The Killing of Mustard and Other Noxious Weeds in the Grain Fields of South Dakota.

By E. W. Olive.

To the best of the writer's remembrance, mustard, though abundant enough, was not considered some years back as a serious pest in Indiana grain fields. But throughout the great grain fields of the Northwest the situation is different. The traveler sees on every hand, during the month of June, field after field of grain absolutely yellow with the blossoms of the common wild mustard. The fields sown to cereals are often enormous in extent; it is not an uncommon sight to see a quarter-section or even a section sown to one crop of wheat, barley, oats or flax. Only small areas here and there bear what we call "cultivated crops." Cultivation cannot therefore hold in check troublesome weeds as is done in the smaller farms of the older States. Hence the great abundance of the yellow pest through the older parts of the Dakotas is actually startling to a stranger from Indiana or Illinois.

One large land-owner in an effort to rid his ranch of mustard, two years ago spent a hundred dollars in pulling the weed. A year ago he doubled his expenditures in this work; but had to acknowledge finally that it seemed as though no matter how careful and clean his methods of farming, for years to come he might have to continually increase his appropriation in geometrical ratio before he could ultimately hope to conquer the pest.

It may be of some interest to the members of the Academy to hear a brief account of some of the experiments conducted by the writer during the past summer in trying to eradicate mustard and other weeds in grain fields. Similar experiments had already been performed in North Dakota, Canada, Minnesota, Wisconsin, and other western States, so that the results obtained in South Dakota are in the main corroboratory.

The method, in brief, is this: The grain field is carefully gone over with a traction spraying machine, and sprayed thoroughly with a strong solution (about 20 per cent.) of iron sulphate (or copperas). The machine used in our experiments covered a swath about twenty-five feet wide and threw a very fine and powerful spray, under a pressure of from 80

to 100 pounds, directly down on to the young mustard and grain. Twenty-five acres were easily covered in five hours, so that under favorable conditions, 40 to 50 acres could be readily sprayed in one day. The spraying is best done when the grain and weeds are from 6 to 10 inches high, or just before the mustard plants begin to bloom.

Further, it is highly important that the spraying be done during favorable weather. The great importance of this will be seen when we come to consider the physiological side of the problem. The best time for the most successful work is just after the dew is off, on a bright, sunshiny day. A little Dakota wind also helps the process; but if a rain soon follows, the iron salt is washed off and the work comes to naught.

Now if we keep close watch of the plants sprayed we can readily follow the various steps of the destructive action of the salt. First, the sulphate dries on the leaves, leaving minute, whitish flakes on the surface. Next, we note after two or three hours, particularly in the case of such succulent plants as mustard, the appearance of many scattered, more or less translucent, *sunken* areas on the leaves. The leaves by this time appear to be somewhat wilted and the whole plant looks somewhat sick. Two or three hours later, close examination reveals the next step of the process, in the gradual blackening of the sunken areas. The microscope shows this to be due to the blackening of the cell contents of the shrunken cells. Further wilting and drying up of the leaves is soon followed, in 24 hours or so, by their complete death. In a few days to a week, most of the mustard leaves have fallen off, or remain as dry, withered remnants on the dead stems. Occasionally a leaf may make a weak revival; or a plant here and there may make a futile effort at flowering and seed production. But if the work is thoroughly done, but few weeds survive. I have seen mustard so thick as to approximate 100 plants to the square foot, all totally destroyed by effective spraying.

After following the above description of the various steps in the appearance of a sprayed leaf the interpretation of the physiological action of the sulphate seems clear. First, the salt drying in minute flakes on the surface of the leaf, undoubtedly acts as a strong plasmolyzing agent to draw the water out of the cells with which it is in immediate contact. Thus results the scattered, translucent, sunken areas, merely from plasmolysis of those regions by the overlying salt. This plasmolysis is particularly striking in the case of the ragweed, which responds to the action of the sulphate even more quickly than does mustard or other weeds in-

vestigated. A sprayed solution of common salt apparently acts likewise, first as a strongly plasmolyzing agent, but its action is even quicker than that of the sulphate, plasmolysis resulting even in from 10 to 15 minutes after the application of the spray. Wilting of the entire leaf soon follows, due to general withdrawal of water, to be succeeded in a few hours by the blackening of the protoplasm of the plasmolyzed cells. This blackening is quite probably due to the formation of sulphides by the union of the absorbed iron sulphate with the protoplasm. After the use of common salt, on the other hand, the plasmolyzed spots turn reddish brown; possibly chlorides of some sort, formed in the killed protoplasm, may be responsible for the color in this instance.

It seems clear, then, that the action of the salts in killing the weeds in these experiments is due primarily to their osmotic properties rather than to their toxic properties; although it may well be that chemical action also may enter in after the first steps in the process and may contribute toward the death of the plants.

One of the most interesting sides of the whole problem of spraying for weed destruction is the fact that while mustard, ragweed and most other common weeds are for the most part totally destroyed, the wheat, oats, flax, etc., are themselves but little injured. This sounds almost unbelievable—much like a patent medicine advertisement, in fact. But it is nevertheless true that the grain soon recovers from the effects of the treatment; and further, Prof. Bolley's statement seems true, that the sprayed field often yields as much as one-third more grain than the unsprayed.

A little examination of the sprayed field soon shows to what the grasses and grains owe their peculiar protection from serious injury. It is true that the tips of the young wheat leaves are blackened and killed; but it will be remembered that, when the plants are only six inches to a foot in height, the bases of most of the leaves are amply protected, enwrapped within the sheaths and lower leaves. Their freedom from injury arises, therefore, in the main from the method of indeterminate growth of grains and grasses. The waxy bloom which covers flax and many of the grains must also contribute considerable protection against injury, since the minute droplets of salt solution do not adhere readily to such a surface.