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MISSISSIPPI SOYBEAN PROMOTION BOARD
PROJECT NO. 02-2018 (YEAR 2)
2018 FINAL REPORT

Title: Refinement/Validation of Soybean Looper Thresholds in Mississippi Soybeans

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EXECUTIVE SUMMARY

Soybean looper has become a significant annual pest of soybeans in Mississippi. During 2006 to 2015 the percentage of soybeans in Mississippi treated for soybean looper ranged from 2.8% to 47.3%, with greater than 25% of the soybeans treated in 7 of the 10 years. Also, the control cost has increased from $9.00/acre during 2006 to $16.00/acre during 2015.

The current action threshold for soybean looper infesting reproductive stage soybeans in Mississippi is ≥8 larvae one half inch or longer per row foot using drop cloth sampling or ≥19 larvae one half inch or longer using sweep net sampling.

The first objective of this project was to refine/validate the treatment threshold for soybean looper infesting soybeans in Mississippi. As a component of this objective, comparisons between drop cloth and sweep net sampling methods were conducted.

The second objective was to evaluate alternative insecticides (non-Diamide products) for soybean looper management. Results of these studies will serve as field-based performance and susceptibility monitoring efforts, and will be used to make recommendations to growers and consultants.

The third objective was to monitor the response of soybean looper populations from Mississippi soybeans to Diamide insecticides in laboratory assays. Laboratory assays are often able to detect changes in insect response/susceptibility to insecticides before field control issues are observed or become widespread. Results from these assays will be compared to baseline responses. Since there is potential for numerous collections during the same time period, collections will be shared with other researchers investigating soybean looper response/susceptibility to insecticides.

Objective 1 Results

For every looper larva collected with a drop cloth, 0.44 was collected with a sweep net. For larvae ≥3rd instar collected with a drop cloth, 0.89 larva was collected using a sweep net.

For every increase of 1 <3rd instar larva per 25 sweeps, defoliation increased 0.40%. For every increase of 1 ≥3rd instar larva per 25 sweeps, defoliation increased 0.66%. For every increase of 1 total looper larva per 25 sweeps, defoliation increased 0.42%. Based on these results, 14 soybean looper larvae ≥3rd instar and 20 total larvae would result in 20% defoliation.

Fifth instar larvae consumed a greater percentage of leaf area compared to 1st to 4th instar larvae.

Fourth instar larvae consumed a greater percentage of leaf area compared to 1st to 3rd instar larvae. Fourth instar larvae consumed a greater total amount of leaf area compared to larvae of other sizes.

Objective 2 Results

All insecticide treatments resulted in significantly higher soybean yield compared to that from the non-treated control. Plots treated with Prevathon (20 oz/acre, diamide) had significantly higher yields than plots treated with Radiant (2 oz/acre, spinosyn) or Prevathon (14 oz/acre, diamide). In a second study, all insecticide treatments resulted in significantly lower densities of soybean looper compared to the non-treated control at 3, 6, and 10 days after treatment (DAT). Also, Intrepid Edge (IGR and spinosyn) resulted in significantly fewer soybean loopers per 25 sweeps compared to Diamond (IGR) at 3 DAT. All of the insecticide treatments resulted in significantly higher yields compared to the non-treated control. In a third study, all of the insecticide treatments resulted in significantly lower densities of soybean looper compared to the non-treated control at 3, 6, and 10 DAT, except Cavalier (IGR) at 3 and 10 DAT. At 10 DAT, Intrepid Edge (IGR and spinosyn) resulted in significantly fewer larvae than any of the other insecticide treatments. Only Intrepid Edge (IGR and spinosyn) and Prevathon (diamide) resulted in significantly higher yields compared to the non-treated control. During 2018 only one trial was conducted due to frequent rainfall and widespread natural disease infections in soybean looper populations. Disease ncidence was widespread and most larvae collected were ≤4th instar. Defoliation did not reach 20% in any of the plots. There were no significant differences among treatments for yield.

Objective 3 Results

Soybean looper infestations did not persist in fields for an extended period of time during both 2017 and 2018. The unusually high rainfall during August through September of both years and a tropical system during August 2017 triggered outbreaks of multiple diseases in soybean looper populations. These diseases caused soybean looper densities to decline rapidly to almost non-existent levels. Disease prevalence (both fungal and viral) in all looper collections was very high. Greater than 95% mortality was observed before insects reached the adult stage. Therefore, no larvae were produced to conduct the laboratory insecticide response assays and no assays could be conducted.

BACKGROUND AND OBJECTIVES

Soybean looper has become a significant annual pest of soybeans in Mississippi. During 2006 to 2015 the percentage of soybeans in Mississippi treated for soybean looper ranged from 2.8% to 47.3%, with greater than 25% of the soybeans treated in seven of the ten years. Also, the control cost has increased from $9.00/acre during 2006 to $16.00/acre during 2015.

Recently the defoliation threshold (20% defoliation) for reproductive stage soybeans has been validated. The current action threshold for soybean looper infesting reproductive stage soybeans in Mississippi is ≥8 larvae one half inch or longer per row foot using drop cloth sampling or ≥19 larvae one half inch or longer using sweep net sampling. Annually these thresholds are used to make pest management decisions for soybean looper infestations, which can be a substantial cost to growers.

A search of the literature failed to find any published reference on how the current soybean looper threshold (based on insect counts) was developed or how this threshold relates to the defoliation threshold. With soybean looper management being a significant investment for growers and the defoliation threshold having been recently validated, the soybean looper (insect count) threshold should also be refined/validated.

