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Cultural Control of the Southwestern Corn Borer[1]

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The southwestern corn borer, **Diatraea grandiosella** (Dyar), first entered the United States along the Mexican border about 1913. Until 1931 it had been reported only in parts of Arizona, New Mexico, Oklahoma, and Texas. From 1932 to 1953 the insect moved eastward to infest all of Oklahoma and Kansas and parts of Arkansas and Missouri. Since then the insect has moved farther east to infest corn in all of Arkansas, northern Louisiana and Mississippi, southern Missouri, and the western halves of Alabama and Tennessee. The borer was first reported in Tennessee in 1960 in Tipton County. Since then it has moved eastward into all counties in West Tennessee, and in about half the counties of Middle Tennessee.

LIFE HISTORY

Rolston (6) has described the life history of the insect and the types of damage it causes.

Larvae of the insect develop as two forms: the summer and overwintering forms (Figure 1). In Tennessee, the overwintering larvae pupate and the moths emerge and lay eggs on young corn in May. The eggs hatch to produce the summer larvae which pupate and produce the next generation of adults. A complete life cycle of the summer form of the insect requires about 4 to 6 weeks. The insect produces two or three generations per year.

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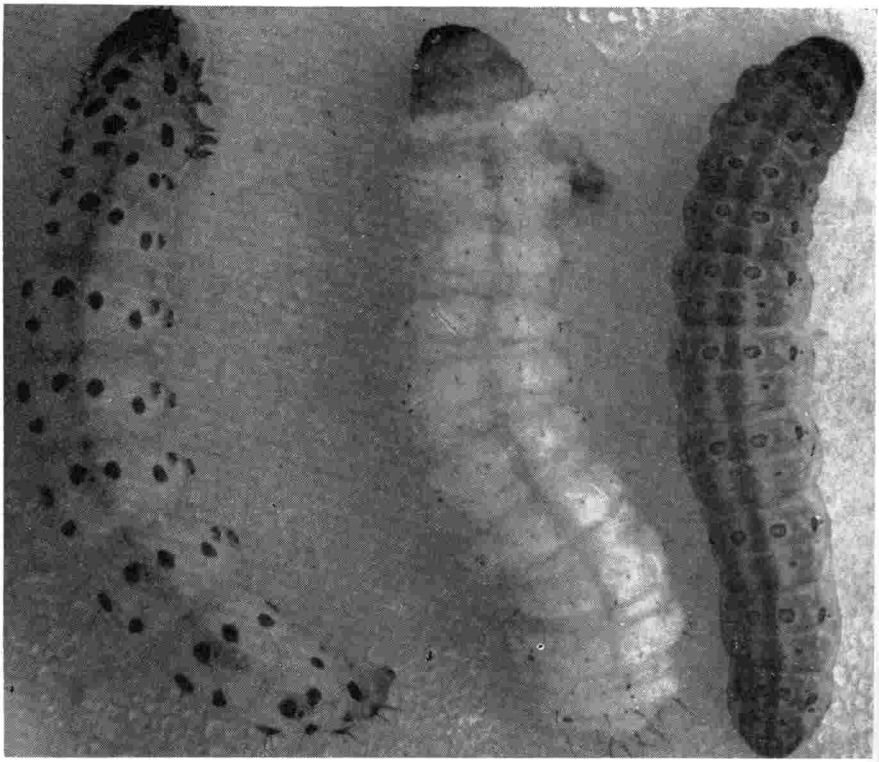

Figure 1. Summer and overwintering forms of the southwestern corn borer larvae (left and center) contrasted with the European corn borer (right).

TYPES OF DAMAGE

The borers (larvae) may produce four types of injury to the plants; leaf feeding, "dead heart," stalk tunneling, and stalk girdling. Young larvae leaf feed during the first two or three instars, but usually this type of injury is of little consequence.

