Proceedings of the Iowa Academy of Science

Volume 67 | Annual Issue Article 18

1960

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Alteration of Symptom Expression In the Cereal Rusts[1]

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Abstract. Cheyenne wheat was treated with varying concentrations of maleic hydrazide and indoleacetic acid in separate and combined applications. Lower concentrations of maleic hydrazide have an inhibitory effect upon germination of wheat seeds and vegetative growth but a stimulatory effect upon uredial pustule development of the leaf rust fungus (*Puccinia recondita* Rob. ex Desm.). Higher concentrations of maleic hydrazide further inhibit germination and vegetative growth of the host plant, but also inhibit development of the leaf rust fungus. Indoleacetic acid has a stimulatory effect on vegetative growth of the wheat plant at rather low concentrations. At the same time it tends to suppress the inhibitory action of heavier concentrations of maleic hydrazide on the leaf rust fungus when the two are applied in combined treatments.

Maleic hydrazide has been shown to inhibit mitotic cell division and growth rates in vegetative tissues (Greulach and Atchison, 1950). It has been shown further that maleic hydrazide inhibition of vegetative growth is decreased by the presence of auxins (Leopold and Klein, 1951, 1952). The effect of maleic hydrazide was shown by Andreae (1953, 1954) to be associated with increased indoleacetic acid oxidation. Several investigators have reported an increase in uredial pustule size of rust fungi on wheat plants treated with maleic hydrazide (Bromfield and Peet, 1954; Lyles, 1957; Forsythe, 1957). In most cases the pustule type was found to be of a clearly more susceptible type.

Studies reported here were initiated in 1957 to investigate the relationships between maleic hydrazide and indoleacetic acid as growth regulants altering uredial pustule formation in the cereal rusts, particularly *Puccinia recondita,* the incitant of wheat leaf rust.

MATERIALS AND METHODS

The host plant selected for use in this study was Cheyenne wheat (C. I. 8885), a winter variety susceptible to most physiologic forms of the wheat leaf rust fungus (*Puccinia recondita* Rob. ex Desm.). Although several physiologic forms of the fungus were studied at various times, a pure culture of physiologic race 15 was used in the

[1]This investigation was supported in part by a research grant from the AAAS through the IOWA ACADEMY OF SCIENCE, and by funds from the ESSO Education Foundation.

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studies reported here. There were no essential differences between the various races studied with regard to the effects of the growth regulants involved.

The formulation of maleic hydrazide used was MH-30, a solution of maleic hydrazide as diethanolamine salt containing 30.0 per cent MH acid equivalent by weight.[3] Indole-3-acetic acid was obtained from commercial supply houses and used in aqueous solution.

Wheat plants were grown in 3-inch paper cups in the greenhouse. Maleic hydrazide (hereafter denoted as MH) solutions were applied as a drench treatment one week following planting time. Indole-acetic acid (hereafter denoted as IAA) solutions were applied at several stages of seedling development in both drench and foliage spray applications. Uptake of IAA as observed in the effects on plant growth was very erratic as a drench treatment, and results were far less dependable than with foliage sprays. For this reason, only results of spray applications are included in this paper.

Inoculation with the leaf rust fungus was made from uredospore cultures on seedling plants. Spores from the seedlings were distributed uniformly on the experimental seedlings following a moistening of the leaves with distilled water spray. Following inoculation the plants remained in a moist chamber for a period of 12 hours. Symptom expression was fully developed from 10 to 12 days following inoculation, and at this time developing uredial infection types were rated according to the scale developed by Mains and Jackson (1926). In this scale a rating of 4 indicates a very susceptible type pustule; 3, moderately susceptible; 2, moderately resistant; 1, very resistant; and 0, highly resistant with no uredial formation.

Elongation of primary and secondary leaves, color of leaf tissue, pustule size, and uredospore size measurements were taken throughout development of the host plant and of the disease symptoms where inoculation was used. No data are included of studies beyond the seedling stage of plant development.

Results

Germination and growth of vegetative tissue in wheat is significantly inhibited as the concentration of MH is increased (Table 1). In preliminary investigations six levels of concentration were employed: .250, .200, .125, .100, .050, and .010 per cent aqueous solutions. At all concentrations beyond .010 per cent the germination was reduced below the 60 per cent level while controls germinated above 80 per cent in every case. Elongation of the primary

[3]MH-30 was supplied through the courtesy of United States Rubber Company.

