EVALUATION OF UV REFLECTIVE MULCHES FOR PROTECTION AGAINST THRIPS (*THRIPS TABACI*) IN ONION (*ALLIUM CEPA*) CROPS

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ABSTRACT

The efficacy of the ultraviolet (UV) reflective plastic mulch Extenday® for preventing onion thrips (*Thrips tabaci*) from colonising onions was evaluated. The mulch reflected 35% of incident UV at 250 nm wavelength and 25% of incident UV at 360 nm, while bare soil reflected 11% and 4% UV at these wavelengths, respectively. In a field trial, the total number of thrips at 8 weeks after transplanting was lower with mulch (18.5 thrips/bulb) than in the control (28.0 thrips/bulb). However, thrips populations were similar for both treatments in subsequent assessments. When onions in seedling trays were placed adjacent to an onion field for 8–18 days during early, mid and late summer, aluminium foil, which reflected UV 250 nm by 43% and UV 360 nm by 35%, and Extenday® did not reduce numbers of *T. tabaci* compared to the control. The use of reflective mulches for repelling thrips in onions does not appear promising.

Keywords: onion thrips, *Thrips tabaci*, UV reflective mulch, aluminium foil, onions.

INTRODUCTION

Onions are a high value crop in New Zealand, providing $100.9 million in export receipts and $23 million in domestic receipts in 2001–2 from about 7000 ha (Kerr et al. 2002). Most of the $280–350/ha p.a. spent by New Zealand growers on chemical control of invertebrate pests is associated with controlling onion thrips (*Thrips tabaci* Lind.) (T. Howey & R. Wood, pers. comm.). Onion thrips reduce onion bulb yields in Canada by 34–43% (Fournier et al. 1995), and its presence in onion bulbs in New Zealand can lead to rejection of the crop by overseas markets.

Thrips search for a host in part based on colour, and ultraviolet (UV) light reflective materials can interfere with thrips' host-seeking behaviour (Terry 1997). UV irradiation in wavelengths of 290–350 nm appear the most effective in repelling thrips species (Mazza et al. 2002). UV-reflective silver mulches have been shown to reduce colonisation by thrips on tomato and pepper crops (Stavisky et al. 2002) and shallots (Lu 1990). The UV-reflective plastic mulch, Extenday® (Extenday New Zealand Ltd, Kumeu, Auckland), reduced numbers of New Zealand flower thrips (*Thrips obscuratus*) in nectarines during spring and summer (McLaren & Fraser 2001).

However, no studies on the effect of UV-reflective mulches on *T. tabaci* in onions have been reported. This study evaluated the effect of Extenday® on the number of *T. tabaci* on onions in a field crop in 2002–03, and in seedling trays along with aluminium foil in the following summer.

METHODS

Onion crop trial

The trial was located at Crop & Food Research, Lincoln, New Zealand. Onion cv. Pukekohe Longkeeper seedlings (6 weeks old) were hand sown on 19 December 2002 into a prepared seed bed at 6.2 cm spacing within rows, which were 33 cm apart. Plots were 3x3 m. The treatments consisted of an untreated control (bare soil) and Extenday®

plastic mulch which were each replicated six times in a randomised block design. The mulch was applied on the day following transplanting in 3x1 m strips that were held at the ends of the plots with 10 mm diameter fibreglass rods stapled to the soil with 35 mm long tent pegs. Each strip was cut longitudinally, 33 and 66 cm from one side, to allow two 5 cm wide sections of exposed ground for the onions to grow though.

