OBSERVATIONS ON THE SUGARCANE BORER (*DIATRAEA SACCHARALIS* FABRICIUS) IN TEXAS, WITH SPECIAL REFERENCE TO CORN AND GRAIN SORGHUM

by

AUGUST IRVIN BALZER

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INTRODUCTION

Agricultural Conditions

The sugarcane borer (Diatraea saccharalis Fabricius) has been noted as being particularly destructive for many years in the Gulf Coast area of the United States on sugar cane, corn, sorghums and other large members of the grass family, and has been studied principally in its relation to sugar cane. In recent years it has been particularly destructive in southeast Texas where there once was a thriving sugar industry which had been completely abandoned by 1927. In certain sections grain sorghums ceased to be a paying crop due to the ravages of this insect. Corn was also often almost a complete failure. The damage caused by this insect had in fact become so great that practically all agriculture with the exception of rice had been abandoned in a large section of southeast Texas.

In December, 1927, a meeting of agricultural workers was called at Beaumont to consider the problem. As a final result of this meeting the United States Bureau of Entomology began studies of the sugarcane borer in southeast Texas principally on the corn and grain sorghums, to discover, if possible, why the borer was so much more injurious in this section than in other localities. The present report is a summary of the work done by the author from 1929 to 1933,

inclusive, and deals primarily with the insect as a pest of corn and sorghums.

History of the Sugarcane Borer

The sugarcane borer as reported by Holloway and associates (15) was introduced into the United States approximately in the year 1855, but several investigators believe it was present before this date. The source of introduction is probably from the West Indies or South America.

Species of Diatraea

Dyar and Heinrich (11) record five species of Diatraea from the United States. They are as follows:

Diatraea saccharalis Fabricius
Diatraea evanescens Dyar
Diatraea zeacolella Dyar
Diatraea venosalis Dyar
Diatraea grandiosella Dyar

Only two of the Diatraea species, besides the sugarcane borer, are of importance in the United States. The larger corn stalk-borer (*D. zeacolella*) occurs in the south Atlantic States east of the Appalachians from Florida to Maryland is mainly a pest of corn in that section. The southwestern corn borer (*D. grandiosella*), according

to Davis and others (10), occurs in the United States in the "southeastern corner of Arizona, nearly the whole of the southeastern two-thirds of New Mexico, most of the Panhandle and Big Bend districts of Texas and about two-thirds of the Oklahoma Panhandle. It was first observed in 1931 in the extreme southwestern corner of Kansas and the extreme southeastern corner of Colorado."

The Diatraea venosalis and D. evanescens, according to Dyar and Heinrich (11), have been reported each from Louisiana and the later from Mississippi in addition.

The sugarcane borer (Diatraea saccharalis Fabricius) is a member of the order Lepidoptera, family Pyralididae and subfamily Crambinae. It is often referred to as the "Sugar-cane moth borer" but the sugarcane borer is now the official common name.

AGRICULTURAL CONDITIONS IN SOUTHEAST TEXAS

Many factors have been found which contribute to the seriousness of the situation in southeast Texas. One of the most important perhaps was the farmer himself and the type of farming he did. The season is sufficiently long that corn and grain sorghums were planted over a period of about five to six months. The farmer very often made a succession of plantings from early to late in the season,

with the idea that at least a part of his crop would find favorable weather and would escape the ravages of the corn root worms (Diabrotica sp.). This practice, of course, allowed the sugarcane borer ample opportunity to build up a heavy infestation by fall so that a great many borers went into hibernation. It was customary also to leave the stalks standing in the field until the following spring and then have them broken down and partly plowed under. Late rice also became infested and the stubs were left for pasture and were usually not plowed until the second or third year following. Many of the highland farmers, as distinguished from the rice farmers, were of the poorer type. They had but little and asked for little more than a bare living. It can readily be seen that with this type of farmer in the community, the more industrious farmer had a difficult time to control insects on his crops.

DISTRIBUTION OF THE SUGARCANE BORER IN THE UNITED STATES

The distribution of the sugarcane borer was limited to the Gulf Coast area. Holloway et al (15) reported that the borer was distributed all along the Gulf Coast of Texas, the southern half of Louisiana, parts of southern Mississippi and the southern tip of Florida as far north

as Daytona and Floral City.

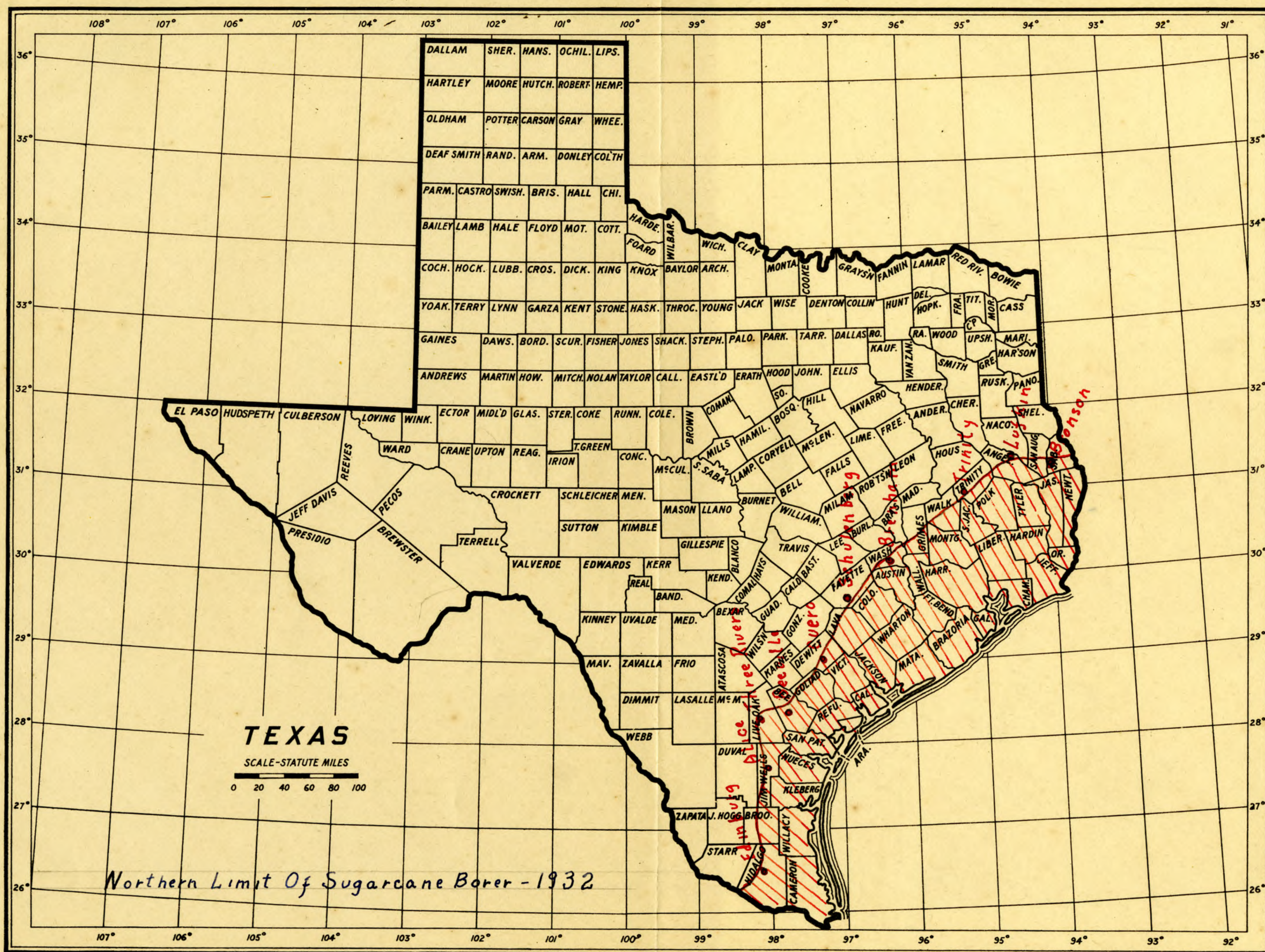
In 1932, Lee Seaton of the Bureau of Entomology at San Antonio and the writer made a survey to determine the northern limits of distribution of the sugarcane borer in Texas. Infestations were found as far north as Bronson, Lufkin, Trinity, Brenham, Schulenberg, Cuero, Beeville, Alice and Edinburg, Texas. The insect was found as far as 160 miles inland. (See map, page 8).

