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ScienceDirect

Crop Protection 26 (2007) 1625–1633

Crop Protection

www.elsevier.com/locate/cropro

Confirmation by fluorescent tracer of coverage of onion leaves for control of onion thrips using selected nozzles, surfactants and spray volumes

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Received 16 August 2006; received in revised form 2 February 2007; accepted 2 February 2007

Abstract

Track sprayer and field sprayer trials were completed to assess the effect of different nozzles, surfactants and carrier volumes on product delivery to the inner leaves of onion plants using a fluorescent tracer. Track sprayer trials revealed more tracer on the inner leaves of onions using either the TeeJet® XR8004 flat fan or D4/DC25 disc-core hollow cone nozzles. In three of four experiments, more tracer was detected on onions sprayed alone or combined with Sylgard® 309 at 200 L/ha than plants sprayed with tracer + Companion®. When the carrier volume was increased to 400 L/ha, more tracer was detected on onions sprayed alone or combined with Companion. In field trials, the XR8004 delivered more tracer than the D4/DC25 ($F = 32.8$; $P < 0.00$; d.f. = 1,77). The best coverage was observed on plants sprayed with the flat fan combined with Agral® 90, sprayed at either 400 L/ha (29% coverage) or 600 L/ha (23% coverage).

Keywords: Fluorescent tracer; Onion thrips; Pest control; Nozzles; Surfactants

1. Introduction

Onion thrips, *Thrips tabaci* Lindeman, are economic pests of *Allium* spp. worldwide (Horsfall and Fenton, 1922; Boyce and Miller, 1954; Theunissen and Legutowska, 1991; Brewster, 1994). Adult and immature onion thrips feed by piercing and rasping leaf tissues, removing the cell contents and destroying chlorophyll-rich leaf mesophyll (Molenaar, 1984). The feeding damage is characterized by white or silvery lesions and can result in reduced yield and increased susceptibility to infection by plant pathogens (Howard et al., 1994; Mckenzie et al., 1993).

Onion thrips nymphs, the predominant lifestage throughout the Ontario growing season (MacIntyre-Allen, 2004), congregate deep within the axils of onion leaves and are thus well protected from foliar-applied chemical control agents. This behaviour, coupled with the potentially rapid increase of field populations under favourable conditions, continues to frustrate growers attempting to control this pest around the world (Sites et al., 1992; Lewis, 1997; Murai, 2000).

In Ontario, foliar applications of one of the five registered insecticides are recommended for onion thrips control (OMAFRA, 2006). Three of the five products, deltamethrin, lambda-cyhalothrin and cypermethrin, are pyrethroids while the remaining two products, diazinon and dibrom, are organophosphorus insecticides. Depending on the season, growers apply 2–10 sprays to manage onion thrips in carrier volumes ranging from 200 to 400 L/ha. In Canada, the Pest Control Products Act requires pesticide–surfactant combinations be registered for inclusion on product labels. Currently, products registered for use on onions for onion thrips control does not include surfactant registrations.

Pesticide performance is based on a particular insect, a particular host, and a particular chemical. Under laboratory conditions, an insecticide may be applied and control

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0261-2194/$ - see front matter
doi:10.1016/j.cropro.2007.02.001

evaluated, often without consideration of the insect–plant interaction. While Crosby (1973) estimated that only 1% of insecticide reaches the intended target under field conditions, work by Hall and Adams (1990) suggests that even less than 1% of insecticide reaches the target. The insect–plant interaction must therefore be considered before an insecticide application is made to maximize delivery and subsequent performance of the control agent. To maximize delivery to the pest, growers should use equipment best-suited for the intended pest and crop. An investigation to optimize spray application systems to improve efficacy of control agents for onion thrips by maximizing delivery into the onion leaf axil was therefore initiated.

There are many types of spray nozzles available, each with characteristic spray angle, droplet size, or spray pattern. Three different components of a typical spray delivery system were investigated: (1) spray nozzle, (2) surfactant, and (3) carrier volume.

