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A BIOLOGICAL AND ECOLOGICAL STUDY OF THE ALFALFA WEEVIL, HYPERA POSTICA (GYLLENHAL), IN EASTERN KANSAS

by

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INTRODUCTION

The alfalfa weevil, eastern strain, was first found in the eastern United States in Maryland in 1952 (Poos and Bissell) and rapidly became the most destructive pest of alfalfa in the area. Since its invasion into southeastern Kansas in 1967 (Simpson 1967), damage has steadily increased so that the weevil is now the most important alfalfa pest in Kansas. (The western strain has been reported in western Kansas since 1960, and later in central Kansas, but has been, at most, of minor importance economically.) This upsurge of importance of the weevil has mandated as understanding of its biology for effective control.

The purpose of this study was to determine the life history of the weevil in Kansas, particularly the presence and importance of fall-laid eggs, and the possibility of occurrence of more than one generation per year, all characteristics which apparently deviated from the usual reports. Because of geographical and meterological differences between northern and southern Kansas, differences in egg deposition and hatching dates, length of larval feeding and time of population peaks in relation to crop development were also studied.

REVIEW OF LITERATURE

The weevil was first recorded from alfalfa in Utah in 1904 (Titus 1910) and subsequently in Maryland and adjoining eastern States in 1952 (Poos and Bissell 1953). A western strain was reported in Cheyene and Hamilton Counties in western Kansas in 1960 (Simpson 1967). An eastern strain was reported in southeast Kansas in Cherokee County in 1967 (Simpson 1967), and by 1972 it had become a severe economic pest on alfalfa in eastern Kansas and over much of the State in 1973.

Blickenstaff (1966) reported on methods of surveying for all life history stages obtained from questionnaires returned from 24 "survey entomologists" and other entomologists. Stems were primarily used in sampling for eggs and the square-foot technique was utilized more often than other methods for larvae. He suggested that plant height early in the season and stage of plant development also should be considered.

Shade (1967) showed that length of time required for larvae to complete development decreased as the plant height increased, to 4 to 5 inches, and that taller plants were more suitable for development of larvae than shorter plants. He suggested that the more rapid development of larvae may result from superior nutritional quality of the rapidly growing, taller plants.

Roberts (1970) showed that biological differences of the weevil occur in relation to latitude in Illinois, and that the theoretical base temperature for egg development is 44.5°F. Sweetman and Wademeyer (1930) and Koehler and Gyrisco (1961) found the theoretical base temperature to be closer to 50°F. However, latter data were based on the average number of days required to hatch 100 viable eggs while Roberts' base temperature was calculated on a 50% hatch. Blickenstaff (1972) over 3 years found that viability in overwintering eggs ranged from 56-90% in 5 different fields, and in one winter 50% or more of the eggs survived. In laboratory studies Cochran and Gyrisco (1966) found it was possible to hold eggs at 4°C. for several months but viability and the ability of newly hatched larvae to initiate feeding decreased with time. Townsend (1928) found 16% of eggs overwintering in Pennsylvania hatched at the end of March, implying that eggs in Kansas could overwinter and hatch the following spring.

By calculating the degree-days accumulated, egg hatching dates can be closely predicted. The number of degree-days required for eggs to hatch can be calculated by accumulating the difference between the minimum base development temperature and the mean daily temperature. Roberts (1970) stated that the average degree days for eggs to hatch is 313 degree days; he had a range of 280 to 333 degree days in a controlled environment of 56, 70, 80, and 90°F. Koehler (1961) found that moisture has considerable influence on hatching of eggs; higher humidity was more favorable for hatching than low humidity.

Armbrust (1961) found that early spring larval populations were significantly correlated with the number of eggs found per stem during the previous winter. Burbutis (1967) showed that large numbers of eggs over-wintered in Delaware in old alfalfa stems and noted that feeding injury per larva at the average time of first cutting in late May was greater from fall than from spring-laid eggs.

Manglitz (1957) stated that egg deposition in the fall is interrupted by cold weather and resumes again in the spring and that in the spring larvae feed and increase in size until early May, when pupation begins. Adults begin emerging shortly before the first growth is cut and very few lay eggs until the following fall.

Because of the frequent occurrence of unseasonal warm temperatures in Kansas in the fall, a premature hatch of fall-laid eggs needs to be considered. Evans (1959) reported that a second generation occurred in Virginia when fall weather was favorable and a small number of larvae hatching from fall-laid eggs reached the adult stage.

Bishop (1967) stated that, although there is no obvious feeding injury to alfalfa early in the spring, there is an adverse effect exerted by young larvae on alfalfa growth. The constant feeding in the terminal buds of young alfalfa shoots, especially when the plant is growing from root reserves, detains growth to a considerable extent. Therefore, it can be assumed that heavy infestations of larvae in the spring will retard the growth of young alfalfa plants in Kansas.

Bishop (1967) also found, in Virginia, that either cutting the first crop somewhat earlier than is normally recommended, or applying an insecticide, resulted in adequate control through the first cutting. In case of an early cutting, a stubble treatment was necessary to allow good regrowth of the second crop.

METHODS AND MATERIALS

Alfalfa fields, ranging from 5-30 acres, located in central, southcentral, and southeastern Kansas were used for study (Figure 1). The variety grown in each field is listed in Table 1. The southern most field located in southeastern Kansas (Independence) and the field farthest north in central Kansas (Kipp) were sampled for overwintering eggs and adults in February 1973.

The stem sampling method recommended by Blickenstaff (1966) was used to estimate overwintering and spring-laid egg populations. The stems were split and eggs counted under a binocular scope.

