Final Report (Pending Fumonisin Data): Determining Yield Lost to Fall Armyworm, Developing Economic Thresholds and Finding an Effective Spray Timing, 2012.

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Summary

We found continuous infestation by fall armyworm (FAW) from green silk to harvest. Significant kernel damage occurred from milk stage to harvest and fungi associated with FAW feeding eventually damaged more kernels than fall armyworm alone. From dent stage to starch line ½ way down in grain maturation, when fall armyworm infested the lower 2/3 of an ear, the average loss to direct fall armyworm feeding was 24.5 kernels per ear. The additional loss per ear to fungi associated with fall armyworm damage was 31 kernels, for a total loss of 55.5 kernels per ear. These observations were terminated several weeks prior to harvest.

At harvest we used two different methods to determine yield loss per ear, and these methods returned loss values of 0.202 – 0.264 lbs./ear that had fall armyworm damage in the lower 2/3 of an ear. We believe the loss estimate of 0.202 lbs./ear to be more accurate. Additionally, formal grain grading showed 26.7% damaged kernels and musty odor in grain samples where all of the ears had fall armyworm damage. Yield loss per acre was 5,570 lbs./acre difference between unsprayed and maximum control (with 82.9% of the unsprayed ears infested), 7.9% reduction in test weight, 660% increase in percent damaged.

The optimal insecticide timing for a single application was found to be at silk. Later applications showed increased yield loss (although not a statistical difference).

Aflatoxin testing showed no significant difference between ears with fall armyworm damage in the lower 2/3 of the ear and ears with tip damage only. Both of these ear types had aflatoxin levels that were not significantly different from those in ears with only minor tip damage. *We will update this report when fumonisin data become available*.

Preliminary Economic Injury Levels for fall armyworm are presented at the end of this report. We are considering recommendations for scouting and control implementation to avoid reaching the economic injury level.

Note: We attempted to determine yield loss to western bean cutworm as well but, although Ed Bynum sprayed the plots as specified in the protocol, we failed to get a large enough population to test. We therefore rebated the funding for this part of the project back to TCPB.

Methods:

Planting Date: 24 May
Hybrid: Pioneer 33D47 non-Bt
Plot length: 40 feet
Row width: 40 inches
Irrigation: weekly, row water
Fertilization: 180 lbs. nitrogen per acre.
Herbicide application: Milo Pro applied the day after planting
Insecticide: Prevathon 5% SC applied at 20 oz/acre at each application
Insecticide applications: Vertical spray, 4 nozzles per side of row, 13.07 GPA, TXVS-2 nozzles,

Harvest Date: 2 October
Ear shelling: 18 – 29 October
Average plant density at harvest: 25,500 plants per acre
Yield determined by harvesting 1/1000 acre per plot, all yields adjusted to 15.5% moisture

Results

1. Ear infestation profile and in-season damage: These data track insect numbers in ears over 7 weeks. THESE DATA ARE NOT USED IN ESTIMATES OF YIELD LOSS PER EAR.

Ears were infested by both corn earworm and fall armyworm. There was relatively little new egg laying by corn earworm after brown silk and corn earworm numbers declined over time. Fall armyworm egg laying continued until harvest. At peak larval density (milk stage) untreated plots averaged 3.3 larvae per ear (Table 1.) It has often been assumed that fall armyworm larvae first feed in ear tips and then exit the tip of the ear and eventually bore into the side of an ear or the shank. However, our data suggest that only about 20 - 25% of the fall armyworm larvae in the tip of the ear eventually end up feeding in the lower part of an ear, and we most often noted 5th instar larvae (0.5 – 0.75 inches) as those exposed on the outside of the ear, presumably moving to the lower part of the ear or the shank.

