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**SUPPLEMENTARY INVESTIGATIONS OF
THE FLUOSILICATES AS
INSECTICIDES**

With Observations on the Effect of Heat and Drouth on the
Mexican Bean Beetle

By
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Bulletins of this Station will be sent, upon application, free of charge, to any farmer in the State.

SUPPLEMENTARY INVESTIGATIONS OF THE FLUOSILICATES AS INSECTICIDES

**With Observations on the Effect of Heat and Drouth on the
Mexican Bean Beetle**

INTRODUCTORY

The first extensive experiments with the fluosilicates as insecticides were carried out at Knoxville in the spring of 1924, with special reference to the Mexican bean beetle.

The sodium salt was the only one available in commercial quantities, and it was not particularly well adapted for dusting. The product as manufactured by the Virginia-Carolina Chemical Company seemed to be the best obtainable for use as a dust. Their material was fairly dense, occupying in the neighborhood of 38 to 40 cubic inches to the pound.

Comparatively favorable results were obtained, which were reported in Bulletin 131 of this Station. Since these results were published one manufacturer has placed a light sodium fluosilicate on the market, and there has also appeared a commercial calcium fluosilicate. These chemicals were tried out in the field during the season of 1925, and much additional information was obtained. The results are not conclusive, however, due to the hot, dry summer, which kept the bean beetles from multiplying.

SODIUM FLUOSILICATE (LIGHT AND EXTRA LIGHT)

To meet the requirements for a good dusting material, Jungman & Company, of New York City, have placed on the market two brands, known as "light" and "extra light." The former contains 80 to 85 per cent sodium fluosilicate and the latter 70 to 75 per cent. According to the distributors, the remainder consists of silica. It was found, however, to be alumina, which was used as a colloid to make a bulkier precipitate. The "extra light" material occupies about 60 cubic inches to the pound, and represents a decided improvement as far as bulk is concerned. The "light" sodium fluosilicate occupies about 45 cubic inches. Since the commercial product as put out by the Virginia-Carolina Chemical Company occupies about 38 cubic inches, there is not much difference in this respect. The latter contains, however, from 98 to 99 per cent sodium fluosilicate.

The "extra light" material was used this year in the experimental tests in the field. The fluosilicate content of this material is only about 70 per cent, and the tests showed proportionately less toxicity. When mixed with lime it was decidedly inferior to the commercial material. For many insects, there appears to be sufficient toxicity when the "extra light" is used undiluted. For insects that feed sparingly, such as the boll weevil, the large amount of filler detracts seriously from the value of the material. It was also found to be considerably safer on foliage. As far as could be ascertained, no foliage injury resulted when the material was used undiluted on beans, cotton, or cucumbers. The only plant on which serious injury occurred was tobacco.

SIZE OF PARTICLES OF FLUOSILICATES

The physical condition of a material to be used as a dust is a matter of much importance, demanding a good deal of attention. For the best results, the insecticide should be bulky in proportion to weight so as to cover a large area; the particles should be small, yet dense enough to settle and not float away; and the adhering properties should be such as to prevent its being easily washed off by rain. If the dust can be given a positive charge of electricity the sticking qualities will be increased because leaf surfaces have a negative charge. The addition of a trivalent ion, such as iron, has been found to reverse the charge of calcium arsenate from negative to positive.

An examination of the commercial fluosilicates revealed a wide variation in the size of the particles, as shown in Table 1.

TABLE 1—*Size of particles of fluosilicates*

Source of material	Microns	Remarks
Sodium fluosilicate		
Commercial (Jungman)	20-100	Mostly 100
"Extra light" (Jungman)	5- 30	
Commercial (Virginia-Carolina)	7- 20	Mostly 10
Calcium fluosilicate (Victor)	4- 8	Mostly 5

In a good grade of calcium arsenate the particles appear to be from 2 to 4 microns in size. It is therefore apparent that a material with particles of the size of 100 microns is poorly adapted for dusting.

The particles of the calcium fluosilicate compound are fairly good as far as size is concerned, being for the most part in the neighborhood of 5 microns. They do not settle on the plants, however, when a light breeze is blowing, because they are porous. As they are also round they easily roll off the leaves.

