SPINOSAD: CONTROL OF LEPIDOPTEROUS PESTS IN VEGETABLE BRASSICAS

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ABSTRACT

Four field trials were conducted in commercial cabbage and cauliflower crops in the Manawatu and Pukekohe, New Zealand. Four to six consecutive broadcast applications of the naturally occurring metabolite spinosad were made at 6-10 day intervals from 3-7 weeks post-transplanting to harvest. Spinosad gave a high level of control of diamondback moth (*Plutella xylostella*), white butterfly (*Pieris rapae*) and leaf miner (*Scaptomyza sp.*) larvae. Pest control and commercially acceptable brassica yield from spinosad was equivalent or superior to deltamethrin. Spinosad produced no visual signs of phytotoxicity.

Keywords: spinosad, vegetable brassicas, *Plutella xylostella, Pieris rapae*, *Scaptomyza* sp.

INTRODUCTION

Synthetic pyrethroid and organophosphate insecticides are used in New Zealand vegetable brassicas to control a range of lepidopterous pests. These pests include diamondback moth, DBM (*Plutella xylostella*) and white butterfly (*Pieris rapae*). There is increasing incidence of resistance to pyrethroid and organophosphate insecticides by diamondback moth (Bell and Fenemore 1990; Cameron *et al*. 1997) and a desire from within the industry to reduce chemical inputs. In addition, new products, with favourable safety and environment profiles, are sought to enable the introduction of integrated pest management programs.

Spinosad belongs to the spinosyn chemical class of insect control products. It is the naturally occurring metabolite (termed Naturalyte) derived from fermentation of the soil bacterium *Saccharopolyspora spinosa.* Spinosad is used for the control of insect pests on fruit and vegetable crops, cotton, tree and vine crops and ornamentals on a global basis. Targeted Lepidoptera include army worms (*Spodoptera* sp.), cutworms (*Agrostis* sp.), DBM, fruitworms (*Heliothis* sp.) and leafrollers (Tortricidae). Certain beetles and dipterous leafminers (*Liriomyza* sp. and *Scaptomyza* sp.), thrips and flies are also controlled (Anon. 1997). The efficacy of spinosad is at least equivalent to the synthetic pyrethroids, most organophosphate and carbamates and other synthetic insecticide chemistries (Bret *et al.* 1997). It is primarily effective through ingestion but does have contact activity. Spinosad acts quickly; the onset of insect control and protection of the plant occurs almost immediately and is irreversible. Symptoms of exposure are flaccid paralysis, cessation of feeding and motility, weak tremors and failure to recover. Immotile larvae are typically found immediately adjacent to a minute feeding hole and may take 4-5 days to disappear from leaves.

Spinosad affects a unique site on the nicotinic acetylcholine receptor on post-synaptic nerve cells. There is no cross resistance to, and its mode of action is different from, both synthetic and traditional biological insecticides (Salgado 1997). These features, in conjunction with the low toxicity of spinosad to most beneficial insects (Petersen *et al*. 1997), allows control of insecticide resistant pests and justifies its use as a foundation in insecticide resistance management programmes (Cameron *et al.* 1998). Spinosad has a reduced risk to humans compared to synthetic insecticides and an excellent environmental profile with reduced risk to fish, birds, earthworms and mammals (Saunders and Bret 1997).

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MATERIALS AND METHODS

During the summer of 1996/97, three trials were established in commercial cabbage crops in the Manawatu, and Pukekohe, New Zealand, with one further trial established in a commercial cauliflower crop in Pukekohe (Table 1). Prior to the first application, trials Pukekohe 1 and 2 and Manawatu 1 were not treated with insecticide, while Manawatu 2 was sprayed with insecticides by the grower.

Trials were of randomised complete block design with four replicates and an individual plot size of 12 - 15 m^2. Each plot contained 3 rows of cabbages. Treatments were applied using compressed air small-plot sprayers, with hand held booms fitted with four hollow cone nozzles, at 38 or 50 cm centres, delivering 470 - 500 litres/ha at 300 - 400 kPa. Four to six consecutive applications of spinosad (6-96 g/ha - Success Naturalyte, Dow AgroSciences) and deltamethrin (10 g/ha - Decis Forte, BASF), at 6-10 day intervals, were made from 3-7 weeks post-transplanting until harvest. All treatments included a non-ionic wetting agent (Citowett, BASF). Fungicides appropriate for disease prevention were applied to all plots including untreated.

