Latest Developments in the Use of Herbicides for Selective Weed Control in Sugar Beets

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Research on the use of herbicides in sugar beet weed control has been along two lines, pre-emergence treatments and post-emergence selective sprays. Numerous difficulties are encountered in both lines of work and results to the present time have been somewhat less than satisfactory from the standpoint of enabling us to formulate field practices which could be recommended for grower usage. It is our purpose, in this paper, to present a progress report and indicate some of the methods which are being employed to solve some of the many problems that exist in this phase of weed control.

The data on which this paper is based are the results from cooperative and somewhat uniform investigations by a number of investigators in the central United States and Canada. These include USDA, state experiment station and commercial representatives. The writers wish to express appreciation for the generous cooperation of all who have had a part in these investigations.

Results of investigations on selective sprays have been, in the past two seasons, uniformly disappointing. The beet foliage is sensitive to most chemicals and any material which is active as a herbicide is likely to be active on beet leaves. Certain chloride salts are exceptions to this statement, however, and the only reports of success have been from the use of sodium chloride and potassium chloride. These two compounds are the only materials which can be suggested for grower usage and they have some very definite limitations. The degree of weed control and possibility of injury to beets are largely dependent upon weather conditions at, and preceding, the spray application. In any case, high rates of application, 200-400 pounds per acre, arc necessary and these require large volumes of water to form a solution of the salt. When the potassium salt is used approximately one-half as much salt is used as compared to sodium chloride. Young beets, or older beets sprayed at high pressures, may be injured or killed by salt spray. Weeds which are too tall, 4-8 inches, or weeds which, because of peculiar growing conditions, have become hardened are not seriously affected by salt spray. Some of the data which we have seen would indicate that, in sugar beets, salt spray should be classified as an unsatisfactory method of weed control.

Copper compounds which are known to cause injury to beet foliage, but because of possible stimulating effects of copper were considered for selective spraying, gave very poor results in 1949. When quantities sufficient

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to kill large weeds were applied a considerable reduction in beet stand was produced. Surviving beets, however, do make a rapid recovery and grow in a normal manner. Copper compunds and zinc sulfate do not appear suitable for commercial use.

The major part of the investigations in 1949 dealt with pre-emergence treatments at East Lansing and at Fargo, N. D. The results of these tests, and data from prior seasons, have enabled us to eliminate certain groups of herbicides from consideration in beet weed control problems. All forms of 2,4-D, when applied as pre-emergence treatments, have reduced the beet stand to a marked extent and have given only fair weed control. Borax and boraxchlorate combinations, likewise, appear to be of little value. The quantities, at least 320 pounds per acre, required for weed control reduced the beet stands and affected the vigor of the beets. Cyanamids, which have been used successfully in corn and some vegetable crops, have not, in two seasons work, shown any promise for use in beets. In fact, they have affected growth and vigor of neither beets nor weeds.

One interesting development concerning the choice of diluent for pre-emergence sprays was apparent at both stations in 1949. In previous seasons most herbicides used for pre-emergence treatment were applied in water

TABLE 1. Screening test rating of selected herbicides applied when sugar beets were in lour to six leaf stage on June 11. Estimates of stand and vigor made six weeks later. Brookings, South Dakota, 1948.