The Diamide insecticides have been the cornerstone of caterpillar pest management, including soybean looper and corn earworm, since their introduction. Reports of inconsistent control of soybean looper with Diamide insecticides occurred during 2016 in Mississippi and in other Southern states. Efficacy of these products in replicated trials conducted during 2016 in Mississippi was observed to be lower than that observed in previous years. These results are consistent with results from both field and laboratory studies conducted in other areas of the Midsouth and the Southeastern U.S. Efficacy trials evaluate alternative products for soybean looper management and laboratory assays to monitor Diamide insecticide performance will be conducted.

OBJECTIVE(S)

The first objective of this project was to refine/validate the treatment threshold for soybean looper infesting soybeans in Mississippi. This will allow producers and consultants to make more informed treatment decisions for soybean looper. As a component of this objective, comparisons between drop cloth and sweep net sampling methods were conducted. This will allow for the development of a conversion factor between the two methods and to estimate the sampling efficiency of the methods.

The second objective was to evaluate alternative insecticides (non-Diamide products) for soybean looper management. Representative Diamide insecticides will also be included in trials for comparison. Results of these studies will serve as field-based performance and susceptibility monitoring efforts, and will be used to make recommendations to growers and consultants.

The third objective was to monitor the response of soybean looper populations from Mississippi soybeans to Diamide insecticides in laboratory assays. Laboratory assays are often able to detect changes in insect response/susceptibility to insecticides before field control issues are observed or become widespread. The baseline responses of soybean looper to several insecticides including representative Diamide insecticides have been established. Results from these assays will be compared to baseline responses. Since there is potential for numerous collections during the same time period, collections will be shared with other researchers investigating soybean looper response/susceptibility to insecticides.

REPORT OF PROGRESS/ACTIVITY

Objective 1.

A study was conducted during 2017 and 2018 to examine the relationship between insect densities using the drop cloth and sweep net sampling methods. Ten commercial fields throughout Mississippi with established looper populations were sampled using both methods. Fields were sampled by at least four individuals, with samples collected at random locations in each field. A sample consisted of at least 5 paired subsamples collected with both a 2.5 ft. drop cloth (5 row feet per drop) and a 15-inch-diameter sweep net (25 sweeps). Larval numbers were recorded and larvae were classified as either <3rd, 3rd instar, 4th instar, or 5th instar. Larval numbers were pooled for analysis into two categories, <3rd instar, and ≥3rd instar. Data for total numbers of soybean looper larvae, larvae <3rd instar, and larvae ≥3rd instar captured using sweep net and drop cloth sampling methods were subjected to regression analysis using PROC GLIMMIX in SAS. The NOINT option in SAS was used to set the intercept of the regression line to zero.

A significant relationship between sweep net sampling and drop cloth sampling was observed for soybean looper larvae <3rd instar (**Figure 1**). For every larva collected with a drop cloth, 0.44 was collected with a sweep net. A significant relationship was measured between sweep net sampling and drop cloth sampling for soybean looper larvae ≥3rd instar (**Figures 2**). For larvae ≥3rd instar collected with a drop cloth, 0.89 larva was collected using a sweep net. Similarly, a significant relationship between sweep net sampling and drop cloth sampling was measured for total soybean looper larvae (**Figure 3**). For soybean looper larvae collected with a drop cloth, 0.77 larva was collected using a sweep net.

Studies to examine the relationship between soybean looper density levels and defoliation were also conducted during 2017 and 2018. Three trials utilized natural soybean looper infestations. Randomized complete block tests with 7 plots per replicate and 4 replications were established each year and allowed to become infested naturally by soybean looper. Plot size was eight 40-in.-wide rows that were 40 ft long, and soybean variety Agrow 46X6 was used.

The trials were treated with acephate to reduce densities of predators and parasitoids. One plot per replication was treated with chlorantraniliprole (Prevathon 0.43SC, 20 oz. form. / acre) at least weekly at the first observation of soybean looper larvae to minimize defoliation as much as possible. These plots served as the non-defoliated control. Sampling was initiated at ca. 3 days after the first observation of soybean looper infestations, and plots were sampled at least weekly while larvae were present using sweep net sampling (25 sweeps/plot). Larval size was visually estimated (<3rd, 3rd, 4th, or 5th instar) and data were recorded based on larval size.

Additional studies were initiated during 2018 using artificial infestations. In these trials, 6ft. x 6ft. cages were placed over Asgrow 46X6 soybean during the R2 to R5 growth stages. There were seven cages (plots) per replicate and four replications. All cages (except the one that served as the non-infested control) per replicate were infested with at least 10 pairs of soybean looper adults. Moths were provided a beer-honey water solution as a source. Soybean were infested at ca. the R3 growth stage with insects from a laboratory colony of soybean looper.

Two collections of soybean looper (>1,000 larvae per collection) were made during July 2018 from infested fields in Louisiana for use in these studies. However, disease incidence in these collections was >95%, and no reproduction occurred. Four trials were attempted, but larvae were only observed in one. When the majority of larvae had reached at least 3rd instar, 2.5 feet of one row in each cage was sampled using a drop cloth. The number of larvae was determined, and larvae were classified as 3rd instar or ≥3rd instar. On the same day as larval sampling, five plants from the sampled area were collected. On each sampling date for both the natural infestation and cage studies, 5 random plants from each plot were removed and area of all of the leaves on each plant was determined using a Li-Cor 3100C leaf area meter. An estimate of percent defoliation for each of the infested plots in a replication was calculated using the formula ((1-(leaf area of infested plot/leaf area of non-infested plot)) *100). Larval numbers for the cage experiment were converted to a sweep net equivalency using regression equations from the study described above. Data for percent defoliation and numbers of looper larvae per 25 sweeps were subjected to regression analysis using PROC GLIMMIX in SAS.

