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CONTROLLING PASTURE MOLE CRICKETS WITH NEMATODES

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ABSTRACT: Several bahiagrass (*Paspalum notatum*) pastures in south Florida have been destroyed by non indigenous mole crickets (Orthopthera: Gryllotalpedae: *Scapteriscus* spp.). 'Pitfall' traps were installed on damaged pastures in July 1997 and weekly numbers of trapped mole crickets were recorded through December 2000 and used to develop mole cricket population histories. The mole cricket nematode (*Steinernema scapterisci)* was applied in strips to cover 1/8, 1/4, and ½ the area of different pastures in May and September 2000, and in March and April 2001 to determine the best procedures and times for using the nematode. An exponential curve (Gaussian, 3 Parameter) best described the weekly incidence of immature (nymphs and juveniles) mole crickets in bahiagrass pasture. Mole cricket eggs usually begin to hatch in May and the number of trapped nymphs reached a peak (average = 23 nymphs/week) in July and then dropped sharply. Preliminary data showed a reduction in peak incidence of immature mole crickets after applying the nematodes in experimental plots, regardless of strip treatment. Percentage of trapped mole crickets that were infected with nematodes ranged from 86% for the ½ area treatment to 41% for the control on 4 April 2001 sample date. These levels of infection clearly indicate that the nematode has become established across entire pasture and is reproducing and killing mole crickets.

INTRODUCTION

Non-indigenous mole crickets *Scapteriscus* spp. (Scudder) cause serious damage to pasture, lawn and crops in Florida. It is estimated from a survey by the South Florida Beef and Extension Program (1998) that nearly $45 million revenue is lost annually to cattle producers in south central Florida as result of reduction in hay and forage production by mole crickets damage and an extra $10 million/year spent on pasture renovation.

All three pest mole crickets found in Florida: 'Tawny', *S. vicinus* (Scudder), 'Southern', *S. borellii* (Giglio-Tos) and 'Short-winged', *S. abbreviatus* (Scudder); were inadvertently introduced into either ports of Georgia, South Carolina or Alabama from South America in ship's ballasts in the early 1900s (Walker, 1981). From these points of introduction, the Tawny and Southern mole crickets spread westwards and southwards and by 1960 had covered the entire state of Florida (Walker and Nickle, 1981).

Mole crickets spend nearly all their year-long life cycle underground (Walker, 1984), making population sampling in the field very difficult. Eggs are laid in clutches in underground chambers. Nymphs tunnel to the surface and feed in the upper soil and litter. Juveniles and adult make and occupy extensive tunnel systems. In south and central Florida, tawny mole cricket has one generation per year but the southern mole cricket has two generations annually (Walker 1984). It is only during their peak mating flights in early spring to late summer that pest mole crickets are conspicuous to the casual observer.

Mole cricket damage to pasture and turfgrass is principally due to feeding by tawny mole crickets (Hudson, 1984). At night, crickets usually leave their borrows to feed on above-ground plant parts, biting off stems and leaves, which are dragged into their burrows to be eaten, whereas roots may be eaten at any time. Mechanical damage to plants is caused by the tunneling activity of mole crickets and is the principal detrimental effect of southern mole crickets on pasture. Damaged pasture first appears as yellow in small or big patches which die and turn brown. In areas of high mole cricket population density, the surface 20 to 25 cm soil layer is honeycombed with numerous tunnels and ground feels spongy when stepped on. Heavily damaged pasture grass has virtually no root system and is easily pulled from the soil by cattle of foot traffic.

Three basic sampling techniques for monitoring mole crickets have been described (Hudson 1988) although none has overcome the basic obstacle of showing good correlation with true population density. These sampling techniques are sound traps for flying adults (Walker, 1982), linear pitfall traps for monitoring the activity of immature mole crickets (Lawrence, 1982) and soil flushing for both classes (Short and Koehler, 1979). More than 15-yr data has been collected around Gainesville and Bradenton urban areas on adult pest mole crickets flights with sound traps (Walker, 1994). However, adult mole crickets could fly over long distances and sound trap numbers may not reflect mole cricket seasonal distribution on specific ranches

This study was designed to 1) use permanently set pitfall traps to monitor the long-term seasonal abundance of immature mole crickets on pasture in relation to rainfall and pasture damage. 2) Use population histories developed as baseline to evaluate the efficacy of biological control with mole cricket nematodes.