Herbicide	Rate in Lbs.	Tolerance rating on sugar beets			Herbicidal rating on weeds					
					Grass weeds[1]			Broadleaved weeds[2]		
used	per acre	Stand	Vigor	T.R.	Stand	Vigor	H.R.	Stand	Vigor	H.R.
E.H. 1*	2	90	70	630	90	80	280	100	100	0
E.H. 2*	2	90	80	720	60	50	700	100	100	0
Check	.	100	100	1,000	100	100	0	100	100	0
E.H. 1	4	80	40	320	60	60	640	100	70	300
E.H. 2	4	80	70	560	50	40	800	100	50	500
LFN—472**	¼	0	0	0	100	100	0	20	80	840
LFN—472	½	0	0	0	90	90	190	2	80	980
EC. 3740***	2	100	100	1,000	5	20	900	100	100	0
E.C. 3740	4	100	90	900	0	0	1000	100	100	0
Check	..	100	100	1,000	100	100	0	100	100	0
E.C. 3441***	½	80	70	560	40	60	760	90	80	280
E.C. 3441	4	80	40	320	10	60	940	90	50	550
E.C. 3221	2	100	100	1,000	60	80	620	100	100	0
E.C. 3221	4	100	70	700	40	60	760	100	60	400
E.H. 1	1	100	100	1,000	100	100	0	100	100	0
E.H. 2	1	100	100	1,000	100	70	380	100	100	0
Check	....	100	100	1,000	100	100	0	100	100	0
E.C. 3740	½	100	100	1,000	100	80	200	100	100	0
E.C. 3740	1	100	100	1,000	90	60	460	100	100	0
IPC	2½	100	100	1,000	100	100	0	100	100	0
IPC	5	100	100	1,000	100	100	0	100	100	0
Check	..	100	100	1,000	100	100	0	100	100	0
IPC	10	100	70	720	80	80	360	100	100	0
IPS	20	100	40	400	60	30	720	100	80	200

[1] *Selaria spp., Echinochloa spp., Panicum spp., Avena fatua.*
[2] *Amararthus spp., Chenopociium spp., Korhia spp.*
* Carbide and Carbon Chemicals.
** 2,4-D, finely divided acid.
*** Sharpels Chemical Co.

and many gave only indifferent results. In 1949, however, a number of compounds were applied both as water and oil sprays and considerable difference in effect was observed. Dinitrophenol, pentachlorophenol, IPC and xanthogen disulfide were all much more effective as weed killers when applied in 40 gallons of diesel fuel per acre. At East Lansing, IPC, which had been considered worthless in other seasons, was one of the most satisfactory materials in the tests when applied in oil. This observation of increased toxicity when applied in oil indicates that further study of this method of application must be made. The possibility that a longer residual action by the chemical, but not extending sufficiently long to injure beet seedlings, exists should not be overlooked

When the entire experimentation is considered it is apparent that no material has been found which is entirely satisfactory for grower use in a pre-emergence weed control program. Dinitrophenols were too toxic to beets in many cases, although one or two of the stations got promising results on a few weed species. A rate of less than 2 pounds per acre is necessary to avoid injury to beet seedlings.

Pentachlorophenol, in oil, was not uniformly satisfactory in performance in 1949. At East Lansing the results indicated a fair degree of weed control without serious injury to beet stands. The experience of certain Michigan vegetable growers, in which complete loss of the crop followed the use of this compound, should be kept in mind when recommendations concerning pentachlorophenol are made. There appears to be some relation between

TABLE 2. Tolerance rating and herbicidal rating of selected herbicides applied as pre-emergence treatments on sugar beets at Brookings, South Dakota.

Chemical	Rate in Lbs.	Sugar beets			Annual grass			Broadleaved weeds		
used	per acre[1]	Stand	Vigor	T.R.[2]	Stand	Vigor	H.R.	Stand	Vigor	H.R.
1. E.H. 1	2	50	90	450	100	60	400	62	70	570
2. E.H. 1	4	56	80	448	100	60	400	56	65	640
3. E.H. 2	2	98	90	882	12	40	960	78	80	880
4. Check	...	100	100	1,000	100	100	0	100	100	0
5. E.H. 2	4	100	90	900	15	30	950	50	80	600
6. LFN—472	1	52	5	260	42	40	580	8	15	990
7. LFN—472	2	12	5	60	38	40	620	4	15	996
8. E.C. 40	2	98	100	980	12	20	875	100	100	0
9. E.C. 40	4	92	100	920	16	10	970	100	100	0
10. Check	...	100	100	1,000	100	100	0	100	100	0
11. E.C. 41	2	82	100	820	74	70	480	84	100	160
12. E.C. 41	4	70	90	636	60	40	760	94	100	60
13. E.C. 21	2	100	100	1,000	76	80	390	88	100	120
14. E.C. 21	4	88	100	880	100	50	500	100	100	0
15. XP 40	5	100	100	1,000	88	100	120	48	90	570
16. XP 40	10	74	80	592	80	50	600	54	75	600
17. Check	...	100	100	1,000	100	100	0	100	100	0
18. Polybor	320	86	75	602	48	50	760	100	20	800
19. Polybor	640	88	40	352	41	20	920	100	10	900
20. IPC	5	100	95	950	74	30	780	100	100	0
21. IPC	10	100	90	900	48	30	860	100	100	0
22. Check	....	100	100	1,000	100	100	0	100	100	0
23. Cyanmate	100	90	70	630	100	100	0	62	100	380
24. Cyanmate	200	54	40	216	100	100	0	64	100	360

[1] T.R.—Tolerance rating
[2] H.R.—Herbicidal rating

climate and soil factors and crop injury, the exact nature of which has not been determined.

