Preparation and Stability of Aldrin-Fertilizer Mixtures

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Uniform aldrin-fertilizer mixtures can be prepared by mixing the cured fertilizers with dry formulations of aldrin, or by impregnating them with aldrin solutions. The phenyl azide colorimetric method for the determination of aldrin is suitable for use on such mixtures. The amount of aldrin found by analysis is equal to the amount applied, if the mixture is properly prepared and carefully sampled. For pelletized fertilizers, impregnation with a 40% aldrin solution (containing 4 pounds of aldrin per gallon) is the preferred technique. Uniform mixtures can be produced using 20% aldrin granules, but some stratification of the aldrin granules may occur if the fertilizer is relatively free of "fines." Aldrin granules are a convenient form for addition to nonpelletized fertilizers, and they do not create a dust hazard. Satisfactory mixtures can also be prepared using aldrin wettable powders or dust concentrates, or by impregnation. Mixtures with lawn-type fertilizer, containing organic nutrients, are prepared as with other nonpelletized fertilizers. The addition of aldrin formulations to fertilizers does not promote caking of the fertilizer, even after extended storage under compaction. Aldrin is not chemically destroyed by fertilizers, even at extreme temperatures. During long-term storage, 5 to 15% of the aldrin content of a mixture may escape by volatilization in a year, regardless of the type of aldrin formulation in the mixture. Storage of mixtures for as long as a year should be avoided. From a practical standpoint, a loss of the observed magnitude is of minor importance, and would have but little effect on the biological effectiveness of the product.

THE ECONOMICAL CONTROL OF INSECT PESTS in the soil has become practical only since the advent of the new synthetic organic insecticides. Soil treatment with insecticides is now common practice. A popular method of application is in the form of insecticide-fertilizer mixtures, which are supplied ready-mixed by fertilizer manufacturers. The methods of preparation and characteristics of insecticide-fertilizer mixtures have been described (*4*). A rapid growth in the use of such mixtures has taken place, brought about primarily by a grower demand. It is estimated (*2*) that the amount of insecticide-fertilizer mixtures used in the ten midwest corn-growing states was about 10,000 tons in 1953, increasing to at least 75,000 tons in 1954. Jacob (*5*) has stated that the chief pesticidal constituent of the mixtures in the north central states is aldrin (1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4-endo, exo-5,8-dimethanonaphthalene), and that the consumption of aldrin in combination with fertilizer probably will increase at a faster rate than that of other pesticides used in this way. As aldrin in this form has been recommended by many state agencies for the control of a wide variety of insects, data on the preparation and stability of aldrin-fertilizer mixtures are of interest.

Aldrin - fertilizer mixtures normally consist of regular commercial grades of inorganic mixed fertilizers to which small amounts of aldrin formulations have been added. The aldrin content varies from 0.2 to 1.5 weight %, but concentrations of 0.5 to 1.0 weight % are most common. Both pelletized and the conventional nonpelletized fertilizers are used in the mixtures. The term "pelletized" is used to describe fertilizers made by special "pelletizing" or "granulation" processes. The term "nonpelletized" is used in this paper in referring to the conventional type of pulverized fertilizers made by processes other than pelletizing or granulation.

Preparation

Mixtures prepared in the laboratory were of several different types, representing the types of mixtures used commercially plus a few experimental blends. The following ingredients were used:

Fertilizer Grades (N-P_2O_5-K_2O)

Pelletized	Non-pelletized	Lawn Type (partially organic)
3–12–12	6–30–0	6–10–4
5–20–20	10–12–8	7–11–5
10–10–10	10–16–8	
10–20–0	10–20–0	
	12–24–0	

Aldrin Formulations

Solids	Liquids
20% wettable powder	40% Solution
20% wettable powder containing 5 wt. % oil	60% Solution
20% dust concentrate	
20% dust concentrate containing 5 wt. % oil	
20% granules, 30–60 mesh	
20% granules, 30–40 mesh	
20% granules, 15–30 mesh	