MATERIALS AND METHODS

The study was conducted on selected ranches in south central Florida with severe initial mole cricket damage symptoms. In July 1997, six pitfall traps were installed on a 4-ha bahiagrass pasture at two heavily infested ranches in the Green Swamp area of Polk County and one each in Manatee and Pasco counties. The same number of traps were set on newly-established, healthy pastures in Desoto and Highlands counties and on .two pastures at the Range Cattle Research and Education Center (RCREC), Ona in Hardee county.

Traps at each site were labeled 1-6 in decreasing slope and were cleaned weekly from July 1997 through December 1999. At cleaning, trapped tawny and southern mole crickets in each trap were counted. Development of immature mole crickets was monitored at one site in the Green Swamp area by measuring the length of the pronotum of 20 trapped mole crickets monthly. Amount of weekly rainfall was recorded for the two Green Swamp sites in Polk County, the Manatee, and Pasco sites. Pasture on damaged sites was rated as to percentage yellow, dead brown, and bare ground/weeds, every spring using a divided m^2 quadrat. The quadrat had 100 divisions, each representing a percentage point, and was thrown randomly to twenty locations on the 4-ha field.

Nematodes (*Steinernema scapterisci (Ss))* were applied in September 2000 to one-acre centers of two-acre bahiagrass plots in strips to cover 0, 1/8, 1/4, and 1/2 of the plots. A modified sod-seeder was used to apply the nematodes to about one inch depth of the topsoil. The standard application rate of nematodes is one billion/A, but stripping allows for significant reduction in quantity applied/A. Following strip-application of nematodes in the field, weekly monitoring of trapped mole cricket number was continued through 2001. Additionally, every 28 d, samples of mole crickets were collected 24 hr after cleaning traps and taken to the laboratory and analyzed for nematode infection. This involved incubation of mole crickets that died in the laboratory at 28 °C for a period up to 14 d. The cadavers were then separately examined under the microscope at 50 X for the presence or absence of *Ss* nematodes.

Data on weekly trapped mole crickets were subjected to statistical analysis of variance (SAS 1989) with site as main plot and year and week as split and split-split plots in time, respectively, and traps as replicated blocks. Due to significant site x year interaction, weekly abundance of trapped mole crickets were fitted to week of the year, separately for each site, using SigmaPlot regression software (SPSS Inc 1997) that maximized regression coefficient of determination (R^2) and minimized standard error (SE). Comparisons of nematode strip-treatment effect on mole cricket abundance and of the level of nematode infection in mole crickets were made with analysis of variance and Fisher's LSD mean separation.

RESULTS AND DISCUSSION

Seasonal Dynamics of Juvenile Mole Crickets on Bahiagrass Pasture

Trapped mole cricket numbers varied depending on site of bahiagrass pasture ($P < 0.05$), year ($P < 0.001$) and week of the year (WOY) ($P < 0.0001$). The interaction between site and year also approached significance ($P < 0.10$). The 3-yr (1997-1999) mean weekly trapped mole crickets ranged from 10.1 to 12.4/trap for the two Green Swamp sites in Polk County, and the sites in Pasco and Manatee counties, but from 0.7 to 1.7/trap for the newly established bahiagrass pastures in Desoto and Hardee counties (Table 1). Sites that recorded annual mean weekly mole cricket numbers > 10 such as Combee, Clark, Nutts, and Harlee ranches also had pasture severe damage (yellow +dead/weeds) ranging from 49 to 72% (Table 2). Conversely, the lightly infested sites including Desoto and the RCREC stayed green in spring and showed little sward damage.