Calcium ammonium nitrate (27% N) was broadcast by hand to onions in rows at 65 kg/ha at transplanting on 19 December 2002 and again on 23 January 2003. The onion plants were irrigated as required using three sprinkler jets connected to an irrigation pipe that ran between blocks down the middle of the trial. To limit any influence of UV reflected from the aluminium pipe, two buffer rows of onions were sown either side of the pipe, and the pipe was covered with black polythene. Plots were sprayed with the herbicide Totaril Super (250 g ioxynil/litre as an emulsifiable concentrate) at 1.35 litres/ha in 450 litres water/ha on 14 February 2003, with a repeat application 2 weeks later to control weeds. Ridomil® Gold MZ WG (40 g/kg metalaxyl-M plus 640 g/kg mancozeb) was applied at 2 kg/ha in 500 litres water on 24 December 2002, 7 January and 14 February 2003 to protect the onions against downy mildew. Benlate (500 g/kg benomyl) was applied at 500 g/ha on 25 February 2003 to control Botrytis and smut diseases.

All measurements were taken within a central 2x2 m area of the plot, encompassing seven rows of 32 plants per row (224 plants per plot). The number of *T. tabaci* adults and larvae were assessed on 10 onions harvested from each plot 6, 8 and 11 weeks after sowing (28 January, 11 February and 3 March 2003), and on 20 onions per plot 15.5 weeks after sowing (3 April 2003).

Tray trial

Soil collected to 100 mm depth from recently cultivated pasture was steam sterilised at 95–100°C for 3 h to kill weed seeds. Fertiliser (1 kg dolomite lime, 600 g garden lime, 1 kg Osmocote, 360 g super phosphate and 90 g potassium nitrate per cubic metre soil) was added to the sterile soil and mixed thoroughly. The soil was added to 330x400 mm x 60 mm deep black plastic seedlings trays so that the top of the soil was 5 mm below the top lip. Fourteen onion cv. Canterbury Longkeeper seeds were sown 28 mm apart along a longitudinal line in the middle of each tray and incubated in a glasshouse at 18°C with daily watering. The newly emerged seedlings were fertilised on 19 November 2003 with 20 ml solution per tray of Gro More (N-P-K 17-8-14; Gro-chem NZ, Porirua, New Zealand) at 100 g/10 litres water. The seedlings were grown to 80–100 mm in height (ca 8 weeks after sowing), and a further 20 ml of Gro More was applied to the soil prior to the first application of the treatments.

The treatments consisted of an untreated soil, and soil covered with Extenday® or aluminium (0.04 mm thick) foil (Al-foil). They were randomly allocated to the onion seedling trays, and covered the soil on either side of the onion row, with a gap of 1.5 cm of bare soil in the middle along the length of the tray to allow for growth of the onions. The trays were placed adjacent to an insecticide-free onion seed crop at Crop & Food Research on three separate occasions: early summer (10–18 December 2003), mid summer (16 January–3 February) and late summer (13–27 February 2004). At each assessment the mulches were reapplied to the trays. Trays were positioned 1 m apart in three rows along the edge of the onion crop, in a randomised block design. For the three assessments, five, eight and seven replicates were used, respectively. The thrips lure benzaldehyde (Teulon et al. 1993) was used in mid and late summer assessments to ensure that onion thrips were present at the trial site. Twenty open glass 2 ml vials, containing filter paper wicks and 1 ml benzaldehyde, were suspended 35 cm above the ground on white fibreglass rods that were equally spaced throughout the trial site.

In the period between early and mid summer the trays were held in the glasshouse at 15°C to slow onion growth and were sprayed with methamidophos at 600 ml/ha in 500 litres water/ha to kill thrips. Gro More (40 ml of the 100 g/10 litres water solution) was applied to the soil in each tray to maintain healthy onion plants.

UV-light radiation ($\mu W/cm^2$) under ambient bright sunshine from each treatment was measured using a Minolta UM10 radiometer with receptor units UM-250 and

UM-360, having spectral response ranges of 220–300 nm and 310–400 nm, respectively. The amount of incident UV was recorded by holding the radiometer at onion level and facing it upwards towards the sky, and the amount of reflected UV by holding the radiometer 30 cm above the central surface of each tray and facing downwards. UV measurements were recorded between 10:00 and 15:00 hours, with incident and reflected UV readings taken within 5 seconds of one another. The amount of reflected UV was calculated as a proportion of the incident UV.

