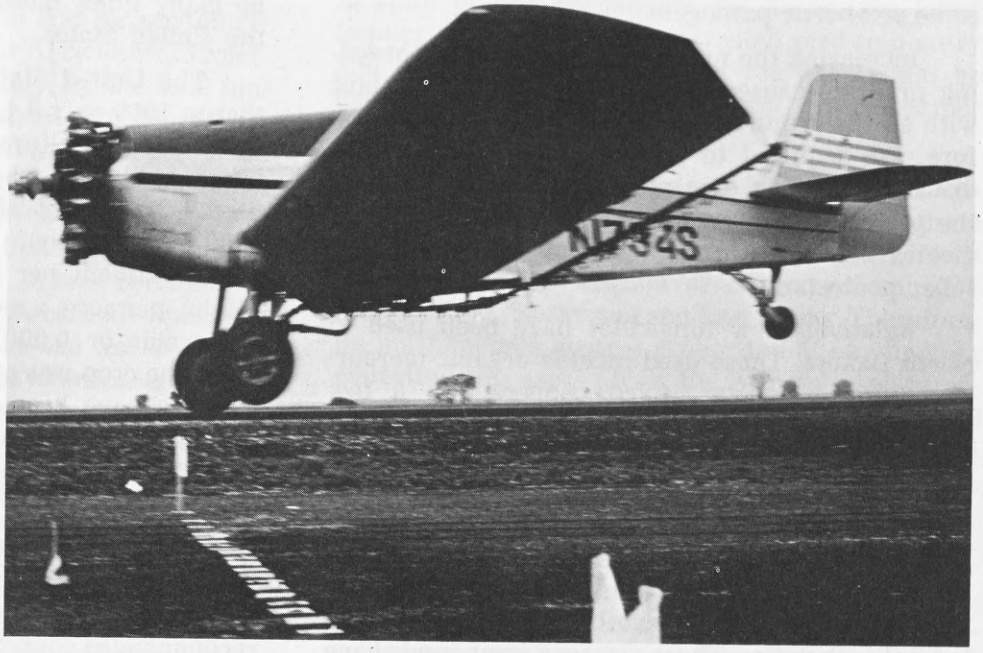

Spray pattern test for calibrating aerial application of liquid pesticides.

Fungicide Uses And Problems In North Dakota

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Fungi cause an annual loss of more than $50 million in North Dakota. This loss includes lower crop yield and quality and destroyed ornamentals, windbreaks, livestock and wildlife. Losses could and will become much greater if a constant effort is not made to use all available control measures to combat these plant diseases.

Plant disease controls include four major categories; (1) excluding the pathogen from the cropping area, (2) eradicating the pathogen from the area by physical or chemical means, (3) protecting the crop by some physical or chemical barrier, and (4) host resistance. All four of these control measures are currently used in North Dakota crop production, and no one method of control works on all diseases.

Biological control of plant diseases has been practiced in North Dakota since 1890. Resistant crop varieties have been selected or bred whenever the resistant genes in the host and the manpower to carry out the selection programs were available. Crop rotations are used to aid in plant disease control, but the limited types of crops grown in North Dakota also limit the effectiveness of plant disease control through the use of rotations. A plant disease organism often attacks several crops; e.g.,

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Helminthosporium sativum attacks wheat, durum and barley. Disease resistance is not always available, and crop rotations are ineffective against some soil-borne pathogens.

Increasing the number of factors in the breeding program causes problems in selecting a plant with all the required characters. Fungicides, therefore, are required to protect crops when neither disease resistance nor crop rotation can provide the protection required. The two main uses of fungicides in North Dakota are seed treatments and foliar protectants.

