A Preliminary Report on the Control of Sugar-Beet Nematode with Two Chemicals, D-D and Dowfume W15

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Soil fumigation for the control of nematodes and other soil inhabiting pests was impractical on a field scale until the recent discoveries of D-D and Dowfume W15. Previously the chemicals known as efficacious nematocides were too expensive for use except in greenhouses and on limited areas producing high-priced specialty crops.

D-D, a mixture of 1.2-dichloropropane[2] and l,3-diehloropropene[2,3] (Syn: 1,3-dichloropropylene), is produced by the Shell Chemical Corporation and was first reported as a successful nematocide by Carter in 1943 (/)[4]. The possibilities of D-D as a soil fumigant appeared to be so outstanding that in 1943 and 1944 tests were conducted by many federal, state, and private agencies, and a large proportion of these gave successful control of nematodes and certain other soil-inhabiting pests- In 1945, extensive experimental work was carried on at many points and in addition large commercial applications were made, principally in California and Hawaii, with small acreages in Utah, Idaho, Texas, and Oregon and on Long Island, N. Y.

Dowfume W15 consist of a 15-percent solution of 1,2-dibromoethane[3] (Syn: ethylene dibromide) in a low grade gasoline and is marketed by The Dow Chemical Company. It was first tested on a few small plots near Seal Beach, Calif., in 1944, and its nematocidal properties proved to be so promising that in the spring of 1945 several large demonstration plots were treated, most of them generally successful.

The sugar beet nematode presents one of the most difficult problems in soil fumigation because of the brown cyst stage in which the eggs are very effectively protected. Data on the killing range of chemicals indicate that for this species it is less than half that for most other plant parasitic species and therefore heavier applications will probably be required to obtain successful control. Results to date show that one good crop of beets can be produced even on the most heavily infested soils if properly treated, but it still remains

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very doubtful if a second crop can be grown without additional treatment.

The work here reported was conducted by the senior writer near Midvale, Utah, in 1944 and 1945, and by both writers at Dewiston, Utah, in 1945.

Field No. 1, 1944.

This field was laid out in 32 plots, each 20 feet long and 4 rows wide. D-D was applied on alternating plots at four rates per acre: 2,000 pounds (10 cc injections, 9 inches by 9 inches apart, in staggered rows) ; 1,000 pounds (5 cc, 9 inches by 9 inches) ; 500 pounds (10 cc, 18 inches by 18 inches) ; and 250 pounds (5 cc, 18 inches by 18 inches). Applications were made by measuring exact amounts from a graduate and pouring them into holes 6 inches deep made with a 1/2inch probe. Applications were made May 6 when the soil moisture was 14 percent and temperature 58° F.

The two heavier applications caused a delay in germination of 1 week with subsequent severe injury of seedlings. Slight retardation was also noted on the 500-pound plots.

Distinct stimulation of growth was noted early in July on the 250-pound plots and to a lesser degree on the 500-pound. Fortunately the autumn was late and digging was delayed until November 9. This partly made up for the late date of planting and gave excellent yields as is shown in the following table.

Amount of D-D per acre	Yield of sugar beets per acre: Treated plots	Untreated plots	Gain **or loss**
2,000 pounds	8.29 tons	10.7,3 tons	- 2.44
1,000 pounds	14.14 tons	12.51 tons	4- 1.53
500 pounds	20.15 tons	12.35 tons	+ **7.70**
250 pounds	27.30 tons	11.70 tons	+15.60

The abnormally high yield of 27.30 tons on the 250-pound plots was most unexpected and was probably due to two factors which produce the so-called "stimulation" by D-D:

1. Control of other species of nematodes, e. g. *Pratylenchus* sp., and perhaps other soil organisms which are not generally recognized as being inimical to plant growth.

2. Destruction of nitrifying bacteria, thus releasing ammonia, produced by decaying organic matter, for immediate use of the plants, as demonstrated in Hawaii by Tarn *(2).*

The moderately good yields of the untreated plots were due to

the fact that in 1943 beets were grown on the field and in this particular area the nematodes practically killed out the crop, thereby giving something of a "trap crop" effect and allowing fertility to accumulate.

Had application been made in the fall, comparable yields would doubtless have been produced on the 2,000-pound and 1,000-pound plots, for then the D-D would have evaporated from the soil before planting. As it was, a strong odor remained in the plots through August and the sugar beets had branching roots which spread out near the surface to escape the pool of gas lying below.

