# PROGRESS REPORT ON USE OF MALEIC HYDRAZIDE FOR GRASS INHIBITION ON HIGHWAY AREAS

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THE SYNTHESIS of maleic hydrazide (MH) was first reported in 1895. The chemical was prepared and its unique growth-inhibiting properties on grasses were observed in our laboratories in 1949. Pure MH is a white crystalline material, slightly soluble in water. The salts must be properly formulated to secure an optimum plant response. The compound is not irritating to the operator. Pharmacological studies show that the sodium salt has a low toxicity by oral ingestion. Spray equipment used for application of MH can be readily flushed free of the chemical with water.

MH-sprayed plants are inhibited for varying periods, depending on dosage applied and stage of plant development at the time of treatment. The effect is most pronounced when young, vigorously growing plants are sprayed, whereas application of an equivalent dosage to plants approaching maturity may show little or no response. High dosages may be herbicidal. The action of MH has been attributed to an antagonism of naturally occurring plant-growth hormones. Many experimenters are evaluating MH for various uses. Some of the reported effects are prevention of suckering of tobacco; inhibition of sprouting of onions, carrots, and potatoes in storage; inhibition of hedges; and control of wild onions.

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## Outline of Highway Tests

The experiments with MH were conducted on the esplanade and roadside areas of the Wilber Cross and Merritt Parkway systems of Connecticut.[1/] Various formulations of the sodium and diethanolamine salts of MH were used. A total of 55 plots comprising 74 acres were sprayed between the period August, 1950, through October, 1951. The experiments were designed to: (1) determine if MH might be a practical method of inhibiting grasses on highway areas to reduce maintenance costs by reducing the number of mowings, (2) determine the effect of dosage and time of treatment on degree of inhibition, and (3) to evaluate equipment for practical application of MH.

Plots were sprayed in August, 1950 and May 1951 to determine if MH might be practical for inhibiting grasses on the esplanade and roadside areas. Grasses on the esplanade were predominately fescue, red top, and clover, and along the roadside witch grass, timothy, foxtail, and fescue.

On August 23, 1950, two 0.1-acre plots on the esplanade were sprayed with 4 and 8 lb. of MH per acre with low-pressure, low-volume apparatus. Two similar plots of roadside were treated with 8 and 16 lb. of MH per acre. The 4-lb. level saved five mowings to the end of the season and the sprayed plots were equal to the check plot in appearance. The 8 and 16-lb. MH plot inhibited growth but produced some browning of the grasses. The following spring and summer the 4-lb. plot was green and vigorous. The higher dosages showed some thinning effect which filled in later in the summer. There was no evidence of a residual effect of MH in the soil.

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1/ - John L. Wright and William G. Greene of the Connecticut State Highway Department initiated the experiments with MH for grass inhibition on highway areas. Their assistance in developing equipment and interpreting results is acknowledged.

On May 2 and 3 a total of twelve 1-acre plots were sprayed at 2 and 4 lb. of MH per acre with a hydraulic sprayer operating at 400-lb. pressure delivering 50 gal. of water per acre at 12 mph. A specially designed nozzle throwing a fan spray over a 10-ft. swath was used. The plots on the esplanade contained checks adjacent to the MH treatments which were routinely mowed according to standard maintenance procedure and other checks which were not mowed, to fully evaluate the effect of the MH.

Three weeks after the spray was applied to the esplanade, there was little apparent difference in height of the sprayed grass and adjacent controls. These observations were very discouraging and it was felt at the time that MH treatments would be of little use. The tests on the esplanade were abandoned and the areas were all mowed on May 23. One month after mowing, maintenance workers reported that regrowth of MH-treated plots was markedly inhibited and interest in further application of MH on the esplanade was renewed. The reason for the difference in response between the late summer and May treatments is not clear at this time.

There is a lag of about two weeks before the effect of MH applications becomes noticeable. The plots treated during the slow growing period in August showed a direct response whereas during the period of rapid growth in the spring, the inhibition was observed after mowing.

All treatments on the esplanade showed varying degrees of inhibition after mowing. Plots most effectively inhibited were those treated with 2 lb. of MH as diethanolamine salt specially formulated with wetting and sticking agents. It was necessary to mow these sprayed plots twice during the season, once on May 23 and a second time on July 17, whereas adjacent checks were mowed 19 times. The cost of spraying the MH plots based on pilot plant production was $10 per acre. This treatment saved approximately $70 per acre per season on the total labor and equipment cost for mowing adjacent checks 17 times. The grass in the sprayed plots was equal in appearance to the mowed plots throughout the season.