A significant relationship between number of soybean looper $<3^{rd}$ instar and percent defoliation was observed (**Figure 4**). For every increase of 1 larva per 25 sweeps, defoliation increased 0.40%. A significant relationship between number of soybean looper $\geq 3^{rd}$ instar and percent defoliation was observed (**Figure 5**). For every increase of 1 larva per 25 sweeps, defoliation increased 0.66%. Also, a significant relationship between the total number of soybean looper larvae and percent defoliation was also measured (**Figure 6**). For every increase of 1 larva per 25 sweeps, defoliation increased 0.42%. Based on the regression equations, 14 soybean looper larvae $\geq 3^{rd}$ instar and 20 total larvae would result in 20% defoliation.

Another study to determine the foliage consumption rates of 1^{st}, 2^{nd}, 3^{rd}, 4^{th}, and 5^{th} instar soybean looper larvae was conducted during 2018. For each larval instar, 50 leaves were removed from greenhouse-grown maturity group IV soybeans. Leaves were weighed and leaf area was determined; an average of 3 measurements were taken to account for variation. Leaves were then placed in petri dishes with a piece of damp filter paper to prevent the leaves from drying out. One soybean looper larvae was placed into each 25 of the petri dishes with the leaves and allowed to feed for the duration of the instar. The remaining 25 samples were left un-infested as a control. After larvae had molted to the next instar, each leaf was then weighed and measured with a leaf area meter again to determine the amount of leaf area consumed. There were three replications of this experiment. Results from the controls were averaged and used to correct for water loss. Corrected data were subjected to analysis of variance and means separated according to Fisher's Protected LSD.

Fifth instar larvae consumed a greater percentage of leaf area compared to 1^{st} to 4^{th} instar larvae (**Figure 7**). Fourth instar larvae consumed a greater percentage of leaf area compared to 1^{st} to 3^{rd} instar larvae. Fourth instar larvae consumed a greater total amount of leaf area (cm^2) compared to larvae of other sizes (**Figure 8**). There was some variation in the duration of the 5^{th} instar for some larvae, with some entering the pre-pupal and pupal stages sooner than others. This is one possible explanation for the lower consumption by 5^{th} instar larvae compared to 4^{th} instar larvae.

The analysis and interpretation of the data for this objective are ongoing as the student's thesis is being prepared.

Objective 2.

Studies were conducted during 2017 and 2018 to evaluate selected insecticides, including non-diamide class insecticides, for management of soybean looper infestations. In the first study conducted during 2017, all of the insecticide treatments, except Besiege (pyrethroid + diamide) and Prevathon (14 oz/acre, diamide), significantly reduced soybean looper densities compared to the non-treated control at 3 days after treatment (DAT) (**Table 1**). Also, plots treated with Intrepid Edge (both rates, insect growth regulator, IGR, and spinosyn), Radiant (both rates, spinosyn), or Steward (oxydiazine) had significantly fewer soybean looper larvae compared to plots treated with Besiege (pyrethroid + diamide), Prevathon (14 oz/acre, diamide), or Intrepid (both rates, IGR).

At 6 DAT, all of the insecticide treatments resulted in significantly lower densities of soybean looper larvae than the non-treated control. Plots treated with Intrepid Edge (both rates, IGR and spinosyn), Radiant (both rates, spinosyn), or Steward (oxydiazine) had significantly fewer soybean looper larvae compared to plots treated with Besiege (pyrethroid + diamide), Prevathon (both rates, diamide), or Intrepid (both rates, IGR). At 10 DAT, all of the insecticide treatments except Besiege (pyrethroid + diamide) resulted in significantly lower densities of soybean looper larvae than the non-treated control. Intrepid Edge (both rates, IGR and spinosyn) and Steward (oxydiazine) significantly reduced soybean looper densities compared to Besiege (pyrethroid + diamide) and Prevathon (both rates, diamide).

All of the insecticide treatments resulted in significantly higher soybean yield compared to that from the non-treated control. Plots treated with Prevathon (20 oz/acre, diamide) had significantly higher yields than plots treated with Radiant (2 oz/acre, spinosyn) or Prevathon (14 oz/acre, diamide).

In the second trial, all of the insecticide treatments resulted in significantly lower densities of soybean looper compared to the non-treated control at 3, 6, and 10 DAT (**Table 2**). Also, Intrepid Edge (IGR and spinosyn) resulted in significantly fewer soybean loopers per 25 sweeps compared to Diamond (IGR) at 3 DAT. All of the insecticide treatments resulted in significantly higher yields compared to the non-treated control.

In the third study, all of the insecticide treatments resulted in significantly lower densities of soybean looper compared to the non-treated control at 3, 6, and 10 DAT, except Cavalier (IGR) at 3 and 10 DAT (**Table 3**). At 10 DAT, Intrepid Edge (IGR and spinosyn) resulted in significantly fewer larvae than any of the other insecticide treatments. Only Intrepid Edge (IGR and spinosyn) and Prevathon (diamide) resulted in significantly higher yields compared to the non-treated control.

During 2018 only one trial was conducted due to frequent rainfall and widespread natural disease infections in soybean looper populations. Approximately 2 inches of rainfall occurred ca. 24 hrs after application. At 4 DAT, all of the insecticide treatments, except for Intrepid (IGR) at 4 oz, reduced soybean looper densities compared to the non-treated control. Plots treated with Steward (oxydiazine) had significantly fewer larvae than all of the other insecticide treated plots. At 7 DAT, all of the insecticide treatments reduced soybean looper densities compared to the non-treated control. Steward (oxydiazine) and Prevathon (both rates, diamide) resulted in lower larval densities compared to Intrepid Edge (4 oz, IGR + spinosyn) and Intrepid (both rates, IGR). By 11 DAT, substantial natural mortality occurred as illustrated by the decline in larval numbers in the non-treated plots from 7 to 11 DAT. At 11 DAT, only Steward (oxydiazine), Besiege (pyrethroid + diamide), Prevathon (diamide), and Denim (avermectin) reduced larval densities compared to the non-treated control. Disease incidence was widespread and most larvae collected were $\leq 4^{th}$ instar. Defoliation did not reach 20% in any of the plots (data not shown). There were no significant differences among treatments for yield.

