Evaluation of Clothianidin Seed Treatments for Bagrada Bug Control in Broccoli

John Palumbo, Yuma Ag Center

The bagrada bug, *Bagrada hilaris,* has become a serious economic pest of brassica crops in Arizona and southern California. Its feeding damage on broccoli can result in excessive seedling mortality, and on established plants can result in malformed plants which are not commercially marketable. Growers and PCAs have estimated that bagrada bugs have infested more than 80% of the acreage in Arizona and southern California from 2010 to 2014, resulting on average in more than 10% stand losses and plant injury to direct-seeded broccoli crops. Consequently, preventing excessive feeding damage on newly-established crops is critical to economic broccoli production.

The potential for the pest to cause significant crop losses coupled with the lack of biological control alternatives has left little alternative but to control outbreak populations with foliar applied insecticides. Furthermore, because bagrada bug can quickly cause significant feeding damage to seedling plants, effective insecticide treatments applied in the field need to be quick acting. Currently, vegetable growers in Arizona and California rely heavily on frequent applications of pyrethroid insecticides to control adult infestations on seedling cole crops. Given the magnitude of pyrethroid usage historically applied to desert vegetable crops, alternative insecticides will be needed to protect desert cole crops from bagrada bugs and conserve the pyrethroid chemistry.

Among the newer classes of chemistry, foliar-applied neonicotinoids such as Venom/Scorpion (dinotefuron) have been shown to effectively control bagrada bug adults. In several studies, Venom/Scorpion applied to broccoli foliage provided significantly better plant protection against bagrada bug adults than Assail and Belay. In contrast, several field trials evaluating at-plant, soil systemic applications of neonicotinoids such as Admire Pro (imidacloprid), Belay (clothianidin) and Venom showed that this application approach did not prevent bagrada bug from damaging seedling broccoli plants. However, neonicotinoid seed treatments have been shown to provided preotection against bagrada bug. For example, in India, field trials showed that planting mustard seeds treated with imidacloprid resulted in significantly lower plant damage due to bagrada bug. Recently, broccoli seed treated with the neonicotinoid clothianidin (Nipsit®) has been made available for evaluation for control of bagrada bugs in the U.S. This report is a summary of the results of field trials conducted at the Yuma Ag Center from 2012-2014 that evaluated the effectiveness of Nipsit (clothianidin) seed treatments for preventing bagrada bug feeding damage and yield loss in broccoli.

Experimental Methods

Broccoli seed treated with clothianidin was direct seeded each year in early September into plots four beds wide by 45 ft long. Stand establishment was achieved using overhead sprinkler irrigation, and irrigated with furrow irrigation thereafter. Four replications of each treatment were arranged in a RCB design. Rates for each seed treatment are provided in the tables. Treatment information specific for each trial is provided below. To eliminate confounding effects from beet armyworm and cabbage looper damage, all plots were sprayed with Intrepid (12 oz/ac) or Belt (2.2 oz/ac) when needed. At 28 DAE, all plots including the untreated check, were over-sprayed every 7-10 d until harvest to prevent further damage from bagrada bug, Lep larvae and whiteflies using combinations of Radiant (5 oz), Coragen (5 oz), Movento (5 oz), Venom (4 oz) and Brigade (5.2 oz).

