

United States Department of Agriculture
Agricultural Research Administration
Bureau of Entomology and Plant Quarantine

EFFECT OF DDT AND CHLORDANE APPLIED TO CONTROL
JAPANESE BEETLE LARVAE ON THE YIELD OF GRASS,
RYE, SOYBEANS, AND CORN

By W. E. Fleming and W. W. Maines^{1/}
Division of Fruit Insect Investigations

DDT at the rate of 25 pounds per acre or chlordane at 10 pounds per acre, mixed intimately with the upper 3 inches of soil, is authorized for the treatment of beds and plots in commercial nurseries that are under quarantine because of the Japanese beetle (*Popillia japonica* Newm.). These toxicants are recommended also for application to the surface of established turf to protect it from damage by this insect.^{2/}

Large areas of turf are treated with these toxicants, and rye, soybeans, and corn are used by commercial nurseries in rotations for soil improvement. In 1947 an experiment was undertaken to simulate these applications of chlordane and DDT to large areas, maintaining them according to accepted procedure, to determine the effect of the toxicants on growth of the crops. This experiment was concluded in 1951 after four growing seasons and the results are presented in this report.

Establishment of Field Plots

A 3-acre field at Moorestown, N.J., that had not been under cultivation for several years was selected for this experiment. The soil in this field is sassafras sandy loam, which is used in the production of general farm crops and nursery stock in southern New Jersey. A light-brown sandy loam about 6 inches deep, with a scattering of well-rounded quartz gravel throughout, rests on a sandy clay subsoil. Drainage is well established. Analysis^{3/} of this soil showed that the pH was 5.0 and that it was relatively low in organic matter, magnesium, phosphorus, and potassium.

^{1/} The writers acknowledge the assistance of L. W. Coles, C. A. Perkins, H. W. Strabel, and A. R. Whitcraft, of the Japanese Beetle Laboratory, Moorestown, N.J., in conducting this investigation.

^{2/} Fleming, W. E. 1950. Protection of turf from damage by Japanese beetle grubs. U.S. Dept. Agr. Leaflet 290, 8 pp.

^{3/} Made by the Soil Testing Laboratory, New Jersey Agricultural Experiment Station, New Brunswick, N.J.

During the summer of 1947 an area 330 by 340 feet in this field was plowed, harrowed, and graded. It was kept relatively free of weeds by frequent cultivation. In September, in order to have established turf available for treatment the following spring, a mixture of grasses and clover was sown at the rate of 190 pounds per acre by means of a 10-foot tractor-drawn spreader to a strip 330 feet long and 100 feet wide on the southerly side of the area. This mixture, recommended by the New Jersey Agricultural Experiment Station, contained 45 percent of Kentucky blue grass, 25 percent of redtop, 10 percent of Colonial bent, 15 percent of rye grass, and 5 percent of white clover. After the seed was sown, the ground was rolled lightly to compact the soil and stimulate germination. A deficiency of rain that fall was not favorable to the new grass, but by the spring of 1948 the turf was well established and ready for application of insecticides.

The problem was how to lay out the experimental plots so that the spreader could be used to apply the insecticides in the same manner as used in commercial nurseries and on large turf areas. Accordingly, the field, including both turf and cultivated portion, was divided into 11 strips, each 30 feet wide and extending northward 340 feet.

By trial and error over a distance of 435 feet, the spreader was adjusted to deliver approximately 250 pounds of 10-percent DDT or 200 pounds of 5-percent chlordane per acre. The DDT dust was applied once to strips 1 and 7 and twice to strips 2 and 8; the chlordane dust was applied once to strips 4 and 10 and twice to strips 5 and 11. Strips 3 and 9 were left untreated as checks, and strip 6 was left untreated to serve as a barrier between the replicated plots. The pattern of each application was in the form of parallel ribbons of material, about 2 inches apart, across the field. When two applications were made these ribbons tended to merge. It appeared that a uniform distribution was obtained with all treatments.

With each application the amount of dust put into the hopper was recorded, and when the operation was completed the material remaining in the hopper was removed and weighed. The amount of toxicant applied in each treatment was calculated and expressed as pounds per acre. It was found that the equivalent of 25 pounds of DDT per acre had been applied to strips 1 and 7, and of 60 pounds per acre to strips 2 and 8. The equivalent of 10 pounds of chlordane per acre had been applied to strips 4 and 10 and of 19 pounds per acre to strips 5 and 11. The toxicants applied to established turf were left on the surface of the ground; in the cultivated area the toxicants were mixed immediately by cultivation with the upper 3 inches of the soil.

The arrangement provided for duplicate plots, each 30 by 100 feet, on turf and for two pairs of plots, each 30 by 40 feet, for each treatment in the cultivated areas. These plots are referred to as A, B, C, and D in the tables. It seemed to be the only arrangement possible for

use with the tractor-drawn equipment, but it had the disadvantage that without randomization of the treatments proper compensation could not be made for variations in the soil throughout the plots. It is believed, however, that from a practical viewpoint this experimental design was adequate to determine whether these treatments had any serious effect on the crops.