"Dead heart" results when borers feed on the meristematic tissues and damage the central buds. Young corn may be severely damaged or killed by "dead heart." The most striking types of damage are tunneling in the lower portion of the stalks and, later in the season, girdling of the stalks just above the ground level. Tunneling destroys part of the vascular tissue of the stalks and thus reduces grain yield. It is the nature of this insect to tunnel into the crown of the plant late in the season. For some reason, not fully understood, it then girdles the stalk just above the ground

Figure 2. Plant lodged following girdling by the southwestern corn borer.

level and re-enters the crown. Although both summer and overwintering larvae have been found in girdled plants, the overwintering form is much more numerous and is thought to cause most of the girdling.

Both tunneled and girdled stalks lodge readily (Figure 2). Under high infestation and girdling, lodging may be so severe that mechanical harvesting is nearly impossible (Figure 3). Fields have been observed where more than 90% of the stalks were lodged due to girdling.

Attempts to control the southwestern corn borer with chemicals have not been practical. Likewise, no resistant hybrids have been found (5).

Mortality in overwintering larvae is usually high; therefore, the population of the first generation is small. Any cultural practice that would destroy the overwintering larvae would further decrease infestation of corn by the first generation. Moths prefer to lay their eggs on young corn and by the time second and third generation moths emerge, early-planted corn is beyond the attractive stage for the moths. Thus, early-planted corn may escape most of the damage.

The objectives of the experiments reported herein were to study the effects of various manual cultural operations on survival of overwintering larvae in corn stubble and the influence of dates of planting corn on damage by the insect.

Figure 3. Severely lodged corn due to girdling by the southwestern corn borer.

EXPERIMENTAL PROCEDURES

Cultural Practices

The following five methods of treating the stalks and roots of girdled plants were performed by hand operations at Ames Plan-

tation and at the West Tennessee Experiment Station, Jackson, on December 15, 1965:

1. The stalks were split to expose the overwintering larvae.
2. The stalks and root systems were loosened in the soil with a fork.
3. The stalks and roots were lifted from the soil and left on the soil surface.
4. The stalks and roots were inverted in the soil.
5. The stalks were buried in the soil.

Initial counts of infestation were taken on the same date that the above operations were performed. Survival counts were made in March, 1966. Larval counts were made in undisturbed stubble at Ames Plantation and the West Tennessee Experiment Station to determine the percentage of overwintering survival. Only girdled plants were considered in order to insure that the plants had been infested.

Initial counts of 25% and 60% infestation at Ames Plantation and West Tennessee Experiment Station, respectively, indicate that the overwintering larvae had suffered considerable mortality by December 15 (Table 1). The first three cultural treatments at Ames Plantation reduced the overwintering survival below that in

Table 1. Effect of several manual stalk treatments on survival of overwintering borers at Ames Plantation and West Tennessee Experiment Station, Jackson in 1965-1966

Treatment	Stalks with live borers March 1966	
	Ames Plantation[1]	WTES Jackson[2]
	%	%
Initial count (Dec. 1965)	25	60
Stalks split	0	0
Stalks and root systems loosened in the soil	0	5
Stalks and roots lifted from the soil	3	5
Stalks inverted	10	23
Stalks buried	28	17
Control (undisturbed)	7[3]	5

[1]Percentages based on 60 plants.
[2]Percentages based on approximately 15 plants.
[3]Percentages based on 200 plants.

the undisturbed stubble. At the West Tennessee Experiment Station, splitting the stalks also reduced survival below that in undisturbed stubble. Inverting the stalks allowed some protection for the larvae and burying the stalks furnished complete protection to the larvae at Ames Plantation. Burying the larvae apparently protects them from the elements and predators on the surface. Buried larvae were still alive in March, but moths emerging from pupae would not be able to reach the soil surface. Rolston (6) indicated that few moths emerged from buried stubble.

In additional treatments at Ames Plantation, infested corn stubble was disked and plowed, and disked only. Disking alone reduced survival below that of the control, but disking and plowing did not reduce survival (Table 2).

