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TEXAS AGRICULTURAL EXPERIMENT STATION

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COLLEGE STATION, BRAZOS COUNTY, TEXAS

BULLETIN NO. 380 MAY, 1928

DIVISION OF ENTOMOLOGY

INVESTIGATIONS ON CONTROL OF COTTON FLEA HOPPER IN 1927

AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS

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SYNOPSIS

During the early part of the growing season of 1927 infestations of the flea hopper on cotton were not sufficient to produce any appreciable damage to the crop and no comprehensive data on insecticidal control of the pest were secured. Late in the season heavy infestations of the cotton flea hopper occurred on cotton near Granger and Hutto, in Williamson County. These outbreaks were controlled satisfactorily on half-acre plats by applications of sublimed flowers of sulphur made at weekly intervals. The data presented show a reduction of the number of insects on the treated plats; a reduction of the percentage of small squares injured or blasted; and an increase in the number of blooms and of the number of fruits set.

The results secured in fifteen triplicate tests on the insecticidal control of the insect on goatweed indicate that Superfine dusting sulphur, Electric sulphur, Sublimed flowers of sulphur, and Superfine ventilated sulphur are all effective insecticides when applied at the rate of 15 to 20 pounds per acre at weekly intervals. The average daily control secured with these grades of sulphur over a 14-day period ranged from 79.8 to 86.7 per cent. Applications of insecticides made at 5-day intervals proved most effective in reducing infestations of the cotton flea hopper; however, applications made under similar conditions at 7-day intervals also resulted in a satisfactory control of the pest. Sulphur applied early in the morning when there was little or no air movement was generally slightly more effective in controlling the insect than applications made later in the day.

Young insects or nymphs are killed by sulphur on goatweed plants when it is applied under favorable climatic conditions. The mature insects or adults were not affected unfavorably by the sulphur applied to the plants under observation.

Five new food plants of the cotton flea hopper have been found. These comprise common species of weeds collected at Robstown, Wharton, Taylor, and College Station during May, 1927.

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BULLETIN NO. 380 MAY, 1928

INVESTIGATIONS ON CONTROL OF THE COTTON FLEA HOPPER IN 1927

H. J. REINHARD AND W. L. OWEN, JR.

Practically all the cotton grown in Texas may at times be injured extensively by the cotton flea hopper *Psallus seriatus*. The injury produced appears to be most severe when climatic conditions in the spring delay the hatching of the overwintering eggs of the insect to the time when young cotton is up generally in the field. Since there is no certainty regarding the natural control factors which may prevail during any season the insect assumes the status of a potential enemy of cotton production in this State.

From the time that the cotton flea hopper first attracted attention during the seasons of 1919 and 1920 by its attacks on cotton the injury accomplished by the insect has spread from localized areas in the coastal regions of Texas to practically the whole of the State. In 1926 widespread infestations of the cotton flea hopper were accompanied by a heavy shedding or blasting of small squares generally over the important cotton-producing regions in the State. This resulted in extensive areas of practically barren cotton plants up to the middle of the growing season. Much concern was manifested by growers regarding this situation and a general demand arose for definite information with respect to methods of controlling the insect or reducing the damage done to the crop.

Prior to 1926 the Division of Entomology, Texas Agricultural Experiment Station, had concluded the life history studies on the insect and had also conducted a series of control experiments which indicated that sulphur applied as a dust was an efficient insecticide for reducing infestations. The results of these investigations were published in Texas Station Bulletins 339 and 356. However, many local growers reported unsatisfactory results in combating the cotton flea hopper with sulphur dust. This was primarily due to the fact that essential information, such as the time, rate, and frequency of application of the insecticide was not available. Realizing the seriousness of the problem confronting the farmers of this State the Texas Agricultural Experiment Station outlined and conducted a comprehensive series of experiments on the control of this insect during the season of 1927. This Bulletin contains a description of the experimental work conducted and presents the data which were secured during 1927.

OBJECT OF THE EXPERIMENT

These studies were made to secure definite information concerning the most effective insecticides for controlling the cotton flea hopper; to determine at what rate, frequency, and time applications of insecticides

should be made to secure satisfactory control of the insect; and to obtain data on the performance of cotton plants in the field under flea hopper conditions.

METHOD OF PROCEDURE

Location

In selecting the location for these investigations an attempt was made to conduct the experimental work in various sections of the State where the flea hopper in previous years had done the most severe damage to the crop. This was also a desirable procedure from the standpoint of securing information on variations in the results due to differences in climatic conditions. The original locations selected were College Station, Hillsboro, Paris, Robstown, and Taylor. These locations represent the south, central, north-central, and north-eastern cotton-producing regions in Texas. As the season progressed it developed that the flea hopper infestation on cotton at Robstown remained practically negligible and for this reason the work was transferred to McKinney on June 19, 1927.

Plan

The experiments at each location were conducted on half-acre plats. The plats were carefully selected with respect to uniformity in stand of cotton, age and growth of plants, soil conditions, fertilizers used, and variety of cotton. One plat in each series of tests was left untreated for a check or control on the treatment applied.

The work outlined for each location included the following series of experiments:

Two 4-plat series on time and frequency of application using sublimed velvet flowers of sulphur and "L" grade tobacco dust. Day or dry applications of each insecticide were made on cotton at 5- and 7-day intervals and dew applications at 7-day intervals.

One 4-plat series to determine the effect of deferred applications using superfine dusting sulphur. The dust was applied during the daytime at 7-day intervals, beginning the treatment on one plat at the ordinary time, that is, as soon as cotton began to fruit, and deferring the applications on the other two plats 3 and 6 weeks, respectively, after the first application of insecticide had been made.

Three 3-plat series on comparison of materials in dry or daytime applications at 7-day intervals using superfine dusting sulphur, "L" grade tobacco dust, and 50:50 mixtures of sulphur-tobacco dust "L" grade and sulphur-lime.

One 4-plat series on combination dew applications for control of the boll weevil and the cotton flea hopper by the use of calcium arsenate and 50:50 mixtures of calcium arsenate-sulphur and calcium arsenate-tobacco dust "L" grade. All mixtures of insecticides were applied at the rate of 12 pounds per acre and the undiluted calcium arsenate at 8 pounds per acre.

Four 2-plat series without any applications of insecticides to determine the effect of "strip planting" on the progress of flea hopper infestations on cotton planted in this manner. "Strip planting" is a local term applied to interspersing cotton rows with some other crop. Usually 50 to 90 rows of cotton are alternated with 10 to 25 rows of corn or sorghum. Some growers reported that this practice was effective in protecting the cotton from severe injury by the cotton flea hopper.

