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Roscoe E. Hill
University of Nebraska-Lincoln

H. Douglas Tate
University of Nebraska-Lincoln

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Increases in Aphid Populations on Potato Plants Sprayed with Zinc Arsenite in Western Nebraska[1,2]

Roscoe E. Hill and H. Douglas Tate, *University of Nebraska, Lincoln*

During the 1941 growing season, field observations in western Nebraska indicated that aphids, *Myzus persicae* (Sulz.), were becoming abundant in experimental potato plots that had been treated with zinc arsenite-lime sulfur spray for controlling potato flea beetles, *Epitrix cucumeris* (Harr.), and the potato psyllid, *Paratrioza cockerelli* (Sulc.). Detailed examinations of leaves showed that significantly greater populations were present on the sprayed than on the untreated plants. Evidence of slight increases also was noted on plants dusted with a barium fluosilicate and sulfur mixture.

In western Nebraska zinc arsenite-lime sulfur sprays are widely used to combat potato insects. Since there is a large acreage of potatoes grown with a view to certification for seed purposes in this area, control measures that tend to increase aphids might have important economic implications because of their role in the dissemination of virus diseases. Consequently, in 1942 additional investigations were undertaken in an effort to determine more clearly the effects of different treatments on the aphid populations. It is the purpose of this paper to present briefly the results obtained regarding this phenomenon during 1941 and 1942.

Literature Review.—A number of workers have observed that the application of certain insecticides to plants results in an increased aphid population. Folsom published information in 1927 showing that populations of *Aphis gossypii* Glov. were much greater on cotton plants treated with calcium arsenate than on untreated plants. Additional evidence on this problem has been published by Gaines *et al.* (1940, 1941), Bibby (1942) and Smith & Fontenot (1942). McGarr (1941) and Gaines (1941) both report that cryolite-sulfur dusts increased the aphid population somewhat but considerably less than calcium arsenate. Moore (1937) found that *Brevicoryne brassicae* (L.) was more abundant on cabbage plants dusted with lead arsenate and lime than on untreated plants. Taylor & Blodgett (1930) and Nottingham & Rawlins (1941) reported marked increases in aphid populations following spraying of potato plants with bordeaux mixture. This phenomenon likewise has been observed by a number of other investigators, not only in connection with aphids but also in the case of certain other insects and mites.

Materials and Methods.—The insecticides used were zinc arsenite and barium fluosilicate (*Dutox*), both commercial products. According to the analysis on the container, the zinc arsenite used in 1941 contained 30.5 per cent metallic arsenic (equivalent to 40.3 As_2O_3) and had a water soluble arsenic content of 0.42 per cent. The 1942 sample showed the same analysis except that the water soluble arsenic content was guaranteed to be not more than 1 per cent. As shown on the label, the *Dutox*, here-in-after referred to as barium fluosilicate, contained 72 per cent barium fluosilicate and 8 per cent sodium fluoaluminate. Usually the zinc arsenite was applied at a concentration of 2 pounds to 40 gallons of spray to which 1 gallon of liquid lime sulfur was added. However in one instance a concentration of 1 to 40 was used, and in another wettable sulfur (1–10) was substituted for the lime sulfur; in 2 cases zinc arsenite was used without the addition of sulfur. Barium fluosilicate was used as a dust, prepared by adding 1 part of barium fluosilicate to 4 parts (by weight) of dusting sulfur and in experiments 6 and 7 (Table 2) a dilution of 1 to 8 was also tested. Since an analysis of the data showed that under the conditions of these tests the sulfur did not have a significant effect on the aphid population either alone or in combination with zinc arsenite or barium fluosilicate, further reference to this material is omitted from the discussion.

Sprays were applied at the rate of about 125 gallons per acre and dusts at approximately 35 pounds per acre. The treatments, which varied from 1 to 4, were made between July 6 and August 23. All spray applications were made with power

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equipment at approximately 300 pounds pressure. In experiments 1, 2 and 3 (Table 2) the dusts were applied with a rotary hand duster but in all others a 4-row power machine equipped with a short apron was employed.

Throughout the 1942 growing season aphid collections were made in four different experimental fields in order to determine the seasonal population trend. A 15-inch insect net was used at intervals of from 3 to 5 days and either 50 or 100 sweeps were taken in the center rows of each replicate.