From March 20, 1973 to June 25, 1973 three randomly selected square foot, whole plant samples per field were taken at weekly intervals, chosen over the sweeping method because of variability between individual sweeps and because first and second instars are not sampled efficiently by sweeping. When heavy larvae infestations occurred in the spring, three 1/4 sq. ft. samples were taken instead, and the data converted to square foot counts. All stages were observed and used in life history data. Field observations were continued through December 1973 to complete life history data.

Samples were examined and the percent of plant tips infested, number of larvae per sq. ft., and average of larvae per tip recorded. Plant height, percent of stems containing spring-laid eggs, and the number of these eggs per square ft. were also determined. Samples were collected throughout the second growth to determine if larval infestations affected the second growth and the percent of larvae surviving the cutting of the first growth.

Larval instars were identified by measuring size of head capsule. Adults were collected by the sweep method recommended by Blickenstaff (1966) prior to, and after, aestivation. Stems were sampled in the fall to determine the beginning of fall egg deposition and sweeps to evaluate the possible occurrence of second generation larvae.

Maximum and minimum daily temperatures and relative humidity were obtained from state weather stations located nearest to each field. Degree day calculation methods recommended by Roberts (1970) were used to determine the effect of temperature variation between fields located in southern Kansas and those farther north. Humidity data were obtained to determine if they affected the time required for eggs to hatch.

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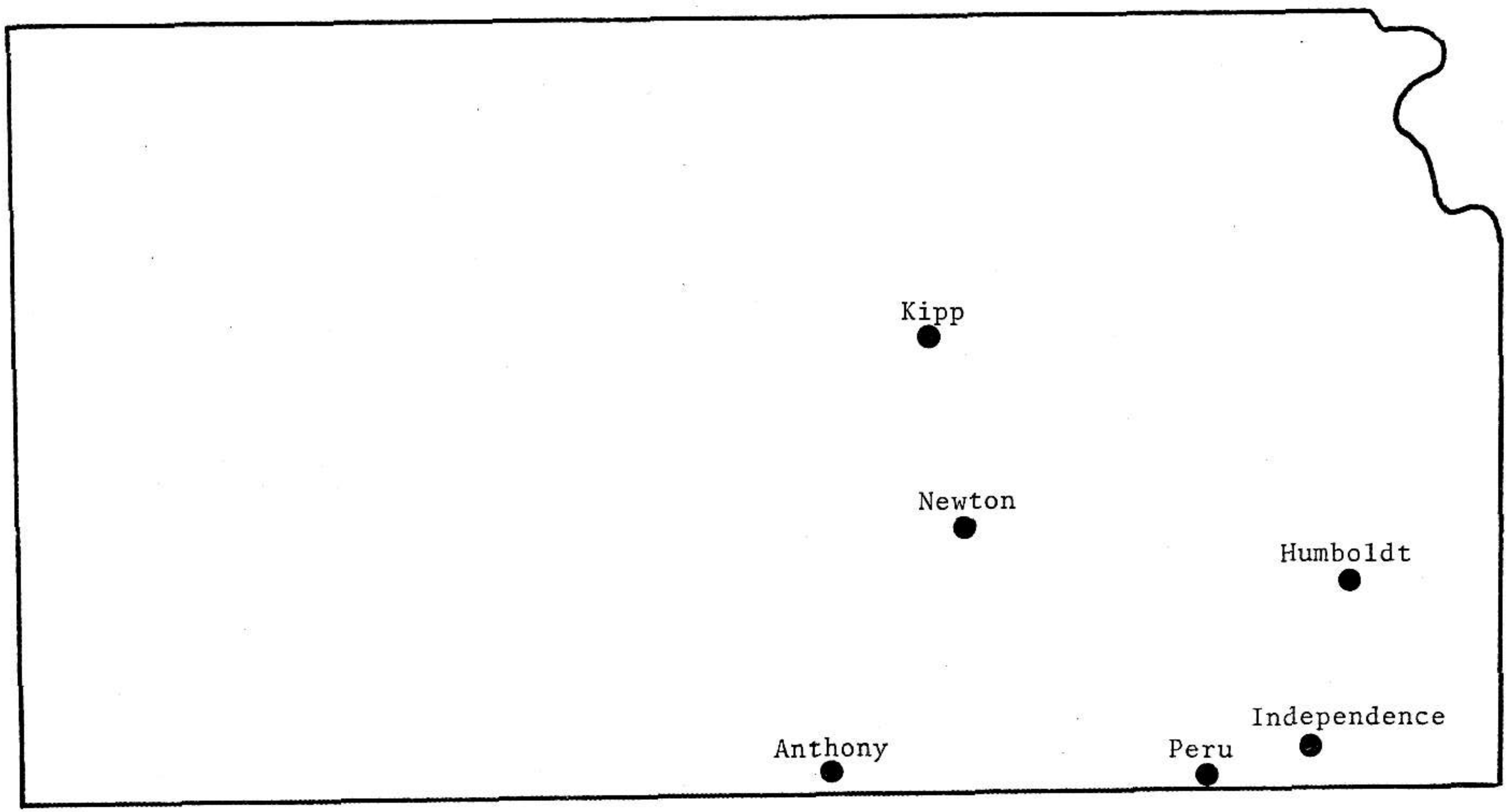
Figure 1. Location of fields in eastern Kansas where studies were made.



RESULTS AND DISCUSSION

Forty-eight percent of the overwintering stems from the southeastern Kansas field (Independence) and 18 percent from the central Kansas field (Kipp) contained overwintering eggs (Table 2).

Table 3 shows the data collected for percent of plant tips infested, number of larvae per sq. ft., and average number of larvae per plant tip. Spring hatching of the overwintering eggs first occurred in the southeastern portion of the State in the Peru and Independence fields. Larval counts were 36 per sq. ft. in the Peru field and 86 per sq. ft. in the Independence field on March 20, with 40 and 80% of the plant tips infested, respectively. Larval infestations peaked in the south by April 18, with all plant tips infested and 880 and 452 larvae counted per sq. ft. in the Peru and Independence field, respectively. These results indicate that fall-laid eggs are largely responsible for infestation on the first growth. The Independence field having a high overwintering egg population had the earliest and most severe larval infestation in the State. Armburst (1966) and Burbutis (1967) also found spring larval infestations were significantly correlated with the number of eggs found per stem during the previous winter in Illinois and Delaware.

