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Supplementary Investigations on the Fluosilicates as Insecticides: With observations on the effect of heat and drouth on the Mexican Bean Beetle

University of Tennessee Agricultural Experiment Station

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AGRICULTURAL EXPERIMENT STATION
Knoxville

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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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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 experimen tests in the field. The fluosilicate content of this material is only abo 70 per cent, and the tests showed proportionately less toxicity. Wh mixed with lime it was decidedly inferior to the commercial materi For many insects, there appears to be sufficient toxicity when the "ext light" is used undiluted. For insects that feed sparingly, such as t boll weevil, the large amount of filler detracts seriously from the val of the material. It was also found to be considerably safer on folia As far as could be ascertained, no foliage injury resulted when th material was used undiluted on beans, cotton, or cucumbers. The on 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 matter of much importance, demanding a good deal of attention. F the best results, the insecticide should be bulky in proportion to weig so as to cover a large area; the particles should be small, yet dense enou to settle and not float away; and the adhering properties should be su as to prevent its being easily washed off by rain. If the dust can b given a positive charge of electricity the sticking qualities will be increas because leaf surfaces have a negative charge. The addition of a tr valent ion, such as iron, has been found to reverse the charge of calci arsenate from negative to positive.

An examination of the commercial fluosilicates revealed a wi 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 10
"Extra light" (Jungman)	5- 30	
Commercial (Virginia-Carolina)	7- 20	Mostly 1
Calcium fluosilicate (Victor)	4- 8	Mostly

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

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

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

CALCIUM FLUOSILICATE

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

"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 8 hrs.	24 hrs.	32 hrs.	48 hrs.	56 hrs.	72 hrs.	Total dead	Injury to bean oliage	Temperature Highest °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 t presence of phosphates. Their material is a by-product in the volatili tion method of treating phosphate rock for phosphoric acid. For i secticide purposes, this product was sold under the name of "Calci 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. was found very safe on foliage, producing no noticeable burning, even tobacco. Great improvement could be made in its adhering properti and we learned through correspondence that experiments have been co ducted to this end with encouraging results. We are also inform that the Victor Chemical Works have discovered a method of increasi the calcium fluosilicate content of their product which should materi enhance its toxicity.

A large number of cage experiments and a few field tests were ma to determine the toxicity of calcium fluosilicate compound toward inse According to Table 2, when this material was used at the rate of pounds to the acre, with high temperatures prevailing, the kill obtai against the bean beetle was excellent. When the dosage was cut do to 5 pounds per acre, the beetles were not noticeably affected, as sho in Table 3. In one field test the compound was applied once, May 26, the rate of about 35 pounds to the acre. There was a medium infes tion present, with 10 beetles to the row. On June 19, the infestation w 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 t cucumber beetle has heretofore been far from perfect. It is a ve difficult insect to poison, the arsenicals, as Howard[1] states, being "mo or less repellent." Recently nicotine dusts have been recommended, b these are expensive and must be applied several times for satisfacto control.

Since this beetle has the habit of cleaning its feet by drawing the through its mouth, it would be expected to yield to the fluosilicates, a such was found to be the case. On June 12 several rows of cucumbe were dusted lightly with sodium fluosilicate about seven o'clock in t morning. Eight hours later dead beetles were found under the plan and it was difficult to find a live specimen. The control obtained w practically 100 per cent. With the commercial sodium fluosilicate, folia injury appeared within 3 days. After a few weeks, however, t plants outgrew the injury. If the commercial material be used, it sho be diluted with 3 parts of lime. The "extra light" sodium fluosilic also gave satisfactory control, and no burning. Cage tests showed th heavy applications of calcium fluosilicate compound gave good contr especially when high temperature prevailed.

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

[1]Howard, 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 8 hrs.	24 hrs.	32 hrs.	48 hrs.	56 hrs.	72 hrs.	Total dead	Injury to bean foliage	Temperature Highest °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. Gentner[2] 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

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

Arkansas, Baerg[3] found that blister beetles, heretofore not successf controlled, are very susceptible to the fluosilicates. These beetles a especially injurious to soybeans, on which they are often found swarms. The sodium fluosilicate caused no appreciable injury to so bean foliage or alfalfa when diluted with an equal quantity of hydrat lime.