Weekly abundance of immature (nymphs and juveniles) pest mole crickets on damaged bahiagrass pastures over time within the year was best described by an exponential curve (Gaussian 3 Parameters) (Figs 1-4). Mole cricket eggs normally hatch in May-June (Walker, 1983), and the number of trapped nymphs on pasture reached a peak after the first major summer rainfall in June-July. The 3yr-mean peak trap counts ('a' value) were 23 on week (X_0) 30 for Combee ranch (Fig 1), 26 on week 25 for Clark ranch (Fig 2), and 40 on week 25 for Nutts ranch (Fig 3). On Harlee ranch (Fig 4), we experienced variable yearly patterns of weekly nymph abundance. A peak reaching over 100 nymphs/trap occurred in early July of 1997, a bimodal peak (June and September) averaging 45/trap in 1998, and a peak of only 20/trap in 1999. On these damaged fields also, at least one spike in mean weekly nymphs/trap exceeded 50 during the three year monitoring. Data on mole cricket numbers obtained during 2001 season will be compared to the previous 3-yr mean to evaluate the effectiveness of nematodes for biocontrol.

Preliminary data obtained in Spring 2001 from the Polk City trial indicate that mole crickets that were initially infected with the nematode have spread the nematode across the whole 24-acre pasture. Nematode infection level in trapped mole crickets was 80% or higher at ½ rate strip application, 60% at 1/4 rate, 50% at 1/8 rate and even 33% at 0 rate (Table 2). These results have persisted through June 2001(Table 3) which suggest that the targeted market price for *Ss* nematode on golf courses ($200/A) can be substantially reduced to $20-30/A using strip application on pasture. Field application cost would run similar to a bush-hog operation of $5-10/A. Grass recovery from previous damage has been slow because of weed infestation into damaged areas. Estimated basal grass cover changed from 43% in May 2000 to 50% in May 2001 and it may be necessary to reseed the damaged areas. However, recycling of nematodes in mole cricket population should result in long-term control of the pest and improve chances of grass recovery from re-seeding. For proper control, nematodes should be injected into the top inch of the soil, during the fall or spring adult mole cricket seasons, after a rainfall, at sundown, in areas where adult mole crickets are abundant.

SUMMARY

Pitfall traps were used to develop 3-yr population histories of pasture mole crickets in several south-central counties of Florida. The period June-July marked peak abundance of mole cricket nymphs on pasture. The efficacy of *Steinernema scepterisci* nematodes for controlling mole crickets was studied from strip filed inoculation of the nematode. Preliminary data showed a successful establishment of the nematode within the mole cricket population even with 1/8 area treatment. Classical biological control is a long-term, slow process and significant improvement in pasture condition is expected over time.

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Table 1. The effect of pasture site on 3-yr mean weekly mole cricket count/trap and corresponding pasture damage estimate.

County	Ranch	count/trap	Damage estimate, %		
			Green	Yellow	dead/weeds
Polk	A. D. Combee	10.1	45	4	51
Polk	George Clark	12.4			
Manatee	Harlee Farm	11.2	28	10	62
Pasco	Mary Nutts	11.0	51	37	12
Hardee	RCREC-71A	0.7	98	1.5	0.5
Hardee	RCREC-87	1.7	85	5	10
Desoto	Steven Houk	1.6	97	2	1.0
	LSD *P*=0.05	5.7	12	8	11

Table 2. Percentage of trapped mole crickets infected with Ss nematodes on 4/21/01 following application on 9/27/00.