Table 2. Effects of disking and disking plus plowing on survival of overwintering borers at Ames Plantation in 1966

Treatment	Stalks with live borers March, 1966
	%
Initial count (Dec. 1965)	25[1]
Disked only[2]	4
Disked and plowed[2]	25
Control (undisturbed)[2]	7

[1]Percentage based on 60 plants.
[2]Percentage based on 200 plants.

Overwintering larvae are susceptible to winter temperatures when not protected by soil around the stubble, and it appears that any cultural practices that will increase exposure to low temperatures should be effective in increasing larval mortality. Exposure to birds and rodents may also be a factor in mortality. Fall disking should be effective in reducing the surviving population if the treatments are practiced over a large area. Disking followed by plowing will prevent emerging moths from reaching the soil surface. Rolston (6) reported that fields a mile or more from the nearest stubble had nearly as many plants infested as fields much nearer to the stubble. The overwintering survival was 7% and 5% in March for Ames Plantation and West Tennessee Experiment Station, respectively, which indicates that overwintering survival was fairly high under undisturbed conditions. Normally, less than 5% of the larvae survive the winter.

Dates of Planting

Field trials were conducted on the West Tennessee Experiment Station at Jackson in 1964, 1965, and 1966, under natural infestations of the borer. Five planting dates were used as the main treatments and three hybrids as the split-plot treatments. Planting dates selected were April 15, May 1, May 15, June 1, June 15. Tenn. 604, Dixie 29, and Dixie 22 hybrids represented early, mid-season and late maturities, respectively. Four replications of the hybrids were planted in plots containing six rows of 20 plants each, spaced 1 foot apart in the row. Yield and natural lodging data were obtained from the two center rows, while infestation and girdling data were obtained from the other rows at harvest. Total infestation was determined by splitting the stalks. Girdled stalks were determined by applying sufficient pressure to break the stalks at the point of girdling. Grain from both lodged and standing stalks was hand-harvested for yield.

All data were analyzed without transformation of percentages. Duncan's multiple range test was used for mean separation, and linear, quadratic, and deviations from quadratic effects were calculated for planting dates by using orthogonal polynomials for the data from the West Tennessee Experiment Station.

The percentage of infested plants increased significantly as planting was delayed in 1966 (Table 3). For all planting dates, there was an average increase of 11.1% for each 15-day delay in planting. No significant differences among planting dates were obtained in 1964 or 1965, or for the means of the 3 years.

The number of girdled plants increased in all years as planting was delayed. The greatest increase occurred when planting was delayed until May 1. All hybrids responded similarly. The linear regression of girdling on planting date was significant in all years, with a mean increase of 9.1%, 1.1%, and 3.6% in girdling for each 15-day delay in planting in 1964, 1965, and 1966, respectively. The mean increase in girdling computed from the means of the 3 years was 4.6% for each 15-day delay in planting.

The percentages of infestation and girdling were much lower in 1965 and 1966 than in 1964, due in part to earlier planting of the surrounding commercial corn crop, reducing the total infestation of borers these years.

Data for yield and lodging for the April 15 planting date in

Table 3. Mean values for infestation, girdling, yield, and lodging of three hybrids for each of five planting dates in 1964, 1965, and 1966 at West Tennessee Experiment Station, Jackson

Year	Planting date	Infested plants	Girdled plants	Mean yield	Lodged plants
		%	%	Bu./acre	%
1964					
	April 15	95a*	10a	87.5a	28 b
	May 1	84a	24a	75.0ab	19a
	May 15	90a	39 b	82.0a	32 b
	June 1	96a	46 b	75.8ab	17a
	June 15	96a	45 b	56.7 b	26 b
1965					
	April 15	44a	9a	——	——
	May 1	39a	14 bc	80.0	77ab
	May 15	32a	17 c	49.5a	86 bc
	June 1	46a	13ab	45.3a	72a
	June 15	39a	16 bc	30.4a	92 c
1966					
	April 15	14	1	69.8a	28a
	May 1	43	13a	64.4a	24a
	May 15	63a	14a	70.0a	54 b
	June 1	64a	21a	76.2a	67
	June 15	59a	15a	71.0a	46 b
Means for 3 years ‡					
	April 15	51a	7	78.7a	28a
	May 1	55a	17a	69.8a	21a
	May 15	62a	23a	76.0a	43a
	June 1	69a	27a	75.9a	42a
	June 15	64a	25a	64.0a	36a

*Means followed by the same letter are not significantly different at the .05 probability level.

