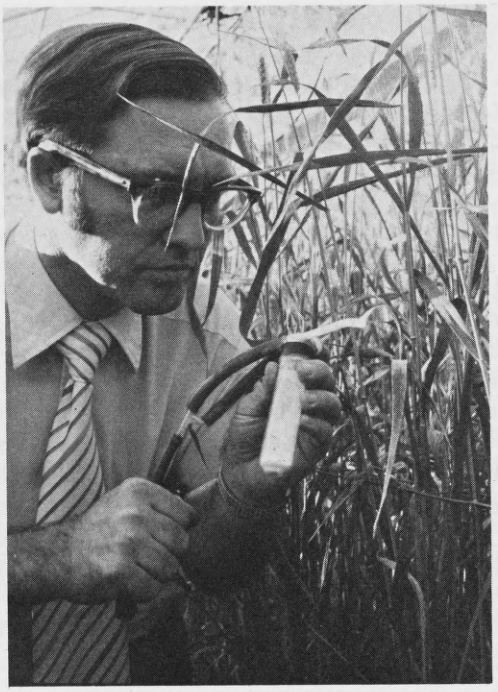

Dr. Statler inoculates test wheat plants in his greenhouse laboratory.

THE RELATIONSHIP OF LEAF RUST INFECTIONS AND WHEAT YIELDS

Glen D. Statler

Leaf rust can cause costly yield reductions in the wheat growing areas of the U.S. and Canada when conditions are favorable for rust development. This study attemtps to evaluate losses from leaf rust in spray trials using fungicides to control the disease on susceptible and moderately susceptible wheat varieties.

Introduction

Leaf rust, caused by the fungus **Puccinia recondita,** is potentially one of the most destructive diseases of wheat. In 1967, yield losses in the spring wheat areas of the United States and Canada were estimated at 40 million bushels annually (4). Yield reductions are correlated to rust severity and the stage of plant development. Less damage is caused when more mature plants are infected (1). Destruction of leaf tissue and rapid desiccation of rusted leaves are the cause of yield reduction. Leaf rust not only reduces yield, but also grain quality (5).

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Methods and Materials

Spray trials were conducted at several North Dakota locations to evaluate the potential de-

structiveness of the leaf rust fungus. A split-plot design with four replications was the standard design. Half the plots were treated with a fungicide to control wheat leaf rust. Each plot consisted of two 10-foot rows trimmed to 8 feet, with one row of the rust-susceptible variety Thatcher bordering each plot. Slight modifications of this design were made to conform to planting equipment at various stations.

Results and Discussion

In 1971, yield increases of 11.9 bu/A were reported when leaf rust was controlled in drill strip plots of Thatcher with Manzate 200 (maneb + zinc ion) and 5.8 bu/A when rust was controlled on Manitou (6). Since Manzate 200 controls leaf rust as well as leaf spotting diseases, another trial was established to determine the effect of only leaf rust on yields. Ten varieties were sprayed with RH-124 (Rohm & Haas 4-n-Butyl-1, 2, 4- triayole) which controls only leaf rust of wheat. In this trial, rust was more severe than in drill strip plots, and yields were increased in the sprayed plots an average of 14.2 bu/A for Thatcher, 9.7 for Manitou, 7.9 for Selkirk, 3.0 for Rolette, and 3.4 for Waldron. Yield differences were nonsignificant for the other varieties tested. Since Waldron is resistant to leaf rust, the 3.4 bu/A increase cannot be explained by leaf rust control. Protein was increased by 0.5 per cent for Thatcher, 0.7 per cent for Manitou and 0.5 per cent for Chris, but decreased by 0.8 per cent for Justin. Results from the 1972 trials indicated that protein could usually be increased significantly only when rust was controlled on susceptible varieties.

In 1972, RH-124 was applied at 0.4 lbs. active ingredients/acre to half the plots in a split-plot design using 10 varieties. Although RH-124 only partially controlled rust at this rate, it significantly delayed rust development. Yields were increased by 8.7 bu/A for Thatcher and 9.5 bu/A for Manitou, but were nonsignificant for the other varieties (Table 1).

Table 1. Yields and Leaf Rust of Wheat Sprayed with RH-124 in 1972

	Leaf Rust	Sprayed Minus Unsprayed Yield Bu/A	500 K.W.	Protein
Thatcher	77S	8.7	.16	.12
Manitou	65S	9.5	.51	.43
Fortuna	44S	1.9	.00	.00
Justin	40S	0.0	.64	.00
Chris	14S	0.5	.00	.04
Waldron	tS	0.0	.41	.13

To determine if different severities were related to yield, several different applications of protectant-type fungicides were applied to Manitou to get varying rust severities. Yields were increased considerably in plots when rust was partially controlled. Yields were 32 bu/A in plots in which rust was not controlled, and up to 40 bu/A in plots where rust was reduced with fungicides (Fig. 1). Kernel weight was increased significantly in plots where the average final rust rating was less than 42S, but not in plots with higher evaluations including the unsprayed control.

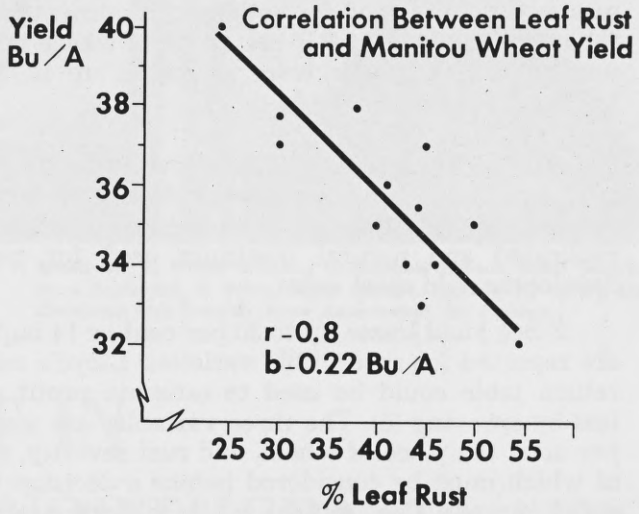

Figure 1. Correlation Between Leaf Rust and Manitou Wheat Yield.