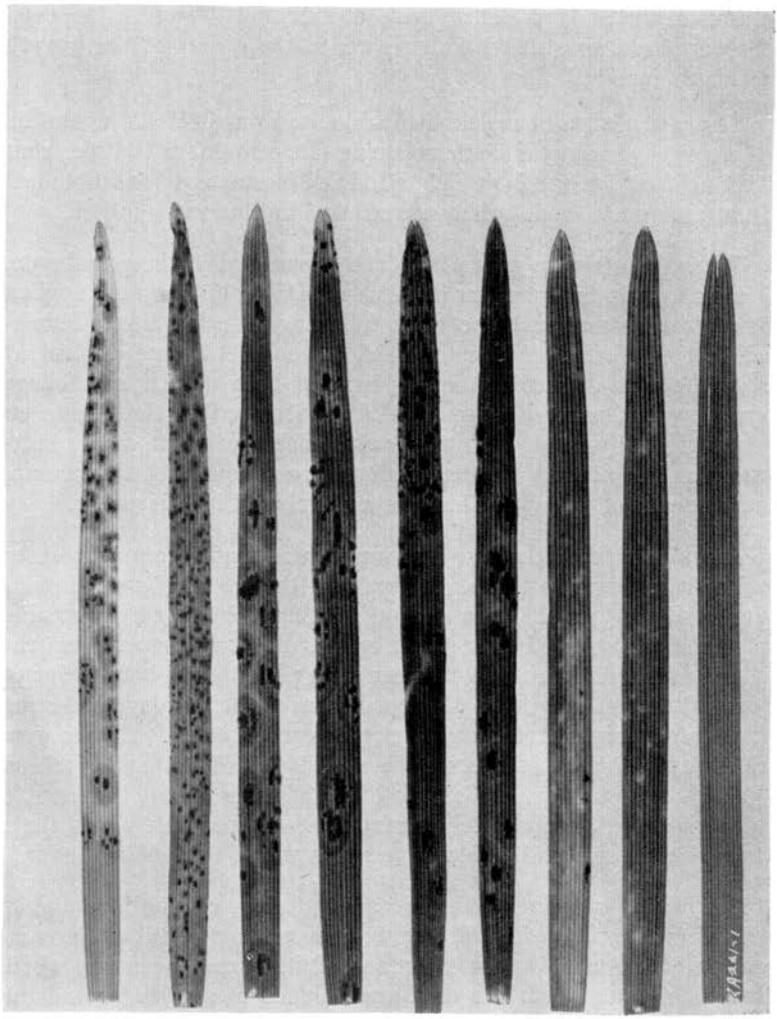

Figure 1. Effect of maleic hydrazide on symptom expression of leaf rust (*Puccinia recondita*) on Cheyenne wheat. From left to right: Untreated check. .010% .050%, .075%, .100%, .125%, .200%, .250%, and uninoculated-untreated check.

leaf blade was inhibited in a similar, though more pronounced fashion as the concentration of MH was increased. At heavier concentrations death of the seedling plant occurred in most cases prior to appearance of the second leaf.

With concentrations of MH from .050 to .200 per cent the coloration of seedling leaves was altered from normal yellow-green to a deep blue-green, and in nearly all cases the degree of color intensity was closely correlated with development of type 4+ pustules at least two times the normal size (Figure 1). At concentrations be-

Table 1

Effect of Maleic Hydrazide on Germination and Primary Leaf Elongation in Cheyenne Wheat

	Maleic Hydrazide Concentration (Percent Solution)						
	Check	.010	.050	.100	.125	.200	.250
Per Cent Germination	86	78	62	51	49	19	21
Average length of first leaf (cm.)	7.3	7.5	3.9	3.1	1.9	.9	.9

yond .200 per cent the leaves developed extreme chlorosis in a few days, and pustule types were of the moderatly resistant type 2.

Although some evidence was obtained that MH influenced the size of uredospores produced on treated plants, the size range fell within the limits of variability described for *P. recondita*. The appearance of the extremely large pustules in the treated plants was due to a more extensive spore production and greater enlargment of the pustule itself.