Planting and Rotation of Crops

The rye, soybeans, and corn were each planted in two adjacent strips, each 40 feet wide, extending across the strips of the treatments described previously. The adjacent strips of a crop were separated by a noncount row, or swath. The seed bed was prepared for each crop by disking to a depth of 3 inches to avoid distributing the toxicants mechanically to a lower level.

Spring rye, a grain-producing type not so tall or so plump as the common winter rye, was broadcast at the rate of 100 pounds per acre on April 19, 1948, April 12, 1949, and May 11, 1950. In 1948 and 1949 good stands were obtained, but in 1950 the planting was so delayed by the cold wet spring that the crop was a failure. It was decided to use the common winter rye in 1951. This seed was sown on October 10, 1950, and a good stand was obtained.

Soybeans of the Black Wilson type were broadcast at the rate of 2 bushels per acre on May 10, 1948. A good stand was obtained, but so many weeds developed that the crop could not be harvested in a satisfactory manner. Thereafter the soybeans were sown in rows 36 inches apart, the seed about 3 inches apart in the rows, so that the plants could be cultivated. Twenty-five rows, including the middle barrier row, were sown on May 12, 1949, June 6, 1950, and June 4, 1951.

The hybrid field corn, Funk G-94, was planted in rows 42 inches apart, the seed about 15 inches apart in the rows. Twenty-one rows, including the middle barrier row, were sown on May 10, 1948, May 13, 1949, June 6, 1950, and June 4, 1951.

The rotation of these field crops was rye, soybeans, corn, and rye, so that, except for the first and the fourth years, each crop was planted in a different strip across the treated plots.

Soil-Fertility Program

Although sassafras sandy loam is one of the important agricultural soils, it is necessary to add organic matter, lime, and commercial fertilizers to grow crops or grass in a satisfactory manner. The organic matter in the cultivated area has been built up gradually during the 4 years by shredding and disking the crops into the soil and by incorporating a cover crop into the soil in the spring. Rye grass was used as the cover crop over the winter of 1948-49, but because of the difficulty

of killing this crop and mixing it with the upper 3 inches of soil by disking, the use of rye grass was discontinued. Winter wheat was found to be more satisfactory under these conditions.

Each spring lime was applied to the established turf and to the cultivated area. In 1948 hydrated lime was used at the rate of 800 pounds per acre. In subsequent years ground limestone was used, 500 pounds per acre in 1949, 1,000 pounds in 1950, and 800 pounds in 1951. With this program of liming, the pH of the soil was maintained between 6.0 and 6.5.

A commercial 5-10-10 fertilizer was applied twice each year, the first treatment in the spring to the turf and cultivated area, and the second later in the season as a side-dressing to the corn and soybeans in the following amounts:

	<u>Pounds per acre</u>	
	<u>Spring</u>	<u>Later in season</u>
1948	1,000	500 (corn only)
1949	600	250
1950 and 1951	500	250

Harvesting of Crops

When the rye had made full growth and the heads were maturing, the plants were cut at the surface of the ground in 4-foot swaths with a tractor-powered sickle bar. The swaths in each plot were collected and weighed. Then the cuttings were spread over the plot and disked into the soil.

The soybeans were cut at the surface of the ground when they had made good growth and the pods had formed. Each 30-foot row in each plot was cut and weighed. These cuttings were then spread over the plot and incorporated into the soil.

The weight of the husked ears of corn was used for comparison between plots. When the corn matured, late in September or early in October, the ears were removed, husked, counted, and weighed. The stalks were then shredded and incorporated into the soil.

Periodically as required the grass on the turf plots was mowed with a power mower and the clippings were left on the ground. During June of each year, when the turf was in its best condition, the grass was cut and the clippings were collected by means of an 18-inch hand mower equipped with a grass catcher. The clippings were then weighed.

Discussion of Results

The green weights of the rye, soybeans, grass, and of the mature ears of husked corn in the plots to which the different treatments had been applied are summarized in tables 1 and 2.

In 1948 the rye in all plots germinated normally but the seedlings in the plots treated with DDT had an abnormal purple color. Although this color gradually disappeared, the growth of the rye was visibly retarded. At harvest it was evident that the application of DDT to the soil had definitely reduced the green weight of the crop. In 1949 and 1951, although some discoloration and retardation of the seedlings were evident, there was nothing to indicate that the application of DDT up to 60 pounds per acre had modified the green weight at harvest. During the 4 years there was nothing to indicate that applications of chlordane up to 19 pounds per acre had any detrimental effect on the growth of the rye.

The application of DDT at rates up to 60 pounds per acre and of chlordane at rates up to 19 pounds per acre appeared to have no significant effect on the growth of soybeans, corn, or mixed grasses.

This experiment should not be considered as a study of the phytotoxicity of these insecticides to these plants. As the chemical analyses of the soil^{4/} showed that practically all the DDT and chlordane had remained within the upper 3 inches during the 4 years following the application, it would be expected that when the roots penetrated below this layer the plants would grow fairly normally.

Summary

DDT or chlordane mixed with the upper 3 inches of soil is authorized for the treatment of beds and plots in commercial nurseries that are quarantined because of the Japanese beetle (Popillia japonica Newm.). Applied to the surface, these toxicants are recommended also for the protection of turf from damage by this insect.