DATA ON SUGARCANE BORER

Description of Stages of the Life Cycle

The larva, pupa and adult have been adequately described technically by Carl Heinrich as recorded by Holloway (13). A brief summary of descriptive features by this author follows: "The eggs are oval, flattened, about 1.16 mm. long by about 0.75 mm. wide, and are deposited in clusters, overlapping one another, like scales on a fish. A group or cluster contains from 2 or 3 to 50 or more eggs ... They are white at first, but later an orange hue develops ... Just before hatching the black heads of the young larvae are plainly visible through the egg shell, and the eggs assume a blackish line.

"Eggs may be deposited on either side of a leaf. The fresh ones are very difficult to find, their whiteness


TEXAS
SCALE-STATUTE MILES
0 20 40 60 80 100
Northern Limit Of Sugarcane Borer - 1932
Edinburg
Alice
Three Rivers
Beeville
Cuero
Schulenburg
Brenham
Trinity
Lufkin
Bronson

JAN. 1, 1920

blending with the green of the cane or corn leaf .....

"The larva .... is when full grown about one inch long by one-eighth inch wide .... The head is brown and the body white with brown spots. This is the summer coloration of the larva, but in the winter it loses its spots, and the body assumes a uniform dirty white color.

"The adult is a straw-colored moth, the forewings marked with darker lines. It varies in size, average specimens measuring about an inch across the wings."

Character of Injury to Corn

The injury to plants by this insect which is caused exclusively by the larvae consists of feeding in the whorl and on the leaves in the immature corn causing small holes in the leaves and on the bud, often killing it outright resulting in injury known as "dead heart" or "rag worm".

The damage caused by the tunneling of the larvae into the interior of the stalk is by far the most serious injury. The plant is often killed, when attacked while young by a large number of larvae, or it is weakened, thus reducing the size of stalk and ear. A severe infestation frequently prevents the setting of an ear or only nubbins are produced. The weakening of the stalk often causes it to break over.

The larvae frequently infest the ear but the damage is usually not serious enough to prevent the production of a grain crop. They often enter the shank of the ear and cause damage by weakening it thus preventing the ear from developing properly.

Life History of the Sugarcane Borer

Life history studies were made annually on a small scale from 1929 to 1933, inclusive. The rearing for the life history studies was carried on in a screened porch insectary at the Texas Agricultural Substation Number 4 at Beaumont, Texas. The insectary is a section of a south side screened-in porch, three sides of which are open, thus making conditions within similar to those outside. The specimens reared were protected from direct sunlight.

Length of the Pupal Stage

The duration of the pupal stage, which was practically the same for male and female, varied in length from 5 to 19 days as shown in Table 1.

Mature larvae collected in the field were placed singly in 8 x 35 mm. glass shell vials in the bottom of which a small piece of absorbent cotton had been packed. Two pieces of blotting paper, almost the length of the

Table 1. A Record of the Length of the Pupal State of the Sugarcane Borer in the Insectary, Based on Pupae Reared from Mature Larvae Collected in the Field at Beaumont, Texas, 1929-1933, Inclusive.

Period	No. pupae observed: Male	No. pupae observed: Female	Av. duration in days: Male	Av. duration in days: Female	Extreme duration in days: Minimum: Male	Extreme duration in days: Minimum: Female	Extreme duration in days: Maximum: Male	Extreme duration in days: Maximum: Female
March	20	8	12.1	13.9	8	9	19	18
April	37	35	13.5	13	9	9	19	19
May	22	31	10.1	9.5	7	7	13	16
June	29	65	7.9	7.3	6	5	9	9
July	25	61	7.2	6.9	6	5.5	8	8
August	10	9	7.2	7.2	6	6	8	9
September	5	5	7.2	7	6	6	9	8
October		1		8		8		8
Total and Average	148	215	9.71	9.1	6	5.5	19	19

vials, were placed on the inside of the vials with the larvae between the papers. The vials were temporarily stoppered with a plug of cotton and placed singly in two-ounce opaque glass ointment jars with moistened sand in the bottom. The plugs preventing the larvae from leaving the 8 x 35 mm. vials were removed in a day or so, or as soon as the larvae were settled in their new home. The sand in the bottom of the ointment jar was kept moistened with water. Daily observations were made of the specimens. Each specimen as it pupated was numbered and a record kept of the time of pupation and adult emergence. Results of these records are given in Table 1. The length of the pupal stage closely correlated to temperature as shown in Table 2. It is seen from the table that as the average mean temperature decreased from 81.0° F. to 65.2°F. the length of the pupal stage increased from 5 days to 19 days. The average length of the pupal stage was 9.41 days.

Table 2. Duration of the Pupal Stage of the Sugarcane Borer in the Insectary in Relation to Mean Temperature, Beaumont, Texas, 1929-1933, Inclusive.

Length of pupal stage period (days)	Number pupae observed	Average mean temperature (Degrees F.)*
5	2	81.0
6	32	83.1
7	119	82.9
8	69	80.1
9	36	76.9
10	9	73.3
11	17	72.4
12	10	72.1
13	6	70.0
14	9	69.4
15	10	67.4
16	17	67.0
17	15	66.8
18	9	64.8
19	4	65.2

* The meteorological data presented throughout this paper was obtained from the Texas Agricultural Substation Number 4, through the courtesy of R. H. Wyche, Superintendent. The Station is located five miles west of Beaumont, Texas.

Length of Life of the Moths

The average longevity of 173 females confined in oviposition cages with males was 3.4 days while that of a similar number of males was 3.6 days. The maximum longevity of males and females observed in mating and oviposition cages was nine days each. Females not mated lived an average of 1.8 days longer than those which mated. Males not mated lived an average of 1.7 days longer than those which mated.

The cages in which the moths were confined for mating, oviposition and longevity records were quart cylindrical paper icecream containers lined with loose sheets of white paper and the ends of the cylinder replaced with a small mesh copper wire screen. The sheet lining the cylinders was replaced daily as eggs were deposited. A shallow tray of water was kept in front of the cages and a heavy moistened towel hung up four inches back of the cylinder to maintain proper humidity conditions. Both reared and field collected moths were used for data on the length of life and oviposition.

