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Controlling Weeds in Corn with 2, 4-D

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By the use of 2,4-D on their corn, the farmers in Henderson county, Kentucky, increased the value of their 1947 corn crop by an estimated $2,000,000. News of a success of that kind spreads fast. Many farmers now want to know whether they can do likewise. That question is not easy to answer. Many factors are involved. Our information is limited, and it is not possible to make positive recommendations to fit all cases. A review of what we know at the present time, plus comment on much that we are not sure of, follows.

Kinds of 2,4-D Available.—2,4-D itself is an organic acid, which is not soluble in water or oil, and, so, cannot be used generally for weed-killing applications. It must be compounded for use. These different forms have chemical names and there are no simpler names for them. These names are no harder to use than potash, phosphoric acid, ammonium nitrate, etc., with which we have become familiar in fertilizer chemicals.

There are three general forms of 2,4-D on the market: (1) Dry powders, which are usually the sodium salt of 2,4-D, often with more or less inert material. (2) Liquids, which mix with water in any proportion, making clear solutions. These are water solutions of organic salts of 2,4-D, commonly referred to as amine salts, or "amine" forms of 2,4-D. (3) Liquids which make milky mixtures (emulsions) with water. These contain esters of 2,4-D dissolved in miscible oil.

Under very favorable conditions, there may be little difference in the value of 2,4-D in these various forms. However, because they are in oil solution, which sticks to the plant and permits the 2,4-D to penetrate, the ester forms are more effective under dry conditions, on hard-to-kill plants, and under unfavorable conditions generally. Smaller doses of 2,4-D acid in ester form should be used than of other forms. They are more active than the others, hence more effective on the weeds and more hazardous to the corn, per unit of 2-4-D acid, than others.

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Rate of Application.—The amount of 2,4-D acid in commercial forms varies from 9.6 percent to 83 percent. Obviously, we cannot give rates of application of dozens of varying commercial products. They must state on the label the percent of 2,4-D acid present in the product. We make our recommendations in terms of amount of 2,4-D acid equivalent required per acre, and the amount of any product can be calculated. For example, to furnish ½ pound of 2,4-D acid by a product containing 37 percent 2,4-D will require 1.35 pounds (0.5 ÷ 0.37) of material; to obtain ¼ pound acid from a product containing 70 percent 2,4-D will require 0.36 pound (0.25 ÷ 0.70) of material, and so on.

Types of Treatments.—Experiments were conducted in 1947 on treating weeds in corn with 2,4-D by two general methods—pre-emergence and post-emergence. In pre-emergence treatment, the corn is planted and the soil treated with 2,4-D immediately afterward. Post-emergence treatments include all treatments of weeds in growing corn. Considering both pre-emergence and post-emergence treatments, the writer feels that the use of 2,4-D will bring a greater revolution in practical corn growing than did the introduction of hybrid corn.

Pre-emergence Treatments

Pre-emergence treatments require from five to ten times as much 2,4-D per acre as post-emergence treatments. However, under many conditions, pre-emergence treatment controls not only broad-leaved annual weeds but also seedlings of crabgrass, foxtail, and other weedy annual grasses. No post-emergence treatment will do this. Our experiments with pre-emergence treatments at Columbus last year were very favorable. We controlled annual weeds so that no cultivation was needed for at least four weeks after planting, with no injury to the corn. On the other hand, several investigators at other stations produced severe injury to corn by using this method of application. We have a conviction that finally pre-emergence treatment will be the most important method of weed control in corn, but for this year we are compelled to say that it is extremely promising but entirely experimental.

If pre-emergence treatment were safe, it would be perfectly feasible to attach spray nozzles at the back of a corn planter, attach a pump which could be operated by the power take-off, and carry enough concentrated spray in a tank on the tractor to treat 4 to 8 acres without refilling. The whole job could be done in the same operation as planting the corn. Successful pre-emergence treatment would do away with the necessity for cross cultivation. Substituting drilling for checking corn would save more time in planting than would be required to put on the 2,4-D.

However, pre-emergence treatment will not let us throw away our cultivators. Pre-emergence treatment does not control most perennial weeds. We may have to cultivate to control Canada thistle, bindweed, quackgrass,

and other such perennials, although many of these can be given special spot treatments with 2-4-D.