Data Recorded

To determine the insecticidal value of the materials applied and the progress made by the plants on all plats, regular and uniform observations were made at each location where the work was conducted. The infestation records were made twice each week: first, by noting the average number of insects on 50 plants at 3 different points in each plat using the same plants for each observation; second, by determining the per cent of small squares blasted out of 100 squares counted including all less than $\frac{1}{4}$ inch in size on consecutive plants in the row at 3 points in each plat. Bloom counts were made twice each week on 100 or more consecutive plants in the row on all plats. This record was made to indicate the reaction of the insects to the particular control measure that was being applied. Plant height records were made at bi-weekly intervals during the growing season on all plats by measuring 100 consecutive plants in the row at 3 different points on all plats. The measurements were made on the same plants each time. Since cotton attacked by the flea hopper usually makes a tall vegetative growth, this record was taken as an index to any injury accomplished by the insect. Form counts including squares, blooms, and bolls were made once each week on 50 plants continuous in the row at 2 or 3 points on all plats. This record was taken as an index to the development of the crop and the influence of climatic conditions as well as a measure of the extent of damage done by the insect. Boll counts were made during the latter part of the growing season in the same manner as described above for the form counts. This record was made to determine the actual extent of fruiting on all the different plats as an indication of the extent of injury done by the insect, and other possible factors affecting the results. Yields of seed cotton were secured in all tests that were carried to completion as a final test of the value of the treatment applied, for data on the extent of losses due to the insect, and variations in yields due to factors other than the damage done by the cotton flea hopper.

FACTORS AFFECTING THE EXPERIMENT

The principal limiting factor affecting the experimental work on the control of the cotton flea hopper during the season 1927 was the general scarcity of infestations of the flea hopper on cotton. With only two exceptions the number of insects present on cotton was neither sufficient to do any extensive damage to the crop, nor to secure comprehensive

data on the value of any insecticides applied for controlling the insect. However, the work was continued wherever there was a remote possibility of securing any results. In those locations where infestations of the cotton flea hopper did not develop, work on other cotton insect pests, particularly on the boll weevil and on the boll worm, was conducted. The results secured in these experiments will be published in another bulletin from this Station.

EXPERIMENTS ON CONTROL OF THE FLEA HOPPER ON COTTON

The general scarcity of infestations of the flea hopper on cotton during the early part of the growing season in 1927 precluded the possibility of securing definite or conclusive data in the experiments conducted during that time on the control of the pest. However, in the latter part of July and during August, 1927, rather heavy infestations of the cotton flea hopper developed in a field of cotton located 4 miles south of Granger and in another field 1 mile east of Hutto, Texas. These infestations were the heaviest noted during the entire season, and although existing for only two or three weeks, they afforded an opportunity for repeating the experiment conducted earlier in the season to determine the effectiveness of sulphur and "L" grade tobacco dust in controlling the insect on cotton. The data secured in this connection are presented on the following pages and indicate that sulphur is a very effective insecticide for controlling infestations of the flea hopper on cotton.

Discussion of Control Experiments on Light Infestations of Insects

Observations on the time and frequency of applications of insecticides for the most effective control of the cotton flea hopper were made at all locations indicated above, over varying periods between May 21 and August 21. Applications of superfine sulphur and "L" grade tobacco dust were begun at about the time the plants were beginning to form squares freely. The insecticides were applied at the rate of approximately 15 pounds per acre, at 5- and 7-day intervals under dry conditions, and at 7-day intervals when the plants were wet with dew.

At the time the applications were begun the per cent of plants infested with cotton flea hoppers was very low at all points where the work was conducted. The number of plants infested ranged from 0 per cent at all locations to a maximum of 1 per cent at Hillsboro, 8 per cent at Taylor, 12 per cent at Paris, 17 per cent at College Station, and 18 per cent at McKinney. Very few of the heaviest infestations indicated were sustained for more than four or five days at any location. As the season advanced the number of insects did not increase materially on cotton; in fact, the reverse was true, especially at College Station, Hillsboro, and Paris. These conditions were unfavorable for securing any definite results; however, the experiments were completed at all locations except at College Station.

A summary of the observations made in these experiments with data

Table 1. Summary showing the number and type of observations taken at all locations where experiments were conducted

Location	Plats in Test	Duration of Observations	No. of Applications Made	No. Infestation Records On		Plants Infested			Number Bloom Records Made	Number Boll Records Made	Number Plant Height Records Made	Number Total Form Records Made	Yield Seed Cotton Per Acre
				Per Cent Squares Injured	Per Cent Plants Infested	Max.	Min.	Aver.					
		1927				%	%	%					
College Station	6 treated	June 15–July 3	13	18	24	17.3	0.0	3.6	2	0	6	1	.....
	2 untreated	June 15–July 3	0	6	8	8.0	1.3	2.8	2	0	2	1	.....
Hillsboro	6 treated	June 20–Aug. 21	26	42	42	1.2	0.0	.06	18	12	12	18	578.6
	2 untreated	June 20–Aug. 21	0	14	14	.67	0.0	.14	6	4	4	6	536.0
Paris	6 treated	June 24–Aug. 11	31	48	48	12.6	0.0	4.0	9	15	15	6	598.0
	2 untreated	June 24–Aug. 11	0	16	16	16.0	0.0	4.6	3	5	5	2	630.5
Taylor	6 treated	May 21–Aug. 16	32	36	66	8.0	0.0	1.3	24	12	6	24	598.5
	2 untreated	May 21–Aug. 16	0	12	22	8.0	0.0	2.3	8	4	2	8	573.0
McKinney	6 treated	June 27–Aug. 16	45	38	57	14.0	0.0	4.6	32	6	18	21	762.0
	2 untreated	June 27–Aug. 16	0	12	19	18.0	0.0	6.8	7	2	6	7	751.0

on the infestations and yields is given in Table 1. Since the infestations of cotton flea hoppers did not increase on the untreated or check plats to the extent of producing any appreciable injury, no definite data were secured on the effectiveness of the control measures applied; in other words, the differences in yields on the treated and untreated plats were not significant. The points of interest in connection with these experiments may be summarized briefly as follows: (1) When the number of flea hoppers on cotton was small the per cent of minute squares injured was not significant. (2) An increase in the number of this insect was accompanied by a corresponding increase in the per cent of squares blasted and shed by the plants. (3) Superfine dusting sulphur proved more effective than "L" grade tobacco dust in checking infestations of the cotton flea hopper. (4) No appreciable damage resulted when approximately 7 per cent of the cotton plants were infested by 1 to 3 nymphs or immature insects per plant during the optimum fruiting period.