Ear damage was quantified weekly for seven weeks from blister stage until the starch line was ½ of the way down the kernels. Table 2 presents average ear infestation and kernel destruction by grain maturation stage for all ears examined, including those with tip damage only and those with fall armyworm in the lower 2/3 of the ear. Table 3 presents damage done in ears that were infested with fall armyworm in the lower 2/3 of the ear (tip damage is not accounted for). We began to see significant fall armyworm direct feeding damage beginning at milk stage. Fungal damage at the site of fall armyworm feeding in the lower ear began to be significant at dent stage. Kernel loss from direct FAW feeding seemed to level off at dent stage and remained relatively stable thereafter (subject to sampling error in our 40-ear samples). However, damage by fungi in association with direct insect damage continued to increase after dent stage (Table 3). For the last 4 weeks before the starch line was ½ down, direct fall armyworm damage accounted for an average of 24.5 kernels lost per ear, and fungi associated with fall armyworm damage visibly affected an average of 31 additional kernels, for an average loss per ear of 55.5 kernels when fall armyworm did damage in the lower part of an ear (Table 3).

Table 1. Mean number of larvae recovered per ear on different sampling dates.

Ear developmental stage	Mean no. of larvae/ear	Mean no. CEW (% of total)	Mean no. FAW (% of total)	Pct. of all FAW found in lower ear
Blister (Aug. 1)	2.63	2.00 (76)	0.63 (24)	25
Milk (Aug. 6)	3.25	1.75 (54)	1.50 (46)	30
Milk – Dough (Aug. 13)	2.68	0.78 (29)	1.90 (71)	11*
Dent (Aug. 22)	2.03	0.25 (12)	1.78 (88)	17
Starch line 1/8" down (Aug. 27)	1.25	0.13 (9)	1.13 (91)	23
Starch line 1/3 down (Sept. 3)	0.95	0.13 (13)	0.83 (87)	22
Starch line ½ down (Sept. 10)	1.18	0.18 (15)	1.00 (85)	25

* Non-standard sampling, results are not representative.
Means based on 40 ears per date.

Table 2. Ear development and mean progression of lower ear kernel damage. **Means represent all ears in ten consecutive ears per untreated plot x 4 plots.**

Ear developmental stage	No. of ears[1/]	All 40 ears		
		Mean kernels destroyed by FAW (sd)	Mean kernels destroyed by fungi (sd)	Mean kernels destroyed by FAW + fungi (sd)
Blister (Aug. 1)	40	0	0	0
Milk (Aug. 6)	40	15.3 (23.2)	0	15.3 (23.2)
Milk – Dough (Aug. 13)	40	9.8** (24.2)	0	9.8** (24.2)
Dent (Aug. 22)	40	14.5 (21.6)	9.3 (24.2)	23.7 (33.6)
Starch line 1/8" down (Aug. 27)	40	17.8 (24.3)	18.3 (22.6)	36.1 (43.9)
Starch line 1/3 down (Sept. 3)	40	11.2 (17.1)	20.2 (30.9)	31.4 (44.5)
Starch line ½ down (Sept. 10)	40	12.4 (16.2)	24.9 (28.0)	37.3 (40.2)
Avg. of last 4 sampling dates	40	14.0 (2.9)	18.2 (6.5)	32.1 (6.2)

[1/] 40 ears were examined per date.
** Non-standard sampling, results are not representative.

Table 3. Ear development and progression of kernel damage in ears damaged by fall armyworm and fungi in untreated plots. **Means represent only ears that are damaged by fall armyworm in the lower 2/3 of the ear. These are a subset of the ears presented in Table 2.**

		Ears damaged by fall armyworm		
Ear developmental stage	No. of FAW infested ears[1/]	Mean kernels destroyed by FAW (sd)	Mean kernels destroyed by fungi (sd)	Mean kernels destroyed by FAW + fungi (sd)
Blister (Aug. 1)	0	0	0	0
Milk (Aug. 6)	16	38 (22)	0	38 (22)
Milk – Dough (Aug. 13)	6	63** (19)	0	63** (19)
Dent (Aug. 22)	21	28 (23)	18 (31)	46 (34)
Starch line 1/8” down (Aug. 27)	26	28 (25)	28 (22)	56 (43)
Starch line 1/3 down (Sept. 3)	20	23 (18)	40 (33)	63 (44)
Starch line ½ down (Sept. 10)	26	19 (17)	38 (26)	57 (36)
Avg. of last 4 sampling dates	23.3	24.5 (4.4)	31.0 (10.1)	55.5 (7.0)

[1/] 40 ears were examined per date.