Number of Eggs Deposited and Fertility of Eggs

Mated females deposited an average of 267 eggs in an average of 11.3 egg masses. One specimen deposited as many as 875 eggs. Most females not mated usually deposited a few scattered infertile eggs. Thirty such individuals deposited an average of 46.8 eggs each.

Eggs deposited on the paper sheets lining the cages were tacked on a snallow beaverboard tray for incubation. The eggs were dampened twice daily with water. The eggs were counted as soon as the embryos had developed sufficiently to be seen easily.

The fertility of 46,256 eggs was: 85 per cent hatched, 7 per cent were infertile and in the remaining 8 per cent the embryos died before hatching. The incubation period, which was in close correlation to temperature, ranged from 3.5 days to 12 days. See Table 3.

Copulation was observed in three cases and fertile eggs were deposited 3, 6 and 12 hours later.

The average preoviposition period of 156 mated females observed was 1.5 days. Males and females which emerged during the night and were placed together in oviposition cages early in the morning, deposited eggs the following night in approximately 50 per cent of such

Table 3. Incubation Period of Eggs of the Sugarcane Borer in Relation to Mean Temperature Based on Eggs Deposited in the Insectary at Beaumont, Texas, 1929-1933, Inclusive.

Length of incubation period (Days)	Number eggs observed	Average mean temperature (Deg. F.)
4	563	85.5
5	15,315	82.8
6	19,671	80.7
7	3,061	72.2
8	1,383	75.5
9	975	74.5
10	2,113	70.6
11	738	68.6
12	451	67.9

cages. In one instance a male and a female which emerged during the night and were placed together in an oviposition cage in the morning were in coitus at 10:00 a.m. of the same day. The following morning eggs had been deposited. The average length of the oviposition period of the 156 females observed was 1.2 days. One individual deposited eggs over a five-day period. Most females died during the night on which the last eggs were deposited. The post-oviposition period averaged 0.5 day.

A female which was observed in coitus at 8:12 a.m., deposited 348 eggs by 2:00 p.m. of the same day. No observations have been made as yet on the time required to deposit an egg mass.

Seasonal History

Emergence of the adults from the overwintering generation at Beaumont, Texas, varied considerably from year to year, although it normally began the middle of March and was completed, except for straggling individuals, by the latter part of April. Of 232 specimens collected on March 2, 1932, five or 2.2 per cent were pupae. Overwintering larvae were found in the field as late as May 19. The length of the overwintering pupal stage ranged from 8 to 19 days.

Emergence of the adults of the first generation began the latter part of May and continued to the middle of June or approximately 70 to 75 days after the first pupa was found. The variation in the time required for the development of the borer was such that there were no distinct broods or generations after the first of July. In field cage experiments, both pupal cases and half-grown larvae were found in corn plants, artifically infested with larvae known to be of the same age. The life cycle of a

few specimens in a field cage experiment during the summer of 1932 was completed in the minimum time of 25 days.

In the fall, the per cent of pupae found in field collections decreased rapidly after September 15; however, some were found in every month of the year during the five years this work was carried on. Emergence of adults from these pupae was practically completed by the first of November.

Observations reveal that it is possible to have as many as 5 or 6 broods during the year. On the other hand, it is possible, according to data obtained, for two generations to span the year.

Holloway (13) has the following to say regarding the duration of the life cycle: "The length of the life cycle varies considerably with the temperature. Taking the minimum of each immature stage the sum of 28 days is obtained, while in the same way a maximum of 293 days is secured. The sum of the periods required by most individuals in the various stages is 43.1 days, which may be regarded as an average. The maximum larval period recorded was 262 days and included hibernation."

Location of the Borer in the Stalk

As a general rule the larvae fed and hibernated rather high up in the stalk. Seventy-two per cent of the larvae were found 25 inches and more above the ground and only very rarely were they found beneath the surface of the ground even during hibernation. See Table 4.

Table 4. Location of the Larvae of the Sugarcane Borer in Corn Stalks at Beaumont, Texas, 1929-1933, Inclusive.

Location of larvae	Condition of corn	
	Roasting ear : Larvae active	Dry : Larvae hibernating
Below surface	0.0 %	1.5 %
0 to 6 inches	3.3 %	2.3 %
7 to 12 inches	7.7 %	7.2 %
13 to 24 inches	17.0 %	16.6 %
25 inches	72.0 %	72.4 %

Hibernation and Survival

At Beaumont, Texas, larvae ranging from half grown to full grown hibernated in corn, grain sorghums, saccharine sorghum stalks and refuse, Egyptian wheat, rice stubs, seed cane, cane stubble, cane scraps, stalks of large grasses and ear corn, and grain sorghum stored in a dry

place. Larvae in matured and dry host plants began going into hibernation as early as the middle of September while those in green food continued feeding until frost killed the host plant.

In one field of standing hegari as many as 100 larvae per square rod successfully survived the winter, while as many as 37 per square rod were found surviving the winter in corn stalks. Stalks from late planted corn and grain sorghum left standing in the field through the winter furnished ideal conditions for the survival of hibernating larvae.

The survival of hibernating larvae was much influenced by temperature. During the winter of 1928-29, with a minimum temperature of 21° F., there was 85 per cent mortality in standing corn. During the winter of 1929-30, with a minimum temperature of 10° F., the winter mortality in standing corn was slightly more than 99 per cent. In 1930-31, with a minimum temperature of 28° F., 28.2 per cent mortality occurred in corn, 15.7 per cent in hegari[1], 18.2 per cent in Egyptian wheat, and a 60 per cent mortality in rice stubs. In 1931-32, with a minimum of 28° F.

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[1] Hegari is a grain sorghum with a fairly juicy stalk. The plant at maturity is four to five feet tall. It was the commonly grown grain sorghum in southeast Texas.

recorded, a 29.3 per cent mortality occurred in corn, 30.3 per cent in hegari, 16.7 per cent in stored hegari, 28.1 per cent in corn stalks stored and 55.9 per cent in stored rice straw artificially infested. Again during the winter of 1932-33, with two nights with 15° F., there was a 95 per cent mortality in corn stalks, 94.1 per cent in hegari, 92.3 per cent in Egyptian wheat, 90.5 per cent in rice stubs, 53.3 per cent in stored hegari, 50 per cent in stored corn stalks and 31.3 per cent in ear corn stored. See Table 5. On November 19, 1932, immediately after six days with 32° F. or less and two nights with 28° F., a 59 per cent borer mortality was found in standing sugar cane.

Borers hibernating in rice stubs and Egyptian wheat survived the winters of 1929-30 and 1932-33 slightly more successfully than those in corn and hegari. It was interesting to note that after the two unusually cold winters infestations early in the spring occurred first in the earliest corn fields in the rice section, near fields where Egyptian wheat was allowed to stand over winter, or near bedded seed cane.

Work has been conducted during four winters on the survival of the borers hibernating in ear corn and stalks of corn and grain sorghum stored in a dry place. Probably less than 10 per cent of such larvae emerged as adults.

Table 5. Winter Mortality of Larvae of the Sugarcane Borer Hibernating in Host Plant, Beaumont, Texas, 1929-1933.

