Technical Bulletin No. T-32 June, 1948

Seasonal History of the Southwestern Corn Borer, Diatraea grandiosella Dyar, in Oklahoma; and Experiments on Methods of Control

By
R. R. WALTON and G. A. BIEBERDORF
Department of Entomology

OKLAHOMA AGRICULTURAL EXPERIMENT STATION
Oklahoma Agricultural and Mechanical College
W. L. Blizzard, Director Louis E. Hawkins, Vice Director

Stillwater, Oklahoma

Controlling a New Enemy of Oklahoma Corn.

The southwestern corn borer should not be confused with the European corn borer which has received so much publicity as a pest in the Corn Belt. The southwestern borer is moving northeastward from New Mexico, while the European borer moved into the Corn Belt from the east.

Control methods for the two insects are much different, as shown by six year's research on this insect by the Oklahoma Agricultural Experiment Station. Furthermore, this research shows that control methods for the southwestern borer in Oklahoma are somewhat different from those found effective farther southwest.

Methods of identifying and controlling the southwestern corn borer in Oklahoma are given in Oklahoma Agricultural Experiment Station B-321. Preliminary recommendations based on early phases of this research were published in Oklahoma Extension Circular E-424.

Cooperative effort of all states in the "line of march" of the southwestern borer is needed to stop its progress. Therefore this technical bulletin is being published to make the results of Oklahoma research generally available elsewhere. It should be noted that the Oklahoma research has been greatly aided by information published as the result of research in Arizona, Kansas, and elsewhere by state experiment stations and the United States Department of Agriculture.

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Seasonal History of the Southwestern Corn Borer, Diatraea grandiosella Dyar, in Oklahoma; and Experiments on Methods of Control

By R. R. WALTON and G. A. BIEBERDORF*
Assistant Entomologists

Experimental work on the seasonal history, habits, and control of the southwestern corn borer, *Diatraea grandiosella* Dyar, was conducted by the Oklahoma Agricultural Experiment Station during the years 1943 to 1947. Investigation on control included tests on date of planting corn, cultural methods of destroying hibernating borers, use of insecticides, and resistance of varieties to borer attack. The effect of different soil types on winter mortality and the trend of infestations in certain areas over a period of years were also studied.

This publication reports these studies and supplements Bulletin No. B-321, which presents recommendations of control methods. For a description of the insect and its habits the reader is referred to Bulletin No. B-321, U. S. D. A. Technical Bulletin No. 388 (*1*) ** and to Kansas Agricultural Experiment Station Bulletin No. 317 (*7*).

History and Distribution

Diatraea grandiosella was originally described in 1911 by H. G. Dyar (*2*) from a specimen collected in Guadalajara, Mexico. It apparently is a native of Mexico and has been reported from a number of widely distributed areas in that country (*1*). The exact location and time of entrance of the southwestern corn borer into the United States are not known. During the period 1913 to 1931 an extensive investigation was made of this pest by representatives of the Bureau of Entomology and Plant Quarantine. A major portion of the work was done in Arizona and New Mexico. A report

* The authors wish to acknowledge assistance given by F. A. Fenton, R. G. Dahms and D. E. Howell of the Department of Entomology, Oklahoma Agricultural Experiment Station, and by C. F. Stiles, Entomologist, Oklahoma Agricultural Extension Service. Fenton and Dahms took a portion of the data recorded in 1941, 1942 and 1943. Howell and Stiles assisted in the preparation of the manuscript. Acknowledgement is also made for information used in preparing maps in Figures 1 and 2. Figure 1 is from Davis *et al.* (*1*). Kansas information used in preparing Figure 2 is from Walkden (*6*).