At the more northern Humboldt field hatching did not occur until March 30; 10 larvae per sq. ft. infesting 20% of the plant tips. The infestation peaked by May 18, with 116 larvae per sq. ft. infesting 86% of the plant tips. Eggs did not hatch at the Kipp field, located farthest north, until April 18 when 2.5% of the plant tips were infested by one larvae per sq. ft. This infestation peaked by May 3, with 25% of the plant tips infested by 89 larvae per sq. ft. During the first two weeks of hatching the plant tips were averaging 1.5 - 2.0 larvae per plant tip in the south fields and 0.3 larvae per plant tip in the north fields. At the peak of the larval infestation at each location, plant tips were averaging 8 larvae per tip in the south fields and 1.4 larvae per tip in the north fields. The above results indicate that the infestation occurred earlier and was more severe in the southern part of the state in 1973. Roberts (1970) reported similar biological differences resulting from latitude differences in Illinois.

Initial hatching occurred when 178 to 220 degree days accumulated at the six locations. By initial hatching 220, 214, and 215 degree days had accumulated at the Independence, Humboldt, and Kipp fields respectively (Table 4). This range of 42 degree days under field conditions was less than that reported by Roberts (1971) under controlled laboratory conditions. The results indicate that warm temperatures arrived later at the more northern fields. Initial egg hatching occurred 29 days or almost one month later at the Kipp field.

In the spring, eggs (Table 5), were laid first, and in higher quantities, in the southern fields. An average of 18 eggs per sq. ft. were counted at the Peru field on March 20, with 4% of the stems containing eggs. In the south the highest quantity of spring-eggs were laid between April 18 and April 27, with 14% of the stems containing eggs and 98 eggs per sq. ft. present in the Peru field, and 15% of the stems containing eggs and 152 eggs per sq. ft. present in the Independence field. There is no explanation why larval counts began to decline slightly while egg counts were increasing in these two fields. The first cutting was harvested May 11 and May 16 at the Independence and Peru fields respectively with the next sampling date conducted May 22 on the developing regrowth. At this time egg counts and larval numbers had declined drastically. Egg counts at Humboldt peaked around April 27th, and larval numbers continued to increase up to the first cutting on May 20th. In this case the act of cutting disrupted the increasing population either by destroying them or removing them from the field. At this time egg counts had declined and there appeared to be few left to hatch with infestations remaining very low through May and June.

At the Newton field on April 6, 4 eggs per sq. ft.

were present with 1% of the stems containing eggs and 5 eggs per sq. ft. on April 18. Most eggs were laid on May 9 and May 18 at the Newton and Kipp fields respectively, with 19% of the stems containing eggs and 160 eggs per sq. ft. present at the Newton field, and with 17% of the stems containing eggs and 55 eggs per sq. ft. present at the Kipp field. Eggs were laid in higher numbers and earlier in the season in the south. The heavy spring egg laying combined with the heavy initial hatching from fall-laid eggs led to a prolonged severe larval infestation in the south.

A reduction in plant height occurred between April 6 and April 18 at the Peru and Independence fields. By April 27 there was an increase in plant height in spite of high larval populations. The decrease in height was due to the severe larvae population combined with cool temperatures. The average daily mean temperature between April 6 through April 17 was 51 and 52°F. at Peru and Independence fields respectively. Two inches of precipitation was received at each field on April 16, and the average daily mean temperature from April 18 through April 27 was 63 and 64°F. at the Peru and Independence field. The added moisture combined with the increasing warm temperatures could be the reason for the increase in height at these two fields.

Egg counts were minimal throughout the second growth. The maximum number of eggs were present on the last observation date, June 25, with 16 eggs per sq. ft. in the Peru field, with 2% of the plants containing eggs and plant height 13.5 inches, (Table 9), indicating that egg laying and hatching occurred in reduced numbers until the end of June, 1973. Results also indicate that the population on the second growth was greater following a severe infestation in the first growth (which occurred in the southern portion of the state).

During fall, 1973, unseasonal high temperatures occurred and a premature hatch of fall-laid eggs occurred. On November 12 a first instar larva was collected and on November 20 a third instar larva was collected. Both samples were taken in the Manhattan area. Because of cold temperatures it is believed that very few if any of these individuals became adults. Evans (1959) found a similar situation in Virginia when temperatures were favorable in the fall and referred to this as a partial second generation.

Adults were readily found in samples of debris taken from the ground surrounding alfalfa plants throughout the late winter and spring of 1973. Two or three weeks after emergence in the spring the new generation adults began to leave the fields and were not readily found in the fields until mid September.

Table 1. Variety of alfalfa grown in each field sampled.

Fields	Variety
Kipp	Kansas Common
Newton	Dawson
Anthony	Oklahoma Common
Peru	Cody
Independence	Dekalb
Humboldt	Kanza

Table 2. Number and percent of dead stems containing fall-laid eggs of the alfalfa weevil *Hypera postica* (G) in fields at Independence and *Kipp*, Kansas, February, 1973.

	Independence	Kipp
Number of stems counted	50	50
Number of stems containing eggs	24	9
Percent of stems containing eggs	48	18

Table 3. Average percent of alfalfa plant tips infested, number of larvae per square foot, and average number of larvae per plant tip of the alfalfa weevil, <u>Hypera postica</u> (G) from first growth at six study fields in Kansas, 1973.