Late in the season (during the second and third weeks in September) total aphid population counts were made on 25 to 50 leaves from each replicate of both treated and untreated plots in 8 different fields. Two leaves were selected from a plant, both from the lower level of growth, at about 15-foot intervals in the center rows. Both the plants and the leaves were selected at random, an objective which was facilitated by the abundance of foliage present at that time. The experiments (Table 2) may be briefly described as follows: No. 1, 6-row plots 200 feet long, 2 replicates; No. 2, 12-row plots 600 feet long, 2 replicates; No. 3, 4-row plots 250 feet long, 2 replicates; No. 4, 4-row plots 400 feet long, 2 replicates; No. 5, 4-row plots 400 feet long, 4 replicates; No. 6, 20-row plots 270 feet long, 2 replicates; No. 7, 20-row plots 250 feet long, 2 replicates; and No. 8, 12-row plots 350 feet long, 2 replicates. The first 3 experiments were conducted in 1941 and the last 5 in 1942. Additional details are given in table 2.

RESULTS.—In table 1 a summary of data obtained in a number of different irrigated potato fields shows the seasonal trend of aphid populations, as determined by sweeping with an insect net, on untreated plants, plants sprayed with zinc arsenite, and plants dusted with barium fluosilicate. Although a number of different species of aphids were collected, the principal one, and the only one that occurred in significant numbers at any time, was *Myzus persicae*. The aphid populations, in both the treated and untreated plots remained at a very low level, as shown in table 1, until the latter part of August. Following this there was a marked increase which continued until freezing temperatures occurred. The rate of increase was much greater on the plants treated with zinc arsenite, and in 1942 when the last sweepings were made on September 16 the population had increased to an average of 1290 per hundred sweeps, or approximately 40 times that in the checks. The data in table 1 indicate that barium fluosilicate had no appre-

Table 1.—Seasonal trend of aphid populations as shown by sweeping untreated potato plants and plants treated with either zinc arsenite[1] or barium fluosilicate[1] in irrigated fields at Scottsbluff, Nebraska, in 1942.

Collection Dates	Zinc Arsenite[2] Total No. sweeps	Zinc Arsenite[2] Ave. No. 100 sweeps	Untreated[2] Total No. sweeps	Untreated[2] Ave. No. 100 sweeps	Barium Fluosilicate[3] Total No. sweeps	Barium Fluosilicate[3] Av. No. 100 sweeps	Untreated[3] Total No. sweeps	Untreated[3] Av. No. 100 sweeps
July 17–21	450	0.2	150	0.0	100	0.0	50	0.0
23–27	550	0.5	250	1.2	300	0.0	150	0.0
28–29	700	1.0	350	0.3	600	1.8	300	0.3
31–Aug. 2	900	5.7	400	6.2	600	4.2	300	8.7
Aug. 3–7	1350	5.6	650	11.4	1100	4.0	550	10.0
9–12	750	0.4	400	0.0	700	0.1	350	0.0
13–15	700	0.1	350	0.3	600	1.0	300	0.7
17–18	700	1.4	350	3.7	600	0.5	300	2.0
20–23	750	8.7	400	1.5	700	1.0	350	0.6
26–Sept. 1	750	27.7	400	7.5	700	5.4	350	7.1
Sept. 2–8	700	76.1	350	9.7	600	8.2	300	9.0
10–16	700	1290.0	350	32.6	600	19.5	300	18.7

[1] Plants treated from 2 to 4 times between July 6 and August 23.
[2] Zinc arsenite data based on samples taken from 10 replications in 4 different fields; data on untreated plants based on samples taken from 5 replications in same fields.
[3] Barium fluosilicate dust data based on samples taken from 8 replications in 3 different fields; data on untreated plants based on samples taken from 4 replications in the same fields.

ciable effect on the aphid population.

Data on the results of a total aphid count on leaf samples from 8 separate field experiments are shown in table 2. Each treatment was compared with the accompanying check by means of the "t" test. On the basis of these comparisons all 12 treatments which involved two or more applications of zinc arsenite showed a highly significant aphid population increase. In one instance (experiment 4) there was no increase on plots receiving a single application of zinc arsenite; in another (experiment 5) one application resulted in a significant increase as compared to a highly significant increase in the same experiment where two and three applications were made.

Although barium fluosilicate resulted in highly significant population increases in two fields (experiments 2 and 6), the average population per leaf was only about a fourth to a half as great as for zinc arsenite in the same experiments. In one field (experiment 3) a significant increase occurred, but again the population was only about one-half as great as for zinc arsenite under the same conditions. In four other instances (experiments 1, 2, 6 and 7), significant increases did not occur on barium fluosilicate treated plots, whereas in the same experiments there were highly significant increases in plots treated with zinc arsenite.

DISCUSSION.—On the basis of the above data it may be concluded that, under the conditions of these experiments, highly significant aphid population increases occurred on plants treated with zinc arsenite spray, especially when two or more applications were made. Some increase seemed evident on plants treated with barium fluosilicate, but the increase was relatively minor when compared with zinc arsenite.