** Italic numerals in parenthesis refer to literature cited, page 22.

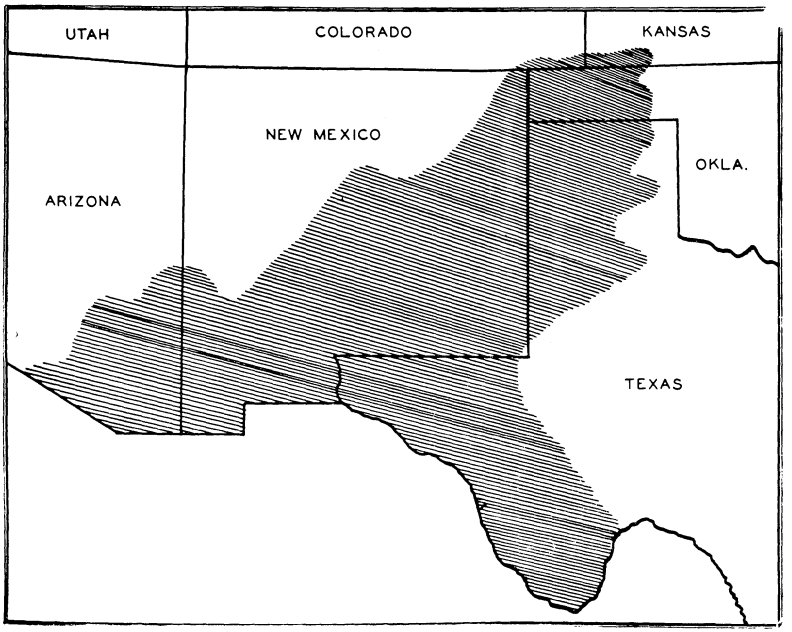

Fig. 1. Where Southwestern Corn Borer Was Found in Oklahoma in 1931.

of the study was published in U. S. D. A. Technical Bulletin No. 388 (*1*). The borer was present in Arizona and New Mexico as early as 1913 and it was the opinion of the investigators that it was also in the Big Bend area of Texas. Howard (*4*) reported the pest being present over a large portion of the Trans-Pecos Region of Texas as early as 1922. Todd (*5*) presented evidence showing that it had infested a large area in Northwest Texas by 1929 and that it had been in this region for several years prior to this date. U. S. D. A. Technical Bulletin No. 388 gave the known distribution in the United States in 1931. This infested area is shown in Figure 1.

Since 1931 the southwestern corn borer has penetrated the western edge of the southern part of the Corn Belt. During this period the spread has been largely to the east and north, resulting in large portions of Oklahoma and Kansas becoming infested. Information on the present distribution in Texas is not available, but it is known to occur as far eastward as Grayson County near the Oklahoma line. By 1947 the range of the borer included all but

12 counties in Oklahoma and extended about the same distance eastward in Kansas. No positive report of an infestation in Nebraska has been made to date. Figure 2 shows the area in Oklahoma and Kansas invaded by 1947.

Seasonal History in Oklahoma

Most of the data on the seasonal history of the southwestern corn borer obtained during the present study came from observation of fields in an upland area of deep sandy soil in southern Payne county. A portion of the records on emergence and egg deposition of spring moths and on hatching of first generation larvae

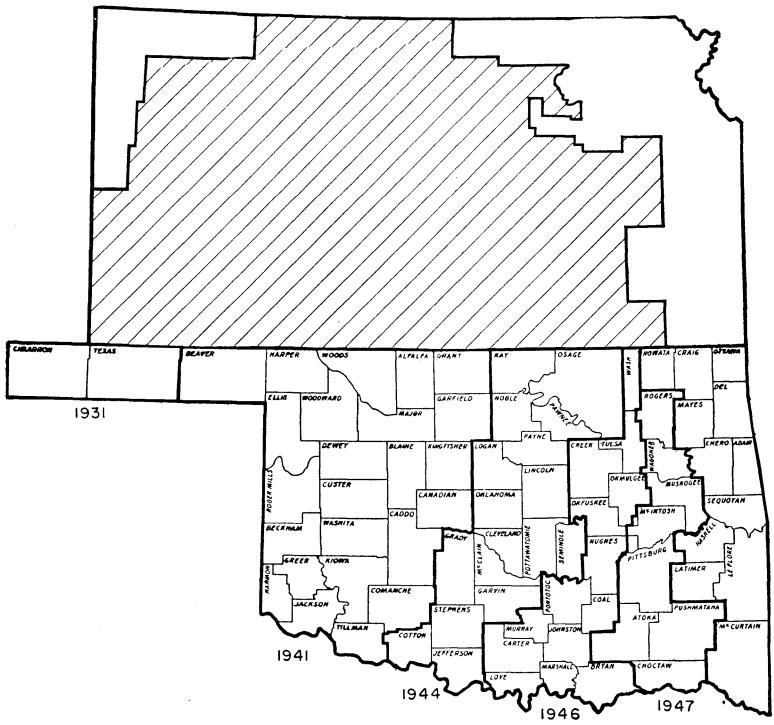

Fig. 2. Distribution of the Southwestern Corn Borer in Oklahoma and Kansas.

The eastward extension of the area of infestation in Oklahoma is shown by periods during 1931 to 1947. The area outlined in Kansas includes all counties in which infestations were found during the same period. The Kansas distribution is based upon records of the Kansas Agricultural Experiment Station and the Bureau of Entomology and Plant Quarantine, United States Department of Agriculture.

was taken from caged material in these fields. Records from the cages were in general agreement with those made by direct field observations.

In addition to the studies made in Payne county, records on seasonal development were also taken in Kay, Logan and Caddo counties. The fields under observation in all of the counties were similar in that they possessed deep sandy soils.