The fertilizers were of several different brands, most of which were manufactured in the midwest states; the manufacturing formulas for these were not available. Of the aldrin formulations, the wettable powders and dust concentrates contained attapulgite clay as the inert carrier. Five per cent of an oil, such as kerosine or Diesel oil, was added to some of these preparations to reduce dustiness. The granules were prepared by impregnation of sized attapulgite granules (Attaclay granules, Grade AA-RVM, a product of Attapulgus Division, Minerals & Chemicals Corp. of America) with a 60 weight % aldrin solution. The liquid aldrin formulations used for fertilizer impregnation included 60% aldrin solution (a commercial grade of the insecticide) and a 40% solution prepared by diluting the 60% product with an aromatic hydrocarbon solvent. The 40% solution contained approximately 4 pounds of aldrin per gallon.

The laboratory-prepared blends of aldrin-fertilizer contained approximately 1 weight % aldrin. The dry blends were prepared in a rotating drum-type mixer with internal fins, with a mixing time of 30 minutes. A normal batch size was 50 pounds. The samples made by liquid impregnation were prepared in a small ribbon blender, with a blending time of 30 minutes. The batch size was normally 80 pounds.

The nonpelletized fertilizers and the lawn fertilizers blended readily with any of the aldrin formulations to give good mixtures. The use of 5 weight % oil in the wettable powder or dust concentrate reduced the dustiness of the mixing operation markedly. The wettable powder did not appear to be superior to the cheaper dust concentrate for mixing with fertilizers. The 20% aldrin granules formed excellent mixtures and did not give rise to dust.

The pelletized fertilizers did not form uniform mixtures with the powdered aldrin preparations, because of the wide divergence in particle size. However, the aldrin granules mixed readily with the fertilizer pellets, and impregnation also was satisfactory. In the impregnation process, a fine spray was required to give good distribution of the solution throughout the fertilizer. A 40% aldrin solution, or a solution containing 4 pounds of aldrin per gallon, was easier to apply than a 60% solution, as the latter tended to crystallize during storage and required warming to dissolve the crystals before it was used.

Table II. Effect of Particle Size on Stratification of Aldrin-Fertilizer Mixtures[a] during Transportation

Pelletized Fertilizer				
Analysis	*Portion finer than 20 mesh, wt. %*	*20% Aldrin Granules, Mesh Size*	*Final Aldrin Content, Wt. %*	
			Top	*Bottom*
10–20–0	31	30–40	0.82	0.94
10–20–0	31	15–30	0.85	0.90
3–12–12	10	30–40	0.60	1.24
3–12–12	10	15–30	0.76	0.99

[a] Each mixture contained sufficient aldrin granules to give original aldrin content of 0.9 wt. %.

Uniformity

Because of the low concentrations of aldrin used in fertilizers, it is important that the insecticide be distributed uniformly throughout the mix in order for the farmer to get consistent insect control. However, prolonged mixing does not always produce a uniform mixture, particularly where the various components differ considerably in particle size. The best method of establishing the homogeneity of the mixtures following blending would involve the analysis of many samples taken at random. Where such data are unavailable, an indication of uniformity can be obtained by analysis of a series of samples taken from different mixtures. If the aldrin found by analysis is consistently equal to the amount of aldrin applied, it can be assumed that uniform mixtures have been obtained.

Twelve laboratory-prepared aldrin-fertilizer mixtures were analyzed for aldrin content. These included samples containing pelletized, nonpelletized, and lawn-type fertilizers to which had been added 1.03 weight % aldrin in the form of wettable powders, dust concentrates, granules, and solutions. The mixtures were sampled by taking a 10-pound portion and, by successive quartering, reducing it to approximately 1 pound. The 1-pound sample was ground in a laboratory sample mill, after which it was thoroughly blended. A 15-gram portion of the ground sample was extracted with hexane, or a 95 to 5 mixture of hexane and acetone. The aldrin solution thus obtained was diluted quantitatively with hexane and analyzed by a modification of the phenyl azide colorimetric method of Danish and Lidov (1, 6, 7), which is specific for aldrin. The repeatability of the method, exclusive of the sampling and extraction steps, is within ±3%. The results of the analyses are shown in Table I. The analytical values varied from 0.96 to 1.06 weight %, with a mean value of 1.03% for the 12 samples. The mean deviation from the theoretical value was 2.4%. The data indicate that uniform mixtures of fertilizers with the various types of aldrin formulations can be prepared by thorough mixing, and that the phenyl azide method for aldrin is applicable to mixtures of these types. Careful sampling is important, and the sample must always be large enough to contain a representative mixture of fine and coarse material.