Evaluations of Bagrada bug control was estimated by carefully examining all plants in two, 3 ft sections of bed in each replicate for the presence of live adults on leaves, petioles and stems, as well as on the soil surface beneath each plant at 2-7 day intervals after plant emergence (DAE). Adult numbers presented in tables were averaged over a sample 21 day period. In addition, the number of plants in each sampled replicate that showed signs of recent feeding damage was recorded by inspecting the terminal growth, cotyledons, young leaves on each plant for fresh feeding signs that appeared as pale, starburst-shaped lesions on foliage where *B. hilaris* adults prefer to feed. Stand densities were estimated by counting all plants within each sample area. Just prior to thinning, and again following thinning, evaluation of terminal damage to broccoli plants was estimated by counting all plants that were blind or had multiple terminals in two 3 ft sections of each bed in each replicate. Flea beetle damage and whitefly densities were estimated in each replicate at 7 and 21 DAE, respectively. Yield estimates were taken by harvesting all commercially marketable crowns in each replicate on three harvest dates. The response variables, fresh feeding damage, terminal damage and flea beetle damage, were subjected to an arcsine transformation before analysis to meet the assumptions of analysis of variance. Treatment means were separated using the Tukey (or Bonferroni) adjustment in LSMEANS at $\alpha = 0.05$. Regardless of transformations, the original non-transformed data are presented in the figures and tables.

2012 Trial

Pelleted broccoli seed 'Express' was planted at a rate of 0.12 and 0.10 mg A.I. /seed of clothinaidin and thiamthoxam respectively. on Sep 6, 2012 at a 3" spacing. Measurements of fresh feeding damage were made at 3-7 DAE. Pre-thinning estimates of terminal damage were made at 15 DAE, and post-thinning estimates were made at 21 DAE. Stand counts were taken at 3, 7, and 14 by counting all the plants in 2*3 row ft sections from each plot (Data not shown).

Results

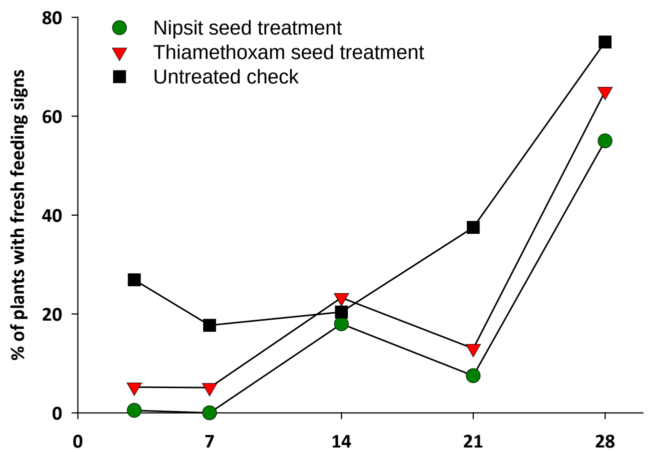
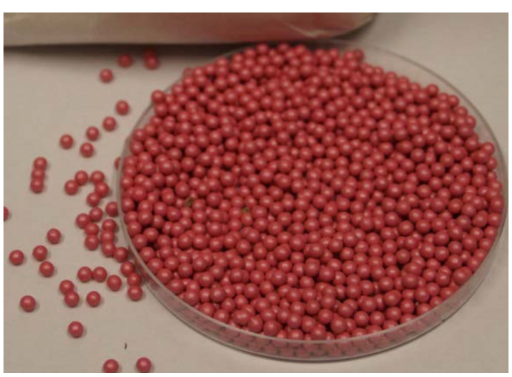


Fig 1. Feeding damage on broccoli at stand establishment, fall 2012

Table 1. Bagrada bug feeding damage on broccoli seed treatments, 2012.

Treatment (mg ai/seed)	Adults / 3 ft	Terminal Damage (% plants)	
		Pre-thin	Post-thin
Nipsit - 0.12	0.4b	1.1b	5.0b
Thiamethoxam - 0.10 mg	1.0ab	13.3a	37.5a
Untreated	2.3a	19.8a	32.5a



