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MULCH AS A POTENTIAL MANAGEMENT STRATEGY FOR LESSER CORNSTALK BORER, *ELASMOPALPUS LIGNOSELLUS* (INSECTA: LEPIDOPTERA: PYRALIDAE), IN BUSH BEAN (*PHASEOLUS VULGARIS)*

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ABSTRACT

Lesser cornstalk borer (LCB), *Elasmopalpus lignosellus* (Zeller), is a serious pest of bean (*Phaseolus vulgaris* L.) and many other crops. The effect of mulching as a management method for LCB was examined in 2 field experiments conducted in small plots (1 m^2) at 2 different locations (experiments A and B) in Alachua Co., FL. Both experiments were conducted in the summer and repeated in the fall, 2007. The treatments were arranged in a randomized complete block design with 5 replications at both locations. In experiment A, treatments were bare ground, plots with mulch, and plots with weeds (original weed cover); while in experiment B, treatments were bare ground and mulched plots. The mulch was obtained from a crop of sunn hemp (*Crotalaria juncea* L.) planted at another location. Data were collected on bean plant mortality, plant growth parameters (fresh weight, height, and length including roots of surviving plants), and population levels of potential predators. LCB attack was less ($P \leq 0.10$) in mulched plots compared with bare ground, considering a number of factors such as location and background of field, season, and amount of precipitation. Greater numbers of surviving plants were found in mulched plots compared with bare ground and weedy plots. In general, fresh weight, height, and total length of bean plants were greater in mulched plots compared with other plots. Treatments did not affect numbers of potential predators of LCB. Evidence suggests that LCB attack is reduced by mulches or weeds around host plants.

Key Words: cultural control, *Crotalaria juncea,* plant mortality, non- target insects, plant disease, sunn hemp

RESUMEN

El barrenador menor del tallo de maiz (BMT), *Elasmopalpus lignosellus* (Zeller), es una plaga seria de frijol (*Phaseolus vulgaris* L.) y muchos otros cultivos. El efecto de poner mantillo como un metodo de manejo para el BMT fue examinado en 2 experimentos de campo que se realizaron en parcelas pequeñas (1 m^2) en dos localidades diferentes (experimentos A y B) en el condado de Alachua, Florida. Se realizaron ambos experimentos en el verano y fueron repetidos en el otoño de 2007. Los tratamientos fueron arreglados en un diseño de bloques completamente aleatorizados con 5 replicaciones en ambas localidades. En experimento A, los tratamientos fueron tierra desnuda (sin vegetación), parcelas con mantillo, y parcelas con malezas (la cobertura de malezas original); mientras en experimento B, los tratamientos fueron tierra desnuda y parcelas con mantillo. El mantillo se conseguió de un cultivo de "sunn hemp" (*Crotalaria juncea* L.) sembrado en otra localidad. Se recolectaron datos sobre la mortalidad de las plantas de frijol, los parámetros de crecimiento de la planta (peso fresco, altura y longitud incluyendo las raices de plantas que sobrevivieron), y niveles de la población de depredadores potenciales. El ataque de BMT fue menor ($P \leq 0.10$) en parcelas con mantillo en comparación con la tierra desnuda, considerando un numero de factores como la localidad e historia del campo, la estación y la cantidad de precipitación. Se encontró un numero mayor de plantas sobrevivientes en parcelas con mantillo comparado con las parecelas de tierra desnuda y con malezas. Por lo general, el peso fresco, la altura, y la longitud total de las plantas de frijol fueron mayor en parcelas con mantillo comparados con otras parcelas. Los tratamientos no afectaron el numero de depredadores potenciales de BMT. La evidencia indica que el ataque de BMT es reducido por el mantillo o malezas alrededor de las plantas hospederas.

Lesser cornstalk borer (LCB), *Elasmopalpus lignosellus* (Zeller), is a polyphagous pest with a wide range of host plants including weeds, vegetable crops, and field crops (Funderburk et al. 1985). Larvae burrow into the stalk base near the soil surface, damaging vascular tissues resulting

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in "deadheart" symptoms and allowing pathogens to enter the plant (Smith & Ota 2002). The larval stage tunnels within stems and roots. Wilting is the first sign of an infestation in affected plants, followed by stunting, plant deformities, and a thin crop stand (Gill et al. 2009).