The most complete records on seasonal history were obtained in 1944 and 1945. Incidental observations, made in connection with other work, were obtained in 1942, 1946 and 1947.

Table I gives the records on seasonal history in Payne county for 1944 and 1945. Data for the years 1942, 1944, 1945, 1946 and 1947 indicate that 1944 was about average as far as seasonal development of the southwestern corn borer was concerned. It can be seen from a study of the table that development in 1945 was retarded by approximately one week when compared with that in 1944. Less complete records for the other three years showed that, in relation to 1944, 1942 was about two weeks early, 1947 was less than a week early, and 1946 was about the same as 1944.

TABLE I.—Seasonal History of the Southwestern Corn Borer, Payne County, Oklahoma

	1944			1945		
	Earliest record	Latest record	Approximately 50% had completed process on:	Earliest record	Latest record	Approximately 50% had completed process on:
Pupation of spring larvae	May 16	June 14	May 30	May 21	June 27	June 7
Emergence of spring moths	June 5	June 24	June 14	June 11	June 30	June 20
Feeding of 1st gen. larvae	June 11	July 21	July 16	June 19	July 26	July 20
Pupation of 1st gen. larvae	July 5	Aug. 3	July 18	July 14	Aug. 13	July 24
Emergence of 1st gen. moths	July 14	Aug. 6	July 27	July 20	Aug. 14	Aug. 1
Feeding of 2nd gen. larvae	July 20	Oct. 3	Aug. 26	July 23	Oct. 1	Aug. 30
Feeding of 3rd gen. larvae	Sept. 8	Oct. 3		Sept. 9	Oct. 17	

From the above results it can be seen that the rate of seasonal development may vary in different years. However, the following average dates will generally apply to the Payne County area:

Emergence of Spring Moths. The bulk of this group appears *during the month of June,* although emergence may begin in late May and continue until early July. The egg-laying period of the spring brood corresponds closely with the period of emergence.

First Generation Borers (Larvae). Borers begin to appear on plants about the *middle of June* or earlier and continue to hatch for about three weeks or a month.

First Generation or Summer Moths. A very extensive brood of moths emerges from the growing plants in which the larvae have matured. Emergence begins about the *middle of July* and may continue well into August.

Second Generation Borers. During the *last half of July and in August,* corn is attacked by the second brood of borers. This generation is much greater in numbers than the first generation. Early planted corn sustains much less injury from this attack than late seeded fields.

Partial Third Generation. The great majority of the second generation borers do not usually pupate on reaching maturity but pass the winter in the larval stage. However, some of the larvae of this group always pupate in the stalk and emerge as moths during the *latter part of August and early September.* The small larvae appear in early September and may be active in late corn until frost. They are usually not very numerous nor do they cause much damage.

As indicated above, there are usually two complete generations and a partial third. However, records obtained in 1942 indicate that occasionally the third generation may be complete or nearly complete. During the last week of June, 1942, first generation larvae began to pupate, and by July 7 over 50 percent had completed the process. Second generation larvae appeared in early July, and 85 percent of these had pupated by August 21. Later observations indicated that the total percentage of this generation that pupated was higher than this figure. Third generation larvae were about two-thirds grown on October 2. Observations were not made to see if these third generation larvae were able to survive and emerge as adults in the spring.

Reduction of Corn Yields by Borer Injury

The southwestern corn borer also infests sorghums, broomcorn, Sudan grass and Johnson grass, but corn is the only crop seriously damaged. Although borer injury to corn is often quite noticeable, it has been somewhat difficult to obtain accurate quantitative data on total damage. Table II presents comparative yields of infested and non-infested plants in the same fields. In cases where the infestation approached 100 percent, the numbers of non-infested plants included were limited. In the absence of more accurate information, the results are shown with the understanding that they are but approximate measurements of the effect of borer injury upon the yield of the field as a whole. These records and observations made during five seasons support the results of date-of-planting tests (Table III) in showing that late-planted corn suffers greater damage from borer attack.

Date-of-Planting Tests

Four tests were conducted during the years 1943, 1944, and 1945 to determine comparative borer injury to corn planted on different dates. In each test corn was seeded on four different dates as shown in Table III. All tests were located on deep, sandy soil where a borer infestation had been present the previous year.

TABLE II.—Reduction of Corn Yields by Southwestern Corn Borer Injury.

Date planted	Soil type	Percent of stalks infested	Yield per Stalk (ounces)		Percent reduction of yield
			Infested	Non-infested[1]	
March 27	Sandy upland	57	5.76	6.31	8.7
Late March	Sandy bottomland	98	7.20	9.60	25.0
Late April	Sandy bottomland	97	11.20	17.76	36.9
Late May	Sandy upland	73	5.12	6.72	23.8
June 7	Silt bottomland	76	5.04	6.40	31.9
June[2]	Sandy bottomland	100			100.0

[1] Based upon the yields of 25 stalks from the second and third fields and upon 100 or more from the other fields.