Although the commercial sodium fluosilicate of the Virginia-Carolina Chemical Company is heavy, it dusts well when mixed with hydrated lime. Lime was found to have excellent sticking qualities, which may be partly explained by the fact that it carbonates readily in the air.

CALCIUM FLUOSILICATE

The original experiments with calcium fluosilicate as an insecticide were made with material obtained from Eimer and Amend, market

"C. P." This chemical was found very toxic to both the insects and the plants, which indicates that it is soluble. A careful search of the literature revealed the fact that it is considered slightly soluble, although no figures were given. When it was mixed with water a marked acid reaction could be detected, indicating hydrolysis. A gram of the material was washed ten times with distilled water. The first leachings gave heavy precipitates with barium chloride and potassium chloride, indicating the presence of a soluble fluosilicate. The filtrate also gave a precipitate with sodium phosphate and ammonium oxalate, indicating a calcium salt.

It was evident that a large proportion, perhaps 20 per cent, of the so-called C. P. calcium fluosilicate was soluble. About 12 grams was washed in like manner, and the washed material was tested in the field. This washed material showed no toxicity and no burning. At this time the Victor Chemical Works became interested in the problem and kindly made a chemical analysis of the material. They reported that this sample, marked "Calcium Silicofluoride C. P.," consisted of approximately 30 per cent soluble calcium fluosilicate and 70 per cent calcium fluoride and silica. Their findings at once afforded an explanation of the burning properties exhibited by the material. Further research by the Victor Chemical Works showed that a pure calcium fluosilicate properly prepared is very soluble. When phosphates are introduced into a solution of calcium fluosilicate, however, precipitation takes place, forming, most probably, a double compound with phosphates.

Calcium fluosilicate as manufactured by the Victor Chemical Works

TABLE 2—*Tests of insecticides used as dusts against the Mexican bean beetle under cages—10 beetles under each cage*
Rate of application, about 30 pounds to acre

Material or compound	Date of application	Number dead						Total dead	Injury to bean foliage	Temperature	
		8 hrs.	24 hrs.	32 hrs.	48 hrs.	56 hrs.	72 hrs.			High-est °F	Mean °F
Sodium fluosilicate (Va.-Car.)	July 9	6	2	1	0	1	0	10	None	92	82
Sodium fluosilicate (Jungman)	July 3	0	9	0	0	0	1	10	None	99	84
Sodium fluosilicate (Jungman)	July 9	3	5	0	2	0	0	10	None	92	82
Sodium fluosilicate (Smith)	July 6	0	7	0	2	1	0	10	None	92	82
Calcium fluosilicate (Victor)	July 3	9	1	0	0	0	0	10	None	99	84
Calcium fluosilicate (Victor)	July 9	10	0	0	0	0	0	10	None	92	82
Calcium fluosilicate (Wiarda)	July 13	9	10	0	0	0	0	10	None	96	82
Barium fluosilicate	July 6	6	0	0	0	0	0	6	None	92	82
Barium fluoride	July 6	0	0	2	0	0	4	6	Slig't	92	82
Cryolite (Jungman)	July 13	9	10	0	0	0	0	10		96	82
Potassium fluosilicate C. P.	July 13	9	9	1	0	0	0	10		96	82
Sodium fluosilicate 2 lbs. to 50 gals.	July 7	0	2	0	2	2	2	8		91	80

is not readily soluble, owing to the fact that it is precipitated in the presence of phosphates. Their material is a by-product in the volatilization method of treating phosphate rock for phosphoric acid. For insecticide purposes, this product was sold under the name of "Calcium Fluosilicate Compound." The material is light and fluffy, and marketed in two forms, one occupying approximately 70 cubic inches the pound and the other approximately 120 cubic inches to the pound. It was found very safe on foliage, producing no noticeable burning, even on tobacco. Great improvement could be made in its adhering properties and we learned through correspondence that experiments have been conducted to this end with encouraging results. We are also informed that the Victor Chemical Works have discovered a method of increasing the calcium fluosilicate content of their product which should materially enhance its toxicity.