No attempts were made in the laboratory to establish the conditions or mixing times necessary to produce uniform mixtures. The batch sizes were necessarily small and the mixing times were intentionally excessive. The proper operating conditions for full scale equipment must be determined in the fertilizer plants for each different type of equipment. Only a limited amount of data from experimental trials in plants is available. In one series of tests, aldrin was added to 0–11–22 fertilizer in the form of a 20% aldrin dust concentrate. The operation was batchwise, using a rotary fertilizer mixer, with a mixing time of 5 minutes. The product was uniform, as determined by analysis of grab samples. The mixture contained the calculated amount of insecticide, provided the aldrin dust concentrate was added to the screen above the mixer. When the aldrin was added to the fertilizer in the elevator boot, a portion of the insecticide was lost, and presumably was held up in the elevator. In a second series of plant experiments, aldrin was added to pelletized fertilizer by impregnation with 40% aldrin solution. The solution was sprayed into the cooling tube at a point 8 feet from the exit. The product was very uniform in aldrin content. However, impregnation in the cooling tube may not be satisfactory if the fines are to be screened from the product before bagging. This technique is not recommended if the

Table I. Aldrin Content of Aldrin-Fertilizer Mixtures as Determined by Phenyl Azide Colorimetric Method

(Aldrin applied 1.03 wt. %)

Type of Fertilizer	*Source of Aldrin*	*Aldrin Found, Wt. %*	*Deviation from Theoretical, %*
Nonpelletized	20% wettable powder + 5% oil	1.06	(+) 2.9
	20% wettable powder + 5% oil	1.05	(+) 1.9
	20% wettable powder + 5% oil	1.06	(+) 2.9
	20% dust concentrate	0.96	(−) 6.8
	20% granules, 30–60 mesh	1.03	0.0
	60% solution	1.06	(+) 2.9
	60% solution	1.04	(+) 1.0
Pelletized	60% solution	1.00	(−) 2.9
Lawn type	20% dust concentrate + 5% oil	1.01	(−) 1.9
	20% dust concentrate + 5% oil	1.03	0.0
	60% solution	1.04	(+) 1.0
	60% solution	0.98	(−) 4.9

Aldrin found, mean value for 12 samples = 1.03 wt. %.
Deviation from theoretical, mean value for 12 samples = 2.4%.

temperature of the fertilizer is higher than 110° F., as higher temperatures are likely to cause a loss of aldrin through volatilization, particularly if the product is stored in a bin, where the rate of cooling may be slow. Batchwise impregnation in rotary mixers, or continuous impregnation on a moving belt, has been used successfully by various plants. No data are available with respect to product uniformity, but these techniques should give uniform mixtures if properly applied.

Stratification

Once a uniform mixture has been prepared, it should remain in this condition and resist stratification during handling. Stratification does not appear to be a serious problem in most fertilizers, which contain a high proportion of fine material, and have very little free space within the mass. In such a case, aldrin granules would stay uniformly distributed throughout the fertilizer, and even a fine aldrin dust would not be expected to separate during normal handling. However, a well-made pelletized fertilizer contains very little fine material, and has considerable free space between particles. Some pelletized fertilizers are screened to remove all particles finer than 20-mesh. A powdered aldrin formulation would be unsuitable for addition to such a fertilizer. The ideal method of adding the aldrin is by liquid impregnation, as the insecticide solution is then applied directly to the fertilizer particles, and there is no possibility of segregation. Aldrin granules would appear to occupy an intermediate position with respect to tendency to stratify, and tests were made to evaluate this characteristic.