[2] The crop was a total loss as far as grain production was concerned.

Corn planted in March, April, and early May suffered significantly less borer injury than seedings made later (Table III). In general, borer infestation and injury increased from the earliest to the latest seedings. This is particularly shown in the percentage of "dead-hearts" and "dwarfs" and the number of borers per stalk. However, if the first two dates of planting are compared in each test, it will be seen that the differences are small.

As would be expected, weather as well as borer injury had an important influence on comparative yields of corn planted on different dates. In tests 1, 2, and 3 made in 1943 and 1944, the second planted plots produced significantly higher yields than the earliest planted plots, despite slightly higher borer infestations. The mean

TABLE III.—Southwestern Corn Borer Damage in Corn Planted on Different Dates.[1]

Year	Location	Date of planting	Percent infested	Percent lodged by borers	Percent "dead-hearts" and "dwarfs"[2]	No. borers per stalk	Yield (Bu./A.)
1943	Caddo Co.	Mar. 15	96				18.2
		Apr. 1	96				24.2
		Apr. 15	100				24.0
		May 3	100				8.5
1944	Caddo Co.	Mar. 9	75	10	1	2.4	21.8
		Apr. 17	86	9	2	2.8	26.0
		May 5	86	12	3	3.1	22.0
		June 18	100	4	63	7.3	1.3
1944	Kay Co.	Apr. 3	94	10	3	2.7	21.6
		May 6	88	19	7	2.8	27.1
		May 20	100	26	6	3.7	18.6
		June 25	100	8	47	5.9	4.7
1945	Payne Co	Mar. 27	57	4	0	1.8	33.0
		April 13	51	6	3	2.0	24.8
		May 2	57	7	4	2.3	22.0
		May 18	75	24	7	2.6	14.0
Average of all tests		March 9 to April 3	83.6	8.0	1.3	2.3	23.8
		April 13 to May 6	86.1	11.8	4.0	2.8	24.2
		May 18 and May 20	87.5	25.0	6.5	3.1	16.3
		June 18 and June 25	100.0	6.0	55.0	6.6	3.0

[1] Data are based upon two replicates in 1943 and upon four replicates in succeeding years. Reid Yellow Dent was the test variety.

[2] Plants were classed as "dead-hearts" if the terminal buds were killed by borer injury. Plants were classed as "dwarfs" if they were stunted by borers to the extent that they were less than one-half the height of average plants in the plot at time of harvest.

temperatures for the period of 15 days preceding and 15 days succeeding the earliest dates of planting were from three to four degrees below normal. Poor germination resulted and the stand was only 50 to 68 percent of that in the second planted plots, resulting in correspondingly lower yields. On the other hand, in test 4 in 1945 the mean temperature for the period of the earliest planting was three degrees above normal. A good stand was obtained and the yield was the highest in the test.

Since drouth has often been the chief hazard to the growing of late corn, yields of the late plantings should be examined with rainfall records in mind. The low yield obtained from the plots planted May 3, 1943, might be attributed to a considerable extent to drouth. Following an excessive total of 9 inches in May, the total rainfall for the following three months was 2 inches, or 7 inches below normal. However, in the three tests made in 1944 and 1945, the low yields were largely due to borer injury, since total precipitation for the corresponding periods was from ½ to 6 inches above normal.

Tests of Methods of Treating Stubble

When stubble in which borers are overwintering is dislodged in the fall or winter and left on or near the soil surface, the borers are subjected to the rapid and wide fluctuations of the weather. This generally results in a high percentage of them being destroyed. Also, if stubble is completely covered with soil to a depth of four or more inches before emergence begins in May, few if any of the moths escape. Accordingly, a number of farm implements were tested for use in uprooting or plowing under stubble.

Table IV gives the results obtained with seven of the tools that proved most effective. With the exception of the mold-board plow, the implements were used to dislodge and bring the stubble toward the surface of the soil. The plow was employed to turn the stubble under to a depth of four or more inches. No previous treatment of stalk-cutting was applied to any of the plots, although in tests 1 and 2 the vegetation had been considerably reduced by pasturing. In test 1 the presence of considerable grass and of tough cornstalks in November when stubble was treated made it necessary to add a weight of approximately one hundred pounds to the disk harrow. While using the mold-board plow in test 3, a dragwire was employed to secure good coverage of stalks.

All methods of treating stubble caused an increase in borer mortality over that of the untreated plots. The percentage of mortality in the untreated plots were 69, 68 and 84, respectively, for tests 1, 2, and 3. The most effective results were obtained from the use of the mold-board plow, lister, and one-way disk.