Relatively few fungicides have been used in North Dakota. Those used include organic mercuries, dithiocarbamates, fixed coppers and a few minor organic fungicides. Of the 19 agricultural chemicals listed in the Mrak Report as being potentially dangerous to man with recommendations for minimal exposure, four are fungicides used in North Dakota. These four are mercury-based compounds, Captan, Folpet and PCNB. Only the mercury-based compounds have been restricted by the federal authorities. These mercury compounds have been used in North Dakota to treat small grain, potato seed pieces and golf greens. The other three are used in small amounts. Captan and PCNB are seed treatments and Folpet is a rose fungicide.

In addition to using fungicides for plant disease control, these chemicals are used to prevent spoilage of manufactured products such as latex paints and to prevent mildew from developing on painted surfaces. Mercury compounds have been used to disinfect barns, potato storages, and laboratory benches. Mercury is present in many products used in North Dakota.

Mercury or its compounds have been used in laundry soaps, pharmaceuticals, water conditioners, plastics, paper products, electric supplies (switches, bulbs, wire insulation), cosmetics and dental work. Recently, uses of mercury in a few of these products were discontinued by the federal authorities; i.e., laundry soaps, latex paint and slimicidal compounds. Mercury is a natural ingredient in our world, and it is found in soil, air, water, coal and oil. One authority claims that 50 per cent of our mercury is discharged from rocks.

Emphasis has been placed in the news media on mercury pollution in Sweden, and the Swedish problem has been equated with the problem in the United States. In 1962, Sweden, with a land area of 173,349 square miles, used 625 metric tons of mercury fungicides. During the same period the United States, with a land mass of 3,612,808 square miles, used 777 metric tons of mercury fungicides. The rate of mercury used as fungicides in the United States in relation to land mass was only 5.5 per cent of the Swedish rate. This would indicate that when based on land mass the Swedish problem might be many times more severe than the problem in the United States.

The United States Bureau of Mines reported that in 1969 only 3.4 per cent of the mercury used went for agricultural purposes. Seed treatments, based on data by the NorAm Chemical Company, used 1.2 per cent of all mercury consumption in 1969. Based on their estimates of ½ oz. of mercury seed treatment per bushel and a seeding rate of 1¼ bu. per acre, a mercury equivalent of about 250 milligrams or 0.0001 ppm was applied per acre when the crop was seeded. About 0.02 to 0.04 ppm mercury have been found occurring naturally in the soil. Thus, the natural level is 200 times greater than the level applied through agricultural practices.

Non-mercurial seed treatment compounds have been tested at the North Dakota Agricultural Experiment Station since 1891 when H. L. Bolley recommended copper sulfate to control wheat bunt. Many of these materials were discarded because they were seriously lacking in some important requirement. Frequently these materials were expensive, ineffective and difficult to use. Mercury seed treatments have been effective and cheap and could be applied accurately to large volumes of seed grain with automated treaters.

Within the last two years, mercury seed treatments have been increasingly replaced by non-mercurial, organic fungicides such as Captan, maneb, PCNB, thiram, zineb, maneb + zinc ion complex, carboxin and streptomycin. The seed treatments used in the greatest amounts have been Captan, maneb + zinc ion complex, maneb and carboxin. Of the several crops grown in North Dakota, only hard red spring wheat, durum, barley and potatoes are treated with seed fungicides to any great extent.

Maneb, maneb + zinc ion, and carboxin break down readily in soil through the action of soil chemicals and microorganisms. PCNB and Captan are chlorinated hydrocarbons which may persist in the soil environment. However, the persistence of Captan varies in certain soil types and under some soil conditions. The use of persistent fungicides in the future will be limited in favor of the less persistent seed treatment fungicides such as maneb, carboxin and thiram. The dithiocarbamates are decayed by light, soil and organisms into carbon disulfide and other compounds.

Foliar fungicides are applied to wheat, durum, barley, potatoes and sugar beets to control foliar

diseases. Most of these foliar fungicides are of the dithiocarbamate or fixed copper types.