A large number of cage experiments and a few field tests were made to determine the toxicity of calcium fluosilicate compound toward insects. According to Table 2, when this material was used at the rate of 35 pounds to the acre, with high temperatures prevailing, the kill obtained against the bean beetle was excellent. When the dosage was cut down to 5 pounds per acre, the beetles were not noticeably affected, as shown in Table 3. In one field test the compound was applied once, May 26, at the rate of about 35 pounds to the acre. There was a medium infestation present, with 10 beetles to the row. On June 19, the infestation was only about 5 per cent, whereas the check showed 50 per cent.

TEST WITH THE FLUOSILICATES ON OTHER INSECTS

The Cucumber Beetle (*Diabrotica vittata*).—The control of the cucumber beetle has heretofore been far from perfect. It is a very difficult insect to poison, the arsenicals, as Howard¹ states, being "more or less repellent." Recently nicotine dusts have been recommended, but these are expensive and must be applied several times for satisfactory control.

Since this beetle has the habit of cleaning its feet by drawing the plant through its mouth, it would be expected to yield to the fluosilicates, and such was found to be the case. On June 12 several rows of cucumbers were dusted lightly with sodium fluosilicate about seven o'clock in the morning. Eight hours later dead beetles were found under the plants and it was difficult to find a live specimen. The control obtained was practically 100 per cent. With the commercial sodium fluosilicate, foliage injury appeared within 3 days. After a few weeks, however, the plants outgrew the injury. If the commercial material be used, it should be diluted with 3 parts of lime. The "extra light" sodium fluosilicate also gave satisfactory control, and no burning. Cage tests showed that heavy applications of calcium fluosilicate compound gave good control, especially when high temperature prevailed.

The Tobacco Hornworm (*Protoparce quinquemaculata*).—The tobacco plant is very susceptible to foliage injury by the soluble fluosilicates. Several of the Station plots were dusted with the "extra light" material, but the injury that resulted was not sufficient to attract the attention of the foreman. The control of the hornworm was satisfactory, a kill having been obtained within from 8 to 36 hours. The calcium fluosilicate compound killed the worms within from 12 to 48 hours and gave no foliage injury. Barium fluosilicate killed the worms within 6 hours, with no foliage injury. Cryolite, both natural and artificial, and aluminum fluosilicate were also safe on the foliage while toxic to the worms.

¹Howard, N. F. Insecticide Tests with *Diabrotica vittata*. Jour. Econ. Ent. 11: 1918.

TABLE 3—Tests of insecticides used as dusts against the Mexican bean beetle under cages—10 beetles under each cage
Rate of application, about 5 pounds to acre

Material or compound	Date of application	Number dead						Total dead	Injury to bean foliage	Temperature	
		8 hrs.	24 hrs.	32 hrs.	48 hrs.	56 hrs.	72 hrs.			High-est °F	Mean °F
Sodium fluosilicate (Va.-Car.)	July 27	2	3	2	2	1	0	10	None	90	82
Sodium fluosilicate (Va.-Car.)	July 29	2	0	2	2	2	1	9	None	83	74
Sodium fluosilicate (Jungman)	July 30	10	0	0	0	0	0	10	None	92	76
Sodium fluosilicate (Jungman)	July 29	0	0	1	2	2	2	7	None	83	74
Calcium fluosilicate (Victor)	July 27	0	0	1	0	0	0	1	None	90	82
Check	July 27	0	0	0	0	1	0	1	None	90	82
Sodium fluosilicate C. P. (Baker)	Aug. 10	0	0	4	1	0	5	10	None	98	84
Sodium fluosilicate C. P. (Baker)	Aug. 10	0	0	4	5	1	0	10	None	98	84
Sodium fluosilicate C. P.	Aug. 14	7	2	1	0			10	None	86	78
Sodium fluosilicate (Jungman)	Aug. 10	0	1	1	0	4	2	8	None	98	84
Sodium fluosilicate (Jungman)	Aug. 10	1	2	3	0	1	2	9	None	98	84
Sodium fluosilicate (Jungman)	Aug. 14	0	2	3	2	0	1	8	None	86	78
Sodium fluosilicate (Va.-Car.)	Aug. 14	2	3	2	1	0	1	9	None	86	78
Calcium fluosilicate (Victor)	Aug. 14	0	0	3	2	1	0	6	None	86	78
Check	Aug. 10	0	0	0	0	0	0	0	None	98	84
Check	Aug. 14	0	0	1	0	0	0	1	None	86	78

Since sodium fluosilicate readily injures tobacco, its use is not recommended.