Cultural control practices, including the use of cover crops and mulches, are environmentally safe methods for managing some specific insect pests (Prasifka et al. 2006; Schmidt et al. 2007; Teasdale et al. 2004; Tremelling et al. 2002), and may be applicable against LCB. Organic mulches may be derived from hay, straw, crop residues, pine needles, shredded bark, or other plant material that is readily available. Mulching is an effective way to provide shelter for predatory insects and to control weeds (Brown & Tworkoski 2004). Mulches help to maintain soil moisture required for plant vigor and to promote tolerance in plants to attack of insect pests (Johnson et al. 2004).

Previous experiments showed that early planting in Alabama effectively reduced LCB populations in both conventionally and reduced-tillage peanuts (*Arachis hypogaea* L.), but the tillage systems did not effect population levels of LCB and predators including carabids, elaterids, and labidurids in pitfall traps (Mack & Backman 1990). In Alabama, a diverse fauna of predatory arthropods was captured in pitfall traps and numbers of arthropods increased throughout the peanut growing season (Kharboutli & Mack 1991). Fungi, predators, and other factors affected LCB mortality in a commercial peanut experiment in Texas (Smith & Johnson 1989). Mortality-density relationships revealed that mortality of LCB was density independent, in terms of initial egg density (Smith & Johnson 1989).

The objectives of the current study were to: (1) evaluate the effect of mulch on LCB incidence, (2) examine the effect of mulch on plant mortality and plant growth parameters including fresh weight, plant height, and total length, and (3) determine the effect of mulch on non-target organisms. Mulch was obtained from a cover crop of sunn hemp (*Crotalaria juncea* L.) that was cut and dried before application. Sunn hemp is a tropical legume that is being grown as a nitrogen-rich cover crop. It is an excellent choice as a summer cover crop in Florida (Treadwell & Alligood 2008) and was readily available for this study.

Materials and Methods

Field experiments were conducted in small plots at 2 different locations, the Experimental Design Field Teaching Laboratories (Experiment A) and Plant and Soil Sciences Field Teaching Laboratories (Experiment B), both on the University of Florida, campus in Gainesville, FL (lat. 29º39'N and long. 82°22'). Experiments were conducted in the summer and repeated in the fall, 2007 (4 tests total). The soil was Millhopper sand (loamy, siliceous, hyperthermic, Grossarenic Paleudult, with 92% sand, 3% silt, and 5% clay, and low (<2%) organic matter). Vegetable crops were planted during the previous year in these sites, which had a history of LCB problems.

Experiment A

Summer 2007

The experiment area was 44 m × 19 m. Plots of $1m^2$ area (1m × 1m) were demarcated within this total field area. Prior to treatment establishment, the field was relatively weedy in early summer 2007. The most abundant weeds present were eveningprimrose (*Oenothera laciniata* Hill), Florida pusley (*Richardia scabra* L.), and purple nutsedge (*Cyperus rotundus* L.). Other less common weeds were clover (*Trifolium* spp.), crabgrass (*Digitaria sanguinalis* (L.) Scop.), cudweed (*Gnaphalium purpureum* L.), goosegrass (*Eleusine indica* Gaertn), nightshade (*Solanum* spp.), purslane (*Portulaca oleracea* L.), and toadflax (*Linaria canadensis* (L.) Dumont). Plots were prepared on Jun 10 by removing weeds, hoeing to break soil clods and debris, and irrigating to have optimal soil moisture for planting. Three treatments were compared: bare ground (with all weeds removed), mulch (plot area was first cleaned by removing weeds), and weeds (original weed cover maintained). Treatments were arranged in a randomized complete block design with 5 replications (total of 15 plots). 'Roma II' bush beans (*Phaseolus vulgaris* L.) were planted on Jun 12 in 3 rows 15 cm apart and 70 cm long at a rate of 20 seeds per row and at a soil depth of 2 cm. Bean emergence was observed on Jun 19. A mulch of sunn hemp hay, 3 cm thick (2.8 kg total weight/plot), was applied manually (on the same day that plants emerged) in between rows of beans and surrounding bean plants in the mulch plots only. The mulch was obtained from a crop of 'Tropic Sun' sunn hemp planted at another location on May 8 and harvested on Jun 12 by clipping plants at the base, and air-drying the clippings for 1 week. Mulch was a composite of leaves and stems. Plots were irrigated as needed, and weeds were removed from time to time to maintain bare ground and mulch treatment plots free of weeds.