	Date sampled								
	March		April				May		
Fields	20	30	6	13	18	27	3	9	18
Peru									
% of plant tips infested	40	68	97.3	92	100	93	a		
# of larvae per sq. ft.	36	129	299	527	880	660			
Average # of larvae per tip	0.6	2	5.5	4.5	10	6.5			
Independence									
% of plant tips infested	80	92	99	95	100	77	a		
# of larvae per sq. ft.	86	161	196	339	452	317			
Average # of larvae per tip	2	2.5	3.5	4	7	3.5			
Humboldt									
% of plant tips infested	0	20	30	40	80	45	b	b	86[a]
# of larvae per sq. ft.	0	10	29	56	176	134			256
Average # of larvae per tip	0	0.2	0.6	0.7	2	1			3.6

Table 3. Continued

	Date sampled								
	March		April				May		
Fields	20	30	6	13	18	27	3	9	18
Anthony									
% of plant tips infested	0	0	21	50	67	73	88	80	a
# of larvae per sq. ft.	0	0	19	54	89	322	688	197	
Average # of larvae per tip	0	0	0.3	0.8	1.5	2.5	5.3	3.2	
Newton									
% of plant tips infested	0	0	1.3	0	11	18	50	66	a
# of larvae per sq. ft.	0	0	2	0	10	27	111	125	
Average # of larvae per tip	0	0	0.01	0	0.2	0.2	1.2	2.1	
Kipp									
% of plant tips infested	0	0	0	0	2.5	0	25	18	33[a]
# of larvae per sq. ft.	0	0	0	0	1	0	89	43	56
Average # of larvae per tip	0	0	0	0	0.05	0	1	0.7	1

[a] Last sample taken just prior to first cutting.

[b] Sample not taken because of travel limitations.

Table 4. Initial hatching of overwintering eggs of, alfalfa weevil, *Hypera postica* (G) and number of degree days accumulated from January 1 to initial hatching date at six fields in Kansas, 1973

Fields	Initial hatching	Number of degree days accumulated
Peru	March 20	178
Independence	March 20	220
Humboldt	March 30	214
Anthony	April 2	198
Newton	April 6	195
Kipp	April 18	215

Table 5. Number of eggs, percent of stems containing spring-laid eggs of the alfalfa weevil, *Hypera postica* (G) and plant height from first growth at six fields in Kansas, 1973.

	Date sampled								
	March		April				May		
Fields	20	30	6	13	18	27	3	9	18
Peru									
% of stems with new eggs	4	4	2	4	5.5	14	[a]		
# of new eggs per sq. ft.	18	16.5	8	30.5	44	98			
Plant height	4.6	4.3	6.2	5.9	5.8	10.3			
Independence									
% of stems with new eggs	4	2	4	16	9.5	15	[a]		
# of new eggs per sq. ft.	3	14	31	20	79	152			
Plant height	3	4	5.5	4.5	5.5	8.3			
Humboldt									
% of stems with new eggs	0	0	2.7	2.7	2	16	[b]	[b]	2[a]
# of new eggs per sq. ft.	0	0	4.7	6	36	172			3
Plant height	0	3.8	4.4	5.7	5.6	9			16.4
Anthony									
% of stems with new eggs	0	0	0	3	9	10	13	15	[a]
# of new eggs per sq. ft.	0	0	0	6	27	77	152	120	
Plant height	0	0	5.4	7	9.4	10.8	12.5	15.5	

Table 5. Continued

	Date sampled								
	March		April				May		
Fields	20	30	6	13	18	27	3	9	18
Newton									
% of stems with new eggs	0	0	1	0	0	4	15	19	a
# of new eggs per sq. ft.	0	0	4	0	0	40	112	160	
Plant height	0	0	5.7	7	9	14.6	16.5	19.7	.
Kipp									
% of stems with new eggs	0	0	0	0	2.5	3.5	1	26	17[a]
# of new eggs per sq. ft.	0	0	0	0	5	11	8	20	55
Plant height	0	0	4	6	8.2	9.4	11.3	15.6	22.1

[a] Last sample taken just prior to first cutting.

[b] Sample not taken because of travel limitations.

Table 6. Percent of each larval instar of *Hypera postica* (G) per square foot on the first growth at six study fields in Kansas, 1973.

	Date sampled								
	March		April				May		
Fields (Instars)	20	30	6	13	18	27	3	9	18
Peru									
First	100	84	81	16	49	36	a		
Second		16	19	68	31	13			
Third				14	14	14			
Fourth				2	6	26			
Pupa						11			
Independence									
First	100	86	76	62	48	44	a		
Second		14	24	30	25	17			
Third				5	15	16			
Fourth				3	12	15			
Pupa						8			
Humboldt									
First		100	77	65	84	52	b	b	13[a]
Second			23	35	13	22			22
Third					2	19			25
Fourth						7			1
Pupa									

Table 6. Continued

	Date sampled								
	March		April				May		
Fields (Instars)	20	30	6	13	18	27	3	9	18
Anthony									
First	0	0	98	91	87	80	70	13	a
Second	0	0	2	8	9	11	21	16	
Third	0	0	0	1	3	5	8	17	
Fourth	0	0	0	0	0	4	1	40	
Pupa	0	0	0	0	0	0	0	13	
Newton									
First	0	0	100	0	100	49	55	12	a
Second	0	0	0	0	0	18	29	22	
Third	0	0	0	0	0	33	16	28	
Fourth	0	0	0	0	0	0	0	38	
Pupa	0	0	0	0	0	0	0	0	
Kipp									
First	0	0	0	0	100	0	37	39	23[a]
Second	0	0	0	0	0	0	30	27	18
Third	0	0	0	0	0	0	25	26	27
Fourth	0	0	0	0	0	0	8	8	27
Pupa	0	0	0	0	0	0	0	0	5

[a] Last sample taken just prior to first cutting.