Pelleted broccoli seed treated with clothianidin

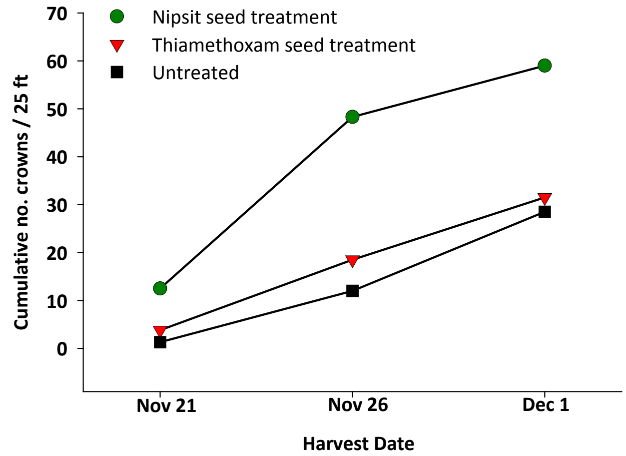


Fig 2. Yield responses to seed treatments and bagrada bug feeding, fall 2012

Table 2. Efficacy of broccoli seed treatments on flea beetle and whitefly nymphs, 2012.

Treatment (mg ai/seed)	Flea Beetle Damage (% plants)	Whitefly nymphs / cm2 / leaf
	7 DAE	21 DAE
Nipsit - 0.12	0.0b	1.8b
Thiamethoxam - 0.10	1.0b	1.2b
Untreated	7.0a	4.6a

Summary

Stand counts showed no differences in plant stand among the treated and untreated seed. Feeding damage on seedling plants was significantly lower in the Nipsit and thiamethoxam seed treatments compared to the untreated check, but did not differ from the check at 14 DAE (Fig 1) . Adult bagrada bug numbers were consistently lower in the Nipsit treatment which provided significantly better protection of plant terminals (Table 1). Yields were significantly greater at each harvest in the Nipsit treatment (Fig 2). These results suggest that this Nipsit seed treatment provided control of bagrada bugs for 14-21 d without additional foliar control. Although flea beetle and whitefly pressure was light to moderate, both Nipsit and thiamethoxam treatments significantly reduced their numbers compared to the untreated check.

2013 Trial

Pelleted broccoli seed 'Express' was planted at a rate of 0.12 and 0.15 mg A.I. /seed of clothinaidin on Sep 6, 2013 at a 3" spacing. Two additional treatments were included: a foliar standard of alternations of Brigade +Venom and Asana +Assail applied four times (Fig1), and a 3 " soil surface band of Capture LFR (8.5 oz/ac) applied over each seedline after planting and prior to sprinkler irrigation. Estimates of fresh feeding damage, Pre-and post-thinning terminal damage, and stand counts were taken similar to 2012.

Results

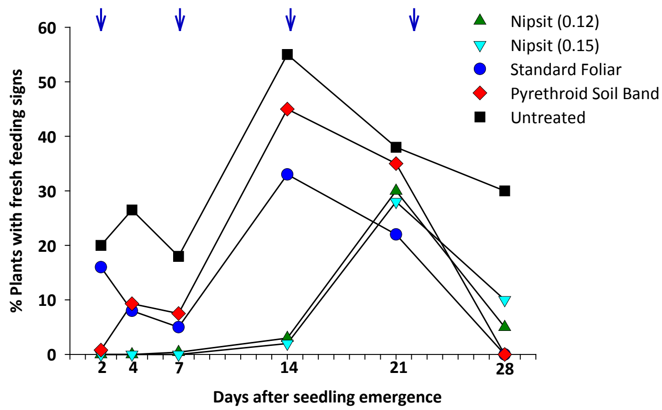


Fig 3. Feeding damage on broccoli at stand establishment, fall 2013 (arrows indicate time of foliar sprays)

Table 3. Bagrada bug feeding damage on broccoli seed treatments, 2013.