2. Materials and methods

2.1. Track sprayer trials

All trials were conducted on onion plants grown from set onion bulbs planted in fibre trays (27 cm × 16.5 cm × 8.5 cm deep) (Kord Products Ltd., Bramalea, Ont.) filled with Premier ProMix BX growing medium (Premier Horticulture, Dorval, Que.). Each fibre tray was planted with approximately 22 onion bulbs in 2 × 2 rows with 2.5 cm spacings between bulbs. Onions were maintained in a greenhouse at the Southern Crop Protection and Food Research Centre—Agriculture and Agri-Food Canada in Delhi, Ontario. Trays of onions were transported to the University of Guelph when onions reached a height of 20–25 cm and had produced approximately 4–5 leaves.

Nozzles delivering different spray angles, droplet sizes and patterns were evaluated at several application pressures in 2002 (four nozzles) and 2003 (three nozzles) (Table 1). Tinopal CBS-X (Ciba-Geigy, Greensboro, NC) (tracer), a water-soluble fluorescent tracer dye, was used to visualize spray depositions. In all trials, the tracer was applied at a concentration of 15 mg/L in reverse osmosis (RO) water. Tinopal fluoresces brilliant blue-violet (Staniland, 1958) with an absorption maximum of 349 nm and an emission maximum of 440 nm is commonly used in spray deposition studies (Downer et al., 1997; Barber and Parkin, 2003; Barber et al., 2003).

Onion plants were sprayed with one of the following tracer + surfactant treatments: tracer, tracer + Sylgard 309 [(0.375%, v/v) (siloxylated polyether) (Dow Corning Corp., Midland, MI)] or tracer + Companion [(0.2%, v/v) (octylphenoxy polyethoxy-9-ether) (Dow AgroSciences, Calgary, Alta.)] using a motorized track sprayer (Research Instrument Co., Guelph, Ont.). In all experiments, the motorized track sprayer was equipped with a single nozzle. Between experiments, equipment was cleaned and the nozzle changed. In experiments 1–4, four different TeeJet nozzles were tested: XR8003 flat fan, XR8004 flat fan, TJ60-8004 twin jet and D4/DC25 hollow cone. In experiments 5 and 6, three different nozzles were evaluated: XR8004, TJ60-8004 and D4/DC25. For all spray runs, each nozzle was calibrated to deliver either 200 L/ha (one pass) at 276 kPa (experiments 1–3) or 400 L/ha (two passes) at 276 kPa (experiments 4–6). For each experiment, the spray nozzle was positioned 35 cm above the plant canopy and the sprayer speed was 1.15 km/h. Each replicate of a given treatment was sprayed during a separate pass of the track sprayer. Treated onions plants were allowed to dry in the dark for 2 h.

Table 1
Nozzle type[a], carrier volume and surfactant combinations tested

Nozzle type	Carrier volume (L/ha)	Surfactants tested
Track sprayer trials		
2002		
XR8003 extended range flat	200	Sylgard® 309, Companion®
XR8004 extended range flat	200	Sylgard 309, Companion
TJ60-8004 vs twinjet	200	Sylgard 309, Companion
D4/DC25 disc-core type cone	200	Sylgard 309, Companion
2003		
XR8004 extended range flat	400	Sylgard 309, Companion
TJ60-8004 vs twinjet	400	Sylgard 309, Companion
D4/DC25 disc-core hollow cone	400	Sylgard 309, Companion
Field sprayer trials		
2003		
XR8004 extended range flat	400, 600	Sylgard 309, Agral 90®, LI-700®
D4/DC25 disc-core hollow cone	400, 600	Sylgard 309, Agral 90, LI-700

[a]Spraying Systems Co., Wheaton, IL, USA.

To compare droplet deposition, onion plants were returned to the laboratory and eight onion plants were harvested from each of three replicates for each tracer + surfactant combination. The outer leaves were removed leaving only the two inner leaves for each plant. Using individual razor blades, the two inner leaves were sectioned into three or four 2 cm regions (Fig. 1). Region 1 encompassed the leaf area closest to the growing point, the location where the majority of nymphs are found throughout the growing season. Using forceps, the two leaves for each cut region of each plant were transferred into a labelled 20-mL glass scintillation vial (Fisher Scientific, Unionville, Ont.) containing 2 mL of RO water.

The onion segments in each vial were swirled for 30 s, removed with clean forceps and discarded. Vials were