The Sinuate-Striped Flea Beetle (*Phyllotreta sinuata*).—This flea beetle was found abundant on a species of cruciferae, and is known as a pest of turnips. Since flea beetles in general have not been satisfactorily controlled by arsenicals, experiments were carried out against this species. Cage tests showed that they yielded to the sodium fluosilicate within 24 hours. An infestation of the potato flea beetle (*Epitrix cucumeris*) occurred at Crossville, Tennessee, and good control was reported from the use of sodium fluosilicate diluted with 4 parts of lime.

The writer was informed that the potato flea beetle is being successfully combated in Maine by the "extra light" sodium fluosilicate. Gentner² found that the mint flea beetle (*Longitarsus menthae*), a new pest on mint, has appeared in threatening numbers in Michigan. Satisfactory control of this pest was obtained the past season with calcium fluosilicate compound.

Blister Beetles (*Epicauta* sp. and *Macrobasis unicolor*).—In

²Gentner. The Mint Flea Beetle. Quarterly Bul. Mich. Agr. Exp. Sta. 7:3. 1925.

Arkansas, Baerg³ found that blister beetles, heretofore not successfully controlled, are very susceptible to the fluosilicates. These beetles are especially injurious to soybeans, on which they are often found in swarms. The sodium fluosilicate caused no appreciable injury to soybean foliage or alfalfa when diluted with an equal quantity of hydrated lime.

Cutworms.—The usual method of cutworm control consists of the use of poisoned bran mash, in which an arsenical is the active killing agent. When sodium fluosilicate or calcium fluosilicate was substituted in the proportion of 1 to 10 or 20 parts of bran, the worms were found dead, under laboratory conditions, within from 7 to 24 hours. Similar results were obtained with the red-legged grasshopper (*Melanoplus femur-rubrum*).

Ripley⁴ found that they "never had a perfect cutworm bait in South Africa." He found that arsenite of soda and Paris green repel the larvae, but that a 2 per cent solution of sodium fluoride gives excellent results. Since sodium fluosilicate is more toxic than sodium fluoride, and appears to be readily eaten, the fluosilicates should prove satisfactory substitutes for arsenicals in poison baits.

Cotton Worm.—An infestation of cotton worms (*Alabama argemone*) occurred at Knoxville October 8, 1925, and afforded an opportunity to test the value of the fluosilicates against this insect. In cage tests the worms succumbed to sodium fluosilicate within 7 hours, whereas under the calcium arsenate treatment they survived 24 hours or longer. The calcium fluosilicate compound did not prove effective against the cotton worm, many larvae being found alive after 5 days.

Ants.—A few experiments showed that ants in a dwelling can be kept in check by the sprinkling of sodium fluosilicate in places where they frequent. Similarly, by the dusting of cotton in the greenhouse ants were kept from tending and spreading the cotton louse.

Roaches.—Sodium fluoride is known to be effective against roaches. Several bad infestations of *Blatta orientalis* and *Blattella germanica* located during the past summer offered opportunity for testing sodium fluosilicate. In all cases the roaches were effectively controlled by the sprinkling of the powder in the corners on the pantry floors. In a few cases dead mice were also found in the pantries after the use of sodium fluosilicate.