The correlation coefficient 'r' was -0.84 and significant (.01 level) indicating a high degree of correlation between increased rust severity and reduced yields. The regression coefficient 'b' was -0.21 indicating that for each unit increase in leaf rust, yield decreased 0.21 bu/Acre.

In 1973, spray trials with RH-124 were continued to evaluate losses attributable to leaf rust. Good rust control was obtained at Minot through the soft dough stage, but not at mid-dough, using RH-124 at 6 oz/A. Although RH-124 did not control rust the entire season, delaying rust increased yields by 9.1 bu/A for Fortuna, 8.6 bu/A for Thatcher, 5.3 bu/A for Tioga, and 3.2 bu/A for a sawfly experimental. The yield of the resistant variety Waldron was not increased (Table 2).

Two rates of the seed treatment formulation (1 and 2 oz/100 lb) and three rates of foliar spray (1, 2 and 4 oz/A) were evaluated at Carrington and Fargo in 1973. The Fargo plots had wind and drought damage, thus causing yield components

Table 2. Average Yields and Leaf Rust Ratings of Five Wheat Cultivars Sprayed with RH-124 Compared to Untreated at Minot in 1973

	Yield Bu/A Increase S-U	Leaf Rust Soft Dough Rating-U	Soft Dough % Control	Leaf Rust Mid-Dough Rating-U	Mid-Dough % Control
Waldron	0	tS	—	tS	
Thatcher	8.6**	40S	95	70S	40
Tioga	5.3*	23S-1MR	92	30S-3R	43
Experimental	3.2	12S-1R	83	18S-5R	61
Fortuna	9.1**	18S-1MR	89	33S-4R	30
*LSD .01 = 5.938***	*Sprayed with RH-124 - 6 oz/A*				
*.05 = 4.335**					

to be invalid. Leaf rust control was fair to good, especially with the higher rates of the foliar application. In irrigated plots at Carrington, control was moderate to good for both seed treatment and foliar applications of RH-124. In plots where rust was controlled, yields were increased up to 9.1 bu/A for Manitou.

Although the results of the above experiments are from plots, data should be applicable to large field situations since the plots were randomized, replicated and natural inoculum used for rust development in most cases.

Since yield losses up to 30 per cent or 14 bu/A are reported for susceptible varieties, Lloyd's cost return table could be used to estimate profit or loss by spraying (3). The three variables are yield per acre, the price of wheat, and rust severity, all of which must be considered before a decision to spray is made. Cost returns in the following table are based on a potential yield of 45 bu/A and wheat at $4.57 per bushel, the 30-day Fargo average price in December, 1973.

Table 3. Net Profits for Controlling Foliar Diseases by Fungicides

% Loss	Bu/A	Net Return/Acre[1]
0	45	—
5	43	$ 3.59
10	41	$12.73
20	36	$35.58
30	31	$58.43

[1]*Net return is yield increase times $4.57 per bushel, minus the two applications of protectant fungicide ($5.55/A)*

Since the foliar protectants presently on the market control not only leaf rust but also leaf spots (2), the present market value of wheat should make fungicidal control economically sound when leaf rust susceptible varieties are grown. This is particularly true in the eastern part of the state where conditions are normally more favorable for rust than in the west. Nevertheless, losses from rust can occur in the west, especially if susceptible varieties are planted and rust-conducive conditions prevail.

Data collected from spray trials conducted in North Dakota clearly indicate the destructiveness of wheat leaf rust when susceptible varieties are planted. The data also indicate a clear relationship between rust severity and yield loss and between the rate of rust development and yield loss. Since leaf rust is associated with yield loss, rust-susceptible varieties should not be planted with the present market value of wheat. Although we may not have sufficient data to project yield loss for the entire state, we know that rust can reduce yields up to 30 per cent when susceptible varieties are severely rusted. We also know that environmental conditions are favorable for rust development each year in certain parts of the state. This indicates that the development and use of disease control practices such as resistant varieties in North Dakota will be worth millions of dollars annually.

References

1. Caldwell, Ralph M., H. R. Kraybill, J. T. Sullivan and Leroy E. Compton. 1934. **Effect of Leaf Rust (Puccinia triticina) on Yield, Physical Characters, and Composition of Winter Wheats.** Journal of Agricultural Research 48: 1049-1071.
2. Hosford, R. M., Jr. 1971. **Wheat Leaf Blight and Blotch - Losses and Control.** North Dakota Farm Research. 29:1, 5-8.
3. Lloyd, E. H., Jr. 1972. **Some Effects of Disease Control on Income.** North Dakota Annual Agr. Conference and Short Course. 167 pp.
4. Loegering, W. Q., J. W. Hendrix and L. E. Browder. 1967. **The Rust Diseases of Wheat.** U.S.D.A. Agr. Handbook No. 334. 22 p.
5. Mains, E. B. 1930. **Effect of Leaf Rust (Puccinia triticina Eriks.) on Yield of Wheat.** Journal of Agricultural Research. 40:417-445.
6. Statler, G. D. 1971. **The Virulence and Potential Destructiveness of Wheat Leaf Rust in North Dakota.** North Dakota Farm Research 29:2, 7-10.