Among the five samples of pelletized fertilizer examined in the laboratory, the content of "fines" (smaller than 20-mesh) varied from 10 to 31 weight %. Mixtures containing 0.9 weight % aldrin were prepared, using a fertilizer having 10 weight % fines and one having 31 weight % fines. The aldrin was added in the form of 20% aldrin granules, both 30- to 40-mesh and 15- to 30-mesh. Twenty-pound samples of each mixture were placed in multiwall paper bags, which they filled to a depth of about 8 inches. The bags were placed on a truck, in an upright position, and were transported for 4 days. At the end of this time the contents of each bag were divided into two equal parts, an upper portion and a lower portion, and each portion was ground, mixed, and analyzed for aldrin content. The results are shown in Table II. The 15- to 30-mesh granules stratified to a lesser degree than did the 30- to 40-mesh, and the stratification of granules of both sizes was inversely correlated with the amount of fines in the fertilizer. The stratification of granules of both sizes was minor in the fertilizer containing 31 weight % fines. In the fertilizer containing only 10 weight % fines, there was a definite stratification of the 30- to 40-mesh granules. Although 30- to 60-mesh granules, which are popular for addition to nonpelletized fertilizers, were not tested in this series, they would be expected to stratify at least as much as the 30- to 40-mesh size. The data indicate that there is a definite danger of stratification of aldrin granules from pelletized fertilizers, and that this danger can be greatly reduced by the use of the larger (15- to 30-mesh) granules. However, field test data on insect control with the larger granules are not yet available, and for that reason some state agencies do not recommend their use. The logical solution to the problem at this time appears to be the use of the liquid impregnation technique for the addition of aldrin to pelletized fertilizers.

Table III. Resistance of Aldrin to Dehydrochlorination by Fertilizers

(Test temperature 120° C. Duration of test 2 hours)

Test No.	1	2	3
Components, grams			
Technical aldrin (89%)	2	2	2
10-16-8	2	. .	. .
5-20-20[a]	. .	2	. .
Triple superphosphate	. .	. .	2
HCl evolved, mole/mole aldrin	0.00	0.00	0.00

[a] Pelletized.

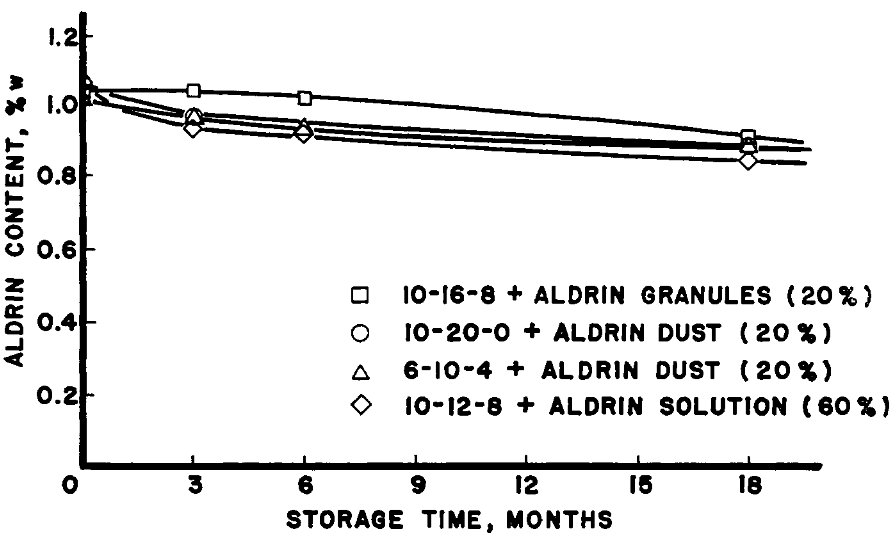
Table IV. Compatibility of Aldrin with Fertilizers at 90° C.

(All samples prepared by impregnation of fertilizer with 40 wt. % solution of aldrin in hydrocarbon solvent)

	Aldrin by Analysis, Wt. %	
Fertilizer	*Initially*	*After 48 hr. at 90° C*
10-10-10	0.92	0.91
5-20-20[a]	0.92	0.85
Hydrated lime	0.93	0.86
Superphosphate	1.02	0.80

[a] Pelletized.