** Non-standard sampling, results are not representative.

2. At harvest ear damage and yield loss per fall armyworm in the lower part of an ear: THESE DATA ARE USED TO DETERMINE YIELD LOSS PER EAR.

Tables 2 and 3 show the progression of damage as the ears matured, but they are not meant to verify yield loss per ear, in part because there may have been kernel compensation, and in part because of the small number of ears examined on each date. In order to determine ear loss per infested ear we examined 202 ears from the untreated plots in our insecticide trial (approximately 50 per replication selected sequentially, 25 from each of two adjacent rows), rated them for damage on a 1 – 4 scale (Table 4), and compared yields from the different classes of ears. In this comparison we determined that 64.5% of ears in the untreated plots had more than just tip damage and, of these, 11.9% had side grazing that can be done by either fall armyworm or corn earworm, 38.1% had fall armyworm damage and light to moderate fungal infestation, and 14.5% had fall armyworm damage and heavy fungal infestation (Table 5). We determined that the average yield loss per ear from fall armyworm and its associated fungi was 91.67 grams (0.202 pounds) (Table 6). In order to estimate how many kernels need to be destroyed to get a 91.67 gram loss, we harvested 20 tip-damaged only ears from the untreated plots, kept only the kernels from the lower 2/3 of each ear, and counted and weighed 10 replications of 200 kernels. After adjusting to 15.5% moisture we determined that there were an average of 2.85434 kernels per gram of corn in the untreated plots (Table 8), so 91.67 grams of lost yield is approximately 32.116 kernels. Table 7 presents expected yield loss per acre projected over two infestation levels.

Table 4. Rating scale applied to ears at harvest:

Rating	Description of damage
1	Tip damage only
2	Tip damage + side damage
3	Tip damage + FAW damage in the lower 2/3 of the ear with fungi absent or at "low to moderate" levels
4	Tip damage + FAW damage in the lower 2/3 and heavy damage by fungi

Table 5. Percentage of ears at each rating level in untreated plots.

Rating	No. of ears	Mean percent	Std. Dev.
Tip damage only	72	35.6	5.9
Tip damage + side grazing	24	11.9	5.6
FAW + light – mod. fungus	77	38.1	6.1
FAW + heavy fungus	29	14.5	5.7

Means based on 202 sequentially selected ears in untreated plots, 50 ears per replication.

Table 6. Yield loss per ear as a function of the type of damage.

Rating	Mean yield per ear (gm) [1/] (sd)	Mean yield loss per ear (gm)	Mean yield loss per ear (lbs)	Mean yield loss per ear (bu, 56 lbs)
Tip damage only	206.98 a (6.8)	--	--	--
Tip damage + side grazing	191.80 a (15.2)	15.18	0.0335	.00060
FAW lower in ear[2/]	130.49 b (16.4)	76.49	0.1686	.00301
Total non-tip damage		91.67	0.2021	.00361

[1/] Oneway ANOVA Damage Type Pr > F < 0.0001.
Means based on 202 sequentially selected ears in untreated plots, 50 ears per replication.
[2/] Represents combined values for FAW + light – mod. fungus and FAW + heavy fungus ears in Table 5 because there were not enough of the latter for percent moisture determination after shelling.