Some of the plots were infested with wild carrot, Daucus Carota, and narrow leaf plantain, Plantago lanceolata. MH at the dosages used had a less inhibiting effect on these two weeds than on grasses. The presence of these weeds gave the treatments a ragged appearance. Later experiments were conducted using a mixture of 2,4-D with MH for control of these weeds. It was observed that clover developed a red anthocyanin coloration of the foliage which was not evident a short time later.

The application of MH at the 2-lb. level to roadside grass in May showed no inhibition even after mowing. One-acre plot sprayed with the sodium salt of MH containing wetting agent and sticker at 4 lb. per acre inhibited the grasses for three months. The grass in the treated plot remained at a 10-in. height whereas the check grew to 45 in.

Since some of the applications of MH in August and May showed a desirable inhibiting effect, sprays were applied to different plots at 4 lb. of MH per acre each month from June through October to determine if there was a variation in response during the year and to select the best equipment for practical use. Variations in pressure, volume of liquid per acre, and choice of nozzles were evaluated since differences between treatments appeared when equivalent dosages were applied with different types of equipment.

Details of these tests will not be reported. The low-pressure (50-lb.) low-volume (40 gal. liquid per acre minimum) apparatus fitted with a ten-nozzle[2/] boom

2/ - Spray nozzle No. 6504, Spraying Systems Co., Randolph St., Bellwood, Ill.

proved most satisfactory for applying MH to the esplanade (Fig. 1). A minimum application of 40 gal. of liquid per acre was found desirable since there was an indication that less response resulted when a lower volume of water per acre was used.


Figure 1. Spraying MH on the esplanade at 50 lb. pressure, 40 gal. of liquid delivered at 5 mph.

Application to cover the roadside was found to be most feasible by use of a nozzle[3/] mounted to deliver a 10-ft. swath over the guard rail and along the roadside. A minimum application of 50 gal. of liquid per acre was found desirable. Satisfactory results were obtained at pressures of 50 to 200 lb. with appropriate variations in nozzle tips and rate of travel to deliver 50 gal. per acre (Fig. 2).

About 60 percent of the plots treated from June through October with variations in equipment and formulations showed a desirable degree of inhibition at the 4-lb. dosage level. The failures were attributed either to improper formulations or to inadequate coverage with the equipment used.

MH applied at 4 lb. per acre to separate plots in June, July, and August showed an equivalent growth-inhibitory effect. In these treatments wild carrot and narrow leaf plantain were only partially inhibited, as was reported for the May results. Some trials were made in August combining an amine salt formulation of 2,4-D at 1½ and 3 lb. per acre with MH as diethanolamine salt at 4 lb. per acre. Observations of these plots in September indicated that the weeds were effectively controlled with 2,4-D at 3 lb. per acre, and MH offered good inhibition of the grasses. Examples of results of several of these trials in June and July will be cited.

3/ - Off-center spray nozzle filled with OC80 tip.

Figure 2. Spraying MH on roadside areas at 200 lb. pressure, delivering 50 gal. of liquid per acre at 10 mph.

Applications to 8 acres of roadside area on June 5 at 4 lb. of MH per acre satisfactorily inhibited the grasses through the season, but three mowings were necessary to check weed growth. Controls were mowed 6 times during the season.

A spray applied to two acres of esplanade on July 27 saved 7 mowings to the end of the season. Treated grasses were 1½ to 2 in. high while grasses in adjacent controls were 7 to 8 in. high on October 2.

A spray of 4 lb. of MH plus 3 lb. of 2,4-D as amine salt was applied August 7 to 2 acres of roadside heavily infested with wild carrot and plantain. The weeds were eliminated and in an observation on October 2 the treated grass was 5 in. high whereas grass in adjacent untreated controls was 8 in. high.

Summary:

1. MH offers promise as a temporary growth inhibitor of grasses on highway areas.

2. Application of 2 or 4 lb. of MH per acre in the spring at the start of the growing season is suggested for grasses in the ~~esplanade~~, and 4 lb. per acre along guard rails and roadsides. Application to esplanade and roadside areas at 4 lb. per acre is suggested for the rest of the year. The optimum time of a treatment has not been fully evaluated. In these trials, the most pronounced response at a minimum dosage resulted when applications were made at the start of the growing season in early May. Little variation in response was evident at equivalent dosages in monthly treatments to different plots from June through September. Plots were sprayed in October just prior to dormancy to determine if there might be inhibition the following spring and are planned in April prior to the active growing period.