An examination on June 15 showed that no moths had escaped from 100 stubs taken from the plots that were treated with the mold-board plow. Of 8 borers that pupated in this group, 6 had emerged as moths and died in the stubs, while 2 were unemerged and alive. No living larvae were found. On the basis of examinations made in late May, the lister, one-way disks and cultivator with sweeps were all highly effective, the percentage kill in these plots being 99, 99 and 97 respectively. The cultivator with points and the disk harrow were the least effective of the implements tested. Nearly all living borers found in the uprooted plots were in stubble missed by the implement.

In preliminary tests, a single-bladed peanut digger was very effective in uprooting stubble in land comparatively free of grass and weeds, but clogged badly when a moderate amount of vegetation was present.

TABLE IV.—Effects of Different Methods of Stubble Treatment on Mortality of Hibernating Borers, 1944-45.

Test location and date of treatment	Implement used	Percentage of Borers Dead by:[1] Mid-January	Early April	Late May
Caddo County Treated Nov. 8	Disk harrow (double disked)		92	94
	Disk harrow (single disked)		88	93
	Untreated		30	69
Logan County Treated Jan. 25	Lister	33	80	99
	14-inch sweeps on cultivator	30	72	97
	Disk harrow	32	79	79
	Untreated	29	60	68
Kay County[2] Treated Feb. 15	One-way disk	49	86	99
	6-inch sweeps on cultivator	48	74	97
	Points on cultivator	51	80	92
	Untreated	35	52	84
	Mold board plow			100

[1] The percentage of borers dead for each period was obtained by examining 50 stubs from each of two plots per treatment. Only stubs containing hibernation cells were included in the records.

[2] This test was on bottomland sand while the other tests were on upland sand.

Tests on Date of Treating Stubble

Table V gives the results of three tests made to compare the mortality of borers in stubble uprooted on different dates. Test 1 is of greater value, because of the relatively low natural mortality. In this test there was, with minor variations, a general decline in borer mortality from the earliest to the latest dates of treatment. From these limited data it appears that stubble should be uprooted not later than early February and preferably by January or earlier.

TABLE V.—Percentage of Hibernating Borers Dead in Stubble Uprooted on Different Dates.[1]

Test No. 1, 1944-1945

Date pulled	Percentage of Borers Dead on:							
	Dec. 2	Jan. 15	Feb. 15	Mar. 2	Mr. 15	Apr. 2	Apr. 16	June 1
December 2	9	45	70	76	79	81	91	96
January 15		17	53	72	81	86	93	98
February 15			21	45	60	72	78	90
March 2				22	30	52	57	83
March 15					22	50	60	86
April 2						27	38	75
April 16							38	67
Undisturbed	9	17	21	22	22	27	38	54

Test No. 2, 1946

Date pulled	Percentage of Borers Dead on:				
	Jan. 1	Feb. 1	Feb. 22	Mar. 15	June 5
Jan. 1	48				100
Feb. 1		54			100
Feb. 22			66		88
March 15				70	89
Undisturbed	48	54	66	70	87

Test No. 3, 1947

Date pulled	Percentage of Borers Dead on:			
	Jan. 14	Feb. 22	Mar. 15	June 1
January 14	38	78	98	100
February 22		49	89	100
March 15			81	96
Undisturbed	38	49	81	92

[1] All tests were made in sandy upland fields in Payne County. The stubs were pulled from the soil by hand and placed on their sides on the top of the ground. In order to obtain a high percentage of hibernating borers, only girdled stubble was pulled. Data are based on a minimum of 50 stubs per examination for each treatment.

Insecticide Tests

During 1947, six insecticidal sprays and six dusts were tested against the southwestern corn borer on late corn. Two applications were made, on July 11 and July 25, to protect against second generation borers which appeared in the field a few days before the first application. The materials were applied with hand equipment. Sprays were applied with 3-gallon compressed air sprayers and dusts with rotary hand dust guns. A special attempt was made to obtain thorough coverage, each plant being treated individually.

The results (Table VI) show little promise for insecticidal control of the southwestern corn borer. An infestation count made on August 20 showed a considerable degree of protection in all treated plots. However, by October 10, when final counts were made, these differences in infestation had largely disappeared. With one exception (cryolite), the various treatments did not differ greatly from the untreated plots in the percent of lodging.

TABLE VI.—Southwestern Corn Borer Damage in Corn Treated With Various Insecticides; Stillwater, 1947.