Clothes Moth.—Several clothes-moth remedies have appeared on the market. For one of them, "Larvex," it is claimed that the spraying of blankets and woolen fabrics makes these articles proof against further infestation. The writer's attention was drawn to the fact that "Larvex" is merely a solution of sodium fluosilicate with a small amount of colloidal material to aid in wetting. A few laboratory experiments with nearly full-grown larvae of the case-building clothes moth (*Tinea pellionella*) showed that they could be killed within 6 hours by being allowed to feed on raw wool which had been dipped in a ½ per cent solution of sodium fluosilicate. Larvae allowed simply to crawl over the powder for 8 days were not affected. To produce results the powder must be eaten.

"Larvex" contains about one ounce per gallon of sodium fluosilicate and is expensive. An equally effective material may be made at a very much lower cost.

³Baerg, W. J. Control Measures for Blister Beetles. Bul. Ark. Agr. Exp. Sta. 30, 1925.

⁴Ripley, L. B. Experiments with Cutworm Baits: Success with Sodium Fluoride. Memoir Union of S. Africa Dept. of Agr. 3. 1925.

COMPATIBILITY WITH FUNGICIDES, AND GERMICIDAL VALUE OF THE FLUOSILICATES

The question arose whether the fluosilicates could be used in combination sprays with lime-sulphur or Bordeaux mixture. In the case of calcium fluosilicate there appears to be little chemical action with either lime-sulphur or Bordeaux. Sodium fluosilicate, however, precipitates sulphur out of the lime-sulphur solution, and the two are therefore not compatible, especially for use on apples. The Bordeaux mixture seems to produce a slight reaction with the sodium fluosilicate, but not enough to destroy the properties of either. This combination was not injurious to potato foliage, and was toxic to the larvae of the potato beetle, as shown in Table 4.

TABLE 4—*Tests of insecticides against the Colorado potato beetle under cages*

Material or compound	Date of application	Date first beetles died	Date last beetles died	Injury to plant	Notes
Barium fluosilicate	May 18	May 18		None	All larvae dead in 5 hours. Material sticks very well to foliage.
Barium fluoride	May 18	May 18	May 20	None	Does not stick well.
Calcium fluosilicate (Victor)	May 18	May 19	May 20	None	
Calcium fluosilicate, 1 lb. to 50 gals. water	May 18	May 20		None	Has very little killing power.
Sodium fluosilicate plus 8 parts gypsum	May 18	May 18	May 19	None	Many dead in 4 hours.
Sodium fluosilicate plus 8 parts lime	May 18	May 18	May 19	None	The lime sticks well to the foliage.
Sodium fluosilicate 2 lbs. to 50 gals. water plus 2 lbs. lime	May 22	May 23	May 24	None	
Sodium fluosilicate, 2 lbs. to 50 gals. water plus Bordeaux 3-3-50.	May 22	May 23	May 24	None	
Sodium fluosilicate, 2 lbs. to 50 gals. water plus lime-sulphur 1-40	May 22	May 23	May 24	None	
Ziderite	June 4	June 5	June 6	None	
Potassium fluosilicate	June 9	June 9	June 9	None	All dead in 2 hours.
Aluminum fluosilicate	June 9	June 9	June 9	None	All dead in 2 hours.
Aluminum fluoride	June 9	June 9	June 9	None	
Calcium fluosilicate (Wiarda)	June 17	June 17	June 17	None	All larvae dead in 4 hours.

In a paper presented before the American Phytopathological Society December 31, 1925, Dr. H. W. Anderson, of Illinois, discussed "The Control of Bacterial Spot of Peach with Sodium Silicofluoride." Bacterial spot (*Bacterium pruni*), considered the most serious disease of the peach in Illinois, is not controlled by the ordinary fungicides. Dr. Anderson found that sodium silicofluoride in dilutions ranging from 1-4,000 to 1-4,500 would always render both sterile when inoculated with *Bacterium pruni*. Sodium silicofluoride was found only moderately fungicidal in inhibiting the germination of spores of *Flomerella cingulata* in dilutions of 1-800 when added directly to the spores in suspension. Field tests showed practically no infection of bacterial spot, whereas those trees not sprayed with sodium silicofluoride showed 20 to 80 per cent of leaves infected.