The conditions which prevailed during the season of 1927 were also very unfavorable for securing definite data on the effect of any treatment applied in the experiments conducted for the purpose of determining the best time to begin dusting cotton with sulphur for the most effective control of the flea hopper. Observations in this connection were begun at all locations during May and June and continued to the middle of July. Throughout this period less than 3 per cent of the cotton plants on the treated and untreated plats in the experiment at all locations were infested with cotton flea hoppers. The extent of injury to minute squares on the plants under observation was also very limited ranging from 0.3 per cent to 10.6 per cent and averaging approximately 5 per cent over the period of observation. These continued light infestations of insects were not sufficient to produce any appreciable damage to the crop and the data secured as the result of sulphur applications were not significant.

Superfine sulphur, "L" grade tobacco dust, 50:50 mixtures of sulphur-tobacco dust "L" grade, and lime-tobacco dust "L" grade were used in a series of control tests at all locations to determine the comparative effectiveness of these insecticides for controlling the cotton flea hopper. These observations extended from May 26 to August 18. As has already been pointed out above, the number of flea hoppers on the cotton during this period was too small to produce any apparent damage. These conditions were unfavorable for obtaining any definite information in these tests with respect to the comparative effectiveness of the materials applied for controlling the insect on cotton.

Observations on the effect of "strip planting" as a measure for protecting the crop from injury by the cotton flea hopper were made on a series of plats located at Taylor, Hillsboro, and McKinney, from May 28 to July 11. The number of insects during this period remained practically insignificant on the plats at all locations and no definite data were secured.

Control Experiments at Granger, Williamson County

These experiments on the control of the cotton flea hopper were located on the farm of Mr. G. C. Pope and begun on July 23, 1927. At that time there were practically no small squares on the plants; however, the lower fruiting branches were bearing bolls and large squares indicating that the cotton had not been heavily infested by the insect early in the season. The initial observations on infestation showed that approximately 50 per cent of the plants on the experimental plats selected were infested by cotton flea hoppers. Superfine dusting sulphur and "L" grade tobacco dust were applied under similar conditions on separate plats to determine the effectiveness of these materials in controlling the insect. No appreciable reduction in the number of cotton flea hoppers occurred on any of the plats treated with "L" grade tobacco dust as a result of the applications made.

Three plats of cotton were dusted with superfine sulphur at 5- and 7-day intervals under dry and dew conditions as indicated in Table 2.

Table 2. Record of sulphur applications made on cotton at Granger

	Plat 1	Plat 2	Plat 3	Plat 4
Date of application	Check, no treatment	July 23, 1927* July 25, 1927 Aug. 1, 1927 Aug. 8, 1927 Aug. 15, 1927	July 23, 1927* July 25, 1927 July 30, 1927 Aug. 4, 1927 Aug. 9, 1927 Aug. 15, 1927	July 23, 1927* July 25, 1927 Aug. 1, 1927 Aug. 8, 1927 Aug. 15, 1927
Interval		7-day	5-day	7-day
Dry or dew applications		Dry applications	Dry applications	Dew applications
Average rate of application per acre		19.3 pounds	17.8 pounds	21.9 pounds

*Washed off by rain, redusted July 25.

Since the plants on all plats in this experiment had practically ceased growth at the time the first application of sulphur was made the reduction of the infestation on the treated plats is the best index of the effectiveness of this insecticide in controlling the insect. The data secured in this connection are presented in Table 3. The first application of sulphur was washed off by rains within 24 hours after it had been applied and the plats were redusted on the following day. Climatic conditions during the remainder of this experiment were favorable for securing the maximum effectiveness of the insecticides applied.

It will be noted that the number of insects decreased rapidly from July 23 to July 30, on all the plats dusted with sulphur. During the same period the number of insects increased approximately 20 per cent on the untreated or check plat. After the second and third applications of sulphur were made the infestation on all the treated plats was practically negligible and the subsequent applications were effective in pre-

Table 3. Infestation on experimental plats at Granger

Date	Plat 1 (Check)			Plat 2			Plat 3			Plat 4		
	Nymphs	Adults	Per Cent of Plants Infested*	Nymphs	Adults	Per Cent of Plants Infested*	Nymphs	Adults	Per Cent of Plants Infested*	Nymphs	Adults	Per Cent of Plants Infested*
July 22, 1927	115	12	50.6	102	16	45.3	118	17	51.3	114	15	45.3
July 26, 1927	142	14	53.3	71	11	37.3	82	11	39.3	76	15	38.6
July 30, 1927	123	29	56.6	35	12	21.3	26	20	15.3	24	16	14.0
August 3, 1927	81	23	39.3	9	8	6.0	9	6	6.0	4	8	2.6
August 7, 1927	46	36	23.3	14	13	8.6	1	6	0.6	3	6	0.6
August 13, 1927	18	27	10.0	7	6	4.0	1	8	0.6	0	6	0.0
August 21, 1927	8	1	5.3	1	0	0.6	1	1	0.6	2	0	1.3

*Only plants infested with nymphs considered.

venting any increase in the number of insects. In this connection it should be pointed out that natural factors also reduced the infestation on the check plat after August 3. However, the reduction in the number of insects on the untreated plat occurred much more slowly than on the treated plats and did not reach the minimum which obtained on the latter.

The plants on all the plats in this experiment had practically ceased fruiting at the time these observations were begun and no significant data were secured on the effect of sulphur applications in reducing the percentage of minute squares injured by the insect. On August 29, all plats averaged approximately 2.25 bolls per plant. Most of these, however, had been set prior to the time when the experiment was started. The yields of seed cotton per acre secured were as follows: plat 1, (check) 480 pounds; plat 2, 522 pounds; plat 3, 522 pounds; and plat 4, 498 pounds. While all plats treated with sulphur produced a larger yield than the check or untreated plat the differences were not sufficient to be significant.

The results of this control experiment may be summarized briefly as follows: (1) Sublimed velvet flowers of sulphur when applied at the rate of 20 pounds per acre is an effective insecticide for controlling an infestation of the flea hopper on cotton. (2) Applications made at 7-day intervals were practically as effective in controlling the insect as those made at 5-day intervals. (3) Applying the sulphur when the plants were wet with dew did not result in any increased effectiveness of the insecticide.