Making Pre-emergence Treatments.—Successful pre-emergence treatments require 1½ to 3 pounds of 2,4-D acid per acre, applied by any convenient method. The cost can be cut down by treating only over the corn rows, leaving the weeds in the middles to be cut out by cultivation. However, if we have two or three weeks of wet weather, it might be advantageous to have the weeds killed in the whole area. It seems quite certain that corn on sandy soils is more subject to injury by pre-emergence treatment than corn on heavy soils. There is also some indication that injury is greater if heavy rains follow the application than otherwise. This, however, is not proven. Here at Columbus, we had considerable rain after some applications, with no damage. There have been no differences between the various forms of 2,4-D in their value for pre-emergence treatment when applied at equivalent rates. The material can be put on as dilute spray or concentrated spray, it makes no difference so long as it is evenly applied. Do not apply 2,4-D and then plant. That disturbs the soil and permits weeds to sprout in the disturbed area.

Farm Trials Recommended.—Because pre-emergence treatment of corn is so promising, it is highly desirable to have wide experience with it under every possible condition of weather, soil, climate, and application. We therefore suggest that corn growers who have access to a 2,4-D sprayer spray at least two rows of their corn fields with 2,4-D. Those who feel that they can afford to take a chance could treat an acre, or an area that could be conveniently harvested as one "land" of a corn picker, to be compared with a similar land not so treated. If these tests are conducted generally over the State there should be, from them and our experimental work, a sufficiently wide base of experience by this time next year to indicate what can and cannot be done with pre-emergence treatment.

Post-emergence Treatments

Post-emergence treatment is much less experimental than pre-emergence, and costs much less. It has the distinct objection that it will not control weedy grasses of any description, either annual or perennial. Heavy doses of 2,4-D will injure growing corn. In 1946 we treated different plots of corn heavily with 2,4-D solutions of two different concentrations, 0.1 percent and 0.2 percent 2,4-D acid, on eight different dates. Since these sprays were applied with a hand sprayer, and as much as possible put on the corn, it is almost impossible to translate these rates into pounds per acre applied as an overall spray, but the applications were certainly equal to 2 and 4 pounds per acre, respectively, as overall sprays. In addition, particular pains were taken in the four early sprays to fill with solution the curl containing the

growing point. These four sprays were on June 18, July 3, July 10, and July 17, when the corn was 10, 20, 35, and 50 inches high, respectively.

The untreated corn made 69 bushels per acre. As an average of the above four dates the corn treated with 0.1 percent solution made 52 bushels and that treated with 0.2 percent solution made 45 bushels per acre. The reduction in yield was significant for both rates. In this experiment, the sodium salt, the amine salt, and two esters were used. There was a definite tendency for the esters to cause more injury than the salts, but the differences between materials were not important. All of them caused injury.

The four later sprays were applied at intervals of a week until two weeks after tasseling, or about the milk stage, on August 14. There was no indication of damage from any treatment on this last date but there was damage at the three earlier dates similar to that produced earlier. On two of these dates, plots were also laid out in which the weeds in the corn row were treated without spraying the corn stalks except for the bottom 18 inches or so. These plots were not significantly injured and were higher yielding than those on which the entire plant was sprayed on the same date. When spraying corn which is tall enough, it is always desirable to keep 2,4-D off the tops of the corn, but usually this is not feasible, and it is not essential with low dosages.

Effect of 2,4-D on Corn.—The first effect of 2,4-D on corn, if applied any time after the stalk has started to grow and before it has reached its full height, is to cause the stalk to become brittle. The stalks also bend over. With dosages as high as 3 or 4 pounds per acre, the stalks frequently become so brittle that they break of their own weight. Even with much lower dosages they are brittle enough to break if they are struck in cultivating or by windstorms. This brittleness passed in about a week to ten days but the corn is permanently stunted and does not yield as much as untreated corn.

One of the most common effects is the so-called "onion leaf," in which the leaves stay tightly rolled instead of unfolding normally. This may be so severe as to prevent tasseling. Brace roots may grow together in broad, spade-like protuberances. Sometimes they form a solid disk of root material around the base of the stalk. This may not be injurious to the plant. In fact, under some circumstances, 2,4-D appears to increase the total root growth of the plant.

There has appeared in farm papers a statement that corn is particularly sensitive while it is establishing itself and again about tasseling time but that between these periods it is not readily injured. Our observations do not agree with this. We have not sprayed enough corn in the one-, two-, and three-leaf stages to be sure what the effects are, but our few observations would not indicate that it was more readily injured then than later. Certainly, in our experiments, corn has been rather uniformly sensitive from 8 inches high to after tasseling. As soon as the stalk starts to grow, our obser-

vations indicate that 2,4-D damage for uniform dosage is proportional to the rate of growth. The faster the plant is growing, the greater the damage.