Fall 2007

The test was repeated at the same site in the following fall season, with all the same treatments. Experimental procedure remained the same as that of the summer season, with a few minor changes. Beans were planted 1-m^2 in plots on Sep 10 in 3 rows 15 cm apart at a rate of 35 seeds per row (higher seedling rate than summer test) with row length of 70 cm. Sunn hemp mulch

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was harvested on Sep 13 and bean emergence started on Sep 14. Sunn hemp hay was applied 3 cm thick (2.8 kg total weight/plot) on the same day of plant emergence.

Data Collection

Bean mortality was recorded throughout both the seasons by counting numbers of dead bean plants/plot due to "deadheart" symptoms. Dead bean plants were removed, brought back to the laboratory, and stems dissected. The plants were examined for presence or symptoms of LCB larvae as well as the presence of pathogens. At the end of both seasons, 5 of the remaining surviving plants were removed, and average fresh weight, above ground plant height, and total length (height of plant plus root length) were measured. Bean yields were not recorded due to the high percentage of dead plants. Insects were collected with pitfall traps on Jun 25 for the summer season and Sep 18 for the fall season. A plastic sandwich container (14 cm × 14 cm × 4 cm) was used as a pitfall trap (Borror et al. 1989). One pitfall trap was placed in the middle of the plot, and buried so that the upper edge was flush with soil surface. The traps were filled three quarters with water, along with 3 to 4 drops of dish detergent (Ultra Joy®, Procter & Gamble, Cincinnati, OH) to break surface tension, ensuring that the insects would remain in the trap. Pitfall traps were set out in the morning and collected before noon the next day (which was recorded as sampling date). The traps were brought to the laboratory, kept in a cold room at 10ºC, and contents transferred and stored in 70% ethanol in vials. Insects were identified to order and family levels with the aid of a dissecting microscope.

Experiment B

Summer 2007

Unlike experiment A, this site had been rototilled in early Jun 2007 and was free of weeds. Plots of $1m^2$ area (1m × 1m) were established on Jun 20, and soil was prepared for planting by hand with a hoe and irrigated to have optimal soil moisture for seed germination. Two treatments were compared: bare ground and mulch. The treatments were arranged in a randomized complete block design with 5 replications (total of 10 plots). 'Roma II' bush beans were planted on Jun 22 in 3 rows 15 cm apart at a rate of 40 seeds per row at a soil depth of 2 cm. Bean emergence was observed on Jun 26. Sunn hemp harvested on Jun 12 was air-dried and applied on Jun 29 to form a mulch 3 cm deep (2.0 kg total weight/plot) using similar protocol as described for experiment A. Hay was placed between rows of beans plants and surrounding the beans plants in mulch plots only. Weeds were removed as needed to maintain bare ground and mulch treatments free of weeds.

Fall 2007

The test was repeated at the same site in the following fall season, with the same 2 treatments. The experimental procedure remained the same as in summer, with some minor changes. Beans were planted on Sep 19 in 3 rows 15 cm apart at a rate of 35 seeds per row with row length of 70 cm. Sunn hemp mulch was harvested on Sep 13 and bean emergence was observed on Sep 23. A layer of sunn hemp hay 3 cm deep (2.0 kg total weight/plot) was applied on the same day of bean emergence in the mulch plots.

Data Collection

Insects were collected on Jul 19 for summer and Oct 16 for the fall season. Procedures for insect trapping and for data collection on plant mortality and plant parameters remained the same as in Experiment A.

Data Analysis

For each data set, data were subjected to one-way analysis of variance (ANOVA) with the Statistical Analysis System (version 9.1; SAS Institute, Cary, NC). For Experiment A, treatment means were separated by the least significant difference (LSD) range test, when analysis of variance showed a significant treatment effect ($P \leq 0.10$).

Results

Experiment A

Summer 2007

Plant mortality did not differ between bare ground and mulched plots (Table 1). Dead plants in this experiment showed typical symptoms caused by LCB which included "deadheart", silken webbing, and plant wilting. Dead plants were removed and examined for the presence of LCB and other pathogens. Of the plants removed and examined in the laboratory, all showed these typical symptoms and most had feeding damage to the stems from LCB. Many contained LCB within the stem. At the end of the experiment, more plants survived in mulched plots than in weedy plots (Table 1). No significant difference was observed in plant weight among treatments, although plant height and length (height + root length) were significantly greater in mulched and weedy treatments compared with the bare ground (Table 2).

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TABLE 1. NUMBER OF DEAD BEAN PLANTS/PLOT COLLECTED ON SELECTED SAMPLING DATES FOR EXPERIMENT A, SUMMER.