Objective 3.

Soybean looper infestations did not persist in fields for an extended period of time during both 2017 and 2018. The unusually high rainfall during Aug, through Sept. of both years and a tropical system during Aug. of 2017 triggered outbreaks of multiple diseases in soybean looper populations. These diseases caused soybean looper densities to decline rapidly to almost non-existent levels.

Ten soybean looper populations (ca. 500 to 1,200 larvae per collection) were collected from different locations in Mississippi (7 during 2017 and 3 during 2018). Disease prevalence (both fungal and viral) in all collections was very high. Greater than 95% mortality was observed before insects reached the adult stage. Therefore, no larvae were produced to conduct the laboratory insecticide response assays and no assays could be conducted. Additionally, two field collections of soybean looper (>1,000 larvae per collection) were made during July 2018 from infested fields in Louisiana for Objective 1 field infestation experiments. Disease incidence in these collection was >95% also.

IMPACTS AND BENEFITS TO MISSISSIPPI SOYBEAN PRODUCERS

Results from these studies will be used to validate/refine treatment thresholds for soybean looper based on sweep net sampling and relate count-based scouting with the defoliation threshold. Results will also help refine treatment recommendations for soybean looper management.

Some consultants prefer drop cloth sampling to sweep net sampling. The equivalency of these two sampling methods determined from these studies will allow for a more accurate drop cloth threshold.

Results from these studies indicate that current thresholds are adequate for preventing yield loss from soybean looper infestations. However, final analysis and interpretation of data are not complete, and some refinements of thresholds may be warranted following completion.

Currently there are limited control options for soybean looper management. The diamides and IGR-spinosyn premix products are the primary tools available, but variation in performance has been observed over time and geographies.

END PRODUCTS–COMPLETED OR FORTHCOMING

2017 Mississippi Entomological Association Meeting, October 16-17, 2017 Starkville, MS.

2018 Entomological Society of America Southeastern Branch Annual Meeting. March 4-7, 2018. Orlando, FL.

2018 Mississippi Entomological Association Meeting, October 22-23, Starkville, MS.

2019 Beltwide Cotton Conferences, Insect Research and Control Conference Student Presentation Competition, January 8-10, 2019, New Orleans, LA.

Student thesis for completion of Masters of Science in Agricultural Life Sciences with a Concentration in Entomology from Mississippi State University (In-Progress).

Results were also presented at >40 grower meetings throughout the state of Mississippi during the winter/spring of 2017 and 2018.

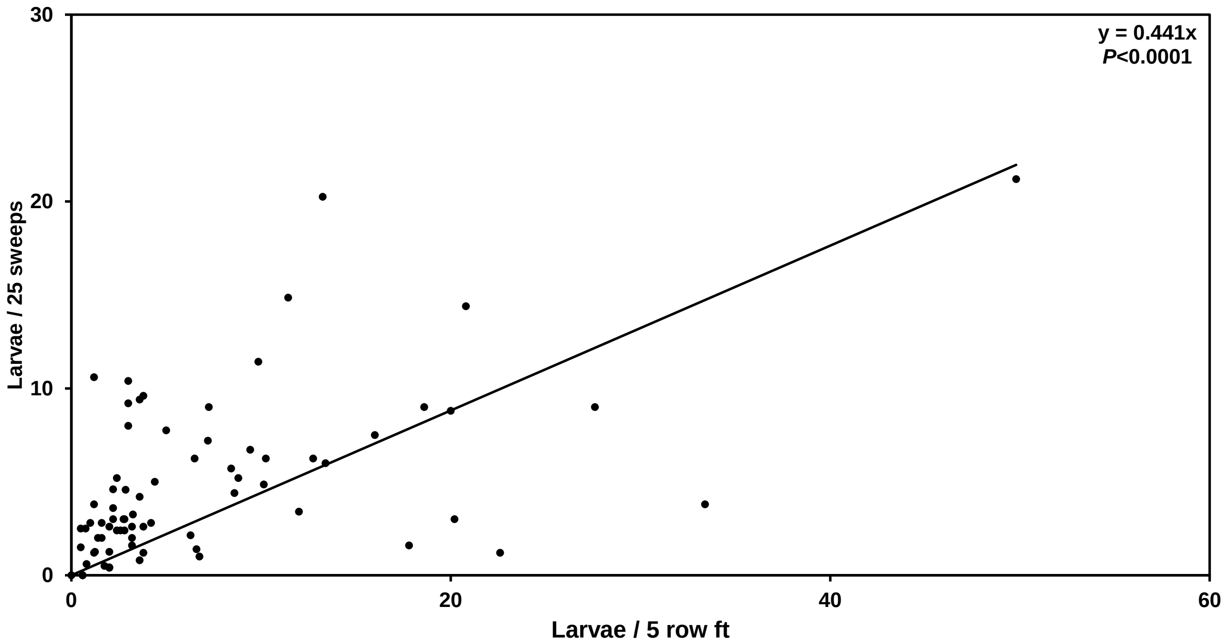

Figure 1. Relationship between numbers of soybean looper larvae <3rd instar captured using drop cloth and sweep net sampling methods.