TABLE 1: Details of trials.

Trial No.	Location	Brassica and variety	Transplant date	Application date	Spray interval (days)	Harvest date
Puke 1	Pukekohe	Sovereign: Cabbage	10 Nov 96	27 Dec 96		07 Feb 97
				06 Jan 97	10	
				15 Jan 97	9	
				23 Jan 97	8	
				31 Jan 97	8	
Puke 2	Pukekohe	All year Hybrid: Cauliflower	10 Nov 96	27 Dec 96		06 Feb 97
				06 Jan 97	10	
				14 Jan 97	8	
				23 Jan 97	9	
				30 Jan 97	7	
Man 1	Manawatu	Summer globe: Cabbage	07 Jan 97	30 Jan 97		25 Mar 97
				07 Feb 97	8	
				17 Feb 97	10	
				26 Feb 97	9	
				08 Mar 97	10	
				14 Mar 97	6	
Man 2	Manawatu	Summer globe: Cabbage	07 Jan 97	17 Feb 97		25 Mar 97
				26 Feb 97	9	
				08 Mar 97	10	
				14 Mar 97	6	

Control of DBM, white butterfly and leaf miner (*Scaptomyza* sp.) was assessed by counting the number of larvae on 10-20 plants in the central row of each plot, 2-11 days after each application. White butterfly larval assessments were made in the Manawatu trials only. At harvest, 10 plants per plot were assessed for commercial acceptability (nil damage/infestation of cut and trimmed plants as submitted by grower, to the market for sale).

Data were analysed by 2 way ANOVA using LSDs to separate means. Means in the same column that are accompanied by the same letter are not significantly different at the 95% level of probability.

RESULTS AND DISCUSSION

Effect of spinosad on diamondback moth larvae

Levels of DBM larvae varied throughout the season in all trials, but generally were not high (1.9-7.3 per 10 plants). Assessments from each trial which clearly demonstrated product efficacy, relative to untreated, are presented in Tables 2-3 below.

TABLE 2: Mean number of Diamond Back Moth larvae per 10 cabbages after broadcast applications of spinosad in the Manawatu and Pukekohe.

		Manawatu 1				Man 2	Pukekohe 1		
Treatment	Rate (g ai/ha)	Pre-trt 29/1/97	7Daa1[1] 6/2/97[2]	7Daa4 5/3/97	11Daa6 25/3/97	10Daa4 24/3/97	Pre-trt 24/12/96	5Daa4 28/1/97	7Daa5 7/2/97
Spinosad	6	2.7a	0.3b	0.8b	1.0b	0.3ab	2.1a	1.3b	1.4bc
	12	1.3a	0.3b	2.8b	0.6b	0.0b	2.0a	1.0bc	1.0bc
	24	2.8a	0.0b	0.8b	0.6b	0.0b	2.3a	1.0bc	1.0bc
	48	2.9a	0.0b	3.0b	0.0b	0.0b	1.8a	0.3c	0.5c
	96	3.2a	0.0b	2.0b	0.0b	0.0b	2.3a	0.5bc	0.8c
Deltamethrin	10	3.6a	0.8b	0.5b	0.3b	0.3ab	2.4a	1.0bc	2.0b
untreated		2.7a	2.3a	7.3a	2.3a	2.5a	2.3a	2.3a	5.0a

[1]Daa = days after application: 7Daa1 = 7 days after application 1 etc.
[2]Date of assessment.

TABLE 3: Mean number of Diamond Back Moth larvae per 10 cauliflowers after broadcast applications of spinosad in Pukekohe.

Treatment	Rate (g ai/ha)	Pre-trt 24/12/96	3DAA1[1] 30/12/96[2]	4DAA4 27/1/97	7DAA5 6/2/97
Spinosad	6	1.9a	2.3ab	1.8b	1.8b
	12	2.0a	1.5b	1.3bc	1.5bc
	24	1.8a	1.8b	1.0bc	1.3bc
	48	1.8a	1.1b	0.5c	0.5c
	96	2.0a	1.3b	0.5c	0.8bc
Deltamethrin	10	2.0a	1.3b	0.5c	1.8b
Untreated		1.9a	3.0a	3.0a	6.8a

[1]DAA = days after application: 7DAA1 = 7 days after application 1 etc.
[2]Date of assessment.