Strip treatment	# trapped mole crickets	# mole crickets infected with Ss nematodes	% infection
½ area coverage	21	18	86
1/4 area coverage	19	16	84
1/8 area coverage	20	12	60
0 coverage	17	7	41

Table3. Percentage of trapped mole crickets infected with Ss nematodes on 5/18/01 following application on 9/27/00

Strip treatment	# trapped mole crickets	# mole crickets infected with Ss nematodes	% infection
½ area coverage	5	4	80
1/4 area coverage	7	3	43
1/8 area coverage	4	2	50
0 coverage	6	2	33

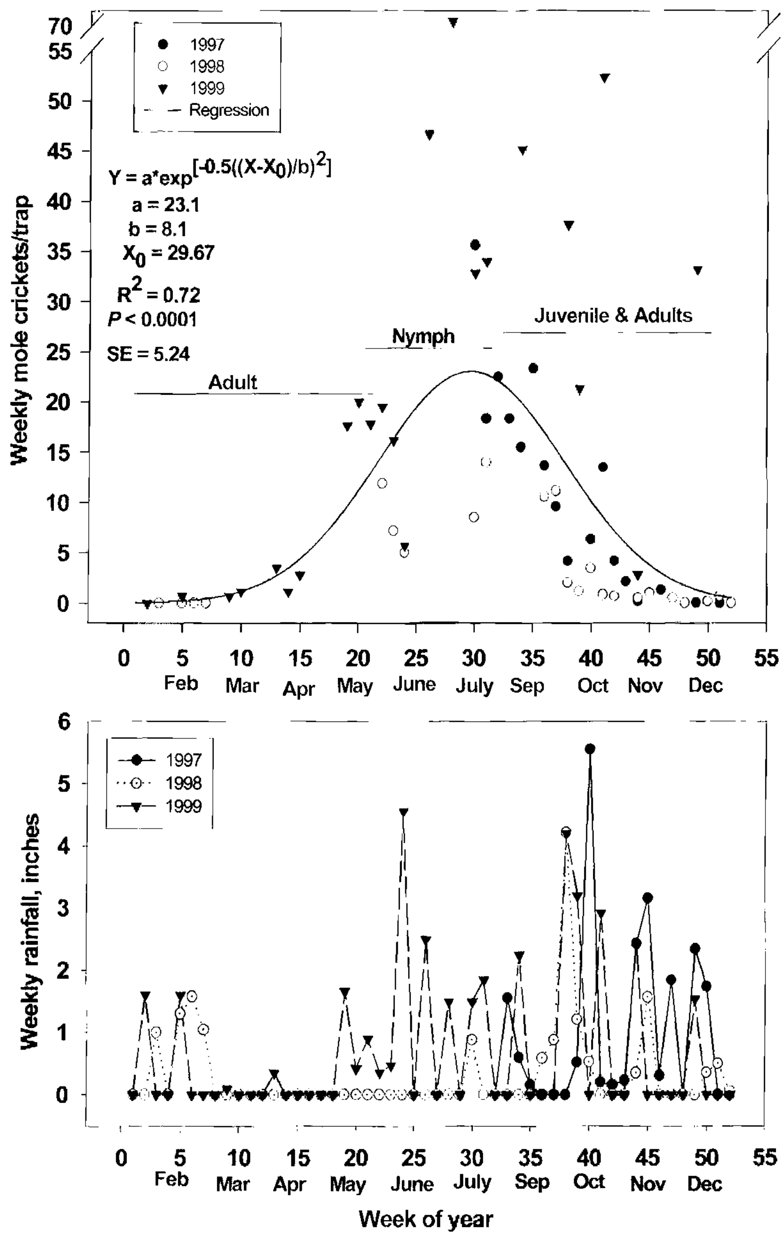

Figure 1. Mean weekly number of mole crickets trapped on A.D. Combee ranch in Polk county from 1997-1999 and weekly rainfall amount.