Date of observation	Temperature (Degrees F.) Mn. for winter	Days with 32° or less	Host Plant	Number borers observed Alive: Larvae	Alive: Pupae	Dead: Larvae	Dead: Pupae	Per cent Mortality	Note
1928-1929	21	17							
3-21-29			Corn	25	2	33	0	55	
1929-1930	10	22							
2-28-30			Corn	0	0	91	0	100	1
3-26-30			Egyptian wheat	0	0	17	0	100	
3-3 to 4-3-30			Rice stubs	1	0	9	0	90	
5-2-30			Corn stalks, stored	0	0	196	0	100	
5-5-30			Corn cobs, stored	0	0	18	0	100	
1930-1931	28	8							
3-19-31			Corn	70	1	28	0	28.2	
3-31 & 4-2-31			Egyptian wheat	31	5	8	0	18.2	
1-21-31			Hegari	79	0	24	0	28.3	
3-20-31			Hegari	77	0	5	0	6.1	
3-23-31			Rice stubs	6	0	4	0	60	
1931-1932	28	7							
3-21-32			Corn	50	8	21	3	29.3	2
3-14-32			Hegari	74	2	31	2	30.3	
3-21-32			Hegari, stored	40	0	8	0	16.7	
3-21-32			Corn, stored	22	1	9	0	28.1	
4-13-32			Rice straw, stored	15	0	19	0	55.9	
1932-1933	15	20							
3- 2 to 29-33			Corn	1	1	35	2	95	
3-21-33			Hegari	1	0	16	0	94.1	
3- 3-33			Egyptian wheat	1	0	12	0	92.3	3
3-14 to 18-33			Rice stubs	2	0	19	0	90.5	
3-22-33			Hegari, stored	28	0	32	0	53.3	
3-23-33			Ear corn, stored	11	0	5	0	31.3	
2-22-33			Corn, stored	20	0	20	0	50	

Note 1. On February 19, in some corn near a bayou south of Orange, 2 live and 13 dead larvae were found.

Note 2. Pupation had already begun when a six-day cold period with a minimum of 28° F. occurred.

Note 3. Of 31 borers found in debris and standing stalks only 24, or 77.4 per cent, were dead.

Pupation was retarded from two to four weeks or more. Of the few specimens that eventually pupated a large per cent died in that stage. See Table 6.

The data in the table show that only 15 pupae out of 433 living larvae and pupae were found in spring examinations made in infested ear corn and stalks of corn and grain sorghum stored in the fall. Forty per cent of the total number of pupae found were dead. Positive evidence of the emergence of only one adult moth in the spring from crop refuse stored in the fall was obtained. It emerged on March 21, 1932, from rice culms artificially infested and stored in the insectary in ice cream containers on November 3, 1931.

Differences in the Larvae of this Species from Different Localities

In 1929, soon after the work was begun at Beaumont, Texas, certain differences in structure were observed between larvae found at Beaumont and those found in the sugar cane section of Louisiana. Those differences were of such nature as to cause suspicion that the borers at Beaumont might be a different species or at least a different race. Adults from the two sections were, however, determined by Carl Heinrich of the United States National

Table 6. Winter Survival of Larvae of the Sugarcane Borer Hibernating in Host Plants Stored. Beaumont, Texas, 1929-1933, Inclusive.

Date stored	Host plants	Date examined	Number of borers observed				
			Larvae		Pupae		
			Alive	Dead	Alive	Dead	
12-19-29	Corn stalks	5- 2-30	-	196	-	-	1
?- ?-29	Corn cobs	5- 5-30	-	18	-	-	2
12-18-30	Corn stalks	4-11-31	30	30	-	-	3
		4-22-31	32	22	3	-	3
11- ?-30	Rice culms	5-21-31	7	4	-	-	4
		5-21-31	14	12	2	-	5
11- 3-31	Rice culms	4-13-22	15	19	-	-	6
		4-27-32	14	9	-	-	6
1-19-32	Corn stalks	3-21-32	22	9	1	-	
		4-7- 32	26	9	-	-	
		4-28-32	15	2	4	-	
1-19-32	Hegari stalks	3-21-32	40	8	-	-	
		4-7-32	25	0	-	-	
		4-25-32	15	5	3	-	
10-27-32	Hegari stalks	3-22-33	28	32	-	-	
		4-11-33	38	62	-	1	
		4-25-33	18	36	-	-	
10-27-32	Ear corn	3-23-33	11	5	-	-	
		4-11-33	3	5	1	1	
		4-25-33	6	7	-	1	
10-27-32	Corn stalks	3-22-33	20	20	-	-	
		4-11-33	16	40	-	2	
		4-26-33	13	47	1	3	
		5-23-33	10	32	-	2	

[1] Practically same number of dead larvae found as count for live larvae showed in fall. Stored in porch insectary.

[2] One dead adult found in tunnel. Cobs stored in barn.

[3] Stalks suspended from rafter in barn.

[4] Rice culm artificially infested and stored in insectary in open cylinder.

[5] Rice culms artificially infested and stored in insectary in closed cylinder.

[6] Rice culms artificially infested and stored in insectary in ice cream containers. One adult moth emerged on March 21.

Museum as being the same species. No reason can be given as yet for the differences observed.

During August, 1929, larvae from several points along the Gulf Coast were collected in corn for making observations on differences in the borers from the different localities. E. V. Walter of the Bureau of Entomology at San Antonio studied some of the larvae and found that the degrees formed by the angles of the dorsal setae on the abdominal segments became gradually larger as one moved westward along the Gulf Coast to Taft and Beeville, Texas.

The results of Mr. Walter's observations on the angles formed by the dorsal setae are given in Table 7.

The larvae from the various localities, except George West and Edinburg, were collected within a week's time during early August.

Mr. Walter in a Station note during 1933 made the following statement regarding differences in borers from different localities: "In addition to the difference in angle formed by the setae, the larvae from Texas seem to show a darker color to the head and thoracic shield and the setal spots, and to be otherwise more darkly marked. They also appear to be much less inclined to cannibalism, thus permitting a greater number to mature in the same stalk. There seems to be some little difference in the point of attack and in feeding habits."

Table 7. Comparison of Placement of Dorsal Abdominal Setae on Sugarcane Borer Larvae from Different Localities, 1929.

Locality	No. larvae	Average of degrees formed by angle of dorsal setae: First abdominal segment	2nd segment	3rd segment	4th segment	5th segment	6th segment	7th segment
Crowley, Louisiana	20	54.52	41.50	35.85	33.00	33.00	32.22	33.66
Beaumont, Texas	54	54.92	42.47	38.02	34.83	35.71	35.76	36.66
Victoria, Texas	21	60.14	43.95	38.71	33.89	36.56	37.75	38.76
Taft, Texas	20	61.95	47.80	40.55	38.95	38.10	40.10	37.17
Beeville, Texas	14	62.86	48.28	43.14	43.71	41.50	43.00	41.84
George West, Texas	7	60.00	47.83	44.00	40.43	37.33	40.71	42.28
Edinburg, Texas	13	59.81	48.00	42.92	39.00	38.18	39.46	40.46

Host Plants of the Borer in Southeast Texas

The cultivated host plants of the sugarcane borer in southeast Texas were corn, grain and forage sorghum, rice, Egyptian wheat, sugar cane and Sudan grass. Infestations were also found in Napier grass, Johnson grass and one known as Echinochloa crusgalli.

