STEM RUST IN THE SPRING WHEAT AREA IN 1878[1]

WHEAT WAS KING of crops in Minnesota in 1878, occupying nearly sixty-nine per cent of the cultivated area of the state.[2] Other small grains and livestock were relatively unimportant. Today, when livestock and its products constitute a major source of income for the state, and barley and oats are produced in greater quantity than wheat, the area devoted to wheat has diminished to approximately fourteen per cent. This marked decline in wheat growing has been brought about by various factors, among them, depredations wrought by diseases and insect pests. While everyone is familiar with grasshopper ravages, the less spectacular effects of plant diseases are not so well known, in spite of the tremendous losses which diseases cause. During the ten-year period from 1925 to 1934, for instance, grasshoppers caused an average annual crop loss in Minnesota of about $935,000.00,[3] while stem rust of small grains was estimated to be responsible for a loss five times as great, amounting to $4,505,594.00. Furthermore, this total represented the damage caused by rust in a period in which there were no major epidemics in the state. Since rust is essentially an epidemic disease, a certain amount of infection occurs each year. But in a year in which weather conditions are particularly favorable for rapid development and

[1] This study was made at the suggestion of Dr. E. C. Stakman, professor of plant pathology in the University of Minnesota and agent in the United States department of agriculture, for whose assistance the writer wishes to express appreciation.

[2] Edward V. Robinson, *Early Economic Conditions and the Development of Agriculture in Minnesota,* 79 (Minneapolis, 1915).

[3] J. R. Parker, *Summary of Losses and Expenditures Due to Grasshoppers in the United States during the Period 1925 to 1934,* 4 (Washington, 1936). This summary was issued in mimeographed form by the bureau of entomology and plant quarantine of the United States department of agriculture.

spread of the rust organism, a crop may be so badly attacked as to be virtually ruined. Under these circumstances rust sometimes causes a reduction in yield of spring wheat in Minnesota of as much as sixty per cent, and the grain that is produced may be so light in weight as to be almost valueless.

Adequate rust observations and loss estimates have been made in this country only since about 1917. Prior to that time, reports of rust are scattered, although there is record of destructive epidemics in 1904 and 1916.[4] Losses were so great in 1916 as to shake badly the faith that farmers still had in bread wheat and were among the factors that caused the complete abandonment of a considerable acreage of wheat in Minnesota. The epidemic of 1904, which was extremely destructive, has had the doubtful distinction of being the first stem rust epidemic in Minnesota. This distinction is undeserved, however, for examination of crop reports indicates that rust was present in epidemic proportions on spring wheat in 1878, and was severe enough to be an important factor in the failure of wheat in the area comprising southern Minnesota, northern Iowa, and Wisconsin, the most important spring wheat states at that time. With wheat growing at its peak in Minnesota, this epidemic struck one of the first blows at the supremacy of king wheat.

Early in the season of 1878 there were alluring prospects for an abundant harvest. Growth was luxuriant, as it was in the summer of 1938, stands were dense, and plants were tall and vigorous. On June 1 the condition of spring wheat was reported by the agricultural bureau as 106 per cent of normal in Minnesota and 110 per cent in Wisconsin and Iowa. Grain plants developed long heads of golden promise, and in thousands of farmers' pockets could be heard

[4] Mark A. Carleton, *Lessons from the Grain-rust Epidemic of 1904,* 1–7 (United States Department of Agriculture, *Farmers' Bulletins,* no. 219 — Washington, 1905); Harry B. Humphrey, "Cereal Diseases and the National Food Supply," in United States Department of Agriculture, *Yearbook,* 1917, p. 481–484 (Washington, 1918).