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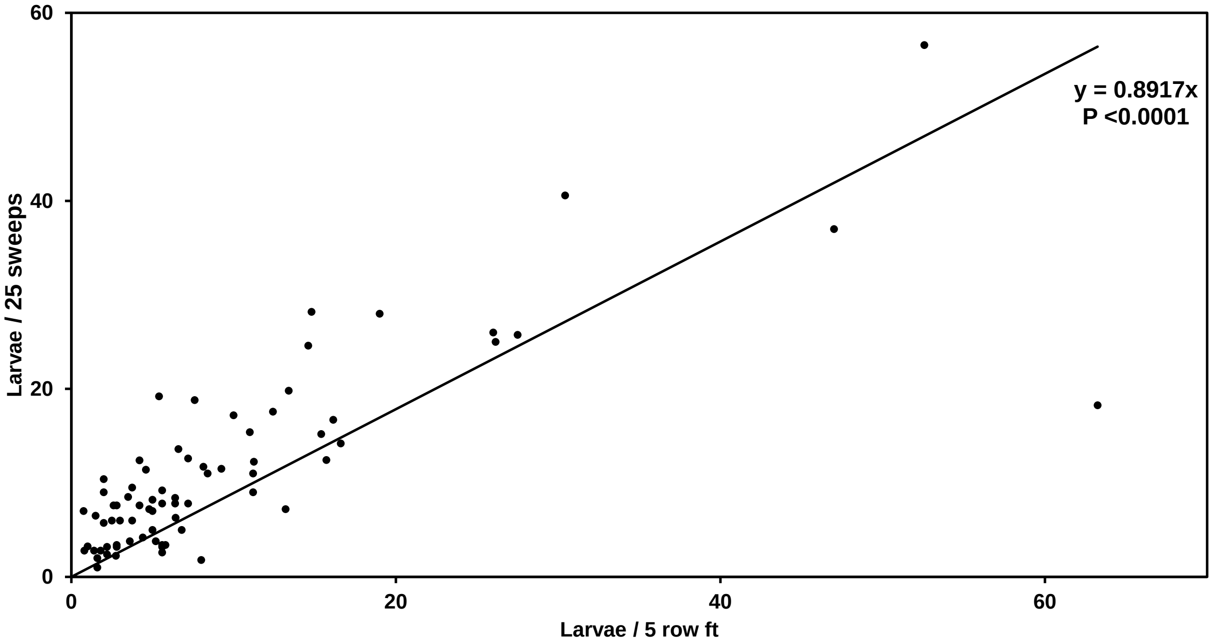

Figure 2. Relationship between numbers of soybean looper larvae ≥3rd instar captured using drop cloth and sweep net sampling methods.

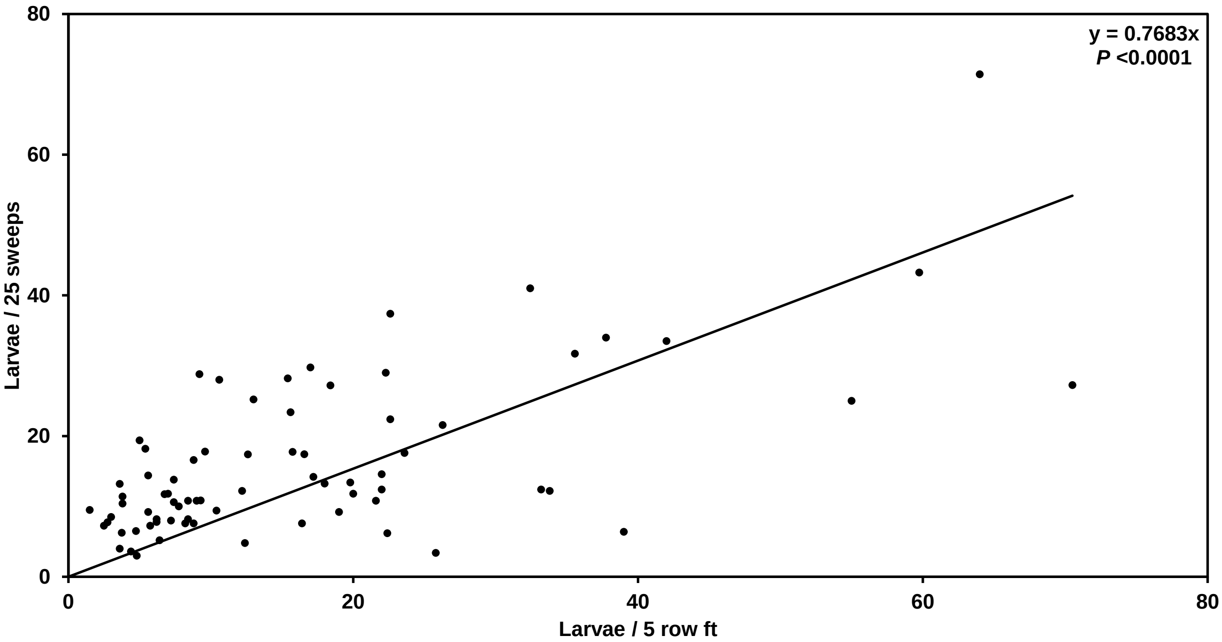

Figure 3. Relationship between total numbers of soybean looper larvae (all sized) captured using drop cloth and sweep net sampling methods.