Control Experiments at Hutto, Williamson County

The heaviest infestation of the cotton flea hopper noted during the season of 1927 occurred on Mr. Carl Allgreen's farm located 1 mile east of Hutto, Texas. The infestation developed late in the season in a portion of a large field where a poor stand of volunteer cotton had been plowed up and replanted to cotton on June 6. On August 19, when these observations were started, the older cotton in the field showed practically no injury by the flea hopper while the infestation on the young or replanted cotton was practically complete; that is, the number of insects present was sufficient to prevent the development of any squares. There were very few bolls present at the time the first observations were made, indicating that the infestation had existed from the time that the plants were beginning to fruit. Many of the plants had made the usual tall whip-like growth as a result of the sustained cotton flea hopper infestation. Another type of injury accompanied the heavy infestation of this insect. In this case the plants were deformed having a topped appearance with many abnormal short lateral branches bearing excessive foliage. The principal growing tips of these plants showed evidence of having been injured or destroyed some time prior to the date on which these observations were started. In this connection it should be pointed out that in 1926 a similar type of injury was noted in local cotton fields in

which there were very light infestations of the insect. However, the injury was more pronounced in the heavily infested cotton at Hutto; in fact, only a small proportion of the plants appeared normal, most of them exhibiting either one or the other types of injury described above.

These experiments on the control of the cotton flea hopper were begun on August 19. On that date the initial observations on the extent of infestation showed that 34 to 52 per cent of the plants on the experimental plats selected were infested with the insect. Sublimed velvet flowers of sulphur and "L" grade tobacco dust were applied at 5- and 7-day intervals under dry and dew conditions as indicated in Table 4.

Table 4. Record of sulphur applications made on cotton at Hutto

	Plat 1	Plat 2	Plat 3	Plat 4
Date of application	Check, no treatment	Aug. 19, 1927 Aug. 26, 1927 Sept. 2, 1927 Sept. 9, 1927	Aug. 19, 1927 Aug. 23, 1927 Aug. 29, 1927 Sept. 3, 1927 Sept. 8, 1927	Aug. 19, 1927 Aug. 26, 1927 Sept. 2, 1927 Sept. 9, 1927
Interval		7-day	5-day	7-day
Dry or dew applications		Dry applications	Dry applications	Dew applications
Average rate of application per acre		17.0 pounds	17.5 pounds	17.0 pounds

Climatic conditions during the extent of these experiments were favorable for securing the maximum effect of the insecticides applied. Practically no control of the cotton flea hopper was secured on any of the plats treated with "L" grade tobacco dust, although essentially the same procedure was followed in applying and noting the effect of this insecticide as in the experiments with sulphur described below.

Effect of Sulphur on Infestation: The data secured on the reduction of the number of insects as a result of dusting the plats with sulphur are presented in Table 5. From August 19 to September 5, the number of insects on all treated plats decreased steadily, while the infestation on the check increased materially during the same period. After September 5, natural factors reduced the infestations on all plats, although the number of insects on the untreated cotton remained greater to the end of the experiment, indicating that the last applications of sulphur were producing most of the excellent control which obtained on all the treated plats on the final days of the test.

In Figure 1 is illustrated graphically the per cent control secured on each treated plat for the duration of the test. There was no marked difference in the effectiveness of dry applications made at 5- and 7-day intervals, or dry and dew applications made at 7-day intervals. The variations in the control secured as indicated by the curves, especially after September 8, are probably due to the reductions in the infestation effected by natural factors.

Table 5. Infestation on experimental plats at Hutto

Date	Plat 1 (Check)			Plat 2			Plat 3			Plat 4		
	Nymphs	Adults	Per Cent of Plants Infested*	Nymphs	Adults	Per Cent of Plants Infested*	Nymphs	Adults	Per Cent of Plants Infested*	Nymphs	Adults	Per Cent of Plants Infested*
August 19, 1927	83	102	34.0	88	110	40.0	109	131	52.0	71	148	40.0
August 23, 1927	118	79	46.6	70	74	36.0	63	56	34.6	56	47	32.0
August 25, 1927	156	94	53.3	66	62	36.0	81	74	44.6	89	57	43.3
August 28, 1927	227	42	75.3	67	27	37.3	73	24	41.3	60	24	36.0
September 1, 1927	161	22	66.0	41	19	23.3	34	16	20.0	22	14	13.3
September 5, 1927	91	24	42.0	22	15	14.0	8	22	5.3	6	21	4.0
September 8, 1927	33	19	21.3	6	11	4.0	9	8	3.3	3	12	2.0
September 12, 1927	17	13	9.3	3	8	2.0	2	6	1.3	5	9	3.3
September 15, 1927	10	12	6.6	4	7	2.6	1	8	0.6	4	3	2.6

*Only plants infested with nymphs considered.

Effect of Sulphur on Squares Blasted: The reduction in the number of cotton flea hoppers on all plats treated with sulphur was followed by a decrease in the number of small squares which were injured or blasted. The data secured in this connection are given in Table 6. On August 20, more than half of the young squares on all plats were blasted as a result of the attack by this insect. The effect of the sulphur applications became apparent on September 5, at which time the plants on all treated plats were beginning to retain the minute squares which were being formed rapidly. The number of squares injured by the insects on the check or untreated plat remained high up to the final observations made on September 16, when there were approximately 50 per cent more squares blasted or injured than on any of the plats dusted with sulphur.

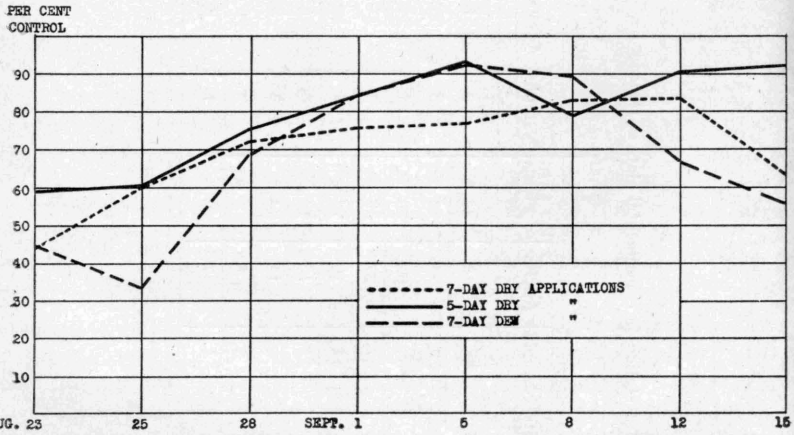

Fig. 1.—Showing the control of the flea hopper on cotton secured with sublimed flowers of sulphur at Hutto, Williamson County.