Rice, the important cultivated crop for southeast Texas, was seldom seriously damaged except in late maturing fields. Very little grain and forage sorghum, sugar cane, Egyptian wheat, and Sudan grass were grown. They were, however, important in considering a cultural control program. The borer prefers corn to the other crops but when a scarcity of green corn occurs the borer infestation rapidly spreads to the other crops, causing more or less serious damage.

Degree of Infestation of Corn and Related Plants

Attempts were made in the field and also in field cages to obtain accurate information on oviposition on the different host plants. Since the writer was unable to find the eggs for a satisfactory count this part of the work was discontinued. Corn, hegari, sugar cane and rice were grown two years in a field cage, 12 x 12 x 7 feet,

until in a suitable stage for oviposition. One year eight and the other two female adults were released in this cage. After the larvae were well established it was found that the average borer population for the two years in the various crops was as follows: Seventeen corn stalks had an average of 10.1 borers each, 23 hegari stalks had an average of one borer each, 21 sugar cane stalks had an average of 2.2 borers each and 261 culms of rice had an average of 0.01 borer per culm, thus showing corn to have been by far the preferred host.

During 1932 and 1933, field plot tests were conducted to compare the infestation and inhabitation of corn to that of four of the leading grain sorghums for southeast Texas. The results showed that for the two years corn had an average population of 2.8 borers per stalk, hegari had 0.48, spur feterita 0.45, darso 0.29 and shrock 0.25. Corn had the greatest population both years. See Table 8.

Sugarcane Borer on Sugar Cane

Sugar cane variety tests were conducted on a limited scale for four years at the Texas Agricultural Substation Number 4, Some of the results of which are given in Table 9. The object of this work was to become acquainted with the best varieties of this crop and the status of the crop in formulating a cultural control program.

Table 8. Infestation and Population of the Sugarcane Borer in Corn as Compared to That of Four of the Leading Grain Sorghums for East Texas. Beaumont, Texas, 1932-1933.

	Per cent infestation				Population			
Plant	1932	1933	Second growth	Av.	1932	1933	Second Growth	Av.
Corn	77.5	40.8		54.3	4.46	1.14		2.8
Hegari	37.3	2	68	35.8	.72	.02	.7	.48
Shrock	19.3	7.5	62	29.6	.11	.03	.6	.25
Feterita	44	11	56	37	.73	.12	.5	.45
Darso	37	16	28	27	.31	.23	.32	..29

It is seen from Table 9 that the per cent of infestation was uniformly high, ranging from 96.5 per cent to 100 per cent. The P.O.J. #36, however, had an average of only 0.61 borers per stalk while Louisiana Purple had an average of 1.89 borers per stalk. Also only 24.6 per cent of the internodes in the P.O.J. #36 were bored or tunnelled while 44.2 per cent of the Louisiana Purple internodes were bored. It is apparent from this that numerous borers attacking the P.O.J. #36 migrated from plant to plant or else died.

Oviposition and infestation occurred simultaneously on corn and sugar cane but early infestations were confined principally to corn when these crops were grown in adjacent

Table 9 . Records of Infestation of the Sugarcane Borer in Relation to Varieties of Sugar Cane Grown at Beaumont, Texas, 1929-31, -32, and -33.

	P.O.J.#36	P.O.J.#234	P.O.J.#213	La. Purple	C.P.#807
Average per cent infestation	96.5	100	99.5	99.3	99.3
Average number borers per stalk	.61	1.09	1.05	1.89	.72
Average height of stalk, inches	63.1	53.7	50.3	52.9	78
Average number internodes per stalk	15.9	16	15.3	17.4	17.7
AAverage per cent internodes bored	24.6	35.6	38.8	44.2	30.6
Average per cent stalks stunted due to borer	10	17	31.6	26	34
Average total weight of 50 stalks in pounds	85.3	59.8	56.1	86.3	81.5
Number years data based on	4	4	4	3	1

fields. As the corn matured, becoming unattractive to the moths, there was a marked increase in the infestation in sugar cane caused by the migration of moths from the corn. Sugar cane being the last host plant to mature in the fall suffers considerably due to this concentrated attack from moths from all the other host plant crops maturing earlier. Sugar cane, therefore, was important in that the larvae hibernated in it thus furnishing a source for spring infestation in corn.

Holloway (13) wrote as follows regarding the sugarcane borer hibernating in sugar cane: "The favorite places of hibernation are scraps of cane left after grinding, and windrowed and planted cane. The windrow forms an ideal place for hibernation, the larvae being well protected by the earth and the quantity of leaves covering the stalks.

"It is evident that the planted cane is a source of serious infestation, and it is also evident that the infestation in a field can be carried over in the sugar cane stubble ..."

Sugarcane Borer on Rice

Infestation surveys were made of rice stubs during the period from 1929 to 1933, inclusive, to determine their importance in hibernating larvae of the sugarcane borer and

thus be a source of spring infestation in corn. The results of the surveys were as given in Table 10.

It is noted from the table that one borer in 1,400 stubs examined in the spring of 1930, successfully survived the 10° F. temperature during the winter of 1929-30. Two borers, in 5,000 stubs examined, survived two days of 15° F. temperature during the winter of 1932-33. No stubs were examined in the spring for the winters of 1930-31, and 1931-32. The minimum temperature for these two winters was 28° F. and the winter mortality in corn was 28 per cent and 29 per cent, respectively, as compared to slightly more than 99 per cent for the winter of 1929-30 and 95 per cent for the winter of 1932-33.

The foregoing shows that rice stubs were an important source of spring infestation and must be considered in formulating a control program.

Establishment and Survival

Records from the experiments on survival show that 24.6 per cent of the larvae hatched on young corn plants became established and grew to at least half grown larvae. Thirty-seven per cent of the larvae hatched on hegari survived in one experiment conducted. See Table 11.

Table 10. Records of Infestation of the Sugarcane Borer in Rice Stubs in the Fall and Spring, Beaumont, Texas, 1929-33.

Year	Time matured	Number fields examined	Number Diatraea saccharalis collected: Fall: Stubs examined	Fall: Larvae	Fall: Pupae	Fall: Pupal cases	Spring: Stubs examined	Spring: Live	Spring: Dead
1929	Early	3	300	3	0	0	300	1	2
	Late	11	1,100	17	0	0	1,100	0	7
1930	Early	12	6,000	5	0	0	None		
1931	Early	6	3,000	12	1	2	None		
	Late	3	1,500	18	0	0	None		
1932	Early	6	3,000	6	0	2	1,500	1	6
	Late	4	2,000	45	0	0	2,500	1	3
1933	Early	4	2,000	0	0	0	Not finished		
	Late	8	4,000	85	0	7	Not finished		

Table 11. Survival and Establishment of Larvae of the Sugarcane Borer Placed on Host Plant at Hatching Time, Beaumont, Texas, 1932-1933.

