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ROOT INTRUSION COMPARISON OF FIVE DRIP IRRIGATION TUBES

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SUMMARY

Root intrusion susceptibility was evaluated for four commercial drip tubes — designated as Chapin Cane Turbulent, Hardie Tape, T-Systems Cane Special, and T-Systems Original Cane Special — in a preliminary six-month test using natural weed populations. Another drip tube — designated as Geoflow (Drip-In) Root Guard — was also evaluated owing to its unique feature of having trifluralin — incorporated emitters; however, since Root Guard with 50-mil wall thickness and high flow rates was not designed for use in Hawaiian sugarcane, it cannot be directly compared with the other four cane tubes. Among the tubes, designed for sugarcane the order of increasing root intrusion was Hardie Tape, Chapin Cane Turbulent, T-Systems Cane Special, and T-Systems Original Cane Special. The same order was observed for the difference in variation between the initial tube flow rate and final flow rate (a measure of plugging). Root Guard tube performed well in the test having a low rate of root intrusion and the lowest flow rate variation. The use of lower than the manufacturer's recommended operating pressure for Root Guard tube may have contributed to the presence of a low incidence of root material in the emitters at the end of the experiment. The concept of herbicide incorporation in drip emitters appears promising.

INTRODUCTION

Root intrusion into commercial drip tubes is becoming a problem owing to changes in emitter design. As a result, it is necessary to compare both new and existing tubes for susceptibility to root intrusion. The results of such testing will aid the plantations in selection of drip tubes and will aid manufacturers in improving drip tube design. Manufacturers have already modified tubes to reduce root intrusion by changing emitter size, shape, and location or by incorporating the herbicide trifluralin. A preliminary test was designed to test for root intrusion in drip tubes.

MATERIALS AND METHODS

A six-month test to determine the root intrusion susceptibility of five drip tubes was begun at the HSPA Kunia Substation on October 1, 1991. Four of the tubes installed were commercial products with 15-mil wall thickness designed for use in sugarcane fields in Hawaii. These were T-Systems Original Cane Special (CS), T-Systems Improved Cane Special (CS-O), Chapin Cane Turbulent (CC), and Hardie Tape (HT). A fifth tube, Geoflow (Drip-In) Root Guard (RG) with 50-mil wall thickness, was not designed for use in Hawaii sugarcane fields, but it was evaluated to determine the effectiveness of trifluralin-incorporated emitters for reduction in root intrusion. The flow rate of RG was greater than that of the four commercial cane tubes at 10 psi; this presented design problems for the experiment. To provide equal flow for all the tubes, RG was operated at 3.5 psi instead of 10 psi. Descriptions of the drip tubes tested follows.

Original Cane Special

The CS tube had emitters spaced 24 inches apart. Each emitter consisted of a 36-opening inlet; a 3.5-inch-long, sharp saw-toothed flow passage; a pressure-dissipating reservoir; and a 0.125-inch-long emitter outlet located in the seam. Initially, the tube discharged water at a flow rate of 0.313 gpm/100 ft at 10 psi with a coefficient of emitter flow variation (CV) of 7%.

Improved Cane Special

At HSPA's request, the CS-O tube was developed by T-Systems International by substituting the outlet of the CS tube with a 0.06-inch-diameter orifice located 0.063 inch away from the seam. Initially, CS-O provided water at a flow rate of 0.313 gpm/100 ft at 10 psi with a CV of 4%.

Chapin Cane Turbulent

The CC tube, manufactured by Chapin Watermatics, Inc., had emitters spaced 24 inches apart. Each emitter consisted of an 8-opening inlet; a 1-inch-long, sharp saw-toothed flow passage; a pressure-dissipating reservoir; and a 0.06-inch-diameter orifice outlet located 0.063 inch away from the seam. The emitter outlet was similar to that of CS-O. Initially, CC supplied water at a flow rate of 0.318 gpm/100 ft at 10 psi with a CV of 3%.

Hardie Tape

HT, a turbo drip tube manufactured by J. Hardie Irrigation, had emitters spaced 24 inches apart. Each emitter consisted of a 12-orifice inlet, a 2.70-inch-long saw-toothed flow passage, a 0.28-inch pressure-dissipating reservoir, and a 0.140-inch-long laser-burned slit outlet located opposite of the seam. Initially, HT supplied water at a flow rate of 0.314 gpm/100 ft at 10 psi with a CV of 4%.