Table 7. Yield loss per acre as a function of type of damage

Damage Type	Avg. yield loss per ear (gm)	Bu loss 7,500 ears/ac infested	Bu loss with 30,000 ears/ac infested
Tip damage only	--	--	--
Tip damage + side grazing	15.18	4.48	17.93
FAW Lower ear[1/]	76.49	22.59	90.34
Total lower ear damage	91.67	27.07	108.27

[1/] Combines ears with light to moderate and heavy fungal damage and fall armyworm feeding.
Means based on 202 sequentially selected ears in untreated plots, 25 ears per replication.

Table 8. Average weight of undamaged kernels in the lower 2/3 of ears that had only tip damage. All ears were collected from untreated plots.

Avg wt./kernel (gm) [1/] (sd)	Avg. no. of kernels/gm (sd)	Avg. no of kernels/pound (sd)
0.35038 (0.00372)	2.85434 (0.03050)	1294.7055 (13.83671)

[1/] Ten ears per plot, top 1/3 of the ear discarded before shelling, grain within plots bulked and weights obtained for 10 lots of 200 kernels each per plot. Weights adjusted to 15.5% moisture.

In a preliminary dataset we examined the size parameters of ears damaged by fall armyworm in the lower 2/3 of the ear as compared to ears with only tip damage. These ears were taken from the same 40-foot section of row. While only 20 ears were measured for size parameters, we did find that fall armyworm damaged ears are smaller than undamaged ears in size and volume (Table 9). In total, fall armyworm reduces yield through direct kernel damage, fungal infection that follows direct damage in many cases, and perhaps smaller overall ear size as a corn physiological response to direct damage and/or fungal infection.

Table 9. Ear size parameters based on measurement of 10 ears that had significant FAW damage in the lower 2/3 of the ear and tip damage and 10 ears that had tip damage only. All ears taken from one 40-foot row of non-Bt corn.

Ear status	Ear length (cm) [1/] (sd)	Ear circumference (cm) [2/] (sd)	Cubic cm water displacement[3/] (sd)
FAW damaged	20.0 a (1.4)	15.8 a (0.4)	256.9 a (28.6)
Tip damage only	21.4 b (1.3)	16.9 b (0.6)	342.2 b (43.5)

[1/] Oneway ANOVA Ear length Pr > F = 0.0419. Mean separations by t-Test.
[2/] Oneway ANOVA Ear circumference Pr > F = 0.0003. Mean separations by t-Test.
[3/] Oneway ANOVA Ear Status Pr > F = .0001. Mean separations by t-Test.

We used a second method to determine yield loss per ear; lost yield in the insecticide timing trial. The highest yielding plots were those sprayed five consecutive weeks with a high rate of Prevathon, and these had ear tip feeding to some degree but very little fall armyworm damage in the lower part of the ear. (We continued to spray these plots for two weeks after we took milk stage larval data.) The yield lost to fall armyworm was calculated as the difference in yield between plots sprayed five times and the untreated plots. Yield in the sprayed plots averaged 12,722 lbs./acre; yield in the unsprayed plots was 7,152 lbs./acre, for an average yield loss attributable to fall armyworm (and a slight difference in tip feeding) of 5,570 lbs./acre (Table 11). Yield loss per ear for this insecticide timing trial is 5,570 lbs/acre loss/25,500 plants/acre = 0.22 lbs./plant = 99.17 grams per plant. However, only 82.9% of the ears in the untreated plots were infested with fall armyworm. To adjust yield to account for every ear being infested, the average loss per ear would be modified to be 99.17 grams / 0.829 = 119.63 grams lost per fall armyworm infested ear (0.2637 lbs.). Using our value of 2.85434 kernels per gram (Table 8) yields a loss of 49.1 kernels per fall armyworm infested ear. (This is reasonably close to the 55.7 average kernel per ear loss reported in Table 3 for damage being done during ear maturation.) However, faced with two estimates of harvest yield loss per ear when a fall armyworm larva infests the lower 2/3 of an ear, we are more certain of the lower value of 0.202 pounds rather than 0.2637 pounds. This is in part because the higher estimate was biased because the insecticide did a good job of protecting tip kernels on most of the ears used to estimate yield without fall armyworm damage, and thus the higher estimate contains tip damage losses plus losses to fall armyworm and is probably an overestimate. The lower estimate of 0.202 pounds per ear does not suffer from complications due to tip kernels, which we assume to be lost to a combination of corn earworm and fall armyworm.