Figure 1. Aldrin content of fertilizer mixes stored in paper bags



Caking

Twelve representative samples were tested to determine whether the addition of aldrin formulations to fertilizers would cause lumping or caking in storage. Twelve pounds of each mixture were placed in a small three-ply paper bag, and stored at room temperature for 8 months under a pressure of approximately 250 pounds per square foot. At the end of this time examination of the samples showed no caking in the samples to which aldrin had been added, regardless of whether the insecticide had been added as a solid formulation or by impregnation. In some cases the control sample, containing no aldrin, appeared to cake slightly under the test conditions.

Compatibility

It is essential that an insecticide be compatible with the fertilizers with which it is mixed. Incompatibility would lead to decomposition of the insecticide, and result in serious losses to either the fertilizer manufacturer or the farmer. The literature contains little information on the compatibility of insecticides with fertilizers. Fleck and Haller (*3*) reported that DDT is not catalytically dehydrohalogenated when heated with a variety of mixed fertilizers and fertilizer components. Of the many types of fertilizers tested, only dolomitic limestone caused decomposition of DDT. Using the technique of Fleck and Haller, the authors tested two mixed fertilizers and triple superphosphate as catalysts for the dehydrochlorination of technical

Table V. Effect of Long-Term Storage on Aldrin Content of Fertilizer Mixes Prepared by Dry Blending of Ingredients

(Samples stored at ambient laboratory temperatures in three-ply paper bags)

Fertilizer	Source of Aldrin	Aldrin Content, Wt. % Initially	After 18 months
12–24–0	20% powder, wettable	0.94	0.88
10–12–8	20% dust	1.07	0.79
10–20–0	20% dust	1.06	0.88
6–30–0	20% dust	1.05	0.92
6–10–4[a]	20% dust	1.01	0.88
7–11–5[a]	20% dust	0.98	0.84
10–16–8	20% granules	1.03	0.91

[a] Lawn fertilizer.

aldrin. The aldrin was heated with the fertilizers for 2 hours at 120° C. No hydrogen chloride was evolved, as shown by the data in Table III.

A more rigorous test for compatibility consists of storing a complete aldrin-fertilizer mixture at elevated temperatures, after which aldrin is determined. Two mixed fertilizers, hydrated lime and superphosphate, were impregnated with a 40 weight % aldrin solution, to give mixtures containing approximately 0.9 weight % aldrin. Portions of these mixtures were placed in test tubes which were kept in an oil bath at 90° C. for 48 hours. The test tubes were stoppered after the contents reached equilibrium temperature. The test temperature of 90° C. was approximately 35° above the normal melting point of technical aldrin, and any chemical incompatibility which would cause decomposition of the aldrin within a few months under normal storage conditions should cause complete destruction of the insecticide within 48 hours at 90° C. At the end of the 48-hour period, the samples were analyzed, with the results shown in Table IV. Losses of aldrin from the mixtures under these drastic conditions averaged about 10%, and in all cases were less than 25%, indicating that no rapid decomposition of aldrin would be expected at normal temperatures.

Stability in Storage

Accelerated tests at high temperatures merely give indications as to whether the ingredients of mixtures will be compatible during storage. The behavior of mixtures during storage can best be determined by actual long-term tests. A number of aldrin-fertilizer mixtures prepared in the laboratory were placed in storage to evaluate the stability of the aldrin. The mixtures all contained about 1 weight % aldrin, added in the form of a wettable powder, dust concentrate, granules, or 60% aldrin solution. Each mixture was analyzed for aldrin content, and a 10-pound portion was put in a small three-ply paper shipping bag, which was closed with tape and stored in the laboratory at ambient temperatures, which averaged about 25° C. Some of the samples were reanalyzed after 3 and 6 months, and all were reanalyzed after 18 months. The analysis showed that there was a slow decrease in aldrin content during the 18 months. In Figure 1 the change in aldrin content during storage is plotted for four representative mixtures. The total loss of aldrin was small and the rate was slow and fairly uniform.