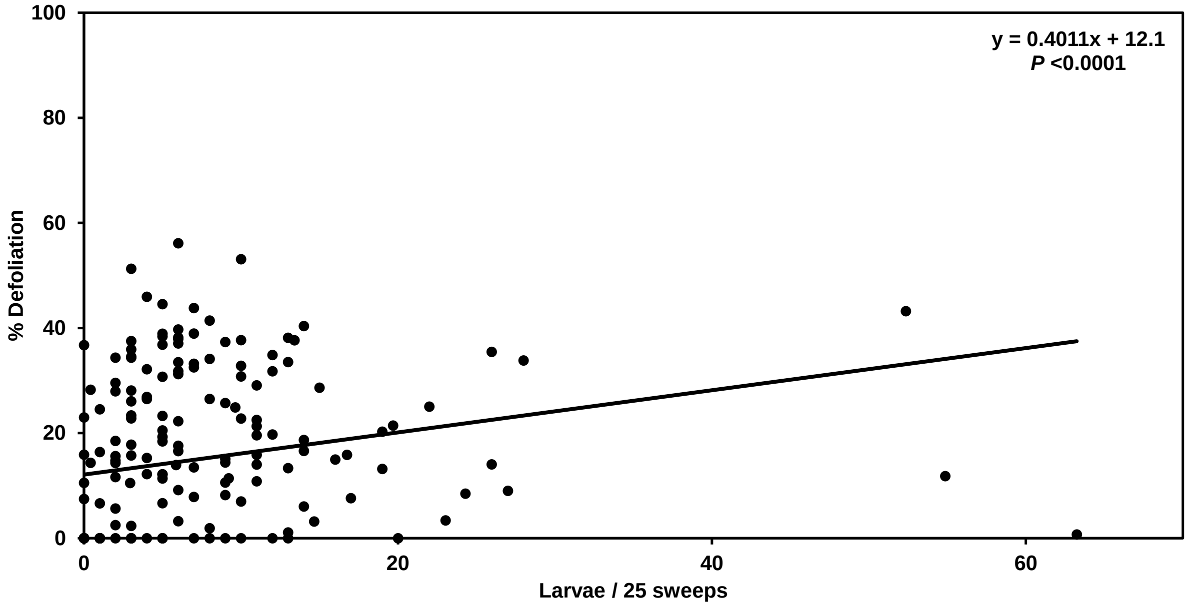

Figure 4. Relationship between numbers of soybean looper larvae <3rd instar per 25 sweeps and percent defoliation.

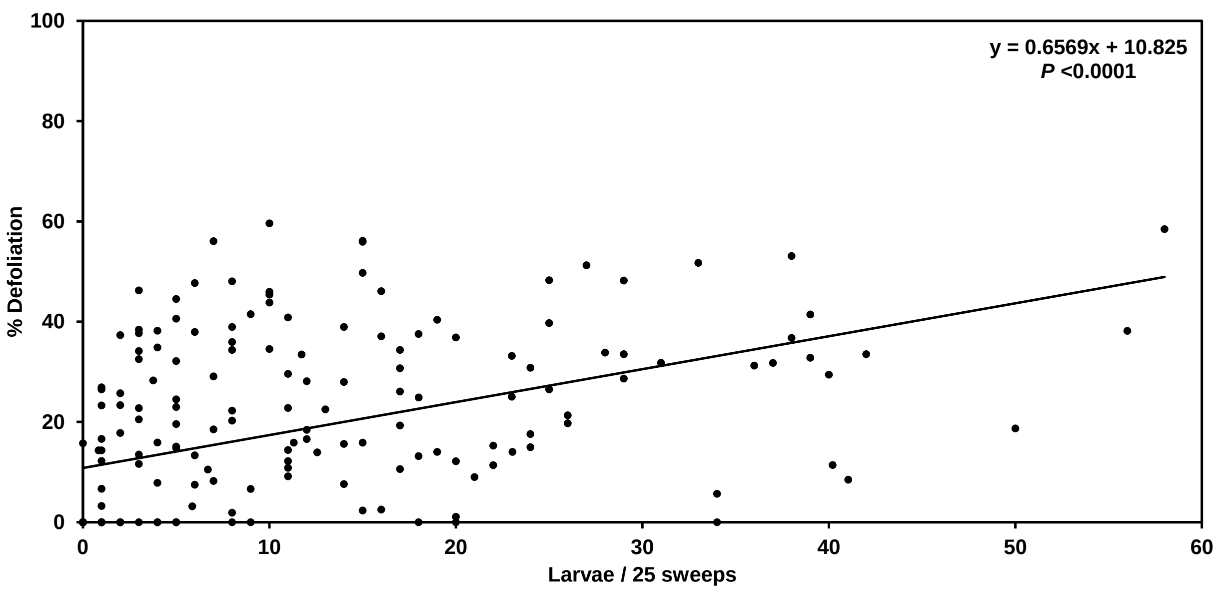

Figure 5. Relationship between numbers of soybean looper larvae ≥3rd instar per 25 sweeps and percent defoliation.

