. maculata* infested with thrips, *Echinothrips americanus*. Acephate 75S, oxamyl 2L, or pirimicarb 50W applications and a series of untreated plants were used as standards for efficacy comparison. Aphid populations were counted visually 1 day after application and then at 7-day intervals on upper and lower surfaces of newly developed foliage while thrips populations were counted for 3 leaves per plant. A randomized block design was used with 4 replications of each treatment.

Resmethrin at the 0.6 g/liter (all concentrations given in active ingredients) and permethrin at the 0.3 g/liter did not satisfactorily control aphids (Table 1). Three applications of resmethrin or permethrin were more effective than single sprays in maintaining reduced populations; however, final numbers of aphids remaining on foliage were unacceptable. Plants receiving single sprays of acephate, oxamyl, and pirimicarb contained low numbers of aphids over the duration of the test. Pirimicarb was the most effective material, but was not significantly better than the other materials. At all rates of application, resmethrin and permethrin produced significant reductions of thrips 1 day after treatment (Table 1). Single applications of permethrin at 0.15 g/liter were comparable to acephate and oxamyl (0.6 g/liter) in maintaining thrips control; whereas, repeated applications of resmethrin at 0.3 g/liter were needed. A previous test also indicated the efficacy of permethrin at 0.15 g/liter against another thrips, *Hercinothrips femoralis* (O. M. Reuter), but as in this test, less activity against *M. persicae* as well as against a mealybug, *Phenacoccus solani* Ferris (1). Previous studies have shown permethrin to be efficacious against the striped mealybug, *Ferrisia virgata* (Cockerell) (6); chrysanthemum aphid, *Macrosiphoniella sanborni* (Gillette) (7), cabbage looper, *Trichoplusia ni* Hubner (7) and leaf miner, *Liriomyza sativae* Blanchard (7).

In phytotoxicity tests uniform *A. squarrosa* 'Dania', *Brassaia actinophylla*, *Chamaedorea elegans* Mart., *D. maculata*, *Dracaena sanderana* Hort. Sander ex M. T. Mast., *Epipremnum aureum*, *Maranta leuconeura* E. Morr., *Nephrolepis exaltata* (L.) Schott 'Fluffy Ruffles', *Peperomia obtusifolia* (L.) A. Dietr. 'Variegata', *Philodendron scandens oxycardium* (Schott) Bunt., and *Saintpaulia ionantha* H. Wendl. 'Maine' were potted in 10 cm containers and grown as in the efficacy tests. Plants were placed in a randomized block design with 8 replications and were sprayed 4 times at weekly intervals with resmethrin 2EC at 0.3, 0.6, and 1.2 g/liter or permethrin 1TEC at 0.15, 0.3, and 0.6 g/liter (equivalent to 1, 2, and 4 × the normal concentrations) using methods as in the efficacy testing. Plyac (Hopkins Agricultural Chemical Co., Madison, Wisconsin) a spreader-sticker (emulsifiable A-C poly-

[1]Received for publication April 21, 1980. Florida Agricultural Experiment Stations Journal Series No. 2337. Mention of a trademark name or a proprietary product does not constitute a guarantee or warranty of the product by the University of Florida and does not imply its approval to the exclusion of other products that may also be suitable.

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[2]Technical assistance of Mrs. M. V. Wettstein is gratefully acknowledged.

ethylene and octyl phenoxy polyethoxy ethanol), was added at 1 ml/liter of spray. Phytotoxicity was evaluated 2 weeks after the final application using a 0-10 visual rating scale with 0 representing no injury and 10 representing severe injury.

Applications of resmethrin at 0.3 g/liter caused little phytotoxicity with ratings significantly greater than controls occurring only with *B. actinophylla* (Table 2). The 0.15 g/liter concentration of permethrin caused phytotoxicity to *B. actinophylla, E. aureum, M. leuconeura* and *N. exaltata* 'Fluffy Ruffles'. Both chemicals resulted in increased severity of injury with increased pesticide concentration. Resmethrin injury was characterized by chlorotic spots and depressions beneath spray residues on *Brassaia* foliage. Injuries from permethrin were characterized by chlorotic or necrotic spotting of foliage of *B. actinophylla, E. aureum, M. leuconeura,* and *N. exaltata,* leaf deformity of *B. actinophylla* and *N. exaltata,* as well as depressions beneath spray residues with *B. actinophylla* and *E. aureum.* Final fresh foliage weights were determined for *E. aureum, M. leuconeura* and *P. scandens oxycardium;* all concentrations of permethrin caused significant reductions in foliar growth of *Philodendron.* Previous tests have shown soil applications of resmethrin or permethrin at comparable concentrations were not excessively injurious to foliage of *B. actinophylla, E. aureum, P. obtusifolia, Pilea cadierei* Gagnep. & Guillaum, or *Schlumbergera bridgesii* (Lem.) Lofgr. (4).