3. If weeds such as plantain or carrot are present, dosages of 2,4-D, recommended for their control in specific areas, should be included with MH.

Figure 3. Close-up view of Figure 2.

5. Since the effects of retreatment have not been fully evaluated, MH-treated plots should not be sprayed a second time during the same season.

6. Application of MH to grass which has not been cut is preferred in order to give a large absorption area of green foliage. One week should be allowed for the MH to be absorbed and translocated before the grass is mowed.

Factors which should be more fully evaluated are effect of dosage on winter survival of various grasses, effect of retreatment during the same season and in successive seasons, and optimum dosage and time of year for the best inhibition of various grass species.

## DISCUSSION

**QUESTION:** In using the chemical to prevent sprouting of onions, for example, is there any possibility of poisoning persons who eat such vegetables?

**ANSWER:** Tests of chemicals on food crops require two to three years for certainty. Our tests so far indicate that 5 percent of maleic hydrazide has no effect whatsoever on cows. Full details will have to await years of tests. We are now encouraging use in nonfood crops and vegetation.

**QUESTION:** What are present costs of the material?

**ANSWER:** At present about $5 per lb. This cost will be very greatly reduced in future years. At present, the company is mostly interested in how to use the chemical to best advantage.

**QUESTION:** Is there any reason why, if maleic hydrazide was applied to grasses 5 to 6 in. high (instead of 8 to 10 in., as shown in the slides) greater injury to grass plants might result?

**ANSWER:** Oh, no! As indicated, we still do not know all these relationships. We have tried the chemical on grasses in the fall to see if effects of the spray would carry over to spring. Height at maturity of grass growth seems to be immaterial as regards effects on the plants.

QUESTION: Is the material effective in inhibiting growth of all grasses, or are there kinds of grasses not affected by maleic hydrazide?

ANSWER: We find that the chemical is most effective on young grasses; after grasses have gone to seed, more chemical is needed. Rain or dew immediately following application seems to remove it from the grass plants. We have overcome this to some extent.

QUESTION: Has the chemical been used on lespedeza and other legumes?

ANSWER: No.

QUESTION: Does the chemical have effects upon seed production of grasses? In some cases we try to get certain grasses to reseed themselves.

ANSWER: Oh, yes! If applied before seed is produced, the terminal growth of the grass will not develop and no seed will be produced. Johnson grass and crabgrass are thus controlled.

QUESTION: In some instances you apply chemical in spray. The effects last till August. Would the grass produce any seed?

ANSWER: The grasses may recover if chemical is applied, say, in May or early June. Then seed will be produced. If applied in August there will seldom be time for the grasses to recover for seed production.

QUESTION: You cannot determine period of recovery required?

ANSWER: No. Rate of recovery will be dependent upon season, rainfall, kind of grass, and other factors.

QUESTION: Are there harmful effects as to drip of this material on valuable plants, say outside of a highway right-of-way?

ANSWER: No. A certain quantity of chemical is needed to inhibit growth. Maleic hydrazide is not like 2-4-D in that a little spray will do serious damage to plants. On woody plants we do not get much penetration, as yet. By drilling holes and putting in the chemical, woody plants are inhibited in growth.

QUESTION: Have counts of grass plants been made before and after spraying to find out actual percentage of grass plants killed by this chemical in normal use?

ANSWER: If dosage is run up to 20 to 30 lb. per acre a large percentage of grass plants may be killed. Application of 2 lb. per acre seems to kill few plants, if any at all. No actual counts of measured plats have, however, as yet been made before and after spraying.

DR. GRAU: Tests at Beltsville, Maryland, seem to indicate that certain strains of grasses are much more susceptible to effect by maleic hydrazide than are others. Investigation is necessary before going too far in the use of this chemical.

QUESTION: If you stop growth, are you also inhibiting root growth of grass plants?

ANSWER: The chemical goes to a concentration in the growing parts of the plant. Possibly the tops are affected more than the roots in spring. We suggest both roots and top growth may be inhibited, however, at different times of the year.