Root Guard

RG, an extruded polyethylene tube manufactured by Geoflow (Drip-In Irrigation Co.), had trifluralin-incorporated emitters spaced 16 inches apart. Each emitter consisted of a 10-opening inlet, a zigzag flow passage, a pressure-dissipating reservoir, and two separate 0.063-inch-diameter orifice outlets. Initially, RG supplied water at a flow rate of 0.336 gpm/100 ft at 3.5 psi with a CV of 4% (at 10 psi). RG tube was included in the test to determine the effectiveness of trifluralin incorporation in the emitters for prevention of root intrusion. The specifications of this tube far exceeded those necessary for the Hawaii sugar industry; however, the concept of trifluralin incorporation is of considerable interest.

A sketch of the experimental layout is presented in Figure 1. The tubes were installed 5 inches below the soil surface with emitters facing up.

The natural population of weeds present in the test were swollen fingergrass (*Chloris inflata* Link), natal redtop (*Rhynchelytrum repens* (Willd.) C. E. Hubb.), spiny amaranth (*Amaranthus spinosus* L.), purple nutsedge (*Cyperus rotundus* L.), sow thistle (*Sonchus oleraceus* L.), guineagrass (*Panicum maximum* Jacq.), and Aiea morningglory (*Ipomoea triloba* L.). Weeds were not treated with herbicide and grew uncontrolled, presenting a severe test for the tubes.

Irrigation was applied three days per week, and fertilizer was added through the drip system to promote weed growth. No sugarcane was included in this preliminary experiment.

Five months after initiation, the tube tail ends were opened for flushing to collect roots; at six months, the tubes were carefully removed to evaluate emitter flow performance and to determine the cause of plugging. Individual emitters were examined, flow rates were determined, and a CV was calculated for each tube. The main chamber of the tubes was inspected for root intrusion.

RESULTS AND DISCUSSION

There was considerable variation among tubes with regard to the number of emitters penetrated by roots and in the extent of the penetration within individual emitters and main flow chambers. The order of increasing root intrusion was HT<RG<CC< CS-O<CS, and the order of increasing change in flow rate from the initial reading to the final reading was RG<HT<CC<CS-O<CS (Table 1). The lower change in flow rate is indicative of lower plugging for any reason but including root intrusion.

Roots in RG emitters did not penetrate the inner chamber and did not completely block water flow from individual emitters. In contrast, some CS and CS-O emitters were completely plugged with roots, and their main chambers were penetrated by roots, reducing water movement to downstream emitters. CC tubing had some blocked emitters, but only a few roots reached the main chamber. HT tubes were essentially free from root intrusion (one emitter penetrated), but flow rate and CVs were affected by other factors.

