Amelioration of Tan Spot-Infected Wheat with Nitrogen

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ABSTRACT

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Effects of nitrogen rate and form (0, 55, 110 kg/ha with and without nitrapyrin) on severity of tan spot of winter wheat were evaluated in southern Indiana. The Ryker silt loam soil was conventionally tilled, and wheat cultivars Auburn, Caldwell, and Blazer (resistant, moderately susceptible, and susceptible, respectively, to *Pyrenophora tritici-repentis*) were planted in a randomized, complete block design field experiment. Nitrapyrin inhibited nitrification, prevented overwinter loss of nitrogen, and increased the proportion of ammonium nitrogen taken up by the plants. The severity of tan spot decreased and yields increased as the rate of nitrogen increased. Disease severity was reduced further by inhibiting nitrification. The number of infection loci was similar in all treatments; however, the rate of lesion development was markedly reduced as the nitrogen rate increased, and the pinpoint lesions developing on Blazer at the highest rate of stabilized nitrogen were similar to those on the resistant Auburn. This research indicates that both the rate and form of nitrogen influence the severity of tan spot of winter wheat and that nitrogen management may provide a cultural control of this disease.

Additional key words: integrated pest management, nitrogen stabilization

Tan spot, caused by *Pyrenophora tritici-repentis* (Died.) Shoem., has been observed frequently on wheat in Indiana during the past 3 yr. Its recent apparent increase may reflect the level of spring moisture during these years that enhances sporulation and disease development (7). The increasing frequency of wheat-soybean double cropping in which soybeans are planted in the standing wheat stubble and wheat is again planted after soybean harvest under minimum tillage conditions also may be a contributing factor (7).

A high incidence of tan spot was observed on wheat in nitrogen fertility plots and adjacent commercial fields conventionally tilled in 1984 at three locations in southern Indiana. Marked differences in disease severity were noted among the nitrogen plots in 1984. Data from this more detailed evaluation in 1985 of the effects of nitrogen rate and form on tan spot of three wheat cultivars differing in resistance to *P. tritici-repentis* are reported.

MATERIALS AND METHODS

Field plots were established on a conventionally tilled Ryker silt loam field (Typic Paleudalf), pH 6.0, as part of an ongoing USDA-Purdue University integrated pest management study near Madison, IN. The soil phosphorus (78 kg/ha) and potassium (460 kg/ha) levels were in the very high range for wheat. The previous crop in 1984 was soybeans, which followed a wheat-double crop soybeans sequence in 1983.

The soft red winter wheat cultivars Auburn, Caldwell, and Blazer were used because of their resistant, moderately susceptible, and susceptible reactions, respectively, to *P. tritici-repentis*. Auburn and Caldwell have similar genetic yield potential in the absence of tan spot (1). The wheat cultivars were planted 13 October 1984 in three-row-wide and 7.6-m-long plots on 16.5-cm centers after nitrogen application in a replicated (five times), random, complete block design. Three levels of nitrogen (0, 55, and 110 kg/ha) as anhydrous ammonia were applied 12 October preplant on 38-cm centers and 15 cm deep with or without 0.6 kg/ha nitrapyrin [2-chloro-6-(trichloromethy) pyridine] to inhibit nitrification. Nitrapyrin was injected into the flowing ammonia between the nitrogen flow meter and the manifold with a down-stream injection system (DecaH Mfg., West Point, IN.). These levels of nitrogen were selected to represent severe and moderate nitrogen deficiency and full nitrogen sufficiency for the plant. Because nitrification in this soil is quite rapid (4), inhibiting nitrification with the biologically specific nitrapyrin provided a means of evaluating both forms of nitrogen using the same initial nitrogen source. By inhibiting nitrification, the total availability of nitrogen for plant growth at each nitrogen rate was not comparable because nitrapyrin reduces leaching and denitrification losses of nitrogen and enhances the uptake of ammoniacal nitrogen by the wheat plant (2–4). Prior studies at this location indicate overwinter nitrogen losses of fall-applied, nonstabilized nitrogen range from 25 to 50% of the applied nitrogen (D. M. Huber, *unpublished*).

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Table 1. Effect of nitrogen fertilization on tan spot severity and yield of wheat in southern Indiana in 1985

Cultivar	Leaf necrosis (%)[a] with various rates and forms of N[b]					Yield (kg/ha) with various rates and forms of N[b]				
	0	55	55+	110	110+	0	55	55+	110	110+
Auburn	Tr	0	0	0	0	2,508	3,498	3,828	4,092	4,488
Blazer	75	30	10	20	3	1,848	2,442	3,168	2,772	3,432
Caldwell	30	14	0	4	0	2,772	3,366	4,092	4,158	4,488
BLSD[c]			8.3					323		

[a] Disease severity readings recorded at soft (early) dough stage of kernel development.
[b] Kilograms of nitrogen per hectare; + = nitrapyrin at 0.6 kg/ha added to anhydrous ammonia fertilizer.
[c] Differences between means for significance at $P = 0.05$ based on Bayesian LSD ($k = 100$) (6).