A 4-year study was made of the effect of these toxicants applied in this manner on growth of grass, rye, soybeans, and corn. The green weights of the crops in the treated plots were compared with the weights in the untreated plots. It was found that, except for a retardation in the growth of rye with DDT the first year, the application of DDT up to 60 pounds per acre, or of chlordane up to 19 pounds per acre, had no detrimental effect on these crops. Since the roots of these plants penetrated below the treated layer of soil, this experiment should be considered as a study of the reactions of crops under this special condition rather than a general study of the phytotoxicity of DDT and chlordane to these crops.

^{4/} These analyses were made by R. D. Chisholm and L. Koblitsky, of the Division of Insecticide Investigations.

Table 1. --Effect of applying DDT for control of Japanese beetle larvae on green weight of rye, soybeans, corn, and grass

Crop	Year	Pounds DDT per acre	Green weight in pounds per plot				
			Plot A	Plot B	Plot C	Plot D	Average
Rye	1948	25	42	40	42	40	41.0
		60	24	29	34	29	29.0
		None	85	72	84	68	77.3
	1949	25	173	223	167	152	178.8
		60	223	221	165	150	189.8
		None	210	229	191	172	200.5
	1951	25	146	91	106	97	110.0
		60	130	85	76	81	93.0
		None	124	121	91	91	106.8
Soybeans	1949	25	262	297	237	254	262.5
		60	281	297	234	207	254.8
		None	291	295	260	251	274.3
	1950	25	194	217	194	197	200.5
		60	205	194	200	202	200.3
		None	223	221	210	202	214.0
	1951	25	135	180	164	192	167.8
		60	125	156	109	164	138.5
		None	113	177	130	177	149.3
Corn (ears)	1948	25	225	232	199	222	219.5
		60	252	245	219	221	234.3
		None	230	226	185	236	219.3
	1949	25	139	138	136	152	141.3
		60	124	143	117	153	134.3
		None	111	124	124	142	125.3
	1950	25	185	168	169	168	172.5
		60	195	184	169	156	176.0
		None	191	189	180	160	180.0
	1951	25	129	189	128	132	144.5
		60	183	200	140	145	167.0
		None	208	207	130	172	179.3

Table 1. --(Continued)

Crop	Year	Pounds DDT per acre	Green weight in pounds per plot				
			Plot A	Plot B	Plot C	Plot D	Average
Grass	1948	25	76	-	95	-	85.5
		60	87	-	89	-	88.0
		None	60	-	78	-	69.0
	1949	25	80	-	68	-	74.0
		60	98	-	65	-	81.5
		None	80	-	40	-	60.0
	1950	25	34	-	36	-	35.0
		60	41	-	36	-	38.5
		None	31	-	32	-	31.5
	1951	25	75	-	79	-	77.0
		60	73	-	73	-	73.0
		None	84	-	75	-	79.5

Table 2. --Effect of applying chlordane for control of Japanese beetle larvae on green weight of rye, soybeans, corn, and grass

Crop	Year	Pounds chlordane per acre	Green weight in pounds per plot				
			Plot A	Plot B	Plot C	Plot D	Average
Rye	1948	11	74	79	82	62	74.3
		19	69	64	74	64	67.8
		None	85	72	84	68	77.3
	1949	11	207	211	173	163	188.5
		19	172	175	178	181	176.5
		None	210	229	191	172	200.5
	1951	11	103	147	96	103	112.3
		19	147	140	92	118	124.3
		None	124	121	91	91	106.8
Soybeans	1949	11	285	306	280	276	286.8
		19	312	345	269	312	309.5
		None	291	295	260	251	274.3
	1950	11	236	199	198	196	207.3
		19	205	211	211	210	209.3
		None	223	221	210	202	214.0
	1951	11	133	137	144	165	144.8
		19	164	175	155	168	165.5
		None	113	177	130	177	149.3
Corn (ears)	1948	11	216	238	173	246	218.3
		19	208	237	185	233	215.8
		None	230	226	185	236	219.3
	1949	11	126	106	149	142	130.8
		19	132	116	149	144	135.3
		None	111	124	124	142	125.3
	1950	11	192	193	184	170	184.8
		19	198	206	190	194	197.0
		None	191	189	180	160	180.0
	1951	11	141	173	110	153	144.3
		19	130	137	120	174	140.3
		None	208	207	130	172	179.3

Table 2. --(Continued)

Crop	Year	Pounds chlordane per acre	Green weight in pounds per plot				
			Plot A	Plot B	Plot C	Plot D	Average
Grass	1948	11	66	-	86	-	76.0
		19	74	-	93	-	83.5
		None	60	-	78	-	69.0
	1949	11	63	-	32	-	47.5
		19	61	-	26	-	43.5
		None	80	-	40	-	60.0
	1950	11	38	-	32	-	35.0
		19	41	-	24	-	32.5
		None	31	-	32	-	31.5
	1951	11	80	-	82	-	81.5
		19	72	-	74	-	73.0
		None	84	-	75	-	79.5