the gratifying clink of prospective dollars. Even as late as July 10 the estimated yield in Minnesota was nineteen to twenty bushels an acre.[5] Weather conditions that favored wheat during May and June, however, became unfavorable with the beginning of July, and the first three weeks of the month were characterized by excessive rainfall and heat over considerable areas of Minnesota, Iowa, and Wisconsin. During this period, apprehension began to be felt because of the danger of damage from heat and because stem rust had begun to appear. One Minnesota paper announced that "Hot, muggy, sweltering weather is having a bad effect upon the wheat crop . . . the greatest apprehension generally being from rust." By July 22, damage to wheat was estimated at twenty-seven per cent for Minnesota and Iowa, and seventeen per cent for Wisconsin. After a week's respite from the heat, beginning on July 20 — during which time local storms caused lodging of grain with consequent damage — high temperatures again prevailed, which hastened ripening in some sections; and harvesting itself was jeopardized by storms or by frequent rains. "To those unfortunate enough to own wheat fields in southeastern Minnesota and northern Iowa," according to the *St. Paul Pioneer Press* of July 29, "it will not be necessary to speak of blight and rust and general failure . . . it has for some days been too apparent to need reiteration here." Hopes for a golden harvest were finally blighted by yields averaging twelve bushels an acre in Minnesota, twelve and four-tenths bushels in Wisconsin, and nine and four-tenths in Iowa.[6] The poorest yields in Minnesota occurred in the two southernmost

[5] *Report upon the Condition of Crops, June 1, 1878,* 5 (United States Department of Agriculture, *Special Reports,* no. 5 — Washington, 1878); *St. Paul Pioneer Press,* July 10, 1878. The estimate was made by the government crop estimator.

[6] *Martin County Sentinel* (Fairmont), July 19, 1878; *Pioneer Press,* July 23, 1878; *Wheat, Yields Per Acre and Prices, by States, 50 Years 1866–1915,* 9 (United States Department of Agriculture, *Bulletins,* no. 514 — Washington, 1917).

tiers of counties, with a low of six and seven-tenths bushels an acre in Mower County. In the years preceding 1878 there frequently had been average yields in Minnesota of from fifteen to seventeen bushels an acre. But it is doubtful whether damage estimates or bushel yields told half the distressing story.

On August 17, Edward B. Drew, a farmer at Rollingstone in Winona County, recorded in his diary: "I cut a piece of wheat next to the woods that I had concluded not to cut. Burned it up after supper." And on August 26 this entry appears: "Have about 20 good-sized loads of the stuff piled up. It will only make feed for the sheep."[7] A determined attempt to take a saving view of the situation came from Cresco, Iowa, in a recommendation that "Unthreshed wheat straw with from 3 to 5 bushels of grain per acre in it would make good fodder for the stock." The only number 1 wheat that was harvested in Minnesota came from the western or northwestern sections of the state, and much of the wheat that was grown elsewhere was not even cut. As one grower described the crop, "If threshers are going to make any money this fall, they will have to charge for the amount of straw run through, and not grain."[8] What had earlier promised full bins and full pockets yielded nothing, when all returns were in, but heartache, bitter disappointment — and plenty of bran!

This ruin of the farmers' hopes was attributed variously, according to the observer, to blight, rust, heat, exhaustion of the soils, lodging, storms at harvest time, or to a combination of several factors. One writer states that "wheat blighted extensively in the southern and central parts of the State." According to the Minnesota crop statistician, "Prospects for a heavy yield were hardly ever more prom-

[7] The Drew Diary is owned by the Minnesota Historical Society.

[8] *Howard County Times* (Cresco, Iowa), July 25, 1878; *Preston Republican,* August 15, 1878. A copy of the article from the *Times* was furnished by Dr. Leonard W. Melander of the bureau of entomology and plant quarantine in the United States department of agriculture.