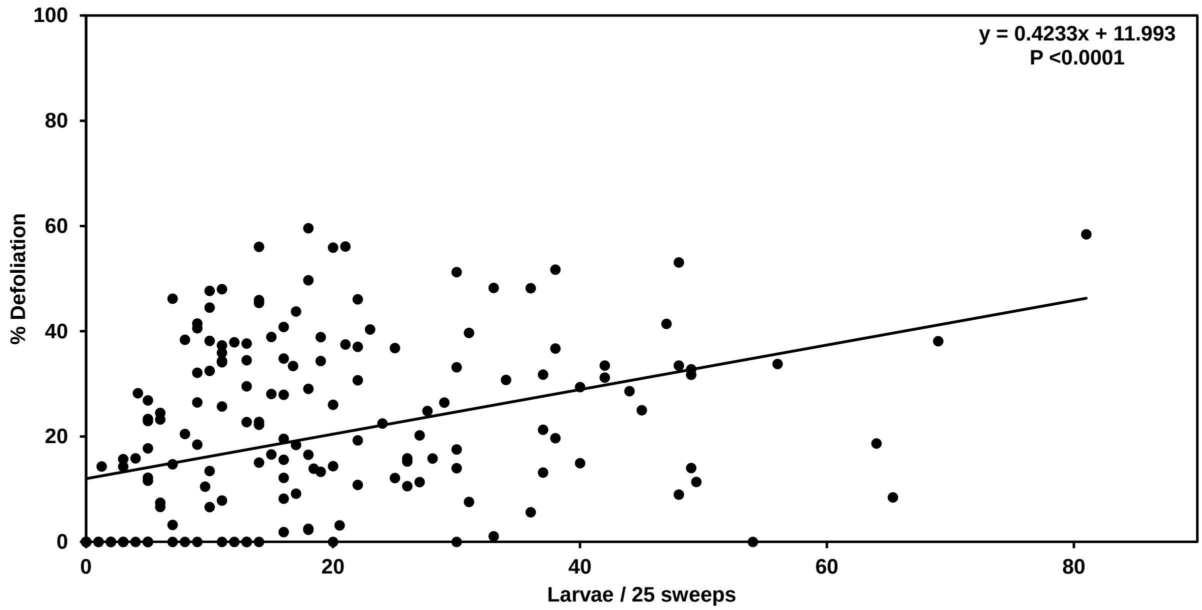

Figure 6. Relationship between total numbers of soybean looper larvae (all sizes) per 25 sweeps and percent defoliation.

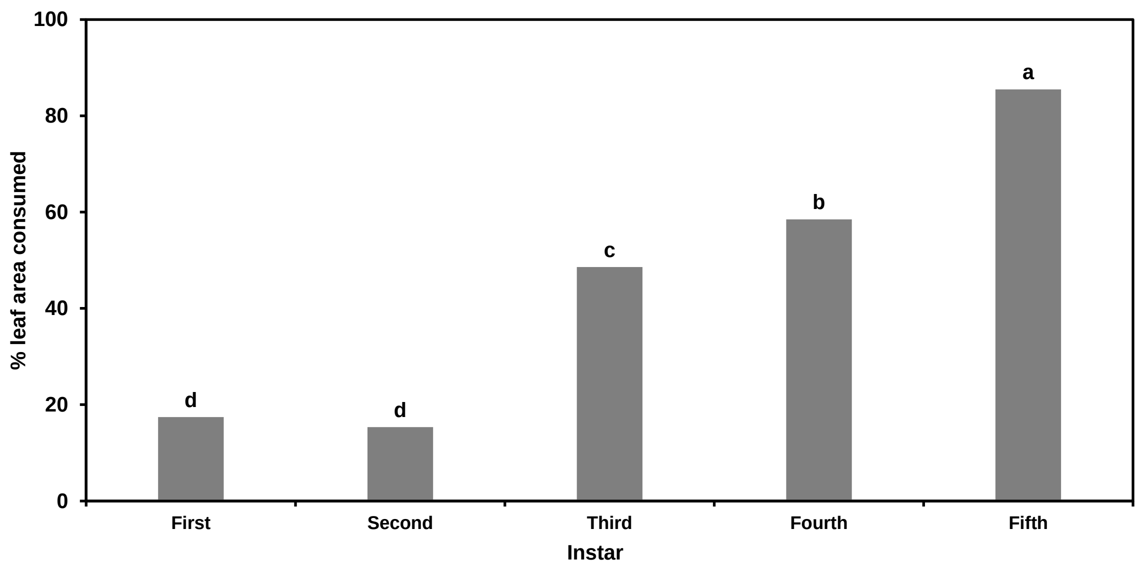

Figure 7. Percent leaf area consumed by soybean looper larvae of different sizes (instar). Bars with a common letter are not significantly different (FPLD *P*>*F* 0.05).

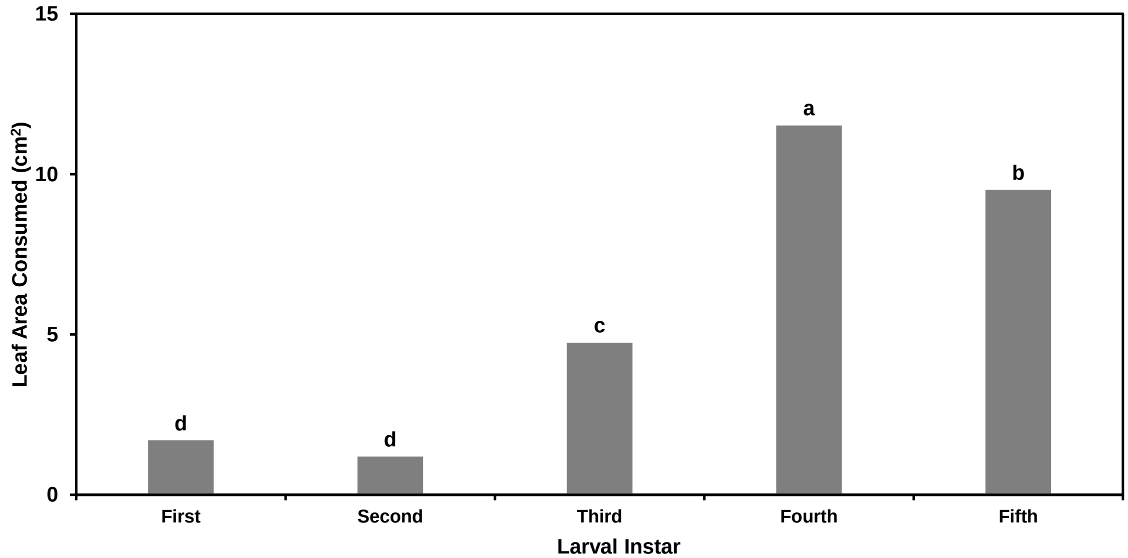

Figure 8. Leaf area consumed by soybean looper larvae of different sizes (instar). Bars with a common letter are not significantly different (FPLD *P>F* 0.05).