3. Insecticide timing and yield loss per acre: Insecticide timing was evaluated by imposing five spray regimes and counting the number of larvae present in ears at milk stage. Plots were 8 rows x 40 feet. Prevathon 5% SC insecticide was applied at 13.07 GPA with a boom held vertically, 4 nozzles (TXVS-2) directed at the side of a row and the row was sprayed on both sides. Two adjacent rows per plot received complete insecticide coverage by this method and all data were collected from these two rows. The earliest applications began one week before tassel. The most aggressive application regime was to treat one week before tassel, at tassel and one week after tassel. There were four replications of each treatment and treatments are displayed in Table 10, which also displays the number of larvae per ear at milk stage upon conclusion of the planned insecticide applications. (Note that we continued the most aggressive treatment for an additional two weeks.) Larval counts (Table 10) showed that, with respect to fall armyworm control, one application of Prevathon at silk was as effective at protecting ears until the milk stage as were three applications (one week before tassel, at tassel and one week after tassel), two applications (at silk and 7 days after silk), or one application 7 days before silk. A single application of Prevathon 7 days before silk or a late application 7 days after silk, resulted in numerically more larvae per ear than any of the other insecticide regimes or timings, but this late application was still superior to no insecticide use (Table 10).

Table 10. Mean number of larvae per ear at milk stage after insecticide applications.

Treatment	Total larvae[1/]	CEW[2/]	FAW[3/]
2. Spray 3 times[4/]	1.63 ab (0.57)	1.28 ab (0.23)	0.35 a (0.36)
4. Silk + 7d after	1.68 ab (0.40)	1.38 ab (0.20)	0.30 a (0.22)
3. Silk	1.58 a (0.37)	1.25 a (0.35)	0.33 a (0.12)
1. 7d before silk	2.38 abc (0.52)	1.40 ab (0.35)	0.98 ab (0.29)
5. 7d after silk	2.83 bc (0.53)	2.03 b (0.38)	0.80 ab (0.26)
6. Unsprayed	3.28 c (0.53)	1.80 ab (0.24)	1.48 b (0.35)

[1/] ANOVA Treatment Pr > F < 0.0014, Replication Pr > F < 0.8677.
[2/] ANOVA Treatment Pr > F < 0.0214, Replication Pr > F < 0.0897.
[3/] ANOVA Treatment Pr > F < 0.0003, Replication Pr > F < 0.2531.
[4/] Two additional weekly applications were made to these plots after these data were taken.

Yield loss to fall armyworm under different insecticide regimes was determined by harvesting 1/1000th of an acre in each plot. The data are presented in Table 11 and show that all insecticide applications resulted in significantly higher yields than in the unsprayed plots. However, plots sprayed 7 days after silk had numerically (but not statistically) lower yields than the other insecticide timing/application regimes. This suggests that insecticides should optimally be applied either just before silk or at silk and applications made after silk should be as close to silk as possible. Based on FAW developmental data (Pitre and Hogg, 1983), larvae from eggs laid at silk (July 24 in our trial) would have become 5th instars approximately 13 days later (August 7), at which time the ears were in the milk stage. Our observations suggest that most FAW larvae that leave ear tips do so at 5th instar, and it is unlikely that there was sufficient insecticide residue in plots treated at silk (only) to kill these larvae 13 days later. So we must assume that the primary benefit of the insecticide applications accrues from killing young larvae as they disperse from the egg mass and seek to establish in ears. This reasoning also suggests that increased damage from applications made significantly after silk is caused by the failure to prevent larvae from eggs laid before silk or at silk from establishing in the ear tip.