ising until the time it had reached its most critical period, just previous to harvest. It was then stricken with a sudden and disastrous blight."[9] The term "blight" apparently was used in some statements as another term for stem rust, in some to indicate an accompanying effect, and in other accounts simply as a blanket term to cover any unhealthy condition of the grain. Thus there is the report in the *Howard County Times* of July 25, 1878, in which damage in the area from central Iowa to central Minnesota is attributed to "blight, rust and smut"; and an account from Red Wing, which states that "Many samples of wheat said to be a fair average . . . show a heavy blight—from 50–75 per cent. The stalks from the head down several inches are dead and covered with black rust and the heads also are turning black." Despite the confusion of terms, this description leaves no doubt that stem rust was involved. Stem rust also evidently was meant by the *Madison* [Wisconsin] *Journal* when it reported that "The wheat, oats and barley will suffer badly, partly from being prostrated and partly from rust or mildew."[10] This old colloquial use of the word "mildew" as a general term including rust occurs again in the diary of Cornelius Janzen, who went to Mountain Lake in Cottonwood County from Russia in 1878 and wrote of his first harvest: "Die Ernte war vom Mehltau ziemlich beschädigt"—"the crop was badly damaged by mildew."[11] Whatever the opinion, however, and whatever the term used to express it, a survey of observers' accounts leaves no doubt that there was abundant rust. The responsibility of exhausted soils for the crop failure could only be secondary, in view of the fact that yields in subsequent years were not consistently so low. Lodging, on the other hand,

[9] Robinson, *Agriculture in Minnesota,* 75; Minnesota Commissioner of Statistics, *Eleventh Annual Report,* 21 (St. Paul, 1880).

[10] *Pioneer Press,* July 21, 1878. The *Madison Journal* is quoted in the *Rochester Post* for July 19, 1878.

[11] A typewritten copy of Janzen's diary is owned by the Minnesota Historical Society.

was in itself a damaging factor, and when it did not occur too late, also promoted rust development.

Heat undoubtedly contributed to kernel shrinkage, as well as stem rust. But it should be pointed out, in view of claims encountered to the effect that heat was mainly responsible in 1878, that the hot, wet weather which prevailed during most of July was precisely suited to rapid rust development.[12] "It was just that sultry, soggy, vapor-bath sort of weather common enough a few degrees south of us and in the corn belt generally but rare in Minnesota," according to the *Pioneer Press* of July 15. It is also noteworthy that July temperatures were higher in the Twin Cities section in two recent heavy rust years than in 1878.[13] One would therefore be inclined to conclude that rust damage was more important than damage from heat alone.

As at present, there was disagreement among observers as to the amount of rust. Similarly, there were various rea-

[12] Showers were of almost daily occurrence in many sections. At Winona, for instance, showers or rain were reported on June 27, 28, and 30 (drenching rain), and on July 3 (heavy rains), 7, 8, 9, 10, 11, 15, 16, 17 (general storm), 19 (rain lasting several hours), and 25. Harvesting began on July 26. The highest temperature, ninety-seven degrees, was reported on July 16. At Des Moines temperatures of from ninety to ninety-six degrees were recorded between July 11 and 18; at Dubuque during the same period there were storms and damp heat. Excessive rainfall in July was recorded by unofficial observers at three points in northeastern Iowa — Charles City, with a total of 8.63 inches and a hundredth of an inch or more on nine days; Hesper, with thirteen rainy days and a total fall of 13.20 inches; and McGregor, with 9.73 inches of rain. See *Winona Daily Republican,* June 29 to July 30; and Iowa State Agricultural Society, *Reports,* 1878, p. 496, 543, 957. Similar reports came from other sections. Heavy rains and muggy weather occurred in southern Wisconsin previous to July 19, and at La Crosse on the same date it was still very hot with daily rains.

[13] The average maximum temperatures for July at Minneapolis were 89.6° in 1935 and 87.5° in 1937, as compared with 84.1° at St. Paul in July, 1878. Minimum temperatures also were lower in 1878. See the *Monthly Meteorological Summary* for July, 1935, and July, 1937, issued by the United States weather bureau at Minneapolis, and the *Climatic Summary of the United States,* section 46, p. 9, 10, 15 (Washington, 1934). The latter item, a publication of the federal weather bureau at Washington, contains climatic data covering the period from the establishment of stations to 1930 inclusive.

sons for the disagreement. It is plain, however, that there actually was considerable local variation within the stricken area, due to differences in soil, in elevation and situation of fields, in date of sowing and maturity, and in varieties used. Lost Nation wheat was being grown extensively and was proving very susceptible to rust. From Osage, Iowa, came the plaint that "Our farmers last spring sowed at least 20 bushels of Lost Nation to one of Fife, so we are all a lost nation in this section, as it will not yield over 5 bushels of screenings per acre."[14] According to all reports, the variety Lost Nation was the most severely injured, although White Russia was not much better in this respect. Brooks was somewhat less severely injured, and Fife wheat withstood rust best and produced the largest yields of highest quality, when compared with the other varieties.