Insecticide[1]	Percent stalks infested Aug. 20	Percent stalks infested Oct. 10	Percent stalks lodged by borer Oct. 10
Sprays			
Cryolite 1%	19	68	17
Parathion .1%	20	66	31
Chlorinated camphene .5%	19	73	28
Chlordan .5%	20	74	33
Gamma BHC .05%	23	84	31
DDT .5%	35	83	35
Untreated	43	86	30
Dusts			
Cryolite (undiluted)	14	76	14
Parathion 2%	22	75	22
Chlorinated camphene 20%	23	78	21
Gamma BHC 1%	33	79	33
DDT 10%	24	79	27
Chlordan 10%	24	83	34
Untreated	59	79	26

Miscellaneous data: Corn variety, U. S. Hybrid 13; date planted, June 7; date of treatments, July 11 and July 25; rates of spray applications, 85 and 110 gallons per acre; rates of dust applications, 25 and 35 pounds per acre; number plots per treatment, 4; average number plants per spray plot, 84; average number plants per dust plot, 656.

[1] The materials used and their manufacturers were: Cryolite, Thompson-Hayward Chem. Co.; Parathion (3422), American Cyanamid Company; chlorinated camphene (Toxaphene), Hercules Powder Company; chlordan spray (technical grade) Velsicol Corp.; chlordan dust (Dow Klor dust concentrate), Dow Chemical Company; benzene hexachloride (Lexone 50), DuPont and Company; DDT (V-D 50), Geigy and Company.

Although the results are based on only one season's test in a single location, it appears that none of the materials at the concentrations tested would be of practical use in borer control.

Borer Injury in Hybrids and Varieties of Corn

Preliminary tests and observations during two seasons show some differences in the amount of borer injury sustained by various hybrids and varieties. Results at present are not sufficiently conclusive to warrant recommendations of specific varieties. Plans have been made to test various strains for borer resistance on an extensive scale. These tests will not only include commercial hybrids and varieties but also experimental strains developed in the corn breeding program of the Experiment Station.

Winter Mortality in Different Types of Soil

Records on the mortality of hibernating borers in different types of soil, obtained by examination of undisturbed stubble, are in Table VII. The table includes only cases where two or more fields of different soil types were examined per county.

TABLE VII.—Percentage of Hibernating Borers Dead in Various Types of Soil.[1]

County	Deep Sand				Silt or Clay Loam			
	Upland		Bottomland		Upland		Bottomland	
	Stalks infested	Borers dead	Stalks infested	Borers dead	Stalks infested	Borers dead	Stalks infested	Borers dead
			1943-44					
Kay	84	92	80	95			12	100
Caddo	100	88	45	97	41	100		
Logan	97	91			22	100		
Canadian	67	87			8	100		
Garfield	100	94			60	100		
			1944-45					
Kay	97	74	92	84				99
Payne	57	54					12	97
Logan	76	68			46	93		
			1946-47					
Payne	52	92					6	100
Garvin[2]	49	89					6	100

[1] The data on mortality are based on an examination of 50 or more girdled stubble in April or May. An empty hibernation cell was considered as representing one dead borer. All fields in each county were examined on the same date. The percentage of stalks infested was obtained gy examining 100 consecutive plants.

[2] The soil of the Garvin County upland field was a shallow sandy loam.

The rate of mortality was consistently higher in the silt and clay soils than in the sandy soils. The average mortality in the 10 fields having silt or clay soils was 98.9 percent as compared with 85.0 percent for the 13 fields with sandy soils. Limited data also indicate that borer mortality is greater on bottomland than on upland. The average mortality of three fields on sandy bottomland was 92.0 percent as compared with 84.7 percent for three fields on sandy upland. No direct comparisons were obtained of bottomland and upland fields of silt or clay soils in the same vicinity. However, records taken at various points in the State showed that mortality was generally slightly higher on bottomland silt-clay than on upland soils of this type.

The higher mortality rate in the silt-clay soils appeared to be due, directly or indirectly, to the greater amount of soil moisture present, although the evidence is not conclusive. As compared with the sandy soils, drainage was poor, stubble deterioration was advanced, and hibernation cells were more frequently invaded by excess moisture. A larger percentage of the borers left the normal position at the tip of the main root and crawled to a point at or near the soil surface. In this position they were subjected to rapid and wide changes in temperature. Dead borers covered with fungous growth, which may or may not have been a parasitic disease, were more commonly found in these soils. By disintegrating and invading the hibernation quarters of the borers, excess moisture appeared to be an important factor in borer mortality.

Since less excess moisture was present in the sandy soils, it appears to have affected borer mortality to a smaller degree, with the bottomland sand being intermediate between the clay-silt soils and the upland sand.

Trend of Infestation in Certain Areas of Oklahoma

During the period from 1941 to 1947, records were taken on the percentage of infestation in various parts of the State. Table VIII gives the records for 14 areas which have been inspected for four or more years. Beginning at the top of the table, the counties are arranged from west to east. This arrangement is also the general order in which the counties became infested.