Effect of Sulphur on Blooming: The number of blooms is an excellent index to the effectiveness of the sulphur applications which were made in this experiment to control the cotton flea hopper. The data secured in this connection are presented in Table 7. Plats 1, 2, and 4 contained approximately the same number of plants, while the number on plat 3 was considerably larger. Calculated on the acre basis the stand of plants for each plat was as follows: plat 1, 15,532; plat 2, 15,233; plat 3, 16,390; and plat 4, 15,235. It will be noted that very few blooms occurred on any of the plats from August 23 to September 9, during the time when the infestation of cotton flea hoppers was at its maximum. About three weeks after the first application of sulphur was made, the number of blooms on all treated plats increased materially while the check plat showed no corresponding increase; in fact, the number of blooms on the check plat decreased at that time. From September 16 to October 14, the plants on all the plats dusted with sulphur were blooming profusely. The check or untreated plat did not show any material

Table 6. Showing the control of the cotton flea hopper as indicated by the reduction in the number and per cent of small squares blasted on treated plats as compared with the squares blasted on the check or untreated plat

Date	Plat 1 (Check)		Plat 2		Plat 3		Plat 4	
	Number Squares Blasted	Per Cent Squares Blasted	Number Squares Blasted	Per Cent Squares Blasted	Number Squares Blasted	Per Cent Squares Blasted	Number Squares Blasted	Per Cent Squares Blasted
August 20, 1927	159	53.0	160	53.3	154	51.3	155	51.6
August 23, 1927	132	44.0	100	33.3	124	41.3	134	44.6
August 25, 1927	111	37.0	113	37.6	105	35.0	117	39.0
August 30, 1927	150	50.0	136	45.3	129	43.0	111	37.0
September 1, 1927	177	59.0	165	55.0	136	45.3	158	52.6
September 5, 1927	176	58.6	147	49.0	133	44.3	127	42.3
September 8, 1927	197	65.6	144	48.0	140	46.6	123	41.0
September 12, 1927	194	64.6	118	39.3	107	35.6	101	33.6
September 16, 1927	175	58.3	88	29.3	83	27.6	75	25.0

Table 7. The relative number of blooms on the treated and untreated plats, computed on acre basis

Date	Plat 1 (Check)	Plat 2	Plat 3	Plat 4
August 23, 1927	103	152	152	0
August 26, 1927	413	203	109	152
August 30, 1927	52	101	109	52
September 2, 1927	207	52	0	152
September 6, 1927	52	101	109	152
September 9, 1927	258	304	164	101
September 12, 1927	207	354	380	101
September 16, 1927	568	1,116	984	1,772
September 19, 1927	155	1,012	1,203	1,013
September 23, 1927	310	1,552	1,148	2,280
September 26, 1927	861	2,888	3,499	4,661
September 30, 1927	568	2,280	2,952	3,648
October 3, 1927	1,188	10,236	12,460	11,096
October 5, 1927	2,015	13,528	11,644	9,476
October 7, 1927	2,377	12,160	9,039	7,490
October 10, 1927	4,030	17,075	19,680	16,872
October 14, 1927	4,288	16,315	15,908	14,491

increase in the number of blooms until the first week in October. Undoubtedly the greater number of blooms which occurred thereafter on the check plat was due to the fact that natural factors reduced the infestation of cotton flea hoppers after September 5 and the untreated plants also began to retain and develop squares. However, each of the treated plats had three or four times as many blooms as the check plat on the date when the final counts were made.

Effect of Sulphur on Forms: Observations on the development of squares, blooms, and bolls were made on all plats at weekly intervals from August 20 to October 14. The data secured are presented in Table 8. These data further evidence the insecticidal value of sulphur in controlling the cotton flea hopper. At the time the first applications of sulphur were made, the plants on all plats were retaining very few squares as a result of the injury produced by the cotton flea hopper. It will be noted that there were practically no blooms present and that the number of bolls which the plants had set was very small. This condition remained unchanged until the first week in September when the effect of the sulphur applications in reducing the infestation of insects became apparent by a rapid increase in the number of squares formed on all the cotton dusted with sulphur. The natural decrease of the number of insects on the check plat during September was manifested also by an increased number of squares produced on the untreated plants. However, the number and the rate of increase in the squares formed was much less pronounced and occurred two or three weeks later than on the cotton treated with sulphur. As the squares developed, the number of blooms on all the treated plats were increasing rapidly during the first two weeks in October. The final observations showed that the plants on these plats averaged more than one bloom per plant while on the check or untreated plat the average was slightly less than one bloom to every three plants.

Table 8. Production and development of squares, blooms, and bolls on treated and untreated plats

Date	Plat 1 (Check)			Plat 2			Plat 3			Plat 4		
	Squares	Blooms	Bolls	Squares	Blooms	Bolls	Squares	Blooms	Bolls	Squares	Blooms	Bolls
August 20, 1927	120	3	53	56	5	32	74	4	34	52	2	41
August 26, 1927	42	4	66	37	3	24	39	2	47	34	3	45
September 2, 1927	31	3	53	42	1	40	35	0	37	26	1	42
September 9, 1927	87	1	59	314	5	36	249	1	50	316	1	34
September 16, 1927	176	8	59	688	15	40	697	10	51	783	19	50
September 23, 1927	295	4	74	1044	20	80	1025	9	80	1169	28	106
September 30, 1927	767	6	83	1453	21	142	1347	19	198	1535	37	162
October 7, 1927	871	37	115	1585	132	381	1472	94	391	1390	65	412
October 14, 1927	906	47	213	1115	174	671	1046	149	573	868	170	668

Effect of Sulphur on Fruiting: In Table 8 it will be noted that most of the bolls were set after October 1. Obviously this was too late in the season for these bolls to mature and hence yields are not available to determine the effectiveness of sulphur in controlling the insect. In this connection, however, the number of bolls set by the plants on all the plats is a good basis for comparison. An increase in the number of bolls set by the plants on all treated plats became apparent on September 23, approximately four weeks after the first application of sulphur was made. Each record made thereafter showed a heavy increase in the number of bolls on the treated cotton. On October 14, when the last observations were made, the untreated cotton averaged 1.4 bolls per plant while the cotton dusted with sulphur averaged 4.2 bolls per plant. In other words, there were three times as many bolls set on the cotton which was dusted with sulphur to control the cotton flea hopper.

The significance of these results may be emphasized by pointing out that the experiment was conducted late in the growing season when the boll weevil destroyed many forms on the plants under observation, and that a practically complete infestation of cotton flea hoppers had prevailed and destroyed a large proportion of the squares formed on the cotton for some time prior to August 19, when the first applications of sulphur were made.