The number of thrips on onion plants was determined *in situ* at the end of each assessment period. Five onion plants per tray were transferred directly into a plastic bag and frozen within 2 h at -12°C for at least a week to prevent thrips from multiplying in the bags. Thrips were extracted from the onions by rinsing dissected plant segments in hot (70–80°C) water that contained detergent, and pouring the rinse water over 5 and 1 mm sieves to separate plant debris, before collecting the thrips on Saatilene® 55 105 µm mesh (Saati Americas, 10589 Somers, New York). The thrips were counted with the aid of a binocular microscope at 16–40x magnifications. A sub sample of 100 adult thrips was collected from all treatments in one block for the three assessments, and thrips were mounted on glass slides for identification using taxonomic keys (Mound & Walker 1982).

Statistical analysis

All data were analysed using GenStat Release 6.2. Data on incident UV light were analysed by analysis of variance. Data on thrips counts per onion plant were analysed by analysis of variance on $\log_e$(data + 0.5) transformed data to stabilise the error variance. Treatment means were compared at P=0.05. Data on reflected UV as a proportion of incident UV were analysed using generalised linear model with a binomial logit link (McCullagh & Nelder 1989).

RESULTS

Onion crop trial

No significant treatment effects on thrips numbers were recorded 6 weeks after transplanting the onion seedlings (Table 1). At this assessment, feeding damage by thrips, characterised by silvery leaf spots that coalesced into white blotches, was observed on onion plants in all plots. Only at the 8 week assessment did Extenday® significantly reduce the total number of thrips resident on each onion plant (by 33%), mainly by reducing the numbers of thrips larvae. No significant effect of the mulch on adult thrips numbers was recorded at any of the assessments.

TABLE 1: Number of *Thrips tabaci* per field sown onion transplant at 6, 8, 11 and 15.5 weeks after sowing. Data are back transformed means ($\log_e$ transformed data in brackets).

Weeks	Treatment	Total		Adults		Larvae	
6	Control	12.5	(2.56)	6.9	(2.00)	4.9	(1.69)
	Extenday®	8.5	(2.20)	4.2	(1.54)	3.1	(1.27)
	LSD (P=0.05; df=10)		(0.71)		(0.70)		(1.28)
8	Control	28.0	(3.351)	14.4	(2.702)	13.5	(2.635)
	Extenday®	18.5	(2.944)	10.8	(2.427)	7.5	(2.077)
	LSD (P=0.05; df=10)		(0.201)		(0.287)		(0.201)
11	Control	16.2	(2.813)	8.1	(2.147)	7.8	(2.118)
	Extenday®	20.3	(3.035)	10.4	(2.388)	9.7	(2.319)
	LSD (P=0.05; df=10)		(0.385)		(0.399)		(0.486)
15.5	Control	12.7	(2.577)	3.8	(1.467)	8.5	(2.20)
	Extenday®	8.4	(2.181)	3.5	(1.374)	3.6	(1.40)
	LSD (P=0.05; df=10)		(0.404)		(0.295)		(1.04)

Tray trial

The amount of incident UV differed between the early, mid and late summer assessment periods, averaging 1099, 1137 and 910 μW/cm² (LSD=109) at 250 nm, and 3223, 3905 and 2703 μW/cm² (LSD=288) at 360 nm, respectively. The amount of reflected UV 250 nm as a proportion of incident UV from Al-foil was significantly higher (P=0.01) in mid summer than for the other assessment periods, although the amount reflected from the untreated control and Extenday® treatments was similar during summer (Table 2). The amount of reflected UV 360 nm was similar (P=0.60) for the three assessments, averaging 4 (3–5), 25 (23–28) and 35 (32–38)% for the untreated control, Extenday® and Al-foil, respectively. In general, Extenday reflected 3 and 6 times the amount of UV at 250 nm and 360 nm respectively than bare soil, with an even greater amount of UV light being reflected from Al-foil.