Crop	Planted	Date infested	Date dissected	Number plants	Total larvae hatched	Borers survived: Larvae: Large	Larvae: Medium	Pupae	Pupal cases	Total per cent
Corn	4-11-32	6-15	7- 6	24	684	66	27	38	8	22.5
Corn	7- 6-32	9-17	10-21	24	615	68	46	3	-	19
Corn	4-17-33	6- 6	6-26	18	458	51	123	7	-	39.5
Hegari	6-30-33	8-24	9-25	35	486	128	2	48	2	37

Eggs from the laboratory rearing cages were pinned just previous to hatching to corn and hegari plants in a 12 x 12 x 7 foot field cage. The stalks were dissected and examined as soon as moth emergence holes were discovered in the plants.

The table shows also that in one experiment a 2.2 per cent adult emergence had occurred 21 days after the larvae hatched on corn plants. In the same stalks were found 38 pupae, 66 large and 27 medium size larvae.

Corn Variety Tests

Eleven corn variety tests were conducted over a period of five years. The tests, in cooperation with R. H. Wyche of the Texas Agricultural Subs tation No. 4, were made at the Experiment Station and Devers and Sillsbee, Texas. A total of 22 varieties were included in the tests at the Station and only the six best varieties at Devers and Sillsbee. The results of the tests are given in Tables 12, 13, 14 and 15.

Results of the corn variety tests indicated a rather close correlation between infestation and yield. Also varieties with a strong stalk were able to withstand the borer damage better than varieties with a tall slender stalk. This was particularly noticeable in Hastings'

Table 12. Records of the Yield and Borer Infestation of Corn at Beaumont, Texas, for the Years 1929 to 1933, Inclusive.

Variety	Bushels yield and average population											
	1929		1930		1931		1932		1933		Average	
	Yield	Pop.	Yield	Pop.	Yield	Pop.	Yield	Pop.	Yield	Pop.	Yield	Pop.
Reese's Drought Resister	22.9	1.98	16.3	.01	23.2	4.83	30	2.41	51.9	1.15	28.9	2.08
Surcropper	22.9	2.41	13.6	.17	22.9	3.75	31.4	3.67	51.1	1.23	28.3	2.25
Tuxpan	21.7	2.65	12.8	.01	17.9	5.17	30.4	8.17	54.9	1.33	27.5	3.47
Hastings' Prolific	19.1	3.07	15.1	.03	12.1	8.42	34.3	4.23	43.6	2.10	24.8	3.95
Nicholson's Giant Yellow	13.4	4.01										
Woods' Golden Dent	13.3	2.80										
Fentress Strawberry	13.2	3.02	8.5	.10							10.9	1.56
Thomas	13	2.85	8.5	.08							10.8	1.47
Oklahoma White Wonder	13	5.04	10.9	.13					37	1.41	20.3	2.19
Horton	12.4	4.50	6.7	.04							9.6	2.27
Chisholm	12.3	3.74	9.3	.04					37.5	2.63	19.7	2.14
Ferguson's Yellow Dent	11.8	1.45	11.7	.01					45.2	1.41	22.9	.96
Reuter's Improved Golden	11.4	3.81	11.9	.17					32.6	1.54	15.3	1.84
Virginia White Wonder	11.2	4.30	10.4	.15					35.5	.83	19	.18
Yellow Creole	10.8	3.93	7.7	.11							9.3	2.02
Sacaton June			15.1	.03	30.2	7.75	31.2	5.08	40.7	1.15	29.3	3.50
Mexican June			14.9	.11					45.3	1.19	30.1	.65
Nicholson's Drought Resistant			15.4	.03	16.2	4.75	29.3	3.00	45.8	1.69	26.7	2.37
Paymaster									48.4	2.16		
Sy. Surcropper									44.3	1.73		
Giant Strawberry									4.8	2.30		
Sur-corn									40.8	1.13		
Bloody Butcher									37	1.67		

Note: Because of irregular crop stand notes were not taken in 1931 and 1932 on regular variety test at Station. The six best varieties were, however, planted for a repeat test.

Table 13. Records of the Yield and Borer Infestation of Corn at Devers, Texas for the Years 1931-1933, Inclusive.

Variety	1931		1932		1933		Average	
	Yield	Pop.	Yield	Pop.	Yield	Pop.	Yield	Pop.
Reese's Drought Resister	35	5.42	44.3	1.26	18	.49	32.8	2.72
Surcropper	35.3	5.38	37.6	009	19.3	.71	30.7	2.03
Sacaton June	36.8	7.08	37.7	.98	14.4	.50	29.6	2.85
Tuxpan	27.3	7.00	31.9	.83	14.8	.51	24.7	2.78
Hastings' Prolific	24.9	18.42	30.9	1.30	17.2	.94	24.3	6.89
Nicholson's Drought Resistant	24.2	10.25	34	1.11	10.9	.73	23	4.00

Table 14. Records of the Yield and Borer Infestation of Corn at Sillsbee, Texas, for the Years 1931-1933, Inclusive.

Variety	1931		1932		1933		Average	
	Yield	Pop.	Yield	Pop.	Yield	Pop.	Yield	Pop.
Hastings' Prolific	50.0	1.25	24.9	.14	19.9	-	31.6	.46
Tuxpan	45	.91	15.3	.19	16.2	.03	25.5	.38
Reese's Drought Resister	36.4	.40	24.2	.09	21	-	27.2	.16
Sacaton June	45.1	.27	22.4	.14	17.2	.05	2882	.15
Surcropper	35.6	.24	23.9	.02	26	-	28.5	.09
Nicholson's Drought Resistant	34.4	1.03	16.8	.22	16.6	.02	22.6	.42

Table 15. Ranking as to Average Yield and Population of the Sugarcane Borer of the Six Best Varieties of Corn at Beaumont, Devers, and Sillsbee, Texas, 1929-1933.

Variety	Beaumont		Devers		Sillsbee		Ranking	
	Ave. yield (Bu.)	Population	Ave. yield (Bu.)	Population	Ave. yield (Bu.)	Population	Ave. yield (Bu.)	Population
Reese's Drought Resister	28.9	2.08	32.8	2.72	27.2	.16	1	2
Surecropper	28.3	2.25	30.7	2.03	28.5	.09	1	1
Sacaton June	29.3	3.50	29.6	2.85	28.2	.15	1	3
Hastings' Prolific	24.8	3.95	24.3	6.89	31.3	.46	4	6
Tuxpan	27.5	3.47	24.7	2.78	25.5	.38	5	3
Nicholson's Drought Resistant	26.7	2.37	23.0	4.00	22.6	.42	6	5

Prolific which ranked high in yield with a light infestation but dropped towards the bottom with a severe infestation. Sacaton June on the other hand showed a remarkable ability to withstand borer damage. Surcropper which ranked first in yield for the three localities also ranked first in borer population with the least borers per stalk. Hastings' Prolific ranked third in yield and had the greatest average borer population. Of the six best varieties compared, Hastings' Prolific had the heaviest borer population in seven of the eleven tests.

Maize Amargo and corn hybrids developed by the Michigan State College for European Corn Borer resistance were included in the tests one year. There was no difference in the per cent of infestation between these and other varieties. The Michigan corn was omitted in later tests for this reason, and also for the fact that they were not adapted to southeast Texas.

Effect of Time of Planting of Corn

In a community in Wharton County, Texas, practically all corn and grain sorghums were planted over a two weeks period early in the spring. As a result there was very seldom serious damage from the borer. In the Beaumont section, corn, grain sorghums, and other host plant crops

were planted over a long period, starting early in the spring and lasting to midsummer. The result was that the successive borer generations had an abundance of green food throughout the season, thus affording ideal conditions for maximum increase. Under such conditions it was possible for only a few overwintering larvae to increase sufficiently to cause serious damage to the late crops and for a large number of larvae to start the winter.