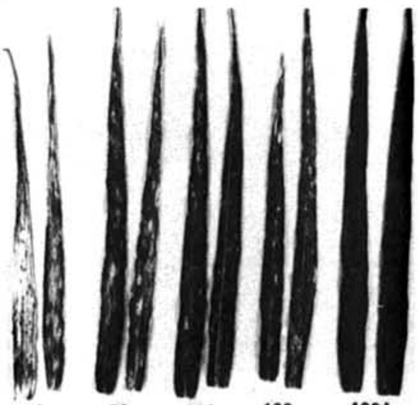

Fig. 1. Influence of rate and form of nitrogen on tan spot severity of Blazer wheat: 0 = no nitrogen, 50 = 55 kg nitrogen as NH_3/ha, 50+ = 55 kg nitrogen as NH_3 + nitrapyrin at 0.6 kg/ha, 100 = 110 kg nitrogen as NH_3/ha, and 100+ = 110 kg as NH_3 + nitrapyrin at 0.6 kg/ha.

Disease readings (percent flag leaf infection of 25 leaves per treatment replicate) were recorded at the soft (early) dough stage of kernel development. Thirty centimeters was trimmed from the ends of each plot, and the remaining area harvested with a small-plot combine at maturity for yield comparisons.

RESULTS

Neither form nor rate of nitrogen had a significant effect on severity of tan spot on Auburn, which had a high level of resistance to *P. tritici-repentis*. Infections remained as very small pinpoint lesions even under severe nitrogen stress. Blazer was very susceptible to *P. tritici-repentis*. On this cultivar, lesions coalesced and extensive chlorosis occurred at the lowest nitrogen level. Disease severity (percent tissue necrosis) decreased as the nitrogen rate increased, and lesion development was greatly reduced at the highest nitrogen rate (Table 1). Inhibiting nitrification reduced disease severity further, and many lesions failed to develop beyond the small, pinpoint stage, comparable to Auburn (Fig. 1). Caldwell's intermediate reaction was more similar to that of Blazer at the low nitrogen rates and to that of Auburn when nitrification was inhibited. Disease development progressed much slower (about 2-wk delay) in Caldwell than in Blazer.

Yield response to nitrogen was lowest with Blazer and similar for both Auburn and Caldwell with all nitrogen treatments. The effect of tan spot on yield was most apparent with Blazer at the high rate of stabilized nitrogen (Table 1). The effect of the form of nitrogen (inhibiting nitrification) was also most apparent with Blazer.

DISCUSSION

Tan spot was probably more severe in this study than is usually observed in southern Indiana because of the fall and late spring precipitation patterns that provided ample moisture for sporulation, dissemination, and infection (7). Because little wheat residue remained on the soil surface after tillage, the primary inoculum may have been produced on nearby grass borders and fence-ways. Little infection occurred before the late boot stage of plant development. This relatively late infection and delayed pathogenesis in Caldwell may account for the failure to observe a yield reduction in Caldwell compared with Auburn. The delayed pathogenesis in Caldwell may also indicate that yield is reduced only if disease is expressed relatively soon after anthesis, as observed with Blazer. Because there was no significant difference in the number of infection loci between treatments, nitrogen appears to influence disease severity primarily by delaying pathogenesis.

The striking effects of nitrogen in reducing the severity of tan spot imply a cultural control for this disease in which the greatest disease reduction with nitrogen was observed with the most susceptible cultivar. Resistance appeared to be mediated by nitrogen metabolism, and both susceptible cultivars appeared as resistant as Auburn when a greater proportion of ammoniacal to nitrate nitrogen was available at levels to provide full sufficiency for growth. Similar effects have been observed with Septoria leaf blight on wheat (5).

The resistance of Auburn, even under nitrogen stress conditions, compared with Caldwell and Blazer, may indicate that a different mechanism of resistance is functional with it or that the mechanism of resistance in Caldwell and Blazer requires a high level of metabolic activity inducible by nitrogen in the ammoniacal form.

Tan spot can be a serious disease of susceptible wheat cultivars grown in Indiana but may be reduced by effective nitrogen management. Control recommendations should also include sanitation and planting resistant cultivars.

LITERATURE CITED

1. Day, K. M., Buechley, G. C., Shaner, G. E., Huber, D. M., Scott, D. M., and Foster, J. E. 1985. Performance of public and private small grain varieties in Indiana, 1984. Agric. Exp. Stn. Bull. 454. Purdue University, W. Lafayette, IN.
2. Huber, D. M. 1980. The role of mineral nutrition in defense. Pages 381-406 in: Plant Disease. An Advanced Treatise. Vol. 5. How Plants Defend Themselves. J. G. Horsfall and E. B. Cowling, eds. Academic Press, New York. 534 pp.
3. Huber, D. M., Warren, H. L., Nelson, D. W., Tsai, C. Y., and Shaner, G. E. 1980. Response of winter wheat to inhibiting nitrification of fall-applied nitrogen. Agron. J. 72:632-637.
4. Huber, D. M., Warren, H. L., Nelson, D. W., and Tsai, C. Y. 1977. Nitrification inhibitors, new tools for food production. BioScience 27:523-529.
5. Raymond, P. J., Bockus, W. W., and Norman, B. L. 1985. Tan spot of winter wheat: Procedures to determine host response. Phytopathology 75:686-690.
6. Steel, R. G. D., and Torrie, J. H. 1980. Principles and Procedures of Statistics. 2nd ed. McGraw-Hill, New York.
7. Watkins, J. E., Odvody, G. N., Boosalis, M. G., and Partridge, J. E. 1978. An epidemic of tan spot of wheat in Nebraska. Plant Dis. Rep. 62:132-134.