[b] Sample not taken because of travel limitations.

Table 7. Average percent of alfalfa plant tips infested, number of larvae per square foot, and average number of larvae per plant tip of the alfalfa weevil, *Hypera postica* (G) from second growth at six study fields in Kansas, 1973.

	Date sampled		
	May	June	
Fields	22	5	25
Peru (Cut May 16)			
% of plant tips infested	0	6	0
# of larvae per sq. ft.	0	4	0
Average number of larvae per tip	0	0.05	0
Independence (Cut May 11)			
% of plant tips infested	9.7	21	0
# of larvae per sq. ft.	27	44	0
Average number of larvae per tip	0.4	0.6	0
Humboldt (Cut May 20)			
% of plant tips infested	0	2	4
# of larvae per sq. ft.	0	1	4
Average number of larvae per tip	0	0.05	0.8

Table 7. Continued

	Date sampled		
	May	June	
Fields	22	5	25
Anthony (Cut May 18)			
% of plant tips infested	19	23	0
# of larvae per sq. ft.	20	36	0
Average number of larvae per tip	0.2	0.4	0
Newton (Cut May 12)			
% of plant tips infested	25	7	0
# of larvae per sq. ft.	16	15	0
Average number of larvae per tip	0.4	0.2	0
Kipp (Cut May 22)			
% of plant tips infested	0	9	0
# of larvae per sq. ft.	0	15	0
Average number of larvae per tip	0	0.2	0

Table 8. Percent of each larval instar of *Hypera postica* (G) per square foot on the second growth at six study fields in Kansas, 1973.

	Date sampled		
	May	June	
Fields (Instars)	22	5	25
Peru (Cut May 16)			
First	0	25	0
Second	0	25	0
Third	0	50	0
Fourth	0	0	0
Pupa	0	0	0
Independence (Cut May 11)			
First	42	23	0
Second	23	13	0
Third	32	32	0
Fourth	3	32	0
Pupa	0	0	0
Humboldt (Cut May 20)			
First	0	100	0
Second	0	0	100
Third	0	0	0
Fourth	0	0	0
Pupa	0	0	0

Table 8. Continued

	Date sampled		
	May	June	
Fields (Instars)	22	5	25
Anthony (Cut May 18)			
First	23	12	0
Second	30	12	0
Third	30	25	0
Fourth	17	51	0
Pupa	0	0	0
Newton (Cut May 12)			
First	50	27	0
Second	37	40	0
Third	6	25	0
Fourth	7	8	0
Pupa	0	0	0
Kipp (Cut May 22)			
First	0	8	0
Second	0	28	0
Third	0	23	0
Fourth	0	23	0
Pupa	0	18	0

Table 9. Number of eggs, percent of stems containing spring-laid eggs, of the alfalfa weevil, *Hypera postica* (G) and plant height from second growth at six fields in Kansas, 1973.

	Date sampled		
	May	June	
Fields	22	5	25
Peru (Cut May 16)			
% of stems with new eggs	0	0	2
# of new eggs per sq. ft.	0	0	16
Plant height	0	0	13.4
Independence (Cut May 11)			
% of stems with new eggs	2	5	0
# of new eggs per sq. ft.	3	60	0
Plant height	4.3	9	0
Humboldt (Cut May 20)			
% of stems with new eggs	0	0	0
# of new eggs per sq. ft.	0	0	0
Plant height	0	5.6	20.5
Anthony (Cut May 18)			
% of stems with new eggs	0	2	0
# of new eggs per sq. ft.	0	3	0
Plant height	4	6	20.5

Table 9. Continued

	Date sampled		
	May	June	
Fields	22	5	25
Newton (Cut May 12)			
% of stems with new eggs	4	0	0
# of new eggs per sq. ft.	5	0	0
Plant height	3.3	6.1	0
Kipp (Cut May 22)			
% of stems with new eggs	0	5	0
# of new eggs per sq. ft.	0	5	0
Plant height	0	6	16.5

RESUME OF LIFE HISTORY

A diagramatic representation of the life history of the eastern strain as it occurred in eastern Kansas in 1973 is presented in Figure 2.

