Delivery of Chemical and Microbial Pesticides from Drip Irrigation Emitters

Traditional pesticide application in nurseries is by sprayer; however, spray application may not be efficient due to a variety of factors, such as gaps in pot spacing, spray drift, and spray operator skill. Chemigation, or injection of insecticides, pesticides, herbicides, etc. through irrigation systems, offers an alternative strategy for efficient and economical application of pesticides to targeted zones in soil or container substrates. Improving water distribution uniformity of drip irrigation systems has been studied extensively, but the specific evaluation of a designated pest control agent's uniformity throughout driplines is lacking, especially for the microbial bio-pesticides before they are used for field trials.

The objective of this study was to investigate the capability of drip irrigation systems for delivering water-soluble chemicals, suspendible microbial bio-insecticides and bio-fungicides, and entomopathogenic nematodes (Table 1). To achieve the objective, the distribution uniformity and recovery rates of these materials throughout driplines were evaluated under controlled conditions as they were discharged from emitters of three flow capacities (2.0, 4.2, and 6.9 L h^{-1}). Coefficient of variation (CV) and distribution uniformity (DU) were used to quantify the uniformity of distribution of each of the materials through the dripline.

Although all materials were readily deliverable through the drip irrigation system, the uniformity of the materials discharged varied with the material formulations and emitter flow capacity. For all emitter flow capacities, BSF had the lowest coefficient of variation, followed by nematodes, Imidacloprid, SF, and EPF. Conversely, the recovery rate of the five materials was in the reverse order. Emitter flow capacity affected the recovery rates of Imidacloprid and SF discharged from the emitters, but not of BSF, EPF, and nematodes (Table 2). Drip irrigation was demonstrated as a viable alternative for application of water-soluble and insoluble materials; however, the discharge rates of EPF and SF must first be determined to compensate for their non-uniformity of delivery and low recovery rates from emitters.

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Table 1. Materials used in the test.

Material	Type	Formulation	Amount Applied[a]
Brilliant Sulfaflavine (BSF)	Fluorescence tracer	Water soluble	150 mg
Imidacloprid	Insecticide	Flowable suspension	2.8 mL
Entomopathogenic fungus (EPF)	Microbial insecticide	Suspendible granule	5.5 g
Soil fungus (SF)	Microbial fungicide	Suspendible granule	10 g
Entomopathogenic nematode (EPN)	Microbial insecticide	Living organism suspension	2,000,000 unit

[a] Amount of the material applied per test.

Table 2. Comparison of predicted and measured amounts of five materials discharged from individual emitters throughout driplines with three different size emitters.

Material	Emitter Flow (L/h)	Mean Quantity of Material per Emitter			Recovery Rate (%)[c]
		Predicted	Measured[a][b]	Unit	
BSF	2.0	1724	1586 (99)A	µg	92a
BSF	4.2	1724	1486 (47)A	µg	86a
BSF	6.9	1724	1608 (98)A	µg	93a
Imidacloprid	2.0	35.9	18.0 (7.5)B	mg	50b
Imidacloprid	4.2	35.9	28.1 (10.7)A	mg	78a
Imidacloprid	6.9	35.9	12.3 (6.6)B	mg	34bcd
EPF	2.0	5.69×10^7	5.1×10^6 (2.8×10^6) A	CFU	9.0de
EPF	4.2	5.69×10^7	3.4×10^6 (2.9×10^6) A	CFU	6.0e
EPF	6.9	5.69×10^7	5.4×10^6 (6.6×10^6) A	CFU	9.5de
SF	2.0	2.3×10^6	3.89×10^5 (3.52×10^5)A	CFU	17cde
SF	4.2	2.3×10^6	4.75×10^5 (3.31×10^5)A	CFU	21cde
SF	6.9	2.3×10^6	2.74×10^5 (1.45×10^5)A	CFU	12de
Nematode	2.0	2.3×10^4	9387 (826)A	Number	41bc
Nematode	4.2	2.3×10^4	9679 (774)A	Number	42bc
Nematode	6.9	2.3×10^4	10754 (528)A	Number	47b

[a] Means for the measured quantity of the same material in a column followed by a different uppercase letter are significantly different ($p < 0.05$), but not for the comparison between materials.
[b] Standard deviation is presented in parenthesis.
[c] Recovery rate (%) = Measured quantity × 100 / Predicted quantity. Means for the recovery rate in a column followed by a different lowercase letter are significantly different among all the materials ($p < 0.05$).

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