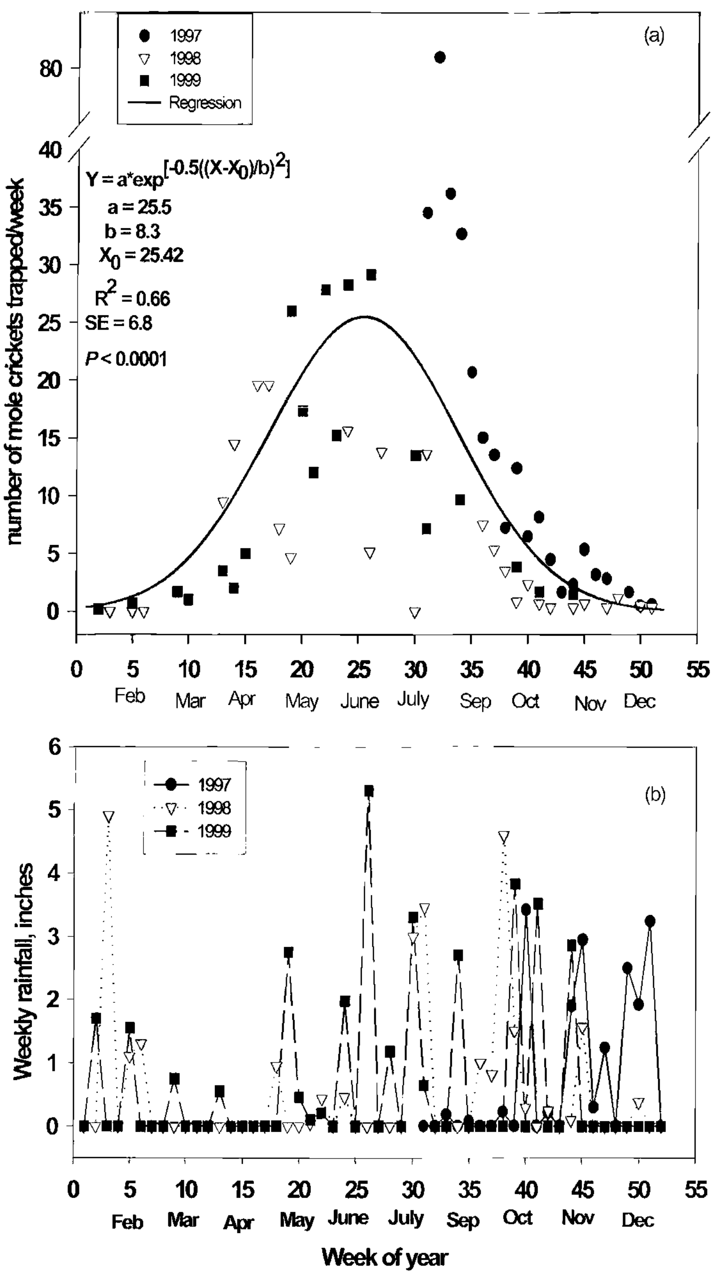

Figure 2. Mean weekly number of mole crickets trapped on Georg Clark's ranch in Polk county from 1997-999 and weekly rainfall amount.