Field No. 2, 1945

This field was known to be heavily infested with sugar beet nematodes but had produced an 18-ton crop of beets in 1944 following a 5-year rotation of alfalfa and grain. Strip plantings were made in 1945 and will be repeated in 1946 to determine the possibilities of growing a second crop after one treatment. Applications were made April 28 with soil moisture of 13 percent and temperature 44° P. at 6-inch depth. Yields are shown as follows:

Amount of chemical per acre	Yield of sugar beets per acre		
D-D	Treated plots	Untreated plots	Gain
500 pounds	14.10 tons	2.86 tons	+11.24 tons
500 pounds	15.92 tons	4.92 tons	+11.00 tons
250 pounds	17.74 tons	3.71 tons	+14.03 tons
250 pounds	18.00 tons	4.55 tons	+13.45 tons
Dowfume W15			
400 pounds	13.0 tons	3.83 tons	+ 9.75 tons
200 pounds	15.99 tons	6.24 tons	+ 9.75 tons

Retardation of germination and injury to seedlings occurred on the 500-pound plots and are reflected *m* the yields.]Vlany of these beets lacked the typical long taproot and possessed numerous lateral roots as if a pool of gas had remained at. a level of 5 or 6 inches. Considering the time of growth, May 8 to October 10, the yields generally are about as good as might be expected.

Low yields of untreated plots are typical of the result of attempting two crops of beets in succession on nematode-inrested fields, even after long crop rotations.

The Dowfume W15 plots were the most conspicuous of all from the standpoint of top growth and root formation, but obviously there was a lack of balance in the fertilizing elements present, resulting

in lower yields from the 400-pound plot. Sugar on this plot was only 13.8 percent compared with 15 to 17 percent on the others.

Field No. 3, 1945

The Lewiston, Utah, district lias a large acreage infested with sugar beet nematodes on which it is difficult to grow a normal crop even after rotations of 5 years or more. The field selected had been in alfalfa 5 years, followed by wheat. Application was made during plowing by means of an applicator driven from the power take-off of a farmall tractor which placed the chemical in a 6-inch band just in front of the plow where it was immediately covered by the furrow.

During hot days, tops of the beets on the treated strips remained upright while those on the check strips wilted badly. Yields of treated plots were somewhat below expectations because of a low level of soil fertility; they are shown in the following tabulation :

Amount of chemical per aere	Yield of sugar beets per acre		
	Treated plots	Untreated plots	
D-D 500 pounds	18.12 tons	13.0-1	+5.08
D-D 500 pounds	14.0!) tons	10.62	+3.47
D-D 250 pounds	10.07 tons	.13.75	+2.32
D-D 250 pounds	11.37 tons	8.45	+5.92
W15 20O pounds	11.03 tons	12.50	—1.47

The Dowfume W15 plot had excellent top growth but, as in Field No. 2, the roots lacked weight. Work planned at Lewiston for 1946 includes an extensive series of fertilizer tests on fields treated with D-D and Dowfume W15, and it may be advisable for all investigators to consider this phase in planning work with either of the chemicals mentioned in order to benefit most from the "stimulation" which is so frequently noted.

Some nematodes invariably remained alive even in the treatments of heaviest application, especially in the top 4 inches of soil and below the 20 to 24 inch levels., and by the end of the season large populations were visible on the roots of sugar beets from all plots.

A delay of 7 to 10 days is necessary between D-D application and planting. If the application is made in the spring, this may give time for the soil to dry out until the seed will fail to germinate. Therefore in the mountain states it may frequently be best to make application in the fall. The field to be treated should be planted with grain, peas, early potatoes, or some other crop which can be removed in the late summer or early fall. It can then be irrigated, plowed, and worked down and the D-D applied while soil temperature is still 50° F. or above. The grower can then take advantage of spring moisture and plant just as early as the season permits. Dowfume W15 does

not have so great a disadvantage since planting can follow treatment within 3 or 4 days. Fields just broken from alfalfa or pasture, or those with large quantities of cornstalks or other trash in them, should not be treated since tests have shown that masses of sod are not penetrated by the gas and that roots, trash, and clods allow much of the gas to escape from the soil.

The optimum conditions for chemical application, based on available information, are just about the same as those for planting. If soil moisture and temperature are suitable for planting, then the field is in good condition for treatment and applications made under these conditions should give satisfactory results.

Literature Cited

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