Distribution of Chemical and Microbial Pesticides Delivered Through Irrigation Systems

The injection of pesticides into drip irrigation lines offers an efficient and economical alternative for the delivery of pesticides to targeted zones in soil or container substrates. While improving the uniformity of water distribution through drip irrigation systems has been studied extensively, little research has evaluated a designated pest control's uniformity through drip lines. This study investigates 1) the capability of drip irrigation systems to deliver water soluble chemicals, suspendible microbial bio-insecticides and fungicides, and entomopathogenic nematodes; 2) distribution patterns of these chemical and microbial pesticides in the soil.

Drip irrigation uniformly dispensed water soluble Brilliant Sulfaflavine (BSF), water-dispersible insecticide (Imidacloprid), and suspended nematodes, but not the suspended powder formulation of the entomopathogenic fungus (EPF) or the suspended granular formulation of the microbial soil fungicide SoilGuard (SF); (Table 1). Emitter size and flow capacity affected the recovery rates of Imidacloprid and SF discharged throughout the drip line, but not of BSF, EPF, and nematodes (Table 2).

These results demonstrated that drip irrigation could be a viable alternative method for water-soluble pesticide applications, but may be limited for delivery of suspended powders and granular agents due to poor uniformity and low recovery rates.

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Table 1. Mean coefficient of variation (CV) and distribution uniformity (DU) of water soluble Brilliant Sulfaflavine (BSF), water-dispersable Imidacloprid, suspended powder formulation of entomopathogenic fungus (EPF), suspended granular formation of microbial soil fungicide SoilGuard (SF), and nematodes discharged from emitters with three different flow capacities (2.0, 4.2, and 6.9 L/h) at 138 kPa pressure.

Treatment	CV (%)*			DU*		
	2.0 L/h emitter	4.2 L/h emitter	6.9 L/h emitter	2.0 L/h emitter	4.2 L/h emitter	6.9 L/h emitter
BSF	2.3	1.7	1.8	0.95	0.97	0.96
Imidacloprid	43	36	54	0.76	0.80	0.76
EPF	90	104	119	0.56	0.26	0.33
SF	98	72	51	0.44	0.62	0.68
Nematodes	8.8	8.0	4.9	0.80	0.83	0.91

* Each value of CV or DU is the mean from 7 emitters in each drip line with three replications. CV and DU were calculated with equations (1) and (2), respectively.

Table 2. Comparison of predicted and measured amounts of five materials discharged from individual emitters throughout drip lines with three different size emitters. Standard deviation is presented in parentheses.

Material	Emitter flow (L/h)	Mean quantity of material per emitter: Predicted	Measured*	Unit	Recovery rate (%)**
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

* 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.

** Recovery rate (%) = Measured quantity x 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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