Development of Management Programs for White Grubs in California Blueberries

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Introduction

The white grub larval stages of *Cyclocephala* spp. are recognized throughout much of the world as pests of turfgrass (Potter 1998). Within turf, the grubs thrive in an environment containing shallow roots, high organic matter and high moisture. Until recently in California, white grubs were rarely considered pests outside of turf. However, the introduction of southern highbush blueberry production in California has allowed white grubs to expand their host range and status as a pest.

Southern highbush blueberries provide an excellent host environment for white grubs, because it is similar to the turf environment with shallow roots, high moisture, and high organic material. The first several years of production, there was little to no recognition of grubs as a pest. However, in 2007, growers recognized them as a pest in newly planted fields adjacent to mature fields.

So, in 2007, we began efforts to identify the grub pest attacking California blueberries in the San Joaquin Valley. The grub was identified as *Cyclocephala longula* LeConte. *Cyclocephala longula* was reported by Saylor as being a widely distributed species, known from Oregon, Arizona, Utah, and extremely common throughout California.

Materials and Methods

Grub Biology: Determine the characteristics of June beetle flight and life stages in the soil prior to and after the June flight.

- Black-light traps were placed from 13 May to 12 July 2007 in Mettler, CA (Kern Co.) and 2 June to 11 August 2009 in Richgrove,CA (Tulare Co.).
- On 15 June 2009, four black-light traps were placed in four adjacent blueberry fields in Richgrove, CA (Kern Co.) from 20:30 hr and evaluated in 30-min intervals until activity stopped.
- *C. longula* life stages were collected on 6 May, 2 June, and 13 July 2009.

Grub Management Observational Trial: Determine the effectiveness of a commercial application of the entomopathogenic nematode, *Heterorhabditis bacteriophora* Poinar, to a 40 ha commercial blueberry field.

- Terranem™ was applied on 1 April 2009 at a rate of 1 billion infective juveniles per ha with soil temperatures ~15°C.
- Evaluations were conducted on 6 May from the cages and additional sampling on 2 June, 13 July, and 6 Aug

Grub Management Replicated Trial: Determine the effects of imidacloprid (Admire® Pro) and Terranem™ on 1st and 2nd instar larvae populations.

- Randomized Complete Block Design with 4 blocks and 2 treatments and an Untreated Check with plot sizes 200 m long by one row wide (~220 blueberry bushes).
- Two drip lines on top of berm with emitters spaced at 0.41 m with a flow rate of 0.95 l/hr.
- Admire® Pro at a rate of 167 ml/ha was applied on the 13 August 2009 with a 24-hr preirrigation, followed by 84 ml of product, then a 20- hr irrigation followed by 84 ml.
- Terranem™ at a rate of 1 billion *Heterorhabditis bacteriophora* infective juveniles/ha was applied on the 13 August 2009 by splicing the drip lines and injecting the nematodes with an Air Driven Diaphragm Pump which was mixed with 15 l of water and injected over a period of 20 minutes following a 12-hr preirrigation and then a 12-hr postirrigation.
- Evaluations were conducted the following spring on 10 June 2010.

Results

Grub Biology

- Spring Beetle Flight started ~1 week into June until 1 August with the highest number of beetles flying in a 3-week period from the 9 to 30 June (Figure 1).
- Beetle catches were 97% *C. longula*
- During the evening flights the greatest amount of beetles were captured between 21:00 to 21:30 hr and 21:30 to 22:00 hr (Figure 2).
- Field collections of life stages in the soil prior to and just after flight were consistent based on the flight (Table 1).

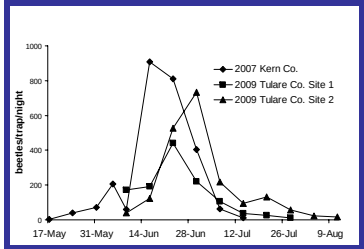

Figure 1. Per night beetle catches in black-light Traps at three sites in the lower San Joaquin Valley.

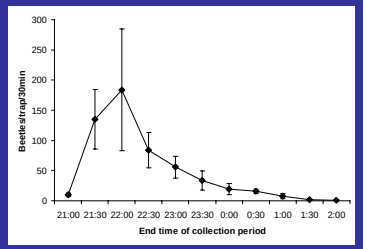

Figure 2. Beetles collected during 30-min periods From 20:00 to)1:30 hr on 15 June 2009.

Table 1. Percentage life stages in soil prior to and just after spring flight.

6 May		2 June		13 July	
70.7%	3rd instar larva	85.5%	Teneral/young adults	14.7%	adults
29.3%	pupae	4.0%	pupae	22.7%	eggs
		10.7%	Larvae	55.7%	1st instar larvae
				6.8%	2nd instar larvae

Grub Management Observational Trial

- On 6 May, 8.3% of the larvae were infested with *Heterorhabitis bacteriophora*, 25% were dying but nematodes could not be confirmed, 66.7% were healthy.
- On 2 June 88.2% of the larvae expressed typical signs of *H. bacteriophora* infection. When dissected 72% were infected and 16.2% appeared to be dead by *H. bacteriophora* but the nematodes had already emerged from the host.
- On 2 June adult beetles that were collected 57.8% were live and healthy and 42.2% were dead and of that percentage 59.2% were infested with *H. bacteriophora*.
- On 2 June all pupae were live and healthy.
- On 3 July 12.3% of the 1st instar larvae and 16.7% of the 2nd instar larvae contained *H. bacteriophora*.
- No beetles were collected in August after a 3 hour search.

Grub Management Replicated Trial

•Table 2 illustrates that treatments with *H. bacteriophora* and Admire® Pro were significantly different from the untreated check. The *H. bacteriophora* treatments were numerically lower than Admire® Pro.

Table 2. The effects of fall 2009 treatments on larvae density in June 2010.

Treatment	Rate per treated ha	Average ± SEM	
		No. larvae per ten plants	Percentage excavation holes with larvae
Admire® Pro	167ml	5.5 ± 1.9 a	16.3 ± 1.3a
Terranem™	1 billion infective juveniles	3.5 ± 1.3a	12.5 ± 3.2a
Untreated Check	--	19.0 ± 4.3b	42.5 ± 4.3b
F		29.76	17.69
df		2,6	2,6
P		0.0008	0.0030

Means in a column followed by the same letter are not significantly different (P > 0.05, Fisher's protected LSD)

Discussion

Surveys of beetle stages present in the ground coupled with black-light trap catches documented that *C. longula* are 3rd instar in April then transition to pupae through May, and adults from mid-June to mid-July and produce eggs to hatch by early August. Data showed that adults begin flying about 30 min after dark and can be collected for a period of two to two and half hours.

Treatments of *H. bacteriophora* were documented in this project to be an effective tool in management programs for *C. longula* as 1st to 3rd instar larvae. This is in contrast with Polavarapu et al. (2007) results were it showed lack of effectiveness of *H. bacteriophora* against 3rd instar larvae of *Anomala orientalis*, the oriental beetle.

Insecticide treatments in August with imidacloprid were also documented to be effective against 1st-2nd instar larvae of *C. longula*. This is also the recommendations for turf (Flint et al. 2009). This timing also would not be detrimental to any *Tiphia* sp. parasitoids that are found in California (Flint et al. 2009) and may or may not begin to provide biological control of *C. longula* in commercial blueberries as they do in other hosts (Rogers and Potter 2003).

Combining all of this information, California blueberry growers should have the basic tools to successfully monitor for *C. longula* and should be successfully reduce pest populations to levels below economic damage.

Literature Cited

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