Table VI. Effect of Long-Term Storage on Aldrin Content of Fertilizer Mixes Prepared by Impregnation with 60% Aldrin Solution

(Samples stored at ambient laboratory temperatures in three-ply paper bags)

Fertilizer	Aldrin Content, Wt. % Initially	After 18 months
10–12–8	1.06	0.84
12–24–0	1.04	0.75
3–12–12[a]	1.00	0.79
6–10–4[b]	1.04	0.81
7–11–5[b]	1.03	0.84

[a] Pelletized.
[b] Lawn fertilizer.

The analyses of mixtures prepared by dry blending are shown in Table V. The mixtures, containing five different agricultural grades and two lawn-type fertilizers, all showed at least a small loss of aldrin. In general, the aldrin content dropped from the 1 weight % level to about 0.8 or 0.9 weight %. The average loss represented a decrease from 1.02 weight % aldrin to 0.87 weight % for the 18 months' storage, which corresponds to a little less than 10% loss for one year.

Table VI shows the analyses, initially and after 18 months, of fertilizers impregnated with 60% aldrin solution. The aldrin content of these mixtures also decreased, dropping from an average original analysis of 1.03 weight % aldrin to an average final analysis of 0.81 weight %. Calculated for 12 months, the loss represents about 15% of the total aldrin.

In addition to the storage tests of samples in paper bags, tests were made with small samples stored in wide-mouthed glass jars. One-pound samples of three different mixtures were stored at ambient laboratory temperatures (approximately 25° C.) and at 43° C. The jars had ordinary screw caps with waxed cardboard liners, and were opened occasionally for inspection and sampling. Sampling involved removal of the contents, and quartering. Table VII shows the results of aldrin analysis after 18 months, compared with the original analyses. Although there was a slight decrease in aldrin content, the loss was only about half that observed in Tables V and VI for the same mixtures stored in paper bags. The decrease in aldrin content during 18 months was 11, 21, and 7% for the three samples, which corresponds to an average loss of 9% for one year. It is noteworthy that samples stored at 25° and at 43° C. contained the same amount of aldrin after 18 months. This indicates that aldrin was not lost as a result of chemical action, as the higher temperature did not accelerate the loss. It is logical to assume that the observed decrease in aldrin content was the result of a physical phenomenon with a relatively low temperature gradient, probably volatilization of the insecticide. A loss of vapors undoubtedly occurred each time the jars were opened and the contents removed for quartering. Also, it is not improbable that aldrin vapors were absorbed by the cardboard cap liner. The theory that vaporization was chiefly responsible for the decrease in aldrin content is supported by the fact that losses from mixtures stored in paper bags were considerably higher than those from the same mixtures stored in glass containers.

Table VII. Aldrin Content of Fertilizer Mixes before and after Storage in Closed Glass Jars

Fertilizer	Source of Aldrin	Aldrin Content, Wt. % Initially	After 18 months at 25° C.	After 18 months at 43° C.
10–12–8	60% aldrin solution	1.06	0.93	0.94
10–12–8	20% dust	1.07	0.85	0.85
6–10–4[a]	20% dust	1.01	0.93	0.94

[a] Lawn fertilizer.

Literature Cited

(1) Danish, A. A., and Lidov, R. E., *Anal. Chem.*, **22,** 702 (1950).
(2) *Farm Chemicals,* **117,** No. 9, 26 (1954).
(3) Fleck, E. E., and Haller, H. L., *Ind. Eng. Chem.*, **37,** 403 (1945).
(4) Folckemer, F. B., and Loeffler, E. S., *Agr. Chemicals,* **9,** No. 2, 42 (1954).
(5) Jacob, K. D., J. AGR. FOOD CHEM., **2,** 970 (1954).
(6) O'Donnel, A. E., Neal, M. M., Weiss, F. T., Bann, J. M., De Cino, T. J., and Lau, S. C., *Ibid.*, **2,** 573 (1954).
(7) Shell Chem. Corp., Agl. Chem. Div., New York, N. Y., "Shell Method Series," Methods 523 and 572.