The results secured in this control experiment on the cotton flea hopper may be summarized briefly as follows: (1) A complete infestation of this insect on cotton was effectively controlled by applying sulphur dust at the rate of 17 pounds per acre. (2) Applications of this insecticide made at 5- and 7-day intervals during the daytime and at 7-day intervals early in the morning when the plants were wet with dew, all proved efficient in reducing the number of insects. (3) The reduction in the number of insects on all treated plats was followed by a decrease in the per cent of minute squares injured or blasted. (4) The increased number of small squares retained by the sulphured plants became apparent about three weeks after the first application was made. (5) Four or five applications of sulphur materially increased the number of blooms on all treated plats. (6) The number of bolls set on the cotton dusted with sulphur was approximately three times greater than the number set by the plants which were not treated.

EXPERIMENTS ON THE CONTROL OF THE COTTON FLEA HOPPER ON GOATWEEDS

To further note the insecticidal value of the various materials used in controlling the cotton flea hopper and to secure further information regarding the most effective time and frequency of application of insecticides, fifteen triplicate control tests on this insect were conducted on *Croton,* or goatweed, during August and September, 1927.

Each series of these control tests extended over a period of two weeks and was conducted on four one-eighth-acre plats. One plat of goatweeds

in each series was left untreated to serve as a check on the effectiveness of the insecticides applied on the other three plats. Daytime or dry applications of insecticides were made at 5- and 7-day intervals, and early morning or dew applications at 7-day intervals. All of the insecticides were applied uniformly over the area of each plat at the rate of 15 to 20 pounds per acre with hand-operated Niagra dusting machines. Prior to the first application and each day thereafter during the extent of the tests fifty terminal bud-clusters were removed from plants situated on all portions of both treated and untreated plats. These samples were placed in tight containers and taken to the laboratory where the insects present on the bud-clusters were counted carefully to determine the extent of infestation. The number of insects present on the bud-clusters taken from the untreated plats was considered to be a 100 per cent infestation and the daily control secured on all plats was computed on that basis.

Climatic conditions during these control tests were favorable for maintaining the maximum effect of all insecticides applied. The temperatures were high throughout August, 1927, and the rainfall for the month totaled 0.01 inch. These conditions were unfavorable for plant growth and the weeds on some plats deteriorated before the tests were completed. In effect, this naturally reduced the number of cotton flea hoppers on the plats affected most by the drought, and the calculations on the per cent of daily control obtained on these plats were based upon comparatively small numbers of insects, which in some instances averaged less than one insect per plant. Undoubtedly the unusually high control of insects secured on these plats is attributable in part to the reduction in infestation produced by natural factors.

Tests on Time and Frequency of Application

Nine triplicate control tests on the cotton flea hopper were conducted to determine any difference in effectiveness of dry and dew applications of insecticides and also to secure data on the comparative effectiveness of applications made at 5- and 7-day intervals.

During these control tests dews were very light and often hardly noticeable. However, conditions for applying the insecticides in the early morning were more favorable since there was practically no air movement at that time. Strong winds often interfered with securing uniform applications during the mid-day or afternoon. A summary of the data secured in these tests is presented in Table 9. These data indicate that applications of insecticides made early in the morning at 7-day intervals are more effective in reducing the infestation of insects than the applications made later in the day at the same intervals when winds interfered. As has already been pointed out, the dews were very light or practically insignificant at the time these tests were conducted and the increased effectiveness of the early morning applications apparently was due to the more favorable conditions for applying the dust. These

data also indicate that applications of insecticides made at 5-day intervals when the plants are dry produce a higher control of the cotton flea hopper than those made at weekly intervals. The increase in per cent of control was more apparent on the plats dusted with sulphur-tobacco mixtures than on those treated with the straight sulphurs. However, this was due, in part at least, to the more rapid deterioration of the plants on all plats dusted with the sulphurs, which effected a natural reduction of the number of insects present.

Table 9. The effect of time and frequency of application of insecticides on goatweed for the control of the cotton flea hopper

Insecticide	Schedule of Application	Per Cent Average Daily Control
Sulphur-Tobacco Dust "L" grade, 60:40 mixture	7-day, dry	46.9
Sulphur-Tobacco Dust "L" grade, 70:30 mixture	7-day, dry	74.7
Sulphur-Tobacco Dust "L" grade, 80:20 mixture	7-day, dry	73.3
Sulphur-Tobacco Dust "L" grade, 60:40 mixture	5-day, dry	72.4
Sulphur-Tobacco Dust "L" grade, 70:30 mixture	5-day, dry	71.9
Sulphur-Tobacco Dust "L" grade, 80:20 mixture	5-day, dry	84.4
Sulphur-Tobacco Dust "L" grade, 60:40 mixture	7-day, dew	72.0
Sulphur-Tobacco Dust "L" grade, 70:30 mixture	7-day, dew	87.6
Sulphur-Tobacco Dust "L" grade, 80:20 mixture	7-day, dew	77.2
Sulphur-Tobacco Dust 3% Nicotine, 60:40 mixture	7-day, dry	58.3
Sulphur-Tobacco Dust 3% Nicotine, 70:30 mixture	7-day, dry	60.0
Sulphur-Tobacco Dust 3% Nicotine, 80:20 mixture	7-day, dry	56.2
Sulphur-Tobacco Dust 3% Nicotine, 60:40 mixture	5-day, dry	70.2
Sulphur-Tobacco Dust 3% Nicotine, 70:30 mixture	5-day, dry	77.0
Sulphur-Tobacco Dust 3% Nicotine, 80:20 mixture	5-day, dry	72.2
Sulphur-Tobacco Dust 3% Nicotine, 60:40 mixture	7-day, dew	64.1
Sulphur-Tobacco Dust 3% Nicotine, 70:30 mixture	7-day, dew	73.6
Sulphur-Tobacco Dust 3% Nicotine, 80:20 mixture	7-day, dew	79.2
Sulphur, Superfine	7-day, dry	81.9
Sulphur, Swan No. 1	7-day, dry	91.4
Sulphur, Electric	7-day, dry	88.8
Sulphur, Superfine	5-day, dry	96.0
Sulphur, Velvet flowers	5-day, dry	97.4
Sulphur, Electric	5-day, dry	97.3
Sulphur, Superfine	7-day, dew	94.5
Sulphur, Velvet flowers	7-day, dew	90.0
Sulphur, Electric	7-day, dew	88.7

Tests on Comparative Effectiveness of Insecticides

From August 20 to September 3, six series of triplicate tests were conducted for the purpose of comparing the effectiveness of several insecticides in controlling the cotton flea hopper. Each series of these tests extended over a period of fourteen days and included two dry or daytime applications of insecticides at 7-day intervals. A summary of the data on the per cent of daily control secured in these tests is presented in Table 10.