Treatment (mg ai/seed)	Adults / 3 ft	Terminal Damage (% plants)	
		Pre-thin	Post-thin
Nipsit (0.12)	0.4b	0.0c	2.5b
Nipsit (0.15)	0.5b	0.0c	0.0b
Foliar Standard	1.6a	3.8c	10.0ab
Pyrethroid Soil Band	1.9a	20.8b	22.5a
Untreated	1.5a	45.3a	32.5a

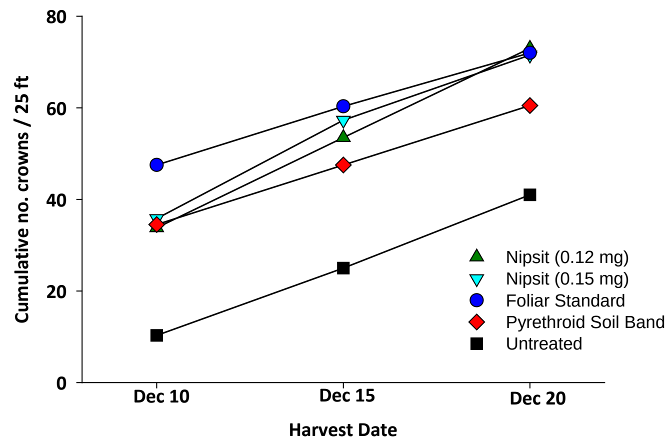


Fig 4. Yield responses to seed treatments and bagrada bug feeding, fall 2013

Table 4. Efficacy of broccoli seed treatments on flea beetle and whitefly nymphs, 2013.

Treatment (mg ai/seed)	Flea Beetle Damage (% plants) 7 DAE	Whitefly nymphs / cm2 / leaf 21 DAE
Nipsit (0.12)	0.0b	8.3b
Nipsit (0.15)	0.0b	10.1b
Foliar Standard	0.0b	4.2b
Pyrethroid Soil Band	2.3ab	22.8a
Untreated	5.5a	20.9a

Summary

In the 2013 trial, stand counts showed no differences in plant stand among the insecticide treatments and untreated check. Fresh feeding damage was initially lowest (2 DAE) in the seed treatments and the pyrethroid soil band; however only the Nipsit seed treatments maintained damage at low levels at 7 and 14 DAE (Fig 3). By 21 DAE, feeding damage had increased significantly in all treatments and was not different from the check. Adult bagrada bug numbers were significantly lower in the Nipsit treatments than all other treatments, and the seed treatments provided minimal terminal damage when measured at both pre- and post-thinning samples. (Table 3). The foliar standard provided protection comparable to the seed treatments. Yields were significantly greater at the first harvest in the foliar standard, but on the final two harvest yields did not differ between the Nipsit treatments and the foliar standard (Fig 2). Similarly, the Nipsit and Foliar standard significantly reduced flea beetle damage and whitefly densities compared to the untreated check (Table 4). These results suggest that this Nipsit seed treatment provided a solid 14 d of control of bagrada bugs for 14 d (2 leaf stage). Increased rates of feeding measured in the seed treatments at 21 DAE did not result in excessive terminal damage.

2014 Trial

Pelleted broccoli seed 'Emeral Crown' was planted at a rate of 0.12 and mg A.I. /seed of clothinaidin on Sep 6, 2013 at a 3" spacing. Additional treatments included treated seed with: 1) a 3 " soil surface band of Capture LFR (8.5 oz/ac) applied over each seedline; 2) Admire Pro at (10.5 oz/ac) applied at-planting; 3) a foliar standard of alternations of Brigade and Brigade+Venom five times (Fig1), and a treatment of non-treated seed that received both Admire Pro and the Foliar sprays.Estimates of fresh feeding damage, Pre-and post-thinning terminal damage, and stand counts were taken similar to 2012 and 2013.