TCA, which appears to offer some possibility for weed grass control, was not considered satisfactory at East Lansing. At Fargo, however, rates of 10 and 20 pounds per acre gave the best weed control of any compound tested and only slightly reduced the beet stand. At the East Lansing station effective weed control was not observed at any rate which would permit beet emergence. Good weed control was obtained in the Manitoba trials but vigor of beets was considerably reduced. Experiments in some of the North Central states with other crops lead us to believe that, in some soils and under some moisture conditions, residual toxicity from TCA may be a serious matter and that field scale use of TCA is hazardous. The use of TCA for the control of patches of quack grass in beet fields is a different matter and it can be recommended.

A number of new herbicides were tested at most of the stations in 1949. Many of these were thought to be of value in the control of grass seedlings. The results were inconclusive at Fargo and at East Lansing, probably due to the fact that the plots at both stations did not have weed grasses in any significant amount. At Brookings dichloral urea, maleic anhydride and certain hydrophthalic acid derivatives were highly specific for grass weeds and had little effect on beets and broad-leaved weeds. While the results are preliminary, there is reason for considerable hope that one or more of these compounds may come to be of great value in seasons and areas where grass weeds are important.

Research in sugar beet weed problems, as in other crop areas, is seldom able to keep up with the large number of new herbicides, or possible herbicides, which are available from the chemical industry. Research workers generally have limited time and space and can apply only a certain number of compounds in trials which are replicated enough to give reliable data. Consequently, rather large amounts of experimental materials are distributed for trial but never reach the field. Laboratory shelves, or possibly small, token applications, are the ultimate fate of many lots of chemicals. This condition is undesirable because it represents considerable waste and undue pressure on research facilities.

A need for some adequate screening procedure for chemicals before they are placed in field trials has been apparent for some time. In 1949, the Brookings station established a screening technique which promises to be of much value in eliminating some compounds and indicating possible types of field trial which should be made on others. Essentially, the method consists of using small, replicated plots to secure weed populations of a representative type, planting one or more types of crop plants and then applying the chemicals of unknown herbicidal value. A stand determination for the crop plants and an estimate of apparent vigor is made. Each of these values is expressed as a percentage of the untreated check plots. The two values are then multiplied, the product divided by ten and designated the "crop tolerance," or C. T., value. Similar determinations are made for the various weed species and the product subtracted from 1,000 to give a positive value. This value is considered the "herbicidal rating," or H. R., for

the compound used. In evaluating compounds, if the C. T. rating is less than 800 and H. R. less than 700 the material is rated as unsatisfactory for field trials. Other details of this screening procedure were reported at the North Central Weed Control conference at Sioux Falls and are available in the Proceedings of the Conference.

This method of screening products represents a considerable saving of time and we believe that this, or some other reliable type of screening, should be the forerunner of extensive field trials of herbicidal materials. Where regional problems are involved such an approach gives data which are comparable and enable investigators to readily evaluate a compound and, in connection with adequate climatological data, facilitate study of variations due to climatic factors.

In conclusion, we should like to emphasize the fact that, in much of the sugar beet producing area, weed problems are seasonal in nature. In dry seasons, where temperatures are normally high, weed control can be accomplished by mechanical methods. However, in wet, cool springs, and these occur frequently in parts of the area, mechanical control is not effective. It is under the latter conditions that selective chemical herbicides are needed, especially in areas where grasses are the most important part of the weed population.

While it is true that suitable chemical methods have not yet been found, we believe that there is room for considerable optimism in regard to the eventual development of a system of tillage combined with chemical methods which will greatly facilitate mechanization of the spring phases of sugar beet production.