SPRAYING WITH FLUOSILICATES

Experiments with a solution of sodium fluosilicate were carried on in 1924 in the greenhouse. Some injury of the foliage occurred, probably to the humid conditions prevailing. In 1925, a $\frac{1}{2}$ per cent solution was used out-of-doors on beans, peaches, and apples, with no noticeable injury. This strength was sufficient to kill adults and larvae of the bean beetle within from 10 to 72 hours.

On July 28 a plot of beans was sprayed with sodium fluosilicate at the rate of 2 pounds to 50 gallons of water. A count July 31 revealed 100 per cent dead beetles in one row 45 feet long.

IS IT NECESSARY TO DUST THE UNDERSIDE OF LEAVES

Since the larvae of the bean beetle feed on the lower epidermis of the leaves, all of the recommendations to date have advised that the applications of dust or spray be made to the underside of the leaves. But the adult bean beetle is frequently found crawling over the tops of the leaves, and even though it feeds from the underside, the beetle bites through the leaf and actually swallows parts of the upper epidermis. With the fluosilicates, the irritation produced on the adults causes them to lick their feet and thus obtain a toxic dose. If control measures are directed against the adults, as has been advised with the fluosilicates, the dust should, theoretically, not have to be placed on the underside of the leaves. In all of the cage experiments the past summer, the dust was applied entirely to the top of the leaves, and a good kill was obtained, as shown in Table 1. The beetles were not abundant enough to test this point thoroughly in the field; yet there was some indication that control could be effected in this manner.

When it is considered that it takes approximately eight hours to dust an acre of beans on the underside of the leaves with a bellows duster and only about one hour to dust the top with a rotary hand-gun, the advantage of the latter method is obvious. Of course if the adults are not controlled, and a crop of larvae appear, it becomes necessary to dust or spray the underside of the leaves. A timely application of dust, however, to the top of the leaves may be easily made to kill the adults and prevent an infestation.

NATURAL CONTROL EFFECTED BY HEAT

Graf⁵ states that the Mexican bean beetle is believed to be a native of the plateau region of Southern Mexico. In that area it has been reported only from altitudes above 4,000 feet. Mexico City has an elevation of 7,350 feet, a mean summer temperature of 60°F to 65°F., and about

⁵Graf, J. E. Climate in Relation to Mexican Bean Beetle Distribution. Jour. Ent. Soc. Amer. 18: 116. 1925.

inches of rainfall during the summer months. These ranges are probably the optimum conditions for the beetle.

At Albuquerque, New Mexico, the mean summer temperature ranges from 70°F. to 76°F., and summer rainfall from $\frac{3}{4}$ inch to 1 $\frac{1}{2}$ inches. Until the introduction of the beetle into the Southeastern United States it was believed that the insect was confined to the Southwest because of the semi-arid conditions prevailing there. Chittenden⁶ states that "cold weather appears to be the most important natural check to the development of the bean ladybird in Colorado."

It was therefore of considerable interest to note the adaptability of the beetle to the comparatively humid conditions prevailing in the Southeastern United States. With normal temperatures and rainfall prevailing in the Southeast during 1920 and 1921, the beetle became extremely abundant around Birmingham. In 1922 Howard⁷ found the infestation much lighter, owing to the prolonged hot, dry period in 1921.

In the vicinity of Knoxville a dry spell occurred in August, 1924, and a decline in the abundance of the insect was observed. The average rainfall for August at Knoxville is 4 inches, with a temperature of 76°F., whereas only 1.77 inches fell, with a mean temperature of 78°F. In 1925, an unparalled drouth occurred in Knoxville and vicinity, so that the effects of hot, dry weather were strikingly apparent. The insect became much reduced in numbers, making it difficult to obtain specimens. It seems likely that the beetle is better adapted to the cool tablelands of Mexico than to our Southwest. Certain it is that the humid conditions prevailing in the Eastern United States are most favorable to this insect.