2,4-D on Single-cross Fields.—An experiment by Stanniforth and Rossman of the Iowa Experiment Station last year is of particular significance to many Ohio corn growers. Four pure lines of corn were treated with 2,4-D at three different periods, two before tasseling, the other after. The latter did no harm, but the first two caused severe injury to the plants in the field. More important is the fact that the seed from these plants, even though they were treated considerably before tasseling, was of low germination and the plants from the seeds that did germinate were abnormal, slow growing, and low yielding. What is still more remarkable is that seedlings from the two strains of which the plants were least affected in the field showed the greatest 2,4-D effects. In view of this experience, no 2,4-D should be used on single-cross fields until we know more about possible effects on the next generation.

2,4-D on Double-cross Fields.—We would be happier to see no 2,4-D used on double-cross seed fields until we know more about it. Experiments to determine the hazard are in progress. There certainly is enough possibility of injury to the seed produced on plants treated with 2,4-D to suggest that we go slow. However, the hazard in producing double-crosses is much less than in producing single-crosses. Considerable acreages of double-cross seed fields were treated in the West in 1947.

In 2,4-D, we are dealing with one of that group of products, some naturally produced in plants, others produced only in the chemical laboratory, known as growth-regulating substances. 2,4-D is capable of producing measurable effects on many plants in concentrations as low as one part in 10,000,000 of water. In dealing with a product of this potency we must use extreme care to check all possible sources of injury before recommending its general use.

Rate of Applying 2,4-D on Growing Corn.—In one of our tests at Columbus last year, Homer Neville applied 0.2, 0.4, 0.6, and 1 pound of 2,4-D acid equivalent per acre in the form of butyl ester. One pound of 2,4-D acid caused brittleness and other visible damage and there was some damage on one or two of the 0.6 pound plots. Two-tenths and 0.4 pound per acre caused no visible damage. When the plots were harvested, there was no significant reduction in yield on any of the plots, even those which had received 1 pound acid equivalent per acre.

These results agree rather closely with results across the Corn Belt. The Policy Committee on Herbicides of the North Central Weed Control Conference recommended ¼ to ½ pound of 2,4-D acid per acre as the maximum dose to apply on corn without injury. This dose is ample to kill seedlings of broad-leaved weeds.

How Can We Apply 2,4-D?

A satisfactory method of applying 2,4-D is vital, if we are to make it a part of regular farm practice. Until 1947, practically all directions for applying 2,4-D involved the use of dilute solutions—0.05 percent or 0.1 percent—applied at 100 to 200 gallons per acre. From the beginning, it has appeared that this costly hauling a ton of water to distribute a pound of 2,4-D would have to be changed before we could make much practical use of 2,4-D on the ordinary farm. We have been active in trying 2,4-D dust to meet this difficulty. Dusts of 2,4-D are effective and satisfactory in many situations. The hazard of drift is one fundamental objection to dust, and it is more difficult to apply dusts evenly than liquids.

The outstanding development of 1947 in 2,4-D work was the discovery and use of nozzles, capable of applying accurately as little as 5 gallons of solution per acre. Even as little as 2 gallons per acre has been accurately applied. This is probably too low for the average farm, but 5 to 10 gallons per acre are entirely practical. The amount of water does not affect results, provided the same amount of 2,4-D is uniformly applied. Anyone purchasing a sprayer to apply 2,4-D to corn will make a serious mistake if he buys one which is calculated to apply more than 10 gallons per acre. In buying any equipment in a field developing with the explosive rapidity with which the weed-killer field is developing, one runs a serious chance of having the equipment become obsolete. To buy a spray rig in 1948 to apply dilute sprays is to buy one that is already obsolete. These sprays are put on at low pressures, 25 to 35 pounds per square inch, making light tanks and low-pressure pumps feasible. These can be used in the field under many conditions when the heavy tanks necessary for dilute sprays could not be used. Although they will control weeds satisfactorily, the dilute sprays using 100 or more gallons per acre require much more labor, time, effort, and expense, and cause more mechanical damage to crops and soils.

Dilute sprays have just two things in their favor. If you are spraying dense tall growth, dilute sprays under high pressure will penetrate it much better than the concentrated sprays will. There may continue to be a place for the use of dilute sprays for highway spraying, orchard spraying, and waste land spraying. This does not apply to spraying field crops. The other advantage of the dilute sprays is that you can see where you have sprayed. It is difficult to tell where you have applied a spray of only 5 gallons per acre. It requires accurate work and accurate setting of the sprayer to do the right job. However, many thousands of acres have been sprayed by this method and it is entirely practical.

