The Retention and Effect of 2,4-Dichlorophenoxyacetic Acid Sprays on Winter Wheat

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THE use of chemical sprays as selective herbicides was started in the latter part of the nineteenth century. There has been an enormous amount of excellent work, such as that of Clark and Frieberg (1), Derscheid (2), Helgeson (6), Klingman (8), Olson (9), Overland and Rasmussen (10), Phillips (11), Slife and Fuellman (12), Staniforth and Atkins (13), Willard (14), and many others, on the control of weeds in cereal crops. However, after more than 50 years of research, there is an almost complete absence of published experimental data on the retention of these sprays.

In some recent work, Holly (7) found that approximately 3.5 times the amount of agent was deposited on barley at 10 gallons per acre as at 175 gallons per acre. Ennis (3) suggested that the varying effectiveness of herbicides in different carriers might be assignable in part to unlike retention of the sprays by the foliage. In a later study with soybeans, Ennis et al. (4) showed that spray retention differences attributable to leaf type, carrier, and leaf angle were highly significant. The work of Fogg (5) showed that distinct and sometimes considerable variations in the degree of wetting of leaves by water may occur not only between species or varieties but also from place to place on the same plant and within a short period of time on the same leaf. The objectives of this investigation were to determine the amount of 2,4-Dichlorophenoxyacetic acid (2,4-D) spray which was retained by a cereal crop under field conditions, the effect of various factors on retention and the effect of these sprays upon the growth and yield of the plants.

MATERIALS AND METHODS

It was considered impractical to attempt to measure the actual amount of 2,4-D retained on the leaves because it is known that a part of it moves into the leaves soon after application. The technique used was to incorporate into the sprays a water soluble dye which does not penetrate intact plants and one which at the same time can be washed off completely from the plant surface. The one which proved best for this purpose was duPont Anthraquinone Blue; all spray solutions had 0.4% of this dye incorporated into them.

The investigations were conducted in 1951 and 1952. Plot size in 1951 was 4 drill rows with 7-inch spacing and 18 feet long, an area of 42 square feet, and in 1952, 5 drill rows, or 52½ square feet per plot. Plots were protected at time of spraying by a movable spray chamber to prevent drift of spray material to adjacent plots. The spray chamber was 4½ feet wide, 5 feet high, and 20 feet long, and constructed of a light metal frame covered with a wind-resistant cloth. The spray applications were made with a modified DeVilbiss type MBC spray gun having a Decorator's combination spray head (MBC-231) and veiling cap, using compressed nitrogen as a source of pressure. Of 10 pounds per square inch was used which produced droplets chiefly in the size range of ½ to 2 mm. in diameter. The spray were covered 4 to 6 times in the spraying operation to insure uniform coverage over the entire area.

Two samples, each 1 foot of a drill row selected at random were cut off at ground level from each plot immediately after it was sprayed. This allowed the sprays to strike the leaves but did not allow the sun to fade the dye. In the laboratory, samples were washed in a measured amount of distilled water, and an aliquot of the resulting wash solution was used to determine the amount of dye present. The concentration in the solutions was determined with an Evelyn colorimeter equipped with a 540 M filter. After these determinations were made, the percentage of dye present was read from a standard density curve which had been obtained using solutions of known concentrations of the dye. The amount of dye retained by the plants was determined from the concentration of dye in the wash solutions; this was used to determine the percentage of retention for the dye. This percentage was assumed to be the same as it was for the dye. The amount of 2,4-D retained was calculated in terms of pounds per 1000 square feet per plot. Plots were protected at time of spraying to adjacent plots. The spray chamber was 4½ feet wide, 5 feet high, and 20 feet long, and constructed of a light metal frame covered with a wind-resistant cloth. The spray applications were made with a modified DeVilbiss type MBC spray gun having a Decorator's combination spray head (MBC-231) and veiling cap, using compressed nitrogen as a source of pressure. Of 10 pounds per square inch was used which produced droplets chiefly in the size range of ½ to 2 mm. in diameter. The spray were covered 4 to 6 times in the spraying operation to insure uniform coverage over the entire area.

The amount of 2,4-D retained was calculated for each plot by the method described previously.

The retention of 2,4-D by Thorne wheat is shown in Figure 1. These data are the average of two samples, each 1 foot of a drill row selected at random from each plot immediately after spraying. The data have been converted to a basis of 1000 square feet per plot. The spray rates used were 1, 2, and 3 pounds of 2,4-D per acre. A randomized block design experiment with 4 replications, 9 stages of development, 3 rates was used to study the effect of these factors on retention and yield of grain. Rates of 3/4, 1 1/2, and 2 pounds of aqueous spray to Thorne wheat at 9 stages of development between March 21, 1951, when the wheat was in the post-fertilization stage, and May 31, 1951, at which time the wheat was in the post-fertilization stage.

The amount of 2,4-D retained was calculated for each plot by the method described previously.