TABLE 5—*Temperature and rainfall at Knoxville*

Month	Temperature 1925	Normal average	Precipitation 1925	Normal average
	°F	°F	Inches	Inches
January	41.5	39.0	3.76	4.97
February	47.2	42.0	2.56	4.90
March	52.0	49.0	1.10	5.58
April	63.0	58.0	2.30	4.64
May	64.0	67.0	2.40	3.70
June	78.4	74.0	1.78	4.17
July	80.0	77.0	1.46	4.21
August	78.6	76.2	1.63	4.00
September	79.7	70.6	2.48	2.81
October	56.9	59.9	9.51	2.61

A glance at the record of temperature and rainfall shown in Table 5, reveals the very abnormal weather conditions that prevailed in 1925. The figures do not, however, give an adequate conception of the extreme drouth, because the little rain that fell came in small, scattered showers, with not a soaking rain during the spring or summer months. Maximum temperatures of 100°F. to 102°F. were reached several times in September, with bright sunshine and a singular absence of clouds. By late September there had accumulated an excess temperature of 664°F., since March 1, with a deficiency in rainfall of 16 inches.

⁶Chittenden, F. H. The Bean Ladybird. Bul. U. S. Dept. of Agr. 843. 1920.

⁷Howard, N. F. Studies of the Mexican Bean Beetle in the Southeast. Bul. U. S. Dept. of Agr. 1243, 1924.

On June 15, the temperature was 90°F. in the shade at 6 o'clock. Out in the open and only a few inches from the ground, the thermometer registered 120°F., while the surface of the ground showed 140°F. Since a temperature of 120°F. for several hours is known to be fatal to many insects, it is not surprising that the larvae of the beetle should have succumbed to the excessive heat. The first instar larvae are very susceptible to direct sunlight, as has been shown by Howard. He found that an exposure of two minutes to direct sunlight was fatal when the temperature was 96°F. in the shade.

The adults were present in fair numbers at Knoxville on July 1 and deposited large numbers of eggs. Nevertheless it was difficult to find any larvae, for they appeared to dry up as fast as the eggs hatched. Usually the beetle prefers garden beans to lima beans, but under dry, hot weather conditions, the beetle appeared to lay more eggs on lima beans due to their greater capacity for shading the ground.

As a result of the drouth, only a few beetles survived to go into hibernation, and much relief from their depredations is expected in the coming spring. Drouth rather than cold appears to be the limiting factor in the multiplication of the insect.

RECOMMENDATIONS FOR THE CONTROL OF THE MEXICAN BEAN BEETLE

Control is simplified by the use of fluosilicates, since the attack is made on the adult beetles. The bean patch should be examined frequently, and as soon as 5 beetles are found to each 50 feet of row should be dusted with one of the following mixtures:

Sodium fluosilicate (commercial) 1 part	}	Pounds per acre
Hydrated lime..... 2 parts		
Calcium fluosilicate compound		
Sodium fluosilicate (extra light)		

If the application is made before many eggs are laid, the dust may be applied to the top of the plants. If egg-laying is under way, or if larvae are present, it would be advisable to direct the dust to the underside of the leaves. Good results may be obtained with a rotary fan dustster by turning the nozzle sideways. A second and a third application, at intervals of a week, may be necessary if the beetles are abundant.

SUMMARY

1. In addition to the commercial sodium fluosilicate, a "light" and an "extra light" form are now obtainable in commercial quantities. The "extra light," containing about 70 per cent sodium fluosilicate, was effective against some insects and was found to be safe on foliage, except tobacco.

2. A by-product, "calcium fluosilicate compound," was marketed the past summer. This product is not readily soluble, is safe on foliage and effective as an insecticide when applied in heavy doses. It is not as toxic as sodium fluosilicate when used at the same rate.

3. The fluosilicates were found especially effective against the striped cucumber beetle, blister beetles, and several flea beetles. In laboratory tests cutworms and grasshoppers readily succumbed to a bait composed of 20 parts of bran and 1 part of fluosilicate.

4. Sodium fluosilicate gives promise of becoming a valuable material for the control of bacterial spot of peach (*Bacterium pruni*).
5. Fluosilicate dusts applied to the top of bean plants under cages were found effective against adult Mexican bean beetles.
6. The larvae of the Mexican bean beetle are very susceptible to extremes of heat and drouth.