Table 1. Performance of selected insecticides against soybean looper during 2017, Trial 1.

Treatment/Form.	Rate (oz/acre)	3 DAT[1]	6 DAT	10 DAT	Yield (bu/acre)
Intrepid Edge 3F[2]	4.0	10.0fg	1.5c	1.1d	42.4ab
Intrepid Edge 3F[2]	5.0	6.6g	2.6c	0.7d	40.5ab
Besiege 1.252SC[3]	10.0	46.8abc	10.1b	10.9ab	44.0ab
Radiant 1SC[4]	2.0	10.1fg	1.9c	3.1cd	36.7b
Radiant 1SC[4]	4.0	5.9g	1.3c	1.7cde	39.3ab
Steward 1.25EC[5]	9.0	14.6ef	2.9c	0.9d	43.1ab
Prevathon 0.43SC[6]	14.0	48.6ab	10.1b	5.2bc	36.9b
Prevathon 0.43SC[6]	20.0	24.8de	14.4b	4.8bc	47.5a
Intrepid 2F[7]	4.0	28.9bcd	8.9b	1.7cd	40.5ab
Intrepid 2F[7]	6.0	27.6cd	12.7b	2.5cde	39.9ab
Non-Treated	-	52.9a	35.1a	19.1a	24.2c
P>F		<0.01	<0.01	<0.01	<0.01

Means within columns followed by a common letter are not significantly different (FPLD *P>F* 0.05).
[1]Days after emergence.
[2]Active ingredient – methoxyfenozide plus spinetoram, Class – IGR and Spinosyn.
[3]Active ingredient – chlorantraniliprole plus λ cyhalothrin, Class – Diamide and pyrethroid.
[4]Active ingredient – spinetoram, Class - Spinosyn.
[5]Active ingredient – indoxacarb, Class - Oxydiazine.
[6]Active ingredient – chlorantraniliprole, Class - Diamide.
[7]Active ingredient – methoxyfenozide, Class – IGR.

Table 2. Performance of selected insecticides against soybean looper during 2017, Trial 2.

Treatment/Form.	Rate (oz/acre)	3 DAT[1]	6 DAT	10 DAT	Yield (bu/acre)
Intrepid Edge 3F[2]	5.0	2.3c	7.0b	2.3b	42.5a
Prevathon 0.43SC[3]	14.0	7.6bc	12.3b	5.3b	41.6a
Diamond 0.43EC[4]	6.0	9.5b	12.0b	4.3b	43.7a
Non-Treated	-	29.8a	36.0a	12.3a	28.9b
P>F		<0.01	<0.01	<0.01	0.02

Means within columns followed by a common letter are not significantly different (FPLD *P>F* 0.05).
[1]Days after emergence.
[2]Active ingredient – methoxyfenozide plus spinetoram, Class – IGR and Spinosyn.
[3]Active ingredient – chlorantraniliprole, Class - Diamide.
[4]Active ingredient – novaluron, Class – IGR.

Table 3. Performance of selected insecticides against soybean looper during 2017, Trial 3.

Treatment/Form.	Rate (oz/acre)	3 DAT[1]	6 DAT	10 DAT	Yield (bu/acre)
Intrepid Edge 3F[2]	5.0	0.3b	1.8b	1.3c	39.7a
Prevathon 0.43SC[3]	14.0	15.5b	12.5b	5.0b	36.4a
Cavalier 2F[4]	8.0	21.4a	17.5b	8.5a	29.2b
Non-Treated	-	13.7a	28.0a	10.5a	22.9c
P>F		<0.01	<0.01	<0.01	<0.01

Means within columns followed by a common letter are not significantly different (FPLD *P>F* 0.05).
[1]Days after emergence.
[2]Active ingredient – methoxyfenozide plus spinetoram, Class – IGR and Spinosyn.
[3]Active ingredient – chlorantraniliprole, Class - Diamide.
[4]Active ingredient – diflubenzuron, Class – IGR.

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Table 4. Performance of selected insecticides against soybean looper during 2018.

Treatment/Form.	Rate (oz/acre)	4 DAT[1]	7 DAT	11 DAT	Yield (bu/acre)
Intrepid Edge 3F[2]	4.0	39.0cd	32.5b	24.6ab	34.4
Intrepid Edge 3F[2]	5.0	38.8cd	24.2bc	17.9abc	39.6
Besiege 1.252SC[3]	10.0	34.5cd	21.5bc	12.9c	36.6
Steward 1.25EC[4]	9.0	13.2e	13.4c	14.6c	39.8
Prevathon 0.43SC[5]	14.0	27.1d	13.8c	10.8c	35.6
Prevathon 0.43SC[5]	20.0	34.3cd	13.8c	12.5c	34.4
Intrepid 2F[6]	4.0	72.7ab	33.6b	25.7a	33.7
Intrepid 2F[6]	6.0	49.2bc	29.6b	17.1bc	37.3
Denim 0.16EC[7]	6.0	34.5cd	20.0bc	12.7c	35.6
Non-Treated	-	82.7a	70.7a	26.3a	35.8
P>F		<0.01	<0.01	<0.01	0.48

Means within columns followed by a common letter are not significantly different (FPLD *P>F* 0.05).
[1]Days after emergence.
[2]Active ingredient – methoxyfenozide plus spinetoram, Class – IGR and Spinosyn.
[3]Active ingredient – chlorantraniliprole plus λ cyhalothrin, Class – Diamide and pyrethroid.
[4]Active ingredient – indoxacarb, Class - Oxydiazine.
[5]Active ingredient – chlorantraniliprole, Class - Diamide.
[6]Active ingredient – methoxyfenozide, Class – IGR.
[7]Active ingredient – emamectin benzoate, Class - Avermectin.