Fall armyworm egg masses were found in the field until harvest and there was a continual re-infestation of ears. However, later infestations seemed to result in less yield loss per larva because the larvae must consume harder kernels (and larger kernels than at stages before dent). Our yield loss estimates below (Table 11) take into account damage done after the milk stage data presented in Table 10.

Table 11. Harvest data: Mean percent of FAW damaged ears and mean total yield per acre.

Spray Timing	Percentage FAW damaged ears. (sd) [1/]	Mean total yield/acre (lbs.) (sd) [2/]	Mean yield reduction (lbs.)
2. Sprayed 5 times	11.8 a (2.7)	12,722 a (2,070)	--
4. Silk + 7d after	20.1 a (16.9)	11,099 a (1,894)	-1,623
3. Silk	29.0 ab (16.0)	11,338 a (1,765)	-1,384
1. 7d before silk	33.7 ab (20.1)	11,820 a (1,054)	-902
5. 7d after silk	44.0 b (10.8)	10,214 a (1,272)	-2,508
6. Unsprayed	82.9 c (11.5)	7,152 b (2,233)	-5,570

[1/]ANOVA Treatment Pr > F < 0.0002. Replication Pr > F < 0.8051. Mean separations by LSD, 0.05 level of probability.

[2/]ANOVA Treatment Pr > F < 0.0159. Replication Pr > F < 0.4788. Mean separations by LSD, 0.05 level of probability.

Almost every ear, regardless of treatment, had tip damage.

4. Grain Quality: Additionally, fall armyworm damage to the lower part of an ear resulted in significantly lower grain quality. Four-pound samples of grain from each of the plots that were sprayed five times and grain from the fall armyworm damaged ears in the untreated plots were submitted to the Plainview Grain Inspection and Weighing Service, Inc. in Plainview, Texas. The test weight of the grain from the untreated treated plots was 7.9% lower than that in the treated plots (53.42 pounds and 58.00 pounds per bushel, respectively, Table 12). Also, the insecticide protected ears had 4.05% damaged kernels while the fall armyworm damaged ears had 26.73% damaged kernels. These values were significantly different (Table 12) and show a 660% increase in damaged kernels in untreated plots.

Table 12. Quality assessment of relatively undamaged ears from the 5-spray application vs. FAW damaged ears in the untreated plots

Ear status	Bushel test weight[1/] (sd)	Percent damaged kernels[2/] (sd)	Odor
Sprayed 5 times	58.00 a (0.26)	4.05 a (2.04)	none
FAW damaged	53.42 b (0.26)	26.73 b (2.04)	musty

[1/] ANOVA Treatment Pr > F < 0.0004. Replication Pr > F < 0.2119. Mean separations by t-test, 0.05 level of probability.
[1/] ANOVA Treatment Pr > F < 0.0016. Replication Pr > F < 0.3159. Mean separations by t-test, 0.05 level of probability.

5. Mycotoxin levels

Mycotoxin levels (fumonisin and aflatoxin) were compared by harvesting 20 ears with tip damage only in each of the four the untreated insecticide plots and 20 ears with significant fall armyworm damage in the lower 2/3 of the ear. Mycotoxin levels in these ears were compared with each other and with levels from the same number of ears harvested from the plots that received five insecticide applications and which had minor tip damage only. Samples were assayed in Dr. Wenwei Xu's laboratory. *As of this December 26th writing we are still waiting on the fumonisin assays.*

Table 13. Mean parts per billion aflatoxin in ears damaged in the lower 2/3 by fall armyworms, ears with tip damage only, and ears with very little tip damage as a result of being sprayed five times with insecticide.

Ear Condition	PPB Aflatoxin (Std. dev.)
FAW damaged lower 2/3 ear	11.7 (14.4)
Tip damage only	12.0 (12.3)
Sprayed 5 times	6.9 (13.4)

ANOVA conducted on Log transformed aflatoxin levels. No significant difference between treatments; Treatment Pr > F < 0.1266.