It will be noted that the effectiveness of these insecticides varied greatly in controlling infestations of the cotton flea hopper. Seven out of the nineteen different materials used resulted in an excellent control of the insect. These include the four brands of sulphur which were used; two sulphur-tobacco dust "L" grade mixtures; and the mixture of

Table 10. Data showing percentage of effectiveness and rank of the insecticides used in tests for controlling the cotton flea hopper on goatweed

Insecticides	1st Day	2nd Day	3rd Day	4th Day	5th Day	6th Day	7th Day	8th Day	9th Day	10th Day	11th Day	12th Day	13th Day	14th Day	Average Per Cent Daily Control	Rank	No. of Daily Observations
Sulphur-Tobacco Dust "L" grade 60:40 mixture	63.9	63.6	76.0	55.5	55.6	44.0	55.8	72.3	61.1	54.8	44.8	38.5	26.5	27.1	52.8	15	19
Sulphur-Tobacco Dust "L" grade 70:30 mixture	34.3	61.8	76.0	75.5	70.4	76.0	75.0	90.8	74.6	87.7	57.9	79.5	64.4	71.9	71.1	6	19
Sulphur-Tobacco Dust "L" grade 80:20 mixture	47.2	77.3	74.1	62.8	77.8	74.0	77.0	88.9	89.9	85.0	85.6	68.0	70.2	61.5	74.2	5	19
Sulphur-Tobacco Dust 3% Nicotine 60:40 mixture	66.5	73.3	59.7	67.4	46.2	48.9	30.6	75.3	82.0	78.4	86.0	69.5	69.1	63.1	65.4	8	33
Sulphur-Tobacco Dust 3% Nicotine 70:30 mixture	59.3	66.4	69.3	72.8	37.1	54.0	3.9	72.3	69.5	91.8	73.7	68.0	58.7	69.8	61.9	11	19
Sulphur-Tobacco Dust 3% Nicotine 80:20 mixture	51.9	57.3	62.5	71.9	33.4	46.0	0.0	81.5	84.8	68.5	77.7	51.3	64.4	76.1	59.0	13	19
Sulphur, Superfine	69.4	76.9	84.7	84.1	77.6	75.4	68.7	84.2	91.8	91.7	87.3	80.4	78.4	77.6	80.5	3	61
Sulphur, Swan No. 1	56.8	77.9	90.5	86.1	88.7	85.2	77.1	91.4	91.0	94.9	92.5	86.1	86.8	84.7	84.9	2	14
Sulphur, Electric	76.6	82.9	89.9	90.5	88.5	76.3	70.7	92.3	93.0	93.9	92.1	88.9	92.6	86.9	86.7	1	33
Sulphur, Velvet flowers	71.0	80.3	90.4	89.4	93.3	68.6	66.7	91.2	93.8	89.5	81.6	73.9	63.8	64.2	79.8	4	19
Sulphur-Tobacco Dust 3% Nicotine 40:60 mixture	58.7	61.6	63.8	65.7	61.0	51.9	53.5	67.7	74.6	77.5	76.4	73.1	61.4	58.6	64.6	9	42
Sulphur-Tobacco Dust 3% Nicotine 30:70 mixture	31.9	44.6	34.8	53.5	28.6	18.6	12.4	36.9	56.7	61.0	62.4	48.6	48.1	50.9	42.0	17	14
Sulphur-Tobacco Dust 3% Nicotine 20:80 mixture	4.6	29.4	30.5	11.9	16.2	14.9	9.1	11.2	10.3	16.3	27.7	15.7	4.8	2.5	14.6	19	14
Tobacco "L" grade-Lime 60:40 mixture	55.7	65.3	81.6	83.2	76.2	63.0	56.2	65.6	63.0	64.3	52.4	38.9	55.2	53.4	62.4	10	14
Sulphur-Tobacco "L" grade-Lime 60:30:10 mixture	44.4	52.2	70.7	77.3	69.6	63.0	62.0	77.6	85.9	87.0	87.0	81.4	63.8	61.7	70.2	7	14
Tobacco Dust "L" grade	22.8	60.9	30.5	34.7	47.7	20.4	35.6	55.2	30.0	34.2	33.1	34.4	44.9	34.2	37.0	18	14
Tobacco Dust 3% Nicotine	33.0	56.6	47.9	68.4	44.8	41.7	33.9	56.8	49.7	47.2	39.3	42.6	41.8	45.9	46.4	16	14
Calcium Arsenate-Sulphur 50:50 mixture	29.6	51.1	35.9	51.5	38.1	31.5	47.2	82.4	81.9	87.0	78.5	79.2	72.5	65.0	59.3	12	14
Sulphur-Tobacco Dust 3% Nicotine 50:50 mixture	12.5	24.0	25.0	54.5	29.6	38.9	39.7	82.4	84.3	88.7	84.7	79.1	78.0	70.9	56.5	14	14

sulphur-tobacco dust-lime. The performance of the sulphurs in reducing the number of insects is especially noteworthy. Each brand of sulphur used resulted in a very rapid reduction in the infestation and remained effective in checking the multiplication of the insects throughout the duration of the tests. On the basis of the average per cent of daily control produced the sulphurs rank closely together ranging from 79.8 to 86.7 per cent. These differences are not considered significant and the cost of the material is the determining factor regarding the kind or grade of sulphur to use in combating outbreaks of the cotton flea hopper.

Many requests have been received for information regarding the possibility of controlling the cotton flea hopper and the boll weevil simultaneously with a mixture of sulphur and calcium arsenate. To determine the effectiveness of a combination insecticide for controlling the cotton flea hopper a mixture containing 50 parts sulphur and 50 parts calcium arsenate was applied on a plat of goatweeds infested with the insect. The results secured are presented in Table 10, and indicate that this combination insecticide is decidedly less effective than undiluted sulphur in controlling infestations of the cotton flea hopper. An average daily control of 59.3 per cent was secured by the use of this mixture while the undiluted sulphurs applied under comparable conditions produced an average daily control ranging from 79.8 to 86.7 per cent. In the light of these results and the control secured in experiments on the boll weevil it is not considered that applications of this combination insecticide would be warranted even though both insects may be present.

The results of several preliminary tests reported in Texas Station Bulletin 356 indicate that mixtures of sulphur and tobacco dust were slightly more effective than straight sulphur in controlling the cotton flea hopper. To secure additional information on this point seven different mixtures of sulphur-tobacco dust and two grades of undiluted tobacco dust were applied on twelve separate plats of infested goatweeds. The results secured in these tests are given in Table 10. Under the conditions of these tests none of the materials produced the high control of the insect that was secured on the plats dusted with the sulphurs. In fact, only the 70:30 and 80:20 mixtures of the sulphur-tobacco dust "L" grade resulted in a uniform reduction of the number of insects present on the treated plats throughout the duration of the tests.