However, the mulches did not have a significant effect on the number of *T. tabaci* adults or larvae recorded on onions in trays (Table 2). There were 0.7, 18.6 and 15.9 total thrips/plant on average for the early, mid and late summer assessments, respectively.

TABLE 2: Percentage of UV reflected and numbers of *Thrips tabaci* per onion plant in 330x400 mm trays at three assessments during summer 2003–04. Data for reflected UV are untransformed % means (95% confidence limits in brackets) and data for thrips are back transformed means ($\log_e$ transformed data in brackets).

Summer period	Treatment	% UV reflected 250 nm		% UV reflected 360 nm		Thrips/onion plant Adults		Thrips/onion plant Larvae	
Early	Control	13	(10–17)	5	(3–8)	0.17	(-0.395)	0	-
	Extenday®	33	(28–39)	27	(23–33)	0.50	(0.002)	0	-
	Al-foil	35	(30–40)	38	(34–44)	0.18	(-0.387)	0	-
	LSD (P=0.05, df=49)	-		-			(0.560)		
Mid	Control	10	(8–13)	4	(2–6)	2.7	(1.18)	16.9	(2.86)
	Extenday®	37	(33–41)	26	(22–29)	4.2	(1.56)	17.5	(2.89)
	Al-foil	51	(46–55)	38	(34–42)	3.4	(1.36)	11.2	(2.46)
	LSD (P=0.05, df=42)	-		-			(0.89)		(0.77)
Late	Control	11	(8–14)	4	(2–6)	14.0	(2.673)	1.03	(0.428)
	Extenday®	33	(29–38)	23	(19–28)	12.3	(2.552)	0.86	(0.304)
	Al-foil	39	(34–44)	28	(24–33)	18.8	(2.959)	0.65	(0.141)
	LSD (P=0.05, df=36)	-		-			(0.686)		(0.525)

DISCUSSION

The field trial was initiated to test the concept that UV reflecting materials could reduce numbers of onion thrips in an onion crop. The wide row spacings in the trial meant there was a large area of reflective mulch. Numbers of adult onion thrips on onion plants tended to be lower in Extenday®-treated plots than in untreated controls at the first two thrips assessments within 8 weeks of transplanting, suggesting that some adult thrips were repelled from the onions. However, the reduction in thrips numbers was temporary; differences in thrips populations with and without reflective mulch disappeared in subsequent assessments. This may have been due to an increase in thrips numbers caused by fecund adults resident in the onions.

In a commercial situation, onions are sown in 1.4 m wide beds spaced 30 cm apart, each bed containing 12 onions rows (G. Tucker, pers. comm.) compared to the three rows/m of bed used in the current study. The large amount of vegetation present in high-density commercial plantings may therefore shade the UV reflective area to a greater extent than observed here, thus reducing the efficacy of UV mulches. Lu (1990) also found in Taiwan that silver mulches were more effective in repelling *T. tabaci* when shallots (*Allium ascalonicum*) were planted at 12x12 cm spacing than at 3x3 cm. Crops for which thrips numbers have been reduced by UV mulches include tomato and pepper plants (Stavisky et al. 2002), which were erect, and nectarine trees in spring, when the leaves had not fully developed (McLaren & Fraser 2001). In these cases there was limited shading of the UV mulch.

In addition, the Extenday® may not have reflected enough UV to repel adult *T. tabaci*. Extenday® reflected an average of 25% of incident UV-A light, much lower than at least the 50% of UV-A required to repel the anthophilous thrips *Frankliniella occidentalis* (Matteson & Terry 1992). However, the tray trial, in which onion trays were covered with freshly applied UV reflective materials that reflected up to 51% of incident UV, also did not demonstrate that adult thrips were repelled from onions. In this situation it is possible that thrips may have been repelled but they were blown on to the onions in the trays from the adjacent crop. Furthermore, it is possible that the attractant or arrestant properties of the benzaldehyde lure may have overcome any repellent effect of the mulches.

Nevertheless, the results from both trials suggest that it is not feasible to control *T. tabaci* in onions using UV reflective mulches.

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