Results

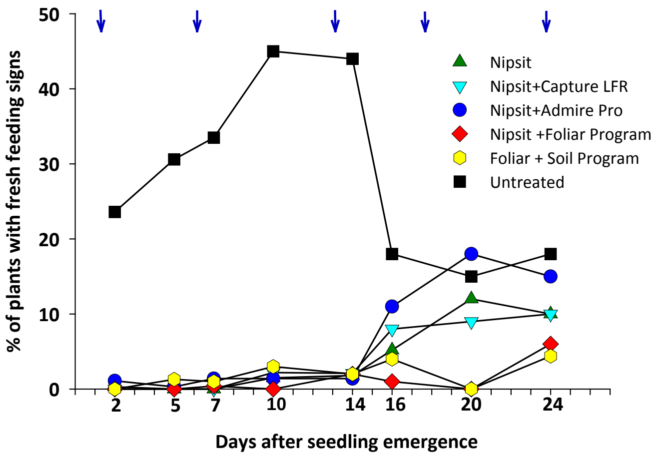


Fig 5. Feeding damage on broccoli at stand establishment, fall 2014 (arrows indicate time of foliar sprays)

Table 5. Bagrada bug feeding damage on broccoli seed treatments, 2014.

Treatment (mg ai/seed)	Adults / 3 ft	Terminal Damage (% plants)	
		Pre-thin	Post-thin
Nipsit (1.2)	0.3b	1.9b	2.6b
Nipsit + Capture LFR	0.1b	1.3b	1.3b
Nipsit + Admire Pro	0.4b	1.4b	5.1b
Nipsit + Foliar Program	0.0b	1.7b	1.3b
Foliar + Soil program	0.1b	2.2b	1.3b
Untreated	1.3a	45.8a	43.3a

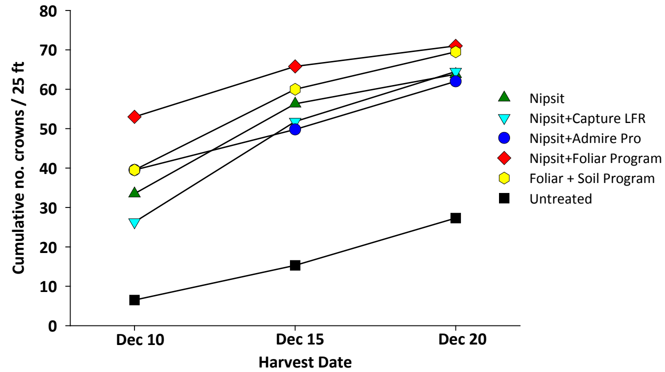


Fig 6. Yield responses to seed treatments and bagrada bug feeding, fall 2014

Table 6. Efficacy of broccoli seed treatments on flea beetle and whitefly nymphs, 2014.

Treatment (mg ai/seed)	Flea Beetle Damage (% plants) 7 DAE	Whitefly nymphs / cm2 / leaf 21 DAE
Nipsit (1.2)	0.4b	0.7a
Nipsit + Capture LFR	0.4b	0.6a
Nipsit + Admire Pro	0.4b	0.2a
Nipsit + Foliar Program	0.0b	0.5a
Foliar + Soil program	0.4b	0.3a
Untreated	11.5a	1.5a

Summary

In the 2014 trial, again stand counts showed no differences in plant densities among the insecticide treatments and untreated check. Fresh feeding damage was significantly low in all Nipsit treatments up to 14 DAE and increased in the Nipsit only treatment thereafter. The Nipsit+Foliar sprays and Foliar+Soil standard maintained feeding damage at the lowest levels overall (Fig 5). All Nipsit treatments reduced both adult bagrada and terminal damage comparably to the foliar and soil program (Table 5), and at levels well below the untreated check. Cumulative yields varied among treatments, but did not differ among treatments on the final harvest (Fig 6). Similarly, the all the Nipsit treatments and Foliar standard significantly reduced flea beetle damage, but whitefly numbers were very light and no differences were detected among seed treatments and the check (Table 6).

Conclusions

Based on these trials, the clothianidin seed treatment (Nipsit®) appears to be a viable option for control of bagrada bugs on broccoli. A grower should expect consistent protection of seedling for 14 DAE (2-3 leaf stage), and perhaps longer under lighter infestations. In addition, the Nipsit treatments controlled flea beetle for 7 days and provided whitefly suppression. Including a pyrethroid or neonicoitinoid with foliar sprays targeted at early worm control should enhance bagrada bug control.