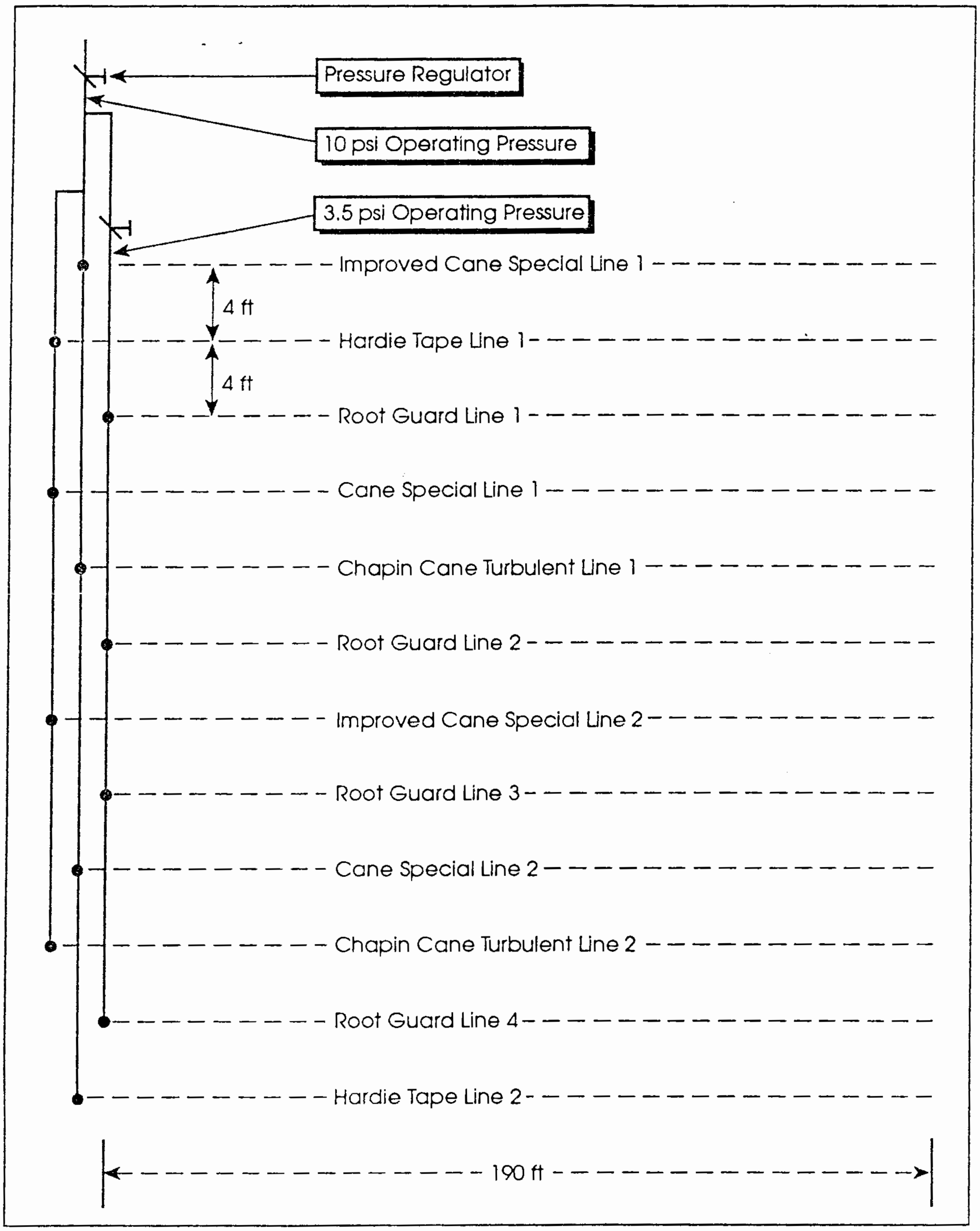

FIGURE 1. Layout of root intrusion test at Kunia Substation.

TABLE 1
Comparison of Root Intrusion, Emitter Plugging, and Tube Flow in Five Drip Irrigation Tubes

	CS	CS-O	CC	HT	RG
Pressure (psi)	10	10	10	10	3.5
No. of Emitters in Test	181	183	185	184	584
Root Intrusion (%)	38.6	22.4	4.8	0.5	3.6
Completely Plugged Emitters (%)[a]	23	8	0.5	0.5	1
Partially Plugged Emitters (%)[a]	6	8	2	2	2
Initial CV Flow (%)	7	4	3	4.	4
Final CV Flow (%)	118	66	22	13	6
Change in CV Flow (%)[b]	1585	1550	633	225	50

Note: CS = Original Cane Special, CS-O = Improved Cane Special, CC = Chapin Cane Turbulent, HT = Hardie Tape, and RG = Root Guard.

[a]All causes of plugging are considered in these categories. ← N B.

[b]$\frac{\text{Final CV} - \text{Initial CV}}{\text{Initial CV}} \times 100.$

The test clearly demonstrated that large differences in root intrusion exist among the five tubes. However, it must be kept in mind that this was a severe test for root intrusion and in commercial practice where good weed control is practiced, the problem may not be as large. It must also be realized that if roots penetrate susceptible tubes near the sub-main inlet, the whole tube will be blocked with serious consequence. We consider root intrusion one of the most important factors in the choice of tubes. There are still many unanswered questions regarding root intrusion, such as which species of weeds are involved and how much of a role do cane roots play in intrusion? These questions will be addressed in future experiments.

All drip tubes tested had no defects, except for RG, which had one defective emitter discharging no flow and two 32-inch tube sections without an emitter. Small holes, which appeared to be of mechanical origin, were found in tube walls of HT.

CONCLUSIONS

The results of this preliminary test clearly showed the large differences in the susceptibility of drip tubes to root intrusion; however, confirmation of these results in follow-up experiments is required before definite conclusions can be made regarding the relative susceptibility of the tubes to root intrusion. Additional experiments are planned and will include plots with sugarcane grown in the presence of weeds and with complete weed control.

Trifluralin incorporation in the RG tube was effective; this concept should be applied to tubes designed for sugarcane.