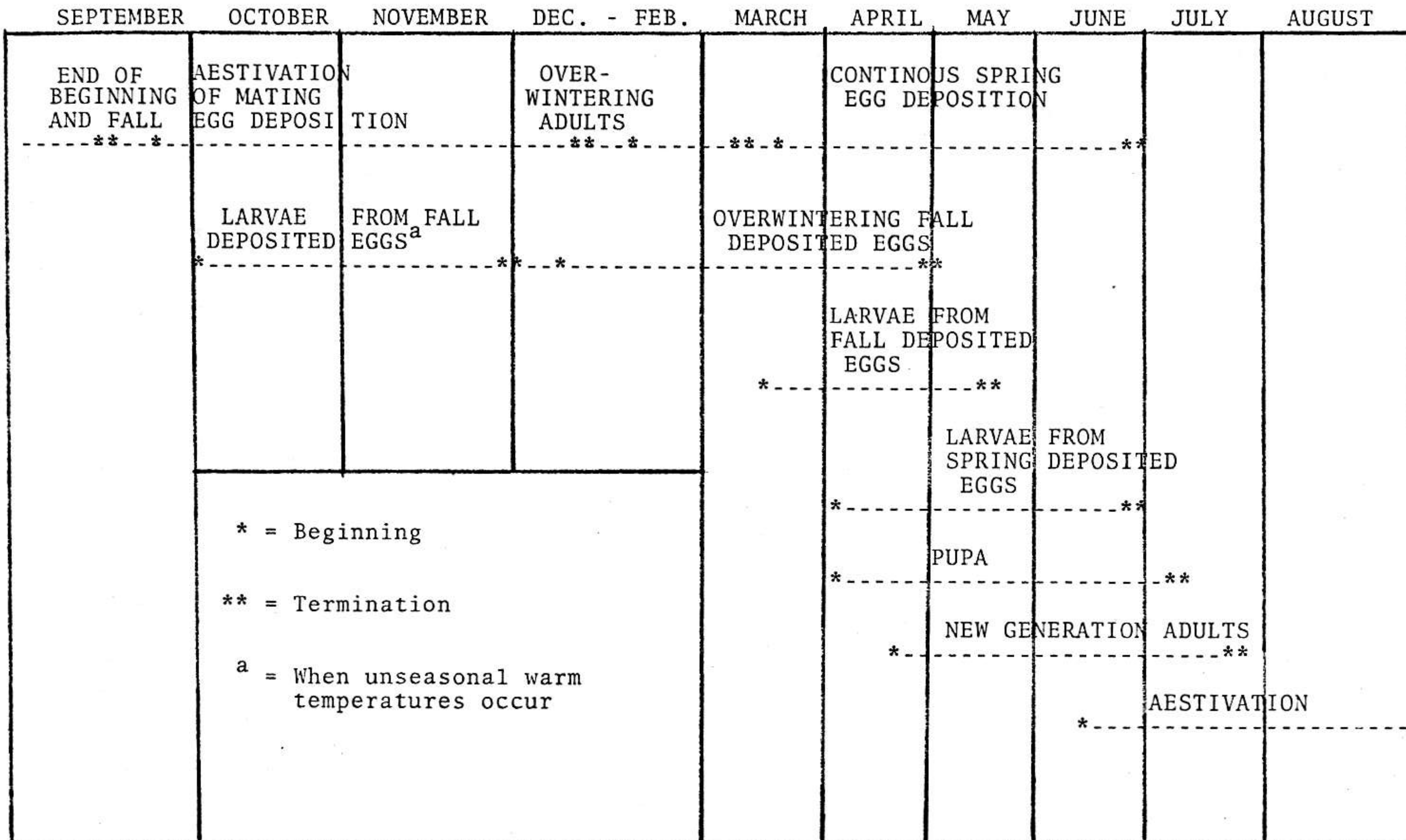
There was one generation a year with a premature hatch of fall-laid eggs. Adult weevils began appearing in alfalfa fields in mid September and early October. After mating, oviposition began and continued until cold weather occurred and then it resumed in the spring. The female punctures the stem with her mouth parts, then turns around, places her ovipositor into the hole, and deposits a cluster of eggs. More eggs per cluster are deposited in the spring than in the fall. The length of time required for the eggs to hatch depends upon temperatures. If unseasonal warm temperatures occur in the fall, similar to fall 1973, hatching may occur. Eggs can be found in the stubble and fresh stems of alfalfa from late fall through the following spring and early summer. Eggs were found in eastern Kansas as late as June 25 in 1973.

Weevils overwintered in the adult and egg stage. Larvae from overwintering eggs hatched in early spring, depending on the time they were laid and the prevailing temperature. Larvae also hatched from eggs deposited in the spring, so that egg hatching occurred for about

3 months. After hatching the first instar larva emerges from the puncture in the stems through which the eggs were deposited and climbs up the outside of the plant until it reaches the bud and begins to feed (Evans 1959).

Larvae lasted 3 to 4 weeks, followed by the pupa; adults emerged in approximately 10 days although in the laboratory at temperatures of 90°F. and above emergence was noted in 6 days. Adults remained in the field and fed on alfalfa or other crops in nearby gardens or fields. After feeding the adult migrated to protective places and burrowed to begin aestivation, in late spring or early summer, which lasted for approximately 3 months. (Aestivation serves for a dual purpose of protecting the adults from the hot, dry summer and also provides for sexual maturity.) (The time necessary for the genitailia to develop varies; Snow (1928) found that the shortest time necessary for sexual maturation was 4 months while Michelbacher and Leighley (1940) indicated that some individuals reached this state in 2 months.) When migration back to the alfalfa field occurred in the fall, mating took place and oviposition began.

Figure 2. Seasonal Life History of the Alfalfa Weevil, Hypera postica (G) in eastern Kansas



SUMMARY AND CONCLUSIONS

The objective was to determine the life history and phenology of the alfalfa weevil, and its relation to alfalfa growth and development at various latitudes in eastern and southern Kansas.

In Kansas the weevil overwinters in the adult and egg stage. One generation occurs and a premature hatch of fall-laid eggs occurred when unseasonal warm temperatures occurred in the fall, 1973.

A field in southeast Kansas (Independence) having a high overwintering population (48% of the stems containing eggs) substained severe damage in 1973. By March 20 this field contained a significant larval population when only a few spring-laid eggs were detected.

Development began later and infestations were less severe in central Kansas in 1973 when initial hatching began approximately 30 days later. Peak infestation occurred when plants had reached a greater height, resulting in more growth at the time of the first cutting.

Second growth sampling indicated that, although reduced in numbers, larval activity and egg laying continued throughout June in 1973.

Differences in various geographical areas may influence the control methods. Insecticide application is currently the primary means of control in Kansas. When larvae hatch early in the season and build into damaging infestations when the plants are short, an application may be necessary as occurred in southeastern Kansas in 1973. A second application may be required if reinfestation occurs prior to the first cutting, although the second application may be delayed by cutting early and spraying the stubble to allow optimum growth for the second cutting. Timing of the second application will depend upon the degree of the infestation and weather conditions.

In east central Kansas, in 1973, the infestation did not become damaging until the plants were 9 to 16 inches high. Then one application may be sufficient for the first cutting and a second stubble application may be necessary to achieve sufficient second growth.

Another situation occurred in central Kansas in 1973. The infestation did not become damaging until just prior to the first cutting. Then it may be adviseable to cut 1 to 2 weeks early and apply an insecticide to the stubble to obtain a good second growth.