Four levels of IAA were applied in preliminary tests at concentrations of 5, 10, 25, and 50 parts per million. Spray applications at 50 ppm resulted in severe damage to leaf tissue, and essentially no differences were apparent at the three lower concentrations. For this reason only the 5 and 25 ppm levels of concentration were used in subsequent investigations. Measurements of the length of the first leaf for each plant were taken at the time of IAA application and 10 days after inoculation. Length of the second leaf was also determined 10 days after the IAA application. Foliage application of IAA resulted in a stimulation of leaf blade elongation in both the first and second leaf stages (Table 2). In addition the treated

Table 2

Effect of Indole-3-Acetic Acid on Leaf Elongation in Cheyenne wheat

	IAA Concentration		
	Check	5ppm	25ppm
First leaf at time of treatment	7.4*	7.2	7.1
First leaf 10 days from treatment	9.1	10.7	10.5
Second leaf 10 days from treatment	15.8	18.5	18.7

*(in cm. units)

plants appeared lighter than normal in color. Infection types on IAA treatment plants were not significantly different from those on untreated plants.

Combination treatments using MH and IAA produced interesting effects in development of rust pustules. Initial tests indicated no measurable differences in response due to relative times of application of either MH or IAA. Applications were made at intervals of 1, 2, and 3 days following rust inoculation, but in all cases the differences due to time of application after inoculation were negli-

gible. Using low concentrations of MH the pre-MH-treatment or post-MH-treatment with IAA produced no change from the large type 4 pustule seen with MH alone. However, at the .250 per cent level of MH, both pre-MH- and post-MH-treatments with IAA enhanced uredial pustule development, resulting in a moderately to very susceptible type 3 or 4 pustule instead of the moderately resistant type 2 pustule observed with MH alone (Table 3). There

Table 3

Effect of Maleic Hydrazide Separateiy and in Combination With Indole-3-Acetic Acid on Pustule Type of Leaf Rust (*P. recondita*) on Cheyenne Wheat

	Method of IAA	Maleic Hydrazide Concentration				
IAA ppm	Application	Check	.010	.050	.125	.250
Check	pre-MH	3+	4—	4	3+	2
Check	post-MH	3+	4—	4—	3+	2
5	pre-MH	4—	4	4	4—	3
5	post-MH	3+	4	4	3+	3+
25	pre-MH	3+	4	4	4—	4—
25	post-MH	3+	4	4	4	4—

Reaction types (Mains and Jackson, 1926)

0 = Completely resistant
1 = Very resistant
2 = Moderately resistant
3 = Moderately susceptible
4 = Very susceptible

is a decided indication that the effect of MH in inducing a resistant type rust reaction at higher concentrations is reversed by application of IAA. This is further evidence of the activity of MH as an anti-auxin and of the "antagonistic" relationship between effects of these two materials on vegetative development in plants.

In addition to the effect of increasing susceptibility of wheat plants to the rust fungus, it was demonstrated that MH may also enhance resistance when used in high enough concentrations. The dual role in increasing susceptibility or resistance due to MH treatment is not well understood and warrants further investigation.

Literature Cited

Andreae, W. A. and Andreae, C. R. 1953. Indoleacetic acid metabolism. Can. Jour. Bot. 31: 426-437.

Andrae, W. A. 1954. Effect of maleic hydrazide on IAA oxidase activity and growth. Chem. Abst. 48: 11565.

Bromfield, K. R. and Peet, E. E. 1954. Chemical modification of rust reaction of seedling wheat plants infected with *Puccinia graminis tritici*. Phytopathology 44: 483.

Forsythe, F. B. 1957. Effect of ions of certain metals on the development of stem rust in the wheat plant. Nature 179: 217-218.

Greulach, V. A. and Atchison, E. 1950. Inhibition of growth and cell division in onion roots by maleic hydrazide. Bul. Torrey Bot. Club 77: 262-267.

Leopold, A. C. and Klein, W. H. 1951 Maleic hydrazide as an anti-auxin in plants. Science 114: 9-10.

Leopold, A. C. and Klein, W. H. 1952. Maleic hydrazide as an anti-auxin. Physiologia Plantarum 5: 91-99.

Lyles, W. E. 1957. The effect of plant growth regulators on the response of wheat varieties to leaf rust. Proc. of the Plant Physiology Meetings, Stanford, California, p 43, August.

Mains, E. B. and Jackson, H. S. 1926. Physiologic specialization in the leaf rust of wheat, *Puccinia triticina* Erikss. Phytopathology 16: 89-120.