Treatment	Days after bean emergence[1]				Total Mortality	Surviving Plants
	10	21	24	30		
Bare	10.00 a ± 0.71	6.20 a ± 3.65	5.60 a ± 2.25	3.20 b ± 1.39	28.00 a ± 7.78	11.00 ab ± 2.59
Mulch	7.00 ab ± 0.84	2.80 a ± 1.50	4.80 a ± 0.80	8.20 a ± 1.77	24.00 a ± 1.64	18.80 a ± 3.65
Weed	6.20 b ± 1.50	5.80 a ± 2.13	5.80 a ± 1.91	6.40 ab ± 0.93	26.00 a ± 4.05	4.80 b ± 1.39
ANOVA[2]:						
F value	3.50	0.51	0.09	3.24	0.15	6.72
df	2,12	2,12	2,12	2,12	2,12	2,12
P value	0.0635	0.6102	0.9146	0.0750	0.8618	0.011

[1]Days after bean emergence = number of days after bean plants emerged. Surviving plants measured at end of experiment.
[2]Statistics from analysis of variance (ANOVA).
Data are means ± standard error of 5 replications.
Means followed by the same letters do not differ significantly based on LSD test ($P \leq 0.10$).

Major groups of predatory arthropods found in pitfall traps in both summer and fall of 2007 in this experiment were Carabidae (1.93 ± 0.6/plot), Formicidae (21.6 ± 13.69/plot), Araneae (1.26 ± 0.53/plot), and Staphylinidae (0.1 ± 0.1/plot) but all were unaffected by treatment. The most common non-predators were Dolichopodidae, Collembola, and Cicadellidae (data not shown). No significant differences with treatment were observed in numbers of these different kinds of insects.

Fall 2007

Plant mortality was higher in the bare ground treatment compared with other treatments toward the middle of the experiment, but at the end of the experiment, total mortality and number of surviving plants remained the same in all treatments (Table 3). Unlike in the summer, dead plants had rotten roots and therefore were examined in the laboratory for the presence of pathogens. In most cases, plant mortality was caused by *Rhizoctonia* fungus. Plant weight and plant length were greatest in the mulched treatment (Table 2). As in the summer experiment, no differences among treatments were found in any of the arthropod groups caught in pitfall traps (data not shown).

Experiment B

Summer 2007

Greater plant mortality in the bare ground treatment than in the mulch treatment ($P \leq 0.10$) was observed on every sampling date (Table 4). The main cause of mortality was LCB, and plants showing symptoms of LCB attack were isolated from all plots. At the end of the experiment, higher numbers of surviving plants were present in mulched plots than in the bare ground. Among these surviving plants, no significant differences were found in weight or height, but a slight increase in length was observed in mulched plots (Table 2).

Major groups of predatory arthropods found in pitfall traps in both summer and fall of 2007 were Carabidae (0.6 ± 0.4/plot) and Formicidae (65.6 ± 12.48/plot). The most common non-predators were Dolichopodidae, Collembola, and Cicadellidae (data not shown). The only significant differences between treatments were observed among Dolichopodidae (42.8 ± 12.94 in bare and 15.6 ± 5.78 in mulch plots) in summer and Collembola in both summer (55.20 ± 16.52 in bare and 299.0 ± 155.9 in mulch plots) and fall (32.40 ± 11.82 in bare and 126.0 ± 30.22 in mulch plots) seasons.

Fall 2007

No difference in plant mortality was found between treatments except that higher plant mortality was observed in bare ground plots on the last sampling date (Table 5). Total mortality and number of surviving plants remained same in both treatments. In fall, plant mortality was mainly caused by attack from fungal pathogens rather than from LCB as in the summer season. Plant weight, height, and length were significantly higher in the mulched treatment compared with the bare ground treatment (Table 2).

DISCUSSION

During the fall season, the major cause of plant mortality was the fungal pathogen *Rhizoctonia* spp. in both experiments A and B. The amount of rainfall was higher in the fall season compared with the summer season. Total rainfall in Jun between planting and emergence was 0.69 cm in experiment A and 1.65 cm in experiment B, while corresponding levels in Sep were 2.49 cm in

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TABLE 2. WEIGHT, HEIGHT, AND LENGTH OF SURVIVING PLANTS IN EXPERIMENTS A AND B, SUMMER AND FALL.