Another explanation of local variations in rust severity which cannot be overlooked, in the light of present knowledge, was the presence of barberry bushes. The role of barberries as the alternate host for stem rust was not a matter of general knowledge in 1878, and settlers in southeastern Minnesota, many of them Yankees, took the shrubs with them when they went to their new homes or planted them subsequently, for the barberry bush was a favorite as an ornamental shrub. One settler is said to have made a planting in the old Portland Prairie district of Houston County as early as 1857.[15] Judging from the density and size of bushes and the large number of escapes found in this district subsequently, other early settlers in the new land of promise also made the sad mistake of sowing wheat with one

[14] E. M. Britts and Company, in *Northwestern Miller,* August 2, 1878.

[15] A report of G. W. Metcalf, Sr., to the effect that his father had transported one barberry plant from the East "nearly 70 years ago" was recorded on the original barberry survey slip of April 25, 1919, by J. M. Holzinger, barberry scout. The father presumably was Cornelius Metcalf, Jr., who went to Portland Prairie from Blackstone, Massachusetts, in 1857, and whose son, George W. Metcalf, was born in 1861. H. V. Arnold, *Old Times in Portland Prairie, Houston County, Minn.,* 20, 112 (Larimore, North Dakota, 1911).

hand and its poison with the other. In the Mankato area there is record of bushes that had escaped from cultivation as early as 1883.[16] It is significant that the bushes were observed in "old" fields — evidence that cultivation of these fields already had been abandoned at this early date, presumably as a result of destruction of the grain by rust spread from the bushes. From these records and others it is evident that wherever there were settlers there were barberry bushes also; just how many there were in the spring wheat area of 1878 can only be conjectured. A systematic survey of barberries made since 1918, however, when the bush was outlawed, indicates that a total of 608,859 bushes had been planted in the state up to that time, and, in addition, that 132,042 had escaped from cultivation.[17] In 1878 this living evidence of the farmer's folly undoubtedly was important enough, particularly in the older counties of the southeast, to have contributed significantly to the rust epidemic and consequent failure of wheat.

Nowadays, in spite of more information regarding the nature of rust development, various methods of control, including eradication of the alternate host and breeding for rust resistance, rust control is still a problem. Serious losses are caused in years in which the combination of factors that go to make up an epidemic are just right. Hope for better conditions in the future, however, is indicated by success with newly developed varieties such as Thatcher.[18] Wheat growers of the state might easily once more have been a "lost nation" in the summer of 1938 on account of rust had they not sown Thatcher, which was developed at the Minne-

[16] Barberry was found particularly in sections 23, 24, 25, 26, 35, and 36 of Wilmington Township, and in the adjoining section 19 of Winnebago Township, Houston County, according to information furnished through the courtesy of Dr. Melander. See also Warren Upham, *Catalogue of Flora of Minnesota,* 21 (Minneapolis, 1884).

[17] These figures represent the numbers of bushes found and destroyed to October 31, 1938, according to Dr. Melander.

[18] Herbert K. Hayes and others, *Thatcher Wheat* (Minnesota Agricultural Experiment Station, *Bulletins,* no. 325 — St. Paul, 1936).

sota Agricultural Experiment Station in co-operation with the United States department of agriculture, and so far has refused to be injured by stem rust on the farms of the Northwest. To prevent such a catastrophe as that of 1878 from occurring every year instead of only occasionally, eradication of barberry bushes must be continued, for on these bushes, through hybridization, new parasitic strains of rust are able to arise which may be able to attack varieties of wheat that strains now in existence are unable to affect. This was the unfortunate experience with Ceres wheat.[19] For the protection of new varieties, therefore, eradication of the alternate host and breeding for resistance should proceed side by side.

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[19] Elvin C. Stakman and R. C. Cassell, "The Increase and Importance of Race 56 of *Puccinia graminis tritici*," in *Phytopathology*, 28:20 (January, 1938).