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ANTIBIOTICS IN PLANT DISEASE

Comparative Studies on Control of Fireblight in Apple and Pear

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This work was undertaken in an attempt to provide an effective control for fireblight, a very damaging disease of pome fruits. The fact that the antibiotics used in medicine were largely effective against bacterial organisms led to their use for the control of fireblight, which is also caused by a bacterium. Laboratory tests showed that streptomycin and Terramycin were most effective in inhibiting the growth of the fireblight bacterium in vitro. Greenhouse studies indicated that foliage sprays of either material would largely prevent fireblight infection when young apple trees were inoculated by needle puncture with *Erwinia amylovora* 24 hours later. Extensive orchard experiments in 1953 and 1954 proved that fireblight of apple and pear can be effectively controlled by spraying during bloom with 50 to 100 p.p.m. of streptomycin. The development of an effective control for fireblight will greatly reduce the damage to apples and pears caused by this disease, and should allow the reestablishment of a profitable pear industry in the eastern United States.

LABORATORY SCREENING TESTS at the Ohio Agricultural Experiment Station during the winter and spring of 1952 indicated that certain antibiotic preparations developed for use in medicine were inhibitory to the fireblight pathogen, *Erwinia amylovora.* A serial dilution technique was used employing nutrient broth as the culture medium. Thiolutin, polymyxin, streptomycin, Chloromycetin, Terramycin, and several different types of penicillin were tried. Of those tested, Terramycin and streptomycin were inhibitory in the greatest degree.

Streptomycin, Terramycin, thiolutin, and polymyxin were next applied in several ways to young Jonathan trees in the greenhouse. Potted trees were watered with solutions of these antibiotics for 2 weeks and then inoculated with *Erwinia amylovora.* Other trees were treated by trunk injection; some were sprayed with antibiotic solutions.

As might have been expected, the antibiotics applied to the soil were either quickly inactivated or failed to be translocated to the susceptible tree parts in sufficient quantity to prevent infection. Results were erratic when tree trunks were injected with solutions of the antibiotics; some of the twigs inoculated on these trees became infected, while others remained healthy. The distribution of the antibiotics in the trees appeared to be very unequal. In addition, trees which were injected with solutions of 50 p.p.m. or more of any of the antibiotics used were severely injured.

When young, rapidly growing Jonathan apple trees in the greenhouse were sprayed with solutions of streptomycin sulfate or Terramycin hydrochloride and inoculated with *Erwinia amylovora* by needle puncture 24 hours later, fireblight infection was largely prevented. A foliage spray application of 100 p.p.m. of Terramycin or streptomycin gave 100% protection, when the sprayed and inoculated twigs were enclosed in a cellophane wrap; uncovered, 200 p.p.m. was required. It is probable that the moist condition of the sprayed foliage enclosed in the cellophane wrap facilitated the absorption of the antibiotic solutions. Since the inoculation was performed by needle puncture to the interior of succulent twigs, it was believed that considerable absorption or penetration of the antibiotics had taken place.

Chas. Pfizer & Co. furnished sufficient commercial grade streptomycin sulfate and crude Terramycin in the spring of 1953 to carry out an orchard experiment on bearing Jonathan apple trees. Three spray applications—early bloom, full bloom, and petal fall—of commercial grade streptomycin sulfate and crude Terramycin were made at dosages to give 60 and 120 p.p.m. of antibiotic activity. The crude Terramycin was first dissolved in methanol, as it was only slightly soluble in water. For comparison purposes, two "in bloom" spray applications of Dithane Z-78 at 2 pounds per 100 gallons of water were made to other trees in the block. Triton B-1956 at 2 ounces per 100 gallons of spray was added in all treatments to ensure adequate wetting and penetration of the sprays into the blossoms. To ensure the presence of adequate disease, all trees were inoculated by spraying them in full bloom with a suspension of *Erwinia amylovora* and pyrophyllite, according to the method suggested by Dunegan and others (*7*) for inoculating pear seedlings. All treatments were made to single trees replicated three times and randomized. Seventeen days after inoculation, abundant blossom cluster and twig blight was evident on the control trees and blight counts were made. The results are given in Table I.