Treatment	Plant parameters		
	Weight (g/plant)	Height (cm)	Length (cm)
	Experiment A, summer		
Bare	3.73 a ± 1.30	12.08 b ± 3.85	20.96 b ± 4.97
Mulch	6.84 a ± 1.02	30.76 a ± 2.73	40.20 a ± 3.26
Weed	3.51 a ± 0.97	26.92 a ± 4.37	36.72 a ± 3.86
ANOVA[1]:			
F value	2.82	7.05	6.28
df	2,12	2,12	2,12
P value	0.0989	0.0094	0.0136
	Experiment A, fall		
Bare	8.44 b ± 0.63	10.91 a ± 0.50	45.97 b ± 1.86
Mulch	11.63 a ± 1.12	11.51 a ± 0.55	56.57 a ± 1.77
Weed	8.58 b ± 1.10	9.59 a ± 1.13	50.66 ab ± 2.61
ANOVA[1]:			
F value	3.41	1.58	6.32
df	2,12	2,12	2,12
P value	0.0670	0.2467	0.0134
	Experiment B, summer		
Bare	5.47 ± 1.06	18.81 ± 1.75	30.38 ± 1.40
Mulch	10.78 ± 2.97	27.39 ± 5.14	40.87 ± 5.08
ANOVA[1]:			
F value	2.84	2.49	3.97
df	1,8	1,8	1,8
P value	0.1304	0.1529	0.0815
	Experiment B, fall		
Bare	5.75 ± 0.43	9.29 ± 0.56	31.69 ± 1.26
Mulch	10.42 ± 0.97	11.62 ± 0.74	44.08 ± 1.35
ANOVA[1]:			
F value	19.45	6.27	45.01
df	1,8	1,8	1,8
P value	0.0023	0.0367	0.0002

[1]Statistics from analysis of variance (ANOVA).
Data are means ± standard error of 5 replications.
Means followed by the same letters do not differ significantly based on LSD test ($P \leq 0.10$).

experiment A and 5.72 cm in experiment B (Anonymous 2010). The higher rainfall in fall may have led to higher soil moisture and the increased growth of fungi, resulting in root rot and ultimately bean plant mortality. LCB attack has been reported to be less severe under moist conditions (Biddle et al. 1992; Nuessly & Webb 2006). During the summer season in both experiments, plant mortality was due to attack of LCB. This insect has been considered a dryland insect, and typically survives well in dry, hot conditions and in sandy soils (Luginbill & Ainslie 1917).

In experiment B, consistently greater plant mortality due to LCB was observed in bare ground plots than in mulch plots throughout the season. Many predators of LCB found in other studies (Kharboulti & Mack 1991; Mack & Backman 1990; Smith & Johnson 1989) including carabids, ants, spiders, and staphylinids, were also recovered in the current experiments. However, there was no evidence that LCB was reduced by predation in the mulch plots because similar numbers of predatory insects were collected in both treatments. Differences may have resulted from the ability of LCB adults to find and oviposit on host plants in areas with differing crop backgrounds (mulch vs. bare). The resource concentration hypothesis argues that the presence of diverse flora negatively affects the ability of insect pests to find and utilize host plants (Root 1973; Dent 2000; Smith & McSorley 2000). Incidence of

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TABLE 3. NUMBER OF DEAD BEAN PLANTS/PLOT COLLECTED ON SELECTED SAMPLING DATES FOR EXPERIMENT A, FALL.

	Days after bean emergence[1]					
Treatment	11	18	22	32	Total Mortality	Surviving Plants
Bare	2.60 a ± 0.93	6.40 a ± 1.03	3.60 a ± 0.68	4.80 a ± 0.97	32.80 a ± 8.84	48.00 a ± 8.38
Mulch	1.20 a ± 0.80	3.20 b ± 0.66	1.20 b ± 0.37	3.80 a ± 2.24	17.40 a ± 5.04	62.40 a ± 4.48
Weed	4.00 a ± 0.89	2.00 b ± 0.84	1.20 b ± 0.58	2.00 a ± 0.84	16.00 a ± 2.30	55.60 a ± 5.82
ANOVA[2]:						
F value	2.56	7.05	6.13	0.89	2.40	1.25
df	2,12	2,12	2,12	2,12	2,12	2,12
P value	0.1189	0.0094	0.0147	0.4358	0.1332	0.3201

[1]Days after bean emergence = number of days after bean plants emerged. Surviving plants measured at end of experiment.
[2]Statistics from analysis of variance (ANOVA).
Data are means ± standard error of 5 replications.
Means followed by the same letters do not differ significantly based on LSD test ($P \leq 0.05$).