The results of these tests on the control of cotton flea hopper may be summarized briefly as follows: (1) Early morning or dew applications of insecticides are slightly more effective in controlling the cotton flea hopper than daytime or dry applications. (2) Insecticides applied at 5-day intervals were most effective in reducing the number of insects present, but a satisfactory control was also secured by applications made at 7-day intervals. (3) Electric sulphur, Superfine ventilated sulphur or Swan brand No. 1, Superfine dusting sulphur, and Sublimed velvet

flowers of sulphur proved to be the most effective of all the insecticides used in the control tests on the cotton flea hopper.

ACTION OF SULPHUR ON THE COTTON FLEA HOPPER

Several tests were conducted to determine the action of sulphur on the cotton flea hopper. Individual goatweed plants were selected in the field and dusted liberally with sulphur while exposed to the direct sunlight during the hottest portion of the day. Superfine sulphur was applied in the first test at 2:05 o'clock p. m. on August 25, 1927. The day was hot and sultry, the sky partly cloudy, and the sun frequently obscured for brief periods. There was practically no air movement during the time the observations were made. The temperatures taken 20 inches above the surface about on a level with the plant ranged from 98 to 104 degrees F.; averaging 101.8 degrees F. during a 2-hour period, from readings taken at 10-minute intervals. The effect of the sulphur on the insects first became apparent 42 minutes after it was applied, at which time the youngest nymphs began dropping to the ground and died shortly thereafter. The older nymphs were also beginning to exhibit discomfort at this time and moved about as if seeking relief. The first fatality among the insects which were one-half or more developed was noted at 2:57 o'clock or 52 minutes after the sulphur was applied. Thereafter most of the youngest nymphs on the plant died rapidly, although there were several fifth instar individuals alive on the plant two hours after it had been dusted with sulphur. Twenty-four hours later the plant was again carefully examined and only one live fourth instar nymph was found. These observations indicate that sulphur applied under favorable conditions becomes effective quickly and is a very efficient insecticide for killing the immature stages of the cotton flea hopper.

Throughout the duration of these tests the adult cotton flea hoppers on the plant were not noticeably affected by the application of sulphur. Many were observed to fly away as the insecticide was being blown over the plant with a hand-operated dusting machine. However, a number of the adult insects remained on the sulphured plant for at least two hours without showing any indication of being affected unfavorably either by coming in contact with or by the fumes given off by the sulphur.

Sublimed velvet flowers of sulphur was used in a test similar to that described above. The results secured were essentially the same; that is, in about one hour after the sulphur was applied to the plant a large proportion of the young cotton flea hoppers were killed by the effects of the insecticide. Twenty-four hours after the application of sulphur had been made, an examination of the plant disclosed no live nymphs although adult cotton flea hoppers were hardly less abundant than on the adjacent untreated plants.

OBSERVATIONS ON FOOD PLANTS

During the course of these investigations several food plants of the cotton flea hopper, not heretofore recorded, were encountered in the field during May, 1927. These include the following five species of weeds collected at Robstown, Wharton, Taylor, and College Station:

Scientific Name	Common Name
Abutilon malacum	Indian Mallow
Gaillardia pulchella	————
Gaura brachycarpa	Primrose
Gaura Pitcheri	Primrose
Marrubium vulgare	Hoarhound

Additional food plants of the cotton flea hopper are reported in Texas Station Bulletins 339 and 356. Among the food plants listed above, *Gaura brachycarpa* is also known to be an important factor in the hibernation of the insect (Texas Station Bulletin 377) in the vicinity of Wharton, Texas. Although the present known food plants of this insect include 59 different species, principally common weeds, there are undoubtedly many other plants, not yet discovered, which are also important in this connection.

Since the insect feeds upon a large variety of early spring weeds commonly found in cotton fields, the complete destruction of all weed growth several days prior to planting cotton is a desirable procedure in combating early infestations of the insect.

SUMMARY

During the early part of the season in 1927 infestations of the cotton flea hopper were generally light on cotton and very little injury by this insect was noted. During July and August rather severe infestations of the flea hopper were found in cotton fields located near Granger and Hutto, Texas.

Control experiments were conducted on half-acre plats in these infested fields using "L" grade tobacco dust and sublimed velvet flowers of sulphur. The applications were made at 5- and 7-day intervals under dew and dry conditions at the rate of 15 to 20 pounds per acre.

No satisfactory control of the cotton flea hopper was secured by the use of "L" grade tobacco dust.

Sublimed flowers of sulphur applied either in the early morning or during the daytime proved very effective in reducing infestations of the insect. The reduction in the number of insects on all treated plats was followed by a material decrease in the number of minute squares injured or blasted. The increased number of small squares retained by the sulphured plants became apparent about three weeks after the first application was made. Four or five applications of sulphur greatly increased the number of blooms on all treated plats. On the final date

of observation the untreated cotton averaged 1.4 bolls per plant; the sulphured cotton 4.2 bolls per plant. The bolls were set too late in the season to mature and the comparison of yields of the treated and check plats could not be secured.

Nineteen different insecticides were used in a series of tests to determine the effectiveness of these materials for controlling infestations of the cotton flea hopper on goatweed. All insecticides were applied at 7-day intervals during the daytime at the rate of 15 to 20 pounds per acre and each test extended over a period of 14 days. Climatic conditions were favorable for securing the maximum effect of the insecticides used in all tests.

Electric sulphur, Superfine ventilated sulphur, Superfine dusting sulphur, and Sublimed flowers of sulphur proved the most effective insecticides among the materials used for controlling the cotton flea hopper. The average daily control secured with these grades of sulphur in all tests over 14-day periods ranged from 79.6 to 86.7 per cent. Two mixtures of sulphur-tobacco dust "L" grade, viz., 70:30 and 80:20, resulted in an average daily control of 71.1 and 74.2 per cent, respectively.

In nine series of tests insecticides applied at 7-day intervals early in the morning under conditions of very light dews produced a slightly higher control of the insect than daytime applications of the same materials made at 7-day intervals. Applications of insecticides made at 5-day intervals were most effective although an average daily control of 80 per cent was secured with materials applied at 7-day intervals under favorable climatic conditions.

Sulphur applied under conditions of little or no air movement during hot clear days affects the young cotton flea hoppers very quickly. Observations in this connection show that many nymphs are killed within an hour from the time of applying the insecticide. The adult or matured insect apparently is not affected unfavorably by the insecticide applied under field conditions.

Five new food plants of the cotton flea hopper are listed. These comprise common species of spring weeds collected at Robstown, Wharton, Taylor, and College Station, Texas.