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

Ripley[4] found that they "never had a perfect cutworm bait in Sou Africa." He found that arsenite of soda and Paris green repel t larvae, but that a 2 per cent solution of sodium fluoride gives excelle results. Since sodium fluosilicate is more toxic than sodium fluoride, a appears to be readily eaten, the fluosilicates should prove satisfacto substitutes for arsenicals in poison baits.

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

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

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

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

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

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[3]Baerg, W. J. Control Measures for Blister Beetles. Bul. Ark. Agr. Exp. Sta. 20 1925.

[4]Ripley, L. B. Experiments with Cutworm Baits: Success with Sodium Fluori 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 Soci December 31, 1925, Dr. H. W. Anderson, of Illinois, discussed "The Co trol of Bacterial Spot of Peach with Sodium Silicofluoride." Bacterial s (*Bacterium pruni*), considered the most serious disease of the peach Illinois, is not controlled by the ordinary fungicides. Dr. Anders found that sodium silicofluoride in dilutions ranging from 1-4,000 1-4,500 would always render both sterile when inoculated with *Bacteri pruni*. Sodium silicofluoride was found only moderately fungici inhibiting the germination of spores of *Flomerella cingulata* in diluti of 1-800 when added directly to the spores in suspension. Field te showed practically no infection of bacterial spot, whereas those tr 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 in 1924 in the greenhouse. Some injury of the foliage occurred, d probably to the humid conditions prevailing. In 1925, a ½ per ce solution was used out-of-doors on beans, peaches, and apples, with noticeable injury. This strength was sufficient to kill adults and lar of the bean beetle within from 10 to 72 hours.

On July 28 a plot of beans was sprayed with sodium fluosilicate the rate of 2 pounds to 50 gallons of water. A count July 31 revealed 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 the leaves, all of the recommendations to date have advised that applications of dust or spray be made to the underside of the leav But the adult bean beetle is frequently found crawling over the tops the leaves, and even though it feeds from the underside, the bee bites through the leaf and actually swallows parts of the upper epiderm With the fluosilicates, the irritation produced on the adults causes th to lick their feet and thus obtain a toxic dose. If control measures a directed against the adults, as has been advised with the fluosilicate the dust should, theoretically, not have to be placed on the underside the leaves. In all of the cage experiments the past summer, the dust w applied entirely to the top of the leaves, and a good kill was obtained, shown in Table 1. The beetles were not abundant enough to test th point thoroughly in the field; yet there was some indication that contr could be effected in this manner.

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

NATURAL CONTROL EFFECTED BY HEAT

Graf[5] states that the Mexican bean beetle is believed to be a nati of the plateau region of Southern Mexico. In that area it has been r ported only from altitudes above 4,000 feet. Mexico City has an elevati of 7,350 feet, a mean summer temperature of 60°F to 65°F., and abou

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

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

At Alburquerque, New Mexico, the mean summer temperature ranges from 70°F. to 76°F., and summer rainfall from ¾ inch to 1½ 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. Chittenden[6] 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 Howard[7] 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.

[6]Chittenden, F. H. The Bean Ladybird. Bul. U. S. Dept. of Agr. 843. 1920.
[7]Howard, 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
o'clock. Out in the open and only a few inches from the ground, t
thermometer registered 120°F., while the surface of the ground show
140°F. Since a temperature of 120°F. for several hours is known to
fatal to many insects, it is not surprising that the larvae of the be
beetle should have succumbed to the excessive heat. The first ins
larvae are very susceptible to direct sunlight, as has been shown
Howard. He found that an exposure of two minutes to direct sunlig
was fatal when the temperature was 96°F. in the shade.

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

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

RECOMMENDATIONS FOR THE CONTROL OF THE MEXICA BEAN BEETLE

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

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

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

SUMMARY

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

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

3. The fluosilicates were found especially effective against t
striped cucumber beetle, blister beetles, and several flea beetles.
laboratory tests cutworms and grasshoppers readily succumbed to a b
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.