There is no known reason why corn and grain sorghum cannot be planted over a short period of time in the Beaumont section. A reason frequently advanced for scattering the planting over five or six months is to prevent the cutworms and southern corn root-worms from destroying the entire crop, should these pests occur.

Observations indicated that the control of the sugarcane borer by planting corn and grain sorghum both early and late without intermediate plantings was not feasible for the Beaumont section. Late corn had to be planted before emergence was completed from the first crop. Also in the rice section green rice acted as an intermediate host to bridge the period between the early and late corn and thus cancelled any advantage gained. Precipitation in the fall frequently made it impossible to destroy the crop refuse of late maturing crops, thus leaving a very excellent

place for larvae to overwinter. Observations on debris counts also indicated that cultural practices performed late in the fall were not as effective as those practiced earlier in the year.

Results showed that corn planted during the latter part of March and the first part of April outyielded corn planted earlier or later. Studies made of approximately 30 representative corn fields per year for the period from 1929 to 1933, inclusive, showed that corn planted before April 1 made an average yield of 21.2 bushels per acre while corn planted during April made an average of 24.1 bushels per acre; corn planted during May made an average of 16.8 bushels per acre; and corn planted June 1 and later made 13.0 bushels per acre. The average borer population for corn planted before April 1 was 1.7 borers per stalk; for corn planted during April, 1.9 borers per stalk; for corn planted during May, 3.7 borers per stalk; and 5.2 borers per stalk for corn planted June 1 and later. See Table 16.

Stalks from corn planted before April 15 may be left in the field with very little danger of larvae hibernating in the refuse but after that date the per cent of larvae hibernating increases with lateness of planting.

Table 16. Yield of Corn in Relation to Planting Date and Infestation of the Sugarcane Borer for Southeast Texas, 1929-1933,

Period corn planted	No. fields observed	Average per cent infestation	Average per cent estimated damage	Av. number borers per stalk	Average estimated yield (Bu.)
Before April 1					
1929	18	29	.8	4	20
1930	20	1.3	.33	.02	20
1931	8	27.3	8.5	2.66	17.6
1932	15	39	13	1.9	25.5
1933	14	3	0	0	23
Average	15	19.9	6	1.7	21.2
April 1-May 1					
1929	12	41	7	3	26
1930	3	6.8	.8	.11	19
1931	5	62.7	18.3	3.7	21
1932	8	39.5	10	2.8	29.4
1933	9	3.4	Trace	-	25
Average	7.4	30.7	7.2	1.9	24.1
May 1-June 1					
1929	-	-	-	-	-
1930	3	10.5	1.5	.36	16
1931	4	93	37	6.3	12.5
1932	8	96	39	6.1	19
1933	6	62.8	9	2.1	19.5
Average	5.3	65.6	21.6	3.7	16.8
June 1 & later					
1929	9	93	54	9	13
1930	4	31	10	.67	15
1931	-	-	-	-	-
1932	2	100	67.5	5.8	11
1933	-	-	-	-	-
Average	5	74.7	43.8	5.2	13

As many as 16 larvae per 100 ears of corn were found hibernating in the cob. The number of larvae hibernating in ear corn depended upon the degree of infestation and lateness of planting. As previously indicated, less than 10 per cent of such larvae emerged as adults when the corn was stored in a dry place. Ear corn must, however, be considered in formulating a control program, if late corn is to be continued.

CONTROL

Cultural Practices

Results from observations to determine the efficiency of various farm practices in the preparation of soil in regard to borer survival and reinfestation are available for only two years. During two other years a 95 per cent and a 99 per cent winter mortality occurred even in standing stalks. The results of cultural practices, although varying a great deal, showed that the hibernating larvae in corn and grain sorghum could be killed by following a few farm practices usually considered good agriculture. Clean or thorough plowing, regardless of time of year, resulted in a 100 per cent control in all such instances observed. The type of soil in a large part of the Beaumont, Texas, section, however, made clean plowing practically impossible.

In 1931, hegari, planted May 26, was subjected to various cultural practices on October 11. On March 1, 1932, with a minimum temperature of 33° F. for the winter, there were 203 live larvae per square rod of standing hegari, 89 when cut up with stalk cutter only, 8 in the cutter and cross disc plot and only 2 in cutter, disc and cross disc plot. In similar experiments with corn, a 100 per cent control was obtained where the stalks were chopped up with a stalk cutter, disced and plowed or bedded. Observations on various farms and experiments conducted show that where the stalks were cut into fairly short lengths with a stalk cutter or otherwise, and partially covered with soil, whether by plowing or middle busting, if performed by September 15, the pieces rotted sufficiently so that the larvae could not survive.

On December 19, 1929, thirty corn stalks with an average of four hibernating larvae per stalk were cleanly plowed under four inches deep and were then surrounded with a trap 10 feet square. Frequent observations of the trap were made but no larvae recovered. On April 2, 1930, 23 dead larvae were recovered from the covered stalks. One of the dead larvae showed no decay, indicating that it had not been dead very long.

Twelve larvae of the overwintering stage removed from their host were covered with two inches of loose sandy soil. Four days later, 8 of the larvae had come to the surface while 3 of the 4 failing to come to the surface were still alive.

In 1931 in a community at Devers, Texas, corn planted March 14, earliest in the community, had a sugarcane borer population of 8.9 borers per stalk, while in 1932 after a mild winter, but with clean-up measures followed as recommended, there was only a 0.96 borer per stalk population in corn planted March 18. The conditions were practically identical for the two years except that the 1931 crop refuse was cleaned up as was recommended while no precaution had been taken for destroying hibernating larvae in the 1930 crop refuse. Both the winters of 1930-31 and 1931-32 had a minimum temperature of 28° F. Other communities observing the cultural practices mentioned, met with similar success in reducing the borer infestation and damage.

Ensiling

Ensiling corn and grain sorghum proved practical in southeast Texas. The optimum time for ensiling both early and late corn and grain sorghum was also the optimum time for destroying the maximum number of borers in the plant.

One isolated farmer succeeded remarkably well in keeping the borer infestation down by ensiling. The writer did not have an opportunity to ensile sugar cane waste for feeding stock. Observations made, however, make it clear that it was impracticable in the Beaumont section because of the small acreage of sugar cane, which was confined to small farms where ensiling is not done.

Ensiling corn and grain sorghum destroyed very few parasites. The only parasite of the sugarcane borer of importance in southeast Texas was the egg parasite, Trichogramma minutum Riley. At the proper time for ensiling, corn and grain sorghum were too mature to be particularly attractive for oviposition by the borer adults and, therefore, very few parasites were destroyed.

Trap Crops

The earliest planted vigorous corn in a neighborhood acted as a very good trap crop for the first generation borer as observed in field survey counts made. During 1933 a half-acre patch of earliest corn in a community near Devers, Texas, had a 48 per cent first generation infestation while an adjoining field of slightly later corn had only a 4 per cent infestation. At China, Texas,

a small patch of earliest corn had a 36 per cent infestation while corn planted a few days later had only a 0.7 per cent infestation. Similar conditions were observed elsewhere from time to time.

