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Rather than to rely on the efforts of historians of the future, this paper will record the devastating oat rust epidemic that occurred in Iowa in 1953. Pertinent facts regarding the initiation, development, geographic distribution, and final loss estimates due to oat crown rust and stem rust will be presented. Attempts will be made to correlate rust spread and development with available meteorological data.

Rusts have attacked cereals for all of recorded history. Some of the oldest rust records are to be found in the Bible where Hebrew writers frequently mention rusts, smuts, and blights on their grain crops. Of course, the true cause of rusts was unknown but the ancients regarded these diseases as acts of God and punishment for misdeeds. Aristotle and later Theophrastus (370-286 B.C.) wrote of the rusts of cereals as well as of diseases of other crops. The Romans for many years paid sacrificial tribute on April 25 each year to a rust god, Rubigus, for protection against rust damage in their fields. Persoon in 1797 was the first to incriminate a fungus organism as the causal agent of rust but it was left to Anton deBary (2) in 1853 to describe the true nature and the various spore forms of the cereal rusts.

In Iowa, oat rusts have been a continuing hazard to successful oat culture, at least since 1858 when the earliest known epiphytotic of rust occurred (3). In the 20 year period of 1870 to 1890 wheat and oats were very unreliable and unprofitable with the average yield of oats being only 33 bushels per acre because of rust damage. Professor Speer (11) of the Iowa Experiment Station in 1890 discouraged the widespread planting of oats saying "from the frequent partial failures of our oat crops on account of rust and the rapid deterioration of good varieties which we have imported from the best oat countries, we can draw no other conclusion than that Iowa is not a good oat state." In reports of rust made prior to 1900, it is problematical whether crown rust or stem rust was involved, since differentiation of these was beyond the abilities of most crop

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reporters in those days. However, the annual reports of the Iowa State Agricultural Society indicate that considerable rust losses were experienced in the oat crops of 1872, 1890, 1893 and 1896. The first specific report of severe damage from crown rust came in 1907 when Pammel (8) estimated a 50 percent loss in yield. This disease was general again in 1908 when losses were given as 34 percent. Loss estimate records have been compiled each year since 1915 for both oat rusts. During this time crown rust losses have varied from zero to 30 percent and stem rust from zero to 10 percent (Table I).

Fortunately, both rusts seldom strike in the same year; however, they did in 1953 which accounts for the rust devastation experienced in our oat crop. In Table II may be noted the monetary loss experienced in certain years from the crown rust disease. In addition to reduced bushel yield, rust commonly results in low test weight, poor quality grain.

Oats as a crop has found a well deserved place in Iowa's agriculture for several reasons. Its suitability as a nurse crop for clover and alfalfa is unsurpassed. Its value as feed for livestock and poultry is well recognized, and finally, it can serve as a ready cash crop if needed. Thus, in spite of sporadic disappointing yields, oats has continued to rank as our second most important crop. Annual acreage is approximately 5½ million acres, although in certain years it exceeds 6 million acres. Therefore, even minor rust damage is costly to Iowa farmers.

## Basic Factors Determining Rust Prevalence

*Puccinia coronata* (Pers) Corda and *Puccinia graminis avenae* Eriks. and Henn. are the causal agents of crown rust and stem rust of oats respectively. These obligate fungus parasites are distinctly different organisms. However, in their microscopic and macroscopic characters and life cycles they are somewhat similar. Both rusts require alternate hosts to complete their life cycles, both are extremely plastic genetically and each consists of many physiologic races within morphologic species. Neither rust can overwinter in Iowa in the red or uredial stage, and both rusts are subject to extensive wind-borne travel from Mexico and the southern Mississippi Valley states into Iowa in late May and early June.

Barberry, the alternate host for stem rust, has been actively eradicated under the law since 1917. At present this host is no longer considered an important factor in rust epidemiology in this state.

The alternate host relationship of buckthorn species, especially

**Table I.**

Iowa Oat Rust Losses—1935-1953[a]

| | Percentage Loss of Potential Crop Yield | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 |
| Crown rust (P. coronata) | 20 | T[b] | 2 | 25 | 3.5 | 0 | 30 | 10 | 12.5 | 3 | 1.5 | T | 0.2 | T | 12 | 18 | 20 | 8 | 30 |
| Stem rust (P. graminis avenae) | 1 | 0.5 | 0.5 | 0.5 | T | T | T | 1 | 5 | 0.8 | 3 | T | T | T | T | 2 | T | T | 10 |
| Total loss (Percent) | 21 | 0.6 | 2.5 | 25.5 | 3.6 | T | 30.1 | 11 | 17.5 | 3.8 | 4.5 | 0.2 | 0.3 | 0.2 | 12.1 | 20 | 20.1 | 8.1 | 40 |

[a] Estimates made by Iowa State College Pathologists and Agronomists.
[b] T = Trace (up to 0.1 percent)

**Table II.**

Iowa Oat Production Figures for Certain Years 1934-1953[a]

| | 1934 | 1935 | 1937 | 1938 | 1940 | 1941 | 1948 | 1951 | 1953 |
|---|---|---|---|---|---|---|---|---|---|
| Production 1,000 Bushels | 58,525 | 210,450 | 271,998 | 209,020 | 199,353 | 176,702 | 273,870 | 190,012 | 154,648 |
| Av. Yield Bu/A | 12.5 | 34.5 | 46 | 35 | 38.5 | 32.5 | 45 | 33.5 | 26 |
| Crown Rust (Percent loss) | T[b] | 20 | 2 | 25 | 0 | 30 | T | 20 | 30 |
| (Dollar loss) millions | T | 11.6 | 1.5 | 13.9 | 0 | 33.3 | T | 47.5 | 51 |

[a] Basic data from Iowa Yearbooks of Agriculture 1934-1953.

[b] T = Trace (Up to 0.1 percent)

*Rhamnus cathartica* L. and *Rhamnus lanceolata* Pursh has been known since deBary's discovery in 1866. As a result, several countries have outlawed *Rhamnus* species in oat growing communities. Buckthorn serves as a host for the pycnial and aecial spore stages of crown rust, thereby enabling the initiation of early uredial development in nearby oat fields. In Iowa, this commonly occurs 10 to 14 days earlier than infection from spores wind-blown from the southern states. This early rust initiation is most important in determining the extent of final rust damage. Murphy (7) found a strong positive correlation between early initial infection and the reduction in yield and weight per bushel as well as an increase in the water requirement of the oat plants. Following Craigie's detection in 1927 of heterothallism in the rusts, the great importance of buckthorn as a pycnial host became evident. It is in such pycnia that hybridization of rust races occurs, giving rise to new physiologic forms of rust which may possess the ability to attack previously resistant oat varieties. Unfortunately *Rhamnus cathartica* L. was introduced into Iowa as a windbreak shrub as early as 1879 and was widely planted in the period 1900 to 1951. Several reports of the Iowa Horticultural Society referred to the desirability of buckthorn for windbreaks. Consequently in the north half of the state, especially in north-central Iowa, buckthorn is commonly found around farmsteads and adjacent to oat fields. In most years in late April or early May basidiospores from stubble infect newly expanded buckthorn leaves where pycnia, and later, aecia are produced. With favorable environmental factors of abundant moisture and moderate temperature aeciospores are soon produced and blow to nearby oats to initiate the new corn rust infection. When these favorable weather conditions continue into June, rust becomes widespread. The dangerous role of buckthorn is well illustrated in Iowa where the earliest rust postules on oats are generally found in proximity to buckthorn hedges. Degree of infection varies directly with the distance between buckthorn and oats. The role of wind-blown inoculum must not be minimized, although its importance