‡Data for infested plants and girdled plants are means for the 3 years while for yield and lodged plants the data are means for 1964 and 1966.

1965 were excluded from the analyses because of poor stands. The linear regression of yield on planting date was significant in 1964 and 1965 with an average decrease in yield of 6.1 and 15.3 bushels per acre, respectively, for each 15-day delay in planting. In 1966, an early season drought followed by better moisture conditions may be the reason the corn planted late yielded as well as that planted early. Since both lodged and standing stalks were harvested, actual yield losses would have been much greater when lodging was high if the plots had been harvested mechanically. The reduced yields with delayed planting in 1964 and 1965 cannot all be attributed to damage by the southwestern corn borer, however. There were no significant differences in yield among hybrids for any year.

The linear regression of lodging on planting date was signifi-

ant in 1966 only. Lodging from causes other than girdling of the talks occurred in this year as in 1965. Infestation was high in all lantings except for the April 15 planting in 1966.

A similar experiment was conducted at Ames Plantation near Grand Junction, Tennessee, in 1966. Tenn. 604 and Dixie 29 hybrids were planted in a commercial field on about the same dates given for the experiments at the West Tennessee Experiment Station, Jackson. Two rows of each hybrid were planted alternately several times the length of the field.

The percentages of infested and girdled plants increased significantly when planting was delayed (Table 4). The greatest increase occurred when planting was delayed from April 13 to May 9. Although the May 9 planting produced the highest yield, much of the grain produced by the girdled and lodged plants would have been lost had the corn been harvested mechanically.

Previous studies in Tennessee (1, 2), Mississippi (4), and other states (3, 6) showed that early-planted corn incurred less damage from southwestern corn borer. These data show that considerable reductions in yield as well as loss of grain from stalk girdling and lodging can be expected when planting is delayed, especially after May 1. The most consistent advantage for planting before May 1 was the reduction in girdling. The use of an early-maturing hybrid was not an acceptable substitute for early planting as a means of reducing damage by the insect.

Table 4. Mean values for infestation, girdling, grain yield, and lodging of two hybrids for each of five planting dates at Ames Plantation in 1966

Hybrids	Planting date	Infested plants	Girdled plants	Grain yield	Lodged plants
		%	%	Bu./acre	%
Dixie 29	April 13	9	2	72.8	7
	May 9	58	36	90.7	47
	May 23	81	67	64.0	59
	June 1	97	52	64.0	56
	June 15	93	61	65.2	44
	Average	68	44	71.3	43
Tenn. 604	April 13	9	2	80.9	11
	May 9	73	48	86.1	63
	May 23	86	70	65.5	68
	June 1	93	62	69.8	67
	June 15	96	64	61.3	51
	Average	71	49	72.8	52
L.S.D. (.05)	Planting dates	6	12	9.2	
	Hybrids	3	4	N.S.	
	Interaction	11	N.S.	N.S.	

SUMMARY

Cultural practices designed to increase exposure of the larvae of the southwestern corn borer insect, **Diatraea grandiosella** (Dyar), to the elements and predators were effective in increasing overwintering mortality. Burying the larvae was not detrimental to their welfare, but the moths would not be able to emerge from the soil. Reduction of the overwintering population will reduce damage due to the first generation, and should also reduce the populations of later generation moths.

Early-planted corn escaped some of the damage. The most consistent advantage for early planting was the reduction in girdling. Corn planted before May 1 was damaged less by girdling in all years and locations, although infestation and lodging were not consistently reduced. The use of an early maturing hybrid was not an acceptable substitute for early planting as a means of reducing damage by the southwestern corn borer.

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