All of the above results were recorded from one season. Other situations could develop in other years, and the dates of initial hatching and peak infestations could vary depending upon temperatures in the spring and the degree of infestation.

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APPENDIX

DESCRIPTION OF STAGES

Egg - Eggs are about 1/32 inch in diameter, oval, and yellow when first deposited (Plate I upper photo). As the embryo developes the color darkens and reaches dark brown or black prior to hatching. The number of eggs in a cluster varies from 1 to 39 (Evans 1959).

Larva - There are four instars (Plate I lower photo). Instars are differentiated by the size of their head capsule. Average widths of 10 head capsules which were measured are: 1st instar - 200 microns, 2nd instar - 280 microns, 3rd instar - 433 microns, and 4th instar - 600 microns. The first instar is slightly longer than 1/32 inch just after hatching, legless, and whitish-tan, with a dark brown or black head capsule. As the larva feeds it becomes larger and greener in color. After the third molt the fourth instar larva is green with a white line down the middle of the back (Plate II upper photo). It is legless and approximately 3/8 inch long.

Pupa - When full grown the larva spins a cocoon of whitish thread-like material on dead leaves or other debris on the ground or on the leaves of the alfalfa plant (Plate II lower photo). In a few days it changes into the pupal stage which is usually found on the plant or in plant debris. The young pupa is light green but as it becomes darker, and the typical external features of the adult, such as legs, beak, and elytra can be observed (Plate III upper photo).

Adult - Upon emerging from the cocoon the adult weevil is light brown with a dark line extending down the middle of the back (Plate III lower photo). These colors are produced by hair-like scales. As it becomes older, these scales are rubbed off, so the older weevil is much darker. It is oval in shape, about 3/16 inch long, and has a short, distinct snout.

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EXPLANATION OF PLATE I

Upper: Cluster of eggs in alfalfa stem (Magnification 16X)

Lower: Four Larval Instars (Magnification 16X)

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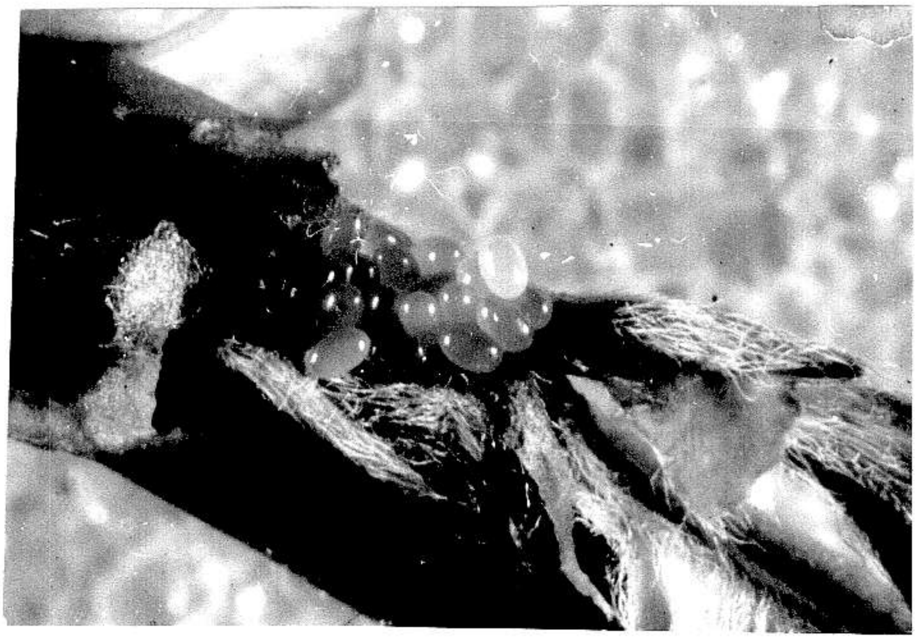
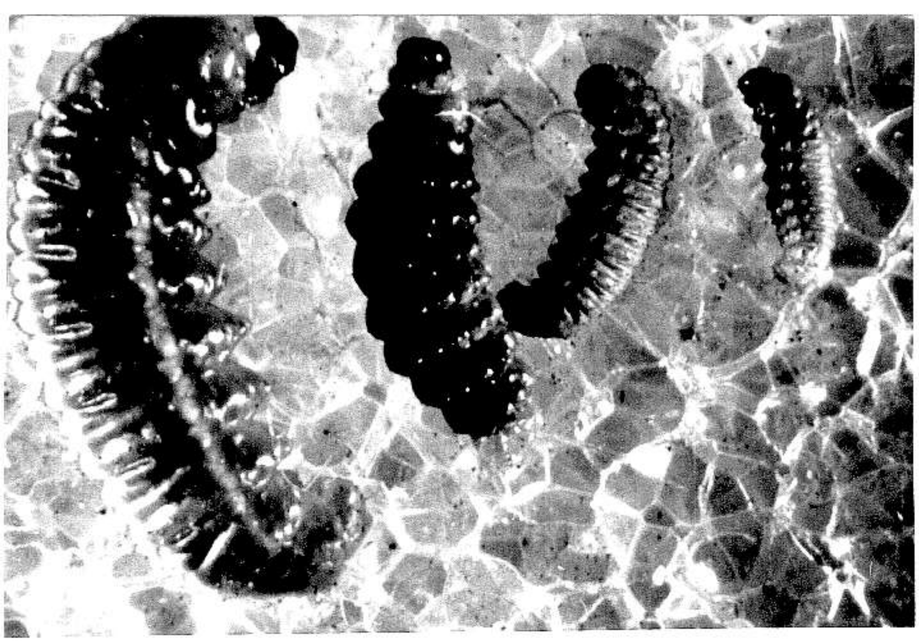
PLATE I