Attrahents

In 1930 four applications of each of three different syrups diluted with water were made with a hand sprayer to single plots of corn consisting of 20 plants each. Infestation counts showed a small increase in infestation for sugar cane syrup and molasses while corn syrup had a slight decrease in infestation. The results of the above observations were, however, only indicative of the probable possibility of attrahents for the moths. The experiment was not repeated due to lack of time.

Light Traps

A light trap with a 200 watt electric lamp was operated at intervals from 1929 to 1933, inclusive, during the moth season. No catches of any consequence were made.

The attraction of the sugarcane borer moth to lights has been well described by Holloway (15): "Attracting the adults to lights has been proposed occasionally as a means for controlling the moth borer. It seems evident, however,

that lights can exercise little attraction for them. The moths avoid the sunlight and remain concealed during the day in dark places, such as between the leaves and the stalk of the sugar cane plant. If disturbed they fly for a short distance, seeking another place of concealment. As dusk approaches, they become very active, but daylight finds them motionless again."

Holloway conducted a number of insect light trap experiments using various kinds of lamps, lights and colors of light. Using a clear light of about 60 candle power, Holloway trapped 41 to 43 males and 5 females during 16 nights the trap was run. "The few females caught, apparently had deposited their eggs already", wrote Mr. Holloway. Similar results were obtained in other experiments.

Parasites

Trichogramma minutum Riley was the only parasite of importance found in southeast Texas. Under natural conditions it became established too late in the season to be of importance in corn. Only one sugarcane borer egg mass, parasitized by Trichogramma minutum was found on corn. Sugarcane borer eggs were seldom found on corn, while on sugar cane they were readily observed.

Parasitization by Trichogramma minutum Riley of sugarcane borer eggs normally became evident in sugar cane fields the later part of August. By October 1, it was difficult to find sugarcane borer eggs not parasitized. See Table 17.

An egg mass parasitized by Trichogramma minutum Riley was found as early as June 25 in 1930, while in 1932 the first such parasitized egg mass was found August 5. In 1933 a first parasitized mass was found on July 3.

Predators

Argentine ants were on several occasions observed feeding on small larvae, pre-pupae and pupae just formed. On one occasion a spider was observed carrying a larvae. Birds apparently also feed to a limited amount on hibernating larvae. These predators, however, were of minor importance in destroying the borer.

Diseases

A few dead larvae supporting a white fungus were found every winter. Of 555 dead overwintering larvae collected in standing corn stalks from February 25, 1929, to May 10, 1929, 65 supported this fungus growth. No diseases were observed in the active larval stage in the field.

Table 17. Records of Parasitization by Trichogramma minutum Riley of Sugarcane Borer Eggs at Beaumont, Texas, 1930-1933.

Date examined	Crop	Number parasitized egg masses	Egg masses with parasites hatched	Egg masses not parasitized	Number egg masses borers hatched
6-25-30	Sugar cane	1	0	0	0
9-19-30	Sugar cane	8	7	2	3
10- 8-30	Sugar cane	8	3	3	0
9-22-31	Sugar cane	19	17	0	0
8- 5-32	Sugar cane	3	0	10	-
8-24-32	Sugar cane	13	0	0	1
9-20-32	Sugar cane	22	-	4	1
10-3 -32	Sugar cane	39	-	0	-
7-3 -33	Corn	1 (N)	0	0	0
7-5 -33	Sugar cane	0	0	2	3
7-20-33	Sugar cane	0	0	0	1
8-17-33	Sugar cane	12	3	0	3
8-24-33	Sugar cane	17	15	3	3
9-15-33	Sugar cane	18	22	5	-

(N) Parasitized egg mass was found while examining 200 corn plants for infestation. Only seven infested plants were found.

Larvae dying in the insectary sometimes supported the white fungus disease.

Insecticides

Three insecticides - calcium fluosilicate, nicotine tannate and nicotine sulphate, which were found to be the most promising in European Corn Borer insecticide control experiments, were tried at Beaumont, Texas, for controlling the sugarcane borer in corn. The insecticides were applied with a three gallon knapsack type sprayer to duplicate series of plots of corn 1.5 miles west of China, Texas. Each plot in a series consisted of three rows of corn each 40 plants long with check plots and two guard rows between the insecticide plots.

The following formulas for insecticides were used:

1. Calcium fluosilicate at the rate of 6 pounds per 100 gallons of soft water.
2. Nicotine tannate.

a.	Water	800 parts
b.	Tannic acid	3 parts
c.	Mix a and b thoroughly	
d.	50 per cent nicotine	
e.	Mix thoroughly	
f.	Ready to use	

3. Nicotine sulphate

a.	Water	800 parts
b.	Soap	4 parts
c.	Mix thoroughly	
d.	Add nicotine sulphate, 40 per cent 1 part	
e.	Mix thoroughly and apply	

Applications of each insecticide were made on July 18, July 31, August 7, August 19 and August 28. The weather was rainy during this period. Although the weather was fair at the time of the application, rain fell on two occasions within an hour after the work was completed and within a short time afterward on two other occasions, which interfered with the results. Because of the unfavorable conditions for the work and the small size of the plots a definite statement cannot be made as to the value of of these insecticides until further work is done.

It is seen from Tables 18, 19 and 20 that in general each insecticide showed advantage over the check plots insofar as borer population is concerned. Calcium fluosilicate and nicotine sulphate plots each showed an increased yield while nicotine tannate showed a decreased yield in both plots.

Table 18. Comparison of the Sugarcane Borer Population Between Treated and Untreated Plots of Corn, Stalks per Plot Dissected, Beaumont, Texas, 1933.

Treatment	Series No. 1		Series No. 2		Average advantage or disadvantage	Per cent increase or decrease over check
	Treated	Check	Treated	Check		
Calcium fluosilicate	97 -	114	101 -	85	-1	-.5 less
Nicotine tannate	91 -	104.5	97 -	109	-25.5	-11.9 less
Nicotine sulphate	103 -	90	74 -	109	.22	-11.1 less

Table 19. Comparison of Yield of Corn in Grams Between Treated and Untreated Plots, Forty Stalks per Plot, Beaumont, Texas, 1933.

Treatment	Series No. 1		Series No. 2		Average advantage or disadvantage	Per cent increase or decrease over check
	Treated	Check	Treated	Check		
Calcium fluosilicate	7775 +	7193	8797 +	7285	+2094	+ 14.5 increase
Nicotine tannate	6518 -	7493.5	6989 -	7555	-1862.5	- 12.4 less
Nicotine sulphate	9124 +	7539.5	6925 -	7555	+ 954.5	+ 6.3 increase

Table 20. Comparison of the Sugarcane Borer Pupal Cases Between Treated and Untreated Plots of Corn, Twenty Stalks per Plot Dissected, Beaumont, Texas, 1933.

Treatment	Series No. 1		Series No. 2		Average advantage of: disadvantage:	Per cent increase or decrease over check
	Treated:	Check:	Treated:	Check:		
Calcium fluosilicate	64-	97	77-	60	-16	-10.2 less
Nicotine tannate	69-	85.5	66-	70	-20.5	-13.2 less
Nicotine sulphate	71-	67	54-	70	-12	- 8.8 less

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