By a few changes, any spray tank can be equipped to apply low gallonage sprays. Accurate distribution of these small amounts of spray is dependent on accurate nozzles. Obviously, a nozzle which will meter accurately an amount as small as 5 gallons per acre must be very accurately machined.

Such nozzles cannot be cheap. These nozzles, however, may be inserted in any sort of boom and many a home-made boom was used in 1947 with every sort of spray tank and spray pump. For pumps that ordinarily produce high pressures, some sort of pressure control device must be installed.

2,4-D on Other Crops

In our experience, winter wheat can be sprayed in the spring with very little injury up until the time it begins to joint. After that, only small doses are permissible until the milk stage of the grain. Two pounds of 2,4-D acid equivalent per acre, in our experience, caused considerable loss. Three pounds per acre at the jointing and heading stages cut the yield in two, although it caused no loss when applied on April 5 before the wheat started to joint.

Perhaps the most important possibility in connection with spraying wheat early in the spring is the possibility of treating wild garlic. Wild garlic will not be killed by one treatment, but by the use of 3 to 4 pounds 2,4-D acid equivalent per acre in an ester form, the tops of wild garlic can probably be knocked down so that aerial bulblets will not be formed. We have not actually done this here, but experiments here and elsewhere give us considerable confidence that it can be done. This treatment will kill any clover or alfalfa sown in the wheat.

Mustard in wheat or oats can be killed by ¼ to ½ pound of 2,4-D acid equivalent per acre. The same amount will at least seriously damage bitter wintercress and the white-flowered mustard that usually accompanies it, field peppergrass, but a heavier dose is more certain. In wheat fields not sown to clover or alfalfa, these two weeds can be removed from the stand by spraying before April 10 to 15 with 1 or 2 pounds of 2,4-D acid per acre.

Another possible use for 2,4-D in small grain is for use on bindweed and Canada thistles after the grain is in the milk. At this stage, 2 or more pounds of acid equivalent per acre will not injure wheat or oats. It will not be possible at this stage to spray an entire field without excessive damage to the grain by trampling. However, with a hand sprayer and concentrated spray, or with a hand duster, a man can carry enough spray or dust to treat a half acre of weed patches. Knocking these patches down at this stage will get them out of the way of harvesting and prevent a great deal of loss at combining time. It is possible that Canada thistles can be treated with concentrated spray at this time without injuring seedling clover or alfalfa below. The spray may not penetrate that deep. Any ordinary 3-gallon hand spray outfit can be fixed to apply concentrated spray by the use of the proper nozzles. Such attachments are on the market.

SUMMARY

1. The use of 2,4-D to control weeds appears destined to be an important aid in corn growing. With proper precautions, it may profitably be used this year, certainly in emergency situations. There are many things that we do not know and some risk is involved.

2. Pre-emergence treatment is more expensive than post-emergence, but may possibly be the most effective method of using 2,4-D. For this year, it is only recommended for trial on a few rows. Such trials are desirable on many farms in all parts of the state.

3. For killing seedling broad-leaved weeds in corn beyond the 2-leaf stage, from ¼ to ½ pound of 2,4-D acid per acre is suggested. Less 2,4-D acid per acre should be used in ester forms than in the various salts of 2,4-D. Grass weeds will not be killed.

4. The hazard in using 2,4-D in fields producing double-cross hybrid seed corn is not known. It is probably small, but unquestionably there is a chance that it exists. If 2,4-D is used in such fields, the doses should not exceed those just stated. Preferably, use on seed corn fields only in a severe emergency.

5. *Fields for the production of single-cross hybrids should not be treated with 2,4-D.* Inbred lines are much more sensitive than the single or double crosses. Not only the plants but *their progeny* have shown 2,4-D injury.

6. For use on corn and most other crops, sprayers are recommended which put on 5 to 10 gallons per acre at pressures of 25 to 35 pounds. Sprayers for 2,4-D on crops which apply 100 or more gallons per acre are definitely obsolete.

7. *Varieties of all crops* may vary greatly in their susceptibility to 2,4-D. This is one of the major uncertainties in its use.

8. Winter wheat may be treated in the spring before it starts to joint or after it is in the milk stage without serious injury, even at moderately high doses. Oats may be treated after the milk stage and perhaps before they start to joint, certainly with doses sufficient to remove mustard. Young clover and alfalfa may be killed by these treatments.

9. Go slow. After all, we have gotten along without 2,4-D for a long time. Except for emergency uses, it might be better to get along without it for another year than to make costly mistakes. *Where weeds, if not controlled, will take the crop, as happened in so many situations in 1947, 2,4-D can be a lifesaver.* In this way, it can be an important adjunct to increasing production in this year of need.