Plant pathologists have tested compounds for their efficacy in disease control and for phytotoxic properties at the North Dakota Agricultural Experiment Station since 1890. Usually, by the time fungicides are ready for testing at the experiment stations, the private companies that developed these fungicides have already run extensive mammalian toxicity tests and field and greenhouse disease control trials. Fungicides causing toxic plant responses, irritation to the applicator, or serious corrosion of equipment are usually soon discarded. Specifications for tests run to determine the toxicity levels of fungicides as well as their environmental effects are set by the federal government.

The incident of mercury poisoning in Alamogordo, New Mexico, in 1970 and other cases of mercury poisoning in the United States are inexcusable, both from the user's (persons affected) point of view and from the person involved in the misuse of the chemical or treated grain. However, of more importance is the fact that some users of seed treatment compounds in North Dakota have misused mercurial seed treatment compounds and other fungicides. Documented cases of mercury treated seed being used as feed for hogs and poultry in North Dakota in the last two years are on record. These misuses have continued even though the plant pathologists have conducted educational programs instructing against misuse of mercury seed treatments and other fungicides over the past 10 years.

One question is whether the users of fungicides understand the seriousness of using proper fungicide rates, correctly calibrated equipment, the proper fungicide for a specific purpose, and the best methods when disposing of unwanted treated seed and fungicide containers! We in plant pathology believe that our educational efforts to aid farmers in avoiding misuse of fungicides have been beneficial.

Our attempts to inform users about the proper use of fungicides have included such programs as calibration and pattern testing of airplanes so they would deliver the proper amount of fungicides on the target area, testing the quality of seed treatment on grain, personal instruction in cleaning and calibrating seed treatment equipment (industrial representatives and knowledgeable county agents have been involved in these programs) and instruction in fungicide use, toxicity and persistence.

In addition to circulars and printed material, adult education classes on fungicides have been held at winter extension meetings and during other conferences and workshops. Both radio and television programs on fungicides have been presented. In spite of our educational programs, the latest inquiry on feeding mercury treated seed to poultry and whether that poultry and the eggs could be used as food was received as recently as November 19, 1970.

Our efforts to decrease the misuse of fungicides has been directed toward the use of these fungicides. The need for using fungicides in North Dakota to protect certain of our crops and synthetics from disease and spoilage exists. Therefore, we must spend a greater proportion of our time on educating the users about the principles of fungicides; i.e., toxicity, breakdown or persistence, use around the home, and the use of fungicide treated products (pasteboard boxes, paints, clothing) as well as food products.

Fungicides are required annually as foliar protectants for potatoes and as seed treatments to control barley smuts. In seasons of severe disease development, sugar beets will have to be sprayed to control Cercospora leaf blight. Wheat and barley plantings also are sprayed in periods favorable for disease development to control leaf diseases. No satisfactory alternatives to the use of fungicides currently exist in most of these cases. Maneb + zinc ion complex, fixed coppers and zineb are used in these foliar spray programs. Several commercial apple orchards are being established in the state and will require periodic fungicide applications. Application of irrigation water will increase the disease hazards and the need for foliar fungicides.

Currently, the total area of all crops sprayed for foliar disease is about 160,000 acres. The cereal and beet acreages, receive only two applications a year, but potato acreages may receive three or four. This acreage of sprayed crops will increase under more intensive culture associated with irrigation.

Fungicides have not been recommended in North Dakota unless there was an established need. Their continued use in the future will depend upon the crops grown in the state and the cultural practices employed to grow these crops.

REFERENCES

Fowler, D. Lee, J. N. Mahan, and H. H. Shepard. 1969. **The Pesticide Review,** United States Department of Agriculture, Washington, D.C.

Knapp, Carol E. 1970. **Mercury in the Environment.** Environmental Science and Technology, 4: 890-892.

Rotem, J., and J. Palti. 1969. **Irrigation and Plant Diseases.** Ann. Rev. of Phytopathol, 7: 267-288

Torgeson, Dewayne C. 1967. **Fungicides. An Advanced Treatise.** Vol. 1 and II. Academic Press, N.Y.

United States Bureau of Mines. 1969. **Annual Preliminary Report.**