TABLE 4. NUMBER OF DEAD BEAN PLANTS/PLOT COLLECTED ON SELECTED SAMPLING DATES FOR EXPERIMENT B, SUMMER.

	Days after bean emergence[1]					
Treatment	15	18	23	31	Total Mortality	Surviving Plants
Bare	19.40 ± 2.62	10.40 ± 2.27	6.20 ± 0.73	11.20 ± 4.15	63.20 ± 6.76	6.20 ± 2.20
Mulch	11.60 ± 2.98	4.00 ± 0.84	2.20 ± 0.86	2.40 ± 1.50	41.80 ± 6.79	23.60 ± 6.46
ANOVA[2]:						
F value	3.87	6.99	12.50	3.97	4.99	6.50
df	1,8	1,8	1,8	1,8	1,8	1,8
P value	0.0847	0.0295	0.0077	0.0814	0.0560	0.0342

[1]Days after bean emergence = number of days after bean plants emerged. Surviving plants measured at end of experiment.
[2]Statistics from analysis of variance (ANOVA).
Data are means ± standard error of 5 replications.

TABLE 5. NUMBER OF DEAD BEAN PLANTS/PLOT COLLECTED ON SELECTED SAMPLING DATES FOR EXPERIMENT B, FALL.

	Days after bean emergence[1]					
Treatment	13	18	23	31	Total Mortality	Surviving Plants
Bare	1.40 ± 0.51	1.80 ± 1.36	0.20 ± 0.2	2.80 ± 1.16	18.20 ± 2.67	29.60 ± 9.54
Mulch	1.80 ± 0.92	1.20 ± 0.49	0.00 ± 0.0	0.00 ± 0.0	14.60 ± 2.29	27.20 ± 7.00
ANOVA[2]:						
F value	0.15	0.17	1.00	5.85	1.05	0.04
df	1,8	1,8	1,8	1,8	1,8	1,8
P value	0.7128	0.6883	0.3466	0.0419	0.3365	0.8443

[1]Days after bean emergence = number of days after bean plants emerged. Surviving plants measured at end of experiment.
[2]Statistics from analysis of variance (ANOVA).
Data are means ± standard error of 5 replications.

LCB attack was higher in the bare ground treatment than in the mulched treatment, possibly because insects may have difficulty in recognizing host plants as compared with easy recognition of host plants in bare plots. Smith (1976) reported increased attraction of the cabbage aphid, *Brevicoryne brassicae* (L.), by visual recognition of a sparsely planted crop that stood out against bare ground.

In contrast, no difference was found between mulch and bare plots in experiment A. The differences in effect of mulch on LCB attack at these 2 experiment locations may be due to the different

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location and background of the experiments. Experiment A had a high, dense background population level of weeds, especially Florida pusley and evening primrose, while experiment B was free from weeds. In fact, the small plots in experiment A were established by removing these weeds from the plots themselves, but weeds remained on the borders of all plots. Because of the small size of the plots, the border area and landscape around the plots may have had a major influence on an actively mobile pest like LCB. It is possible that weeds could serve as alternate hosts and divert LCB from attack on the bean plants. However, Florida pusley and evening primrose are not known hosts of LCB (Gardner & All 1982; Gill et al. 2009; Isely & Miner 1994). Furthermore, incidence of attack by LCB on bean plants was very high at both locations, although differences among treatments were not noted in experiment A. The weedy background of experiment A may have affected the ability of insects to recognize host plants within the small plots at this site. In contrast, the small plots at experiment B stood out easily in a bare landscape, except when young plants were obscured with mulch, which may have led to higher attack of LCB in experiment B during the summer season. This observation of differential LCB attack in experiments A and B may be additional evidence for the ability of this insect to locate host plants when host resources are concentrated. While visual cues may be involved, the presence of weeds may offer olfactory interference as well. Further research is needed to determine the cues used by female moths to find and oviposit on host plants.

In the current study, sunn hemp mulch was found to be effective in managing LCB populations while considering a number of factors such as background of field, treatment, and season. Mulch was helpful in managing LCB when plots stood out against a bare background, but was ineffective when weeds surrounded the plots. Incidence of LCB attack on host plants was severe in experiments starting in Jun, but was absent in experiments beginning in Sep, when *Rhizoctonia* fungus was the major mortality factor.

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