Permethrin in this and previous tests (1,6,7) appears potentially useful for control of major foliage plant insects, although apparent specificity against certain aphids and mealybugs may limit utility. Although synthetic pyrethroids possess moderate mammalian toxicity, are reasonably biodegradable and are effective at low dosages; these chemicals are generally toxic to pests as well as beneficial insects and mites (5). Therefore, use of pyrethroids to selectively reduce pest populations while allowing survival of beneficial species that are important to the success of integrated pest management programs must be thoroughly studied and techniques developed to effectively interface chemical and nonchemical controls.

Table 1. Effect of resmethrin and permethrin on control of *Myzus persicae* infesting *Aphelandra squarrosa* and *Echinothrips americanus* infesting *Dieffenbachia maculata.*

			Avg no. aphid/leaf[z]			Avg no. thrips/leaf[z]		
			Days after initial applic.			Days after initial applic.		
Treatment	Rate (g/liter)	No. applications[y]	0	1	21	0	1	21
Resmethrin	0.30	1	35.0a	32.3b	173.5d	25.6a	4.5a	31.3b
	0.30	3	35.0a	7.3ab	59.0bc	17.8a	1.7a	0.5a
	0.60	1	32.2a	19.5ab	139.8d	18.9a	3.4a	17.4ab
	0.60	3	33.8a	16.3ab	19.0ab	26.7a	6.3a	2.9a
Permethrin	0.15	1	33.8a	20.3ab	188.2d	21.3a	0.2a	0.9a
	0.15	3	32.8a	11.3ab	33.2ab	19.0a	0.9a	0.0a
	0.30	1	33.2a	4.8a	83.8c	22.2a	0.0a	0.1a
	0.30	3	34.8a	8.8ab	7.8ab	26.8a	0.4a	0.0a
Acephate	0.60	1	35.2a	2.5a	7.2ab	23.3a	1.6a	0.2a
Oxamyl	0.60	1	36.0a	2.3a	27.8ab	19.4a	2.7a	1.4a
Pirimicarb	0.30	1	40.5a	0.8a	4.8a	–	–	–
Control	–	–	35.0a	58.0c	149.8d	18.3a	37.1b	93.2c

[z]Mean separation within columns by Duncan's multiple range test, 5% level.

[y]Multiple applications at 7-day intervals.

Table 2. Effect of resmethrin and permethrin on phytotoxicity to greenhouse grown foliage plants 2 weeks after repeated applications.[z]

Plant species	Phytotoxicity rating[y,x]					
	Resmethrin 2 EC (g/liter)			Permethrin 1 TEC (g/liter)		
	0.3	0.6	1.2	.15	0.3	0.6
Aphelandra squarrosa 'Dania'	0.8ab	2.3c	4.9d	0.9abc	1.9bc	1.5bc
Brassaia actinophylla	1.4b	5.5c	5.9c	5.6c	7.0de	7.9e
Chamaedorea elegans	0.0a	3.8c	7.0d	0.0a	0.2a	1.6b
Dieffenbachia maculata	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a
Dracaena sanderana	0.0a	0.0a	1.9b	0.0a	0.0a	0.2a
Epipremnum aureum	0.6ab	3.5c	6.5e	1.5b	4.9d	6.9e
Maranta leuconeura	0.0a	0.2ab	0.5ab	1.0b	4.1c	7.2d
Nephrolepis exaltata 'Fluffy Ruffles'	0.1a	2.9c	7.0e	1.1b	3.3c	5.8d
Peperomia obtusifolia 'Variegata'	0.6a	0.8a	0.3a	0.5a	3.9b	5.0b
Philodendron scandens oxycardium	0.0a	0.1a	0.8ab	0.8ab	0.3ab	1.0b
Saintpaulia ionantha 'Maine'	0.0a	0.6a	3.6b	0.3a	3.0b	3.6b

[z]Applications 4 times at 7-day intervals.

[y]Phytotoxicity rating 0 (no injury) to 10 (severe injury).

[x]Mean separation within rows by Duncan's multiple range test, 5% level. (All control plants had a phytotoxicity rating of 0.0a).

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