Tables 2 and 3 show the populations of DBM larvae were uniform prior to the first application, and peaked in February in Pukekohe and March in the Manawatu. All treatments reduced the number of DBM larvae compared to untreated. Little or no dose response from increasing rates of spinosad was probably the result of relatively low pest populations (Dow AgroSciences, pers. comm.*)*. Spinosad (12-96 g/ha) consistently gave control equivalent to deltamethrin (10 g/ha).

Effect of spinosad on white butterfly larvae

White butterfly were not encountered in the Manawatu until March. Table 4 shows infestation levels were moderate at this time. All treatments reduced numbers relative to untreated. At 11DAA6 in trial Manawatu 1, a dose response from increasing rates of spinosad was visible. Spinosad (12-96 g/ha) gave control equivalent to deltamethrin (10 g/ha).

Effect of spinosad on leaf miner larvae

In the Manawatu trials, leaf miner larvae numbers were not high until the final assessment. Table 5 shows control of leaf miner larvae increased with the rate of spinosad. Spinosad (12-96 g/ha) reduced the number of leaf miner larvae compared to untreated and gave control equivalent to deltamethrin (10 g/ha).

TABLE 4: Mean number of white butterfly larvae per 10 cabbages after broadcast applications of spinosad in the Manawatu.

Treatment	Rate (g ai/ha)	Manawatu 1 7DAA4[1] 5/3/97[2]	Manawatu 1 11DAA6 25/3/97	Manawatu 2 10DAA4 24/3/97
Spinosad	6	0.0b	3.5b	0.5b
	12	0.0b	0.6bc	0.0b
	24	0.0b	1.8bc	0.8b
	48	0.0b	0.5c	0.3b
	96	0.0b	0.0c	0.0b
Deltamethrin	10	0.0b	0.8c	0.0b
Untreated		3.0a	16.0a	19.0a

[1]DAA = days after application: 7DAA1 = 7 days after application 1 etc.
[2]Date shown is date of assessment.

TABLE 5: Mean number of leaf miner larvae per 10 cabbages after broadcast applications of spinosad in the Manawatu.

Treatment	Rate (g ai/ha)	Manawatu 1 11DAA6[1] 25/3/97[2]	Manawatu 2 10DAA4 25/3/97
Spinosad	6	2.8bc	3.0ab
	12	3.3b	1.5bc
	24	2.5bc	0.8bc
	48	0.3c	0.3c
	96	0.3c	0.3c
Deltamethrin	10	0.8bc	0.8bc
Untreated		7.5a	5.5a

[1]DAA = days after application: 7DAA1 = 7 days after application 1 etc.
[2]Date shown is date of assessment.

TABLE 6: Percentage of commercially acceptable brassica heads[1] at harvest following treatment of lepidopterous/leaf miner larvae with spinosad.

Treatment	Rate (g ai/ha)	Manawatu1	Manawatu 2	Pukekohe1	Pukekohe 2
Spinosad	6	93ab	95a	75b	88b
	12	100a	100a	82bc	95bc
	24	98ab	100a	96c	97bc
	48	100a	100a	96c	100c
	96	100a	98a	97c	100c
Deltamethrin	10	90b	98a	73b	92bc
Untreated		0c	35b	50a	65a

[1]Cabbage at Manawatu sites 1 and 2 and Pukekohe 1; Cauliflower heads at Pukekohe 2.

Effect of spinosad treatments on head quality

Table 6 shows percentage commercially acceptable brassica heads at harvest were low (0-65%) in the untreated, despite low to moderate infestation pressures from DBM and white butterfly in both Pukekohe and the Manawatu. All rates of spinosad increased the yield of commercially acceptable brassica heads compared to untreated. In Pukekohe trials, a dose response from increasing rates of spinosad was visible.

Spinosad (48 g/ha) gave a level of commercially acceptable brassica heads that was consistently equivalent to or greater than deltamethrin (10 g/ha). This suggested DBM larvae present in these trials were less well controlled by, and may have been resistant to deltamethrin. However, this was not obvious from larval assessments. These results are very similar to percentage of commercially acceptable heads obtained in trials undertaken in the 1998/99 season (unpublished data, Dow AgroSciences).

Crop injury

Four to six consecutive applications of spinosad (6-96 g/ha) at 7-10 day intervals produced no visual signs of phytotoxicity to cabbages or cauliflowers in any trial.

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