Economic threshold development

At present we have enough data to establish an economic injury level: The point at which the dollar value of the damage equals the cost of control. We do not yet have enough information to create solid economic thresholds. We know that larvae must be prevented from entering young ears, but we do not know how long prior to silking insecticides with residual control can be applied to prevent this. We also do not know how many larvae or egg masses at a given number of days prior to silking will result in infestations that will reach the economic injury level. These factors are being discussed now and we may need to do some more research to nail them down.

The following are factors and assumptions that we are using in developing an economic injury level.

A. Yield loss per ear as a result of fall armyworm feeding in the lower 2/3 of an ear

We used two methods to determine the grams of yield destroyed by fall armyworm and its associated fungi when the larva did damage in the lower 2/3 of an ear. (Yield loss through tip damage was not assessed in this experiment.) The method whereby 202 sequential ears (50 per untreated plot) were harvested, grouped into damage type and shelled (Table 6) gave a yield loss estimate of 91.67 grams per ear (0.202 lbs.). The insecticide timing experiment resulted in a yield loss calculation of 119.63 grams per ear, which, as explained above, we believe to be an overestimate. We believe the estimate of 91.67 grams per ear to be more accurate.

B. Percentage of all fall armyworms infesting an ear that ultimately move to the lower 2/3 of the ear and cause lower ear damage

We were surprised to observe that many fall armyworm larvae apparently did not move to the lower part of the ear to feed after reaching 5th instar. Our methods did not directly examine the proportion of larvae moving down the ear and we therefore have little confidence in our estimate of this number. Table 1 suggests that perhaps approximately 22% of fall armyworm larvae move down the ear, but we really don't know whether this is accurate. Thus, until we get more information on this factor, our threshold values will account for a varying percentage of larvae moving to the lower part of the ear.

C. Yield loss and assumptions: sample calculations

Assumption 1: yield loss per fall armyworm larva is 0.202 lbs. (91.67 grams).
Assumption 2: ¼ of fall armyworm larvae in an ear move to the lower 2/3 and do damage.
Therefore the pounds lost per larva = 0.202 lbs./ear x 0.25 larvae moving lower = 0.0505 lbs. lost per larva. However, we are looking at other percentages to see how they affect the outcome.

Number of larvae needed to cause a pound of yield loss = 1/0.0505 = 19.802

D. Control cost and grain value (working assumptions easily altered)

1. $8.50/bushel corn (56 lb. bushel) has a value of $0.15179/pound.

2. A control cost of $30/acre would be offset by a yield savings of 30/0.15179 = 197.647 pounds of grain.

3. At a yield loss of 0.0505 lbs. per larva, the damage would equal the application cost at 197.647/0.0505 = 3,913 larvae per acre (assuming one in four larvae move lower in the ear). (This is equivalent to 978.45 larvae actually doing damage in the lower 2/3 of an ear: 3,913/4 = 978.45.)

An economic injury level table is presented on the next page.

Estimated economic injury levels for fall armyworms per acre. Assumes 0.202 lbs. of yield lost per larva in the lower 2/3 of an ear.

Proportion that go lower on ear	Value per bushel (at 56 lbs./bu)	Control cost/acre ($)	No. of larvae/acre that equal control cost
0.5	8.50	30	1957
0.3	8.50	30	3261
0.27	8.50	30	3624
0.25	8.50	30	3913
0.22	8.50	30	4447
0.2	8.50	30	4892
0.5	7.00	30	2376
0.3	7.00	30	3960
0.27	7.00	30	4400
0.25	7.00	30	4752
0.22	7.00	30	5401
0.2	7.00	30	5941
0.5	7.00	20	1584
0.3	7.00	20	2640
0.27	7.00	20	2934
0.25	7.00	20	3168
0.22	7.00	20	3600
0.2	7.00	20	3960
0.5	7.00	15	1188
0.3	7.00	15	1980
0.27	7.00	15	2200
0.25	7.00	15	2376
0.22	7.00	15	2700
0.2	7.00	15	2970