TABLE VIII.—Percentage of Southwestern Corn Borer Infestation in Certain Areas of Oklahoma During the Years 1941 to 1947.[1]

Location	Soil	1941	1942	1943	1944	1945	1946	1947
Caddo County								
1 mi. W. Sickles	Upland sand		100	96	86	78		70
1 mi. S. Lookeba	Bottomland sand	35	97	60	72	76		39
Grady County								
2 mi. N., 6 W., Minco	Bottomland sand		0	64	98	81	68	56
Logan County								
2 mi. S., 3 W., Crescent	Upland sand			86	92	88	55	20
2 mi. S., 3½ W. Crescent	Upland sand			91	90	85	63	33
Garvin County								
1 mi. E. Pauls Valley	Bottomland clay loam			0	1	4		0
Kay County								
2 mi. S., 8 W. Tonkawa	Bottomland sand			36	92	85	57	39
5 mi. E. Tonkawa	Bottomland silt			20	74	78	51	35
Payne County								
9 mi. S., 2 W. Stillwater	Upland sand			14	49	50	61	12
1 mi. W. Stillwater	Bottomland silt			10	35	48	22	18
Noble County								
14 mi. N. Stillwater	Bottomland silt			4	60	58	33	23
Pottawatomie County								
3 mi. E. Shawnee	Bottomland sand			0	2	27	64	24
Creek County								
1 mi. S. Keystone	Bottomland silt			0	0	3	9	0
Tulsa County								
5 mi. S. E. Bixby	Bottomland silt				0	0	4	2

[1] Records are based on counts made in early to intermediate planted fields.

Decline of Infestation in 1946 and 1947.

A number of trends can be observed in the results. Perhaps the most noticeable of these is the decline in infestation in 1946 and again in 1947. No satisfactory explanation of this decrease is available. Comparative data on winter mortality during the past four years are available only for an area of sandy upland in Caddo county. The percentage mortality in the undisturbed stubble at that location in 1944, 1945, 1946 and 1947 was 88, 59, 89, and 93, respectively. These records indicate that the decline in infestation during the past two years cannot be attributed entirely to an increase in winter mortality.

Weather conditions during the summers of 1946 and 1947 were unfavorable for borer propagation in certain respects. This was particularly true in 1946. May and June of 1946 were unusually cool, with mean temperatures from two to three degrees below normal. Practically all of the rain for the three summer months came within a six-day period during the last of June. Rainfall of three to five inches in 24 hours, accompanied by gusty winds, was general over the State. During this time, the second generation borers were in the egg and early larval stages. Drowned larvae were found in plant whorls and on the ground. Some eggs were probably destroyed. July and August in both 1946 and 1947 were exceptionally dry with maximum temperatures, usually 100° or above for periods of twenty-five to thirty days. A considerable number of later-hatching larvae of the second generation and third generation larvae, were unable to enter the dried and hardened corn stalks.

No special study has been made of the natural enemies of the southwestern corn borer. No parasitized larvae have been observed. Two cases of parasitization of second generation eggs were noted in 1946. The parasites had already emerged and no positive identification was secured. An important egg parasite of the southwestern corn borer, *Trichogramma minutum* Riley, is known in Oklahoma. In 1938, this parasite was an important factor in controlling the walnut caterpillar, *Datana integerrima* G. & R., in the State (*3*). *Trichogramma minutum* has been observed to attack eggs of the corn earworm in Oklahoma and no doubt parasitizes borer eggs as well.

Trend in Farming Practices.

In those counties where borer damage has been serious (Table VIII), two trends in farming practice have been observed during recent years. First, the corn acreage has been gradually reduced, being largely replaced by grain sorghums. When the first infestation records were obtained, none of the fields were isolated, being adjacent or near to other corn fields. During the past two or three years, the number of corn fields in each vicinity has declined. By 1947, in several instances, the record fields were semi-isolated from other corn fields. Second, along with the decrease in corn acreage, there has been a greater proportional decrease in the seeding of late corn. These two changes in farming practices may account to some extent for a decline in the infestations in the fields studied.

The trend toward less late-planted corn can be observed in the comparatively low infestation in most of the fields having bottomland silt or clay soils (Tables VI and VII). In two such fields, located in Garvin and Creek counties, low infestations present in the previous two or three years had apparently disappeared by 1947 (Table VII).

Infestation in Bottomland Areas.