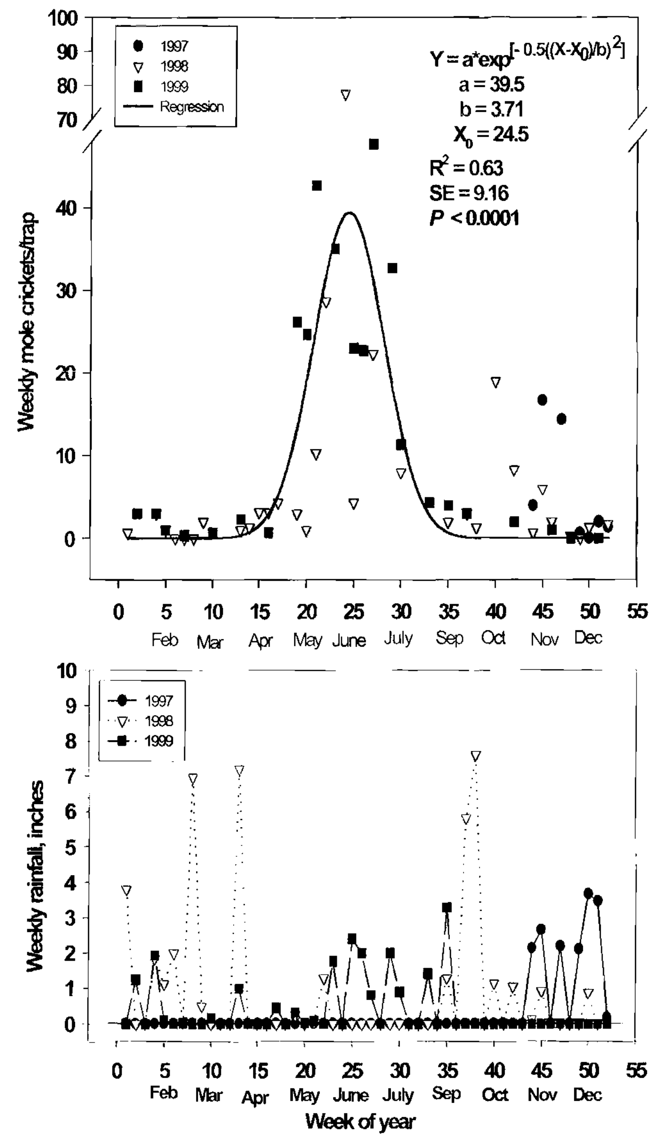

Figure 3. Mean weekly number of mole crickets trapped on Mary Nutt's ranch in Pasco county from 1997-999 and weekly rainfall amount.

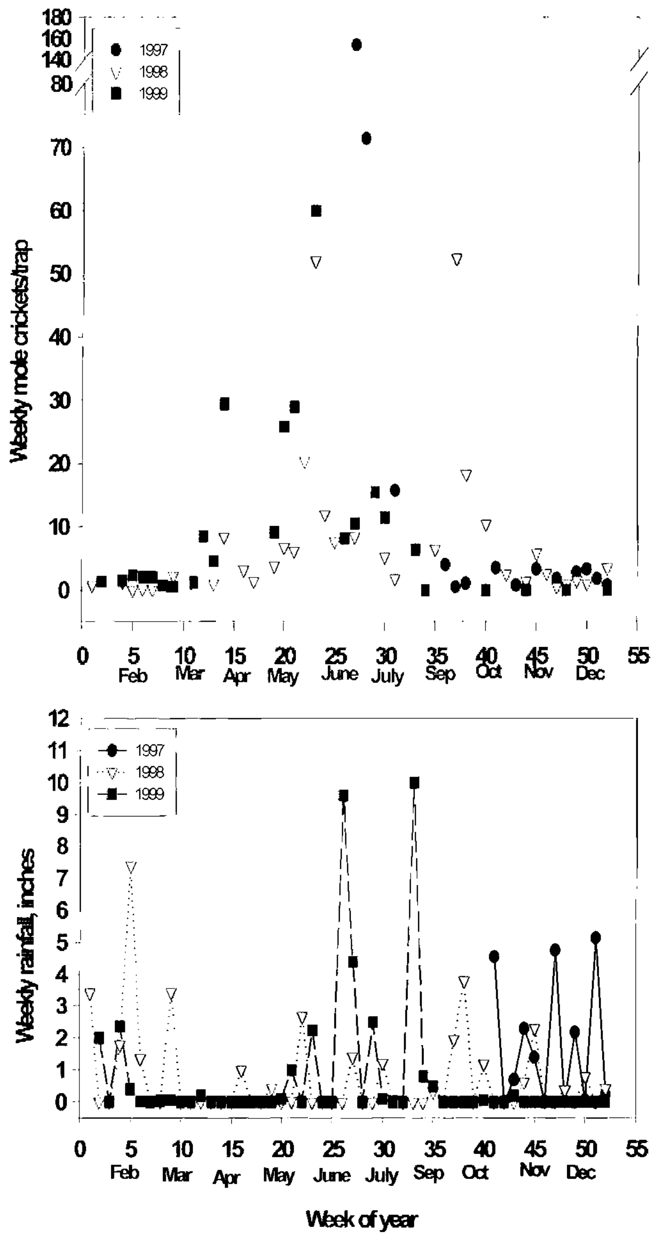

Figure 4. Mean weekly number of trapped mole crickets on Harlee farm in Manatee county from 1997-1999 and weekly amount of rainfall.