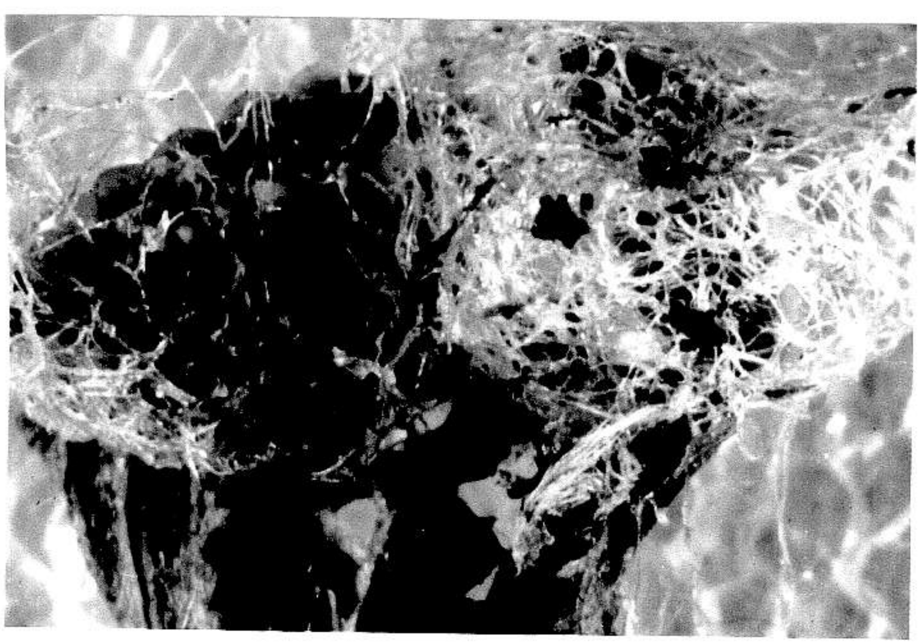


EXPLANATION OF PLATE II

Upper: Fourth instar larva feeding (Magnification 16X)

Lower: Pupa case spun by larva (Magnification 16X)

PLATE II

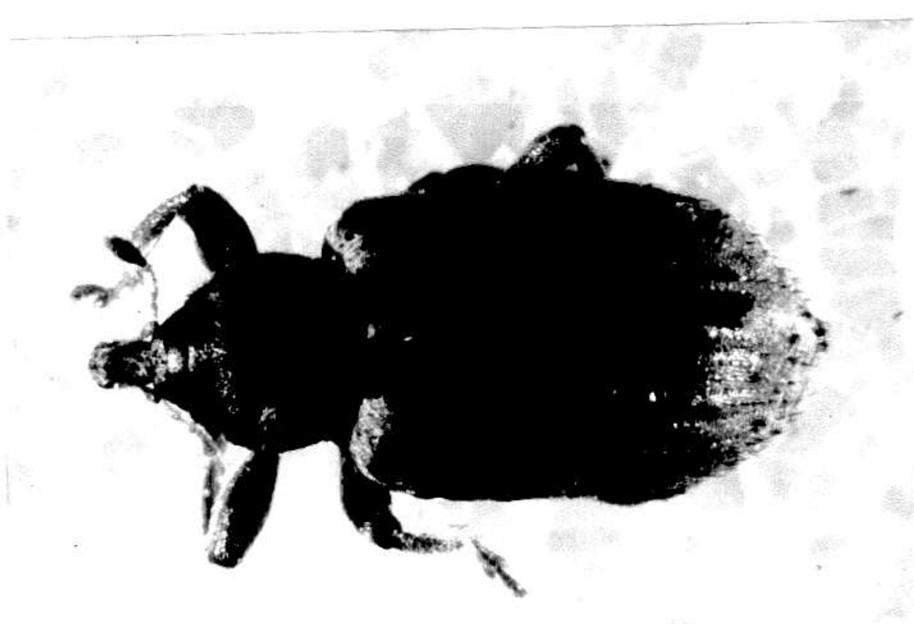


EXPLANATION OF PLATE III

Upper: Ventral view of pupa (Magnification 16X)

Lower: Dorsal view of adult (Magnification 16X)

PLATE III



A BIOLOGICAL AND ECOLOGICAL STUDY OF THE ALFALFA WEEVIL, *HYPERA POSTICA* (GYLLENHAL), IN EASTERN KANSAS

by

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B.S., KANSAS STATE UNIVERSITY, 1968

AN ABSTRACT OF A MASTER'S THESIS

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MASTER OF SCIENCE

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The purpose of this study was to determine the life history of the alfalfa weevil in Kansas, the importance of fall-laid eggs on spring larval infestations, and the possibility of the occurrence of more than one generation per year. Because of geographical and meterological differences between northern and southern Kansas, studies were also conducted to determine if differences in egg deposition and hatching dates, length of larval feeding, and time of population peaks in relation to crop development occurred at different latitudes.

Six fields in central, southcentral, southeastern and east central Kansas were sampled. A field from southeastern and central Kansas was sampled for overwintering eggs. In the spring of 1973, three 1/4 square foot whole plant samples were taken from each field weekly. Data recorded from these samples were the number of larvae per sq. ft., number of spring laid eggs per sq. ft. and plant height in inches. All stages of weevil activity were observed for life history data through December 1973.

Results indicated that in Kansas one generation occurs and a partial second developed when unseasonal warm temperatures occurred in the fall and that the weevil overwinters in the adult and egg stage.

Severe larval damage was substained early at fields where a high overwintering egg population was sampled. Differences in initial egg hatching, larval development, and spring egg deposition occurred between fields sampled in the south and central portion of the state. Initial hatching and spring egg laying occurred earlier and infestations were more severe at fields in the south.

Differences in geographical areas may influence the number of applications and method of control utilized.