The Garvin county field is particularly interesting. It is typical of the bottomland along the Washita River in that county. The soils in this area range from very fine sandy loams to silt and clay loams. They are very fertile and are among the best corn producing soils in the State. The land is level and in a number of fields special ditches are maintained to improve drainage. The great majority of the fields are plowed in the fall or winter using moldboard plows. As a rule, the land is plowed deeply and thoroughly. Corn is seldom planted after May 15, with the bulk being seeded in April. This method of fall or winter plowing is generally not practiced in the sandy upland areas due to the dangers of soil blowing.

The river bottomland area is surrounded by an upland region in which corn has suffered from light to heavy borer damage during the past three or four years. The highest infestation found to date in the bottomland corn was 26 percent, while that for most of the area was less than 10 percent. Little or no stunting of the plants has been observed. Apparently, the only damage of economic importance sustained has resulted from lodging of plants due to the girdling activity of the borers.

Similar low infestations have been found in the bottomlands of the Arkansas River in Creek and Tulsa counties. No serious injury has been observed in this area even in corn planted as late as June.

Records have also been obtained in relatively small areas of silt and clay soils on bottomland in various parts of the State. In these situations the infestations and injury were usually found to be somewhat higher than in the case of the larger areas discussed above. In general, however, the damage was less than in nearby upland fields. Important injury to corn planted on early to medium dates in bottomland fields was usually due to the attack of the second generation of borers. Most of this injury came from the lodging of plants. Fields of late corn, however, have been observed where borer injury had noticeably affected the yields.

The less severe borer infestations and injury on the heavier bottomlands may be due to several causes. However, two factors appear to be important in explaining these conditions. First, there is a relatively high mortality rate of hibernating borers caused by the natural conditions or by deep and thorough plowing of the fields. Second, corn on these fertile soils generally makes a more rapid growth than that on the poorer upland soils. The more mature plants are not only less attractive to the egg-laying moths but sustain less injury from the feeding activities of the larvae. Bottomland fields relatively isolated from infested upland crops suffer less damage than those that are near to such sources of infestation.

Summary

The southwestern corn borer, *Diatraea grandiosella* Dyar, has in recent years caused serious damage to corn in Oklahoma. It also infests the various sorghums, but injury to sorghums is seldom important.

Diatraea grandiosella is apparently a native of Mexico. It entered Arizona and New Mexico in 1913 or earlier and by 1922 had spread over an extensive area in the Trans-Pecos Region of Texas. In 1931 it was present in Arizona, New Mexico, Colorado, Texas, the Oklahoma Panhandle, and the extreme southwestern corner of Kansas. By 1947 the area of infestation had moved eastward and northward to include more than three-fourths of Oklahoma and Kansas.

Data are presented on the seasonal history of the insect in Oklahoma. There are usually two complete generations and a partial third generation. Records show that in one year (1942) more than 85 percent of the second generation larvae pupated, giving rise to a practically complete third generation.

Reduction in corn yields by borer injury ranged from 8.7 percent to 100.0 percent, depending upon the intensity of infestation and the stage of development of the plants when attacked. Corn planted before May 15 sustained much less damage than later plantings. Listers, one-way disks and buzzard-wing sweeps were the most effective tools used for uprooting stubble to kill hibernating borers. Plowing under stubble to a depth of four or more inches was effective in preventing the emergence of moths. Results show the stubble should be uprooted not later than early February to secure effective kills of borers. Six insecticides, applied as sprays and dusts, were generally ineffective in controlling borers during the growing season.

The percentage of winter mortality was higher and the percentage of infestation lower in silt or clay soils than in sandy soils.

Records from 14 areas inspected for four or more years show a general decline in infestation during 1946 and 1947.

LITERATURE CITED

(1) Davis, E. G., J. R. Horton, C. H. Gable, E. V. Walter, and R. A. Blanchard. 1933. The southwestern corn borer. U. S. D. A. Tech. Bul. 388, 62 pp.

(2) Dyar, H. G. 1911.
The American species of *Diatraea* Guilding (Lepid., Pyralidae). Ent. News 22:199-207, 9 pp.

(3) Hixson, Ephriam. 1941.
The walnut datana. Okla. Agri. Exp. Sta. Bul. B-246, 29 pp.

(4) Howard, L. O. 1923.
Ent. Rept. U. S. D. A., 1923.

(5) Todd, C. J. and F. L. Thomas. 1930.
Notes on the southwestern corn borer, *Diatraea grandiosella* Dyar. Jour. Econ. Ent. 23, 3 pp.

(6) Walkden, H. H. 1947.
Status of the southwestern corn borer in Nebraska, Kansas and Oklahoma, fall 1947. U. S. D. A. Ins. Pest Sur., Spec. Supl. (1948; no. 1). 3 pp.

(7) Wilbur, D. A., H. R. Bryson, and R. H. Painter. 1943.
Southwestern corn borer in Kansas. Kan. Agr. Exp. Sta. Bul. 317.