Although these increases might not be of any particular significance in fields grown for table stock, the very low tolerances for virus diseases in certified potatoes makes any increase in the number of vectors a matter of great importance. In some localities of western Nebraska, potato growers have encountered increasing difficulty during the last few years in producing certified seed because of the presence of mosaic. More recently, leaf roll has become of importance in certain localized areas. These observations indicate that the control of virus diseases transmitted by aphids may become more difficult due to the use of zinc arsenite for controlling flea beetles.

Control of the aphids by means of nico-

Table 2.—Aphid populations on leaf samples from untreated plots and plots treated with either zinc arsenite spray or barium fluosilicate dust in irrigated potato fields in western Nebraska—1941 and 1942.

TREATMENT[1]	NO. APPLICATIONS	AVERAGE APHIDS PER LEAF	"t" VALUES[2]
Experiment 1—(40 leaf samples)			
Untreated	—	6.15	—
Zinc arsenite	3	48.40	5.28**
Barium fluosilicate	3	6.05	0.01
Experiment 2—(40 leaf samples)			
Untreated	—	6.15	—
Zinc arsenite	3	55.20	7.64**
Zinc arsenite[3]	3	57.50	7.72**
Barium fluosilicate	3	13.40	4.42**
Barium fluosilicate[4]	3	9.17	1.92
Experiment 3—(30 leaf samples)			
Untreated	—	3.40	—
Zinc arsenite	3	11.00	4.90**
Barium fluosilicate	3	5.76	2.15*
Experiment 4—(50 leaf samples)			
Untreated	—	3.54	—
Zinc arsenite	1	4.44	1.35
Zinc arsenite[5]	3	24.06	4.36**
Experiment 5—(50 leaf samples)			
Untreated	—	2.97	—
Zinc arsenite	1	5.38	2.39*
Zinc arsenite[5]	2	11.82	6.60**
Zinc arsenite[5]	3	14.88	6.80**
Experiment 6—(50 leaf samples)			
Untreated	—	1.92	—
Zinc arsenite	4	8.26	5.03**
Barium fluosilicate	4	4.46	3.30**
Barium fluosilicate (1–8)	4	2.62	1.23
Experiment 7—(25 leaf samples)			
Untreated	—	5.68	—
Zinc arsenite	2	9.52	2.91**
Barium fluosilicate	2	4.40	1.12
Barium fluosilicate (1–8)	2	5.88	0.15
Experiment 8—(50 leaf samples)			
Untreated	—	5.7	—
Zinc arsenite[6]	4	74.0	6.26**
Zinc arsenite	4	102.7	4.84**
Zinc arsenite (1–40)	4	14.6	5.24**

[1] Unless otherwise specified, zinc arsenite applied as spray 2 pounds to 40 gallons of water plus 1 gallon liquid lime sulfur; barium fluosilicate (*Dutox*) used as dust 1 to 4 (by weight) of 300 mesh dusting sulfur.
[2] Treatments compared with check for "t" values.
[3] Three pounds wettable sulfur in place of lime sulfur.
[4] *Electric* dusting sulfur as carrier.
[5] No sulfur added.
[6] Zinc arsenite-lime sulfur plus 0.5 pound wheat flour
* Significant difference (P = 0.05).
** Highly significant difference (P = 0.01).

tine, rotenone or other aphicides presents some complications in view of the fact that the population build-up occurs later in the season (after regular spraying operations have been completed) and when spraying or dusting machinery would cause serious damage to the plants. In field tests conducted during the last 3 years in western Nebraska (unpublished data) barium fluosilicate dust was as effective as zinc arsenite spray in controlling the potato flea beetle. These results combined with the fact that relatively minor aphid population increases occurred on plants treated with barium fluosilicate indicate that substituting this material for zinc arsenite might contribute toward a solution of the problem.

SUMMARY.—Significant increases in aphid populations were found in experimental fields as well as in commercial plantings where zinc arsenite was used for control of the potato flea beetle, especially when two or more applications were made.

Although population increases sometimes occurred following the use of barium fluosilicate dust, these increases were slight as compared to zinc arsenite. In a majority of the tests no significant increases were found where barium fluosilicate was used.

Aphid collections on late plantings, which comprise the principal crop in western Nebraska, showed that populations remained at a low level on both treated and untreated plants until late August or early September.

The direct control of aphids with insecticides in this area would be complicated by the fact that the population increases occur late in the season when the use of machinery would cause serious damage to the vines. The use of barium fluosilicate dust, which is as effective as zinc arsenite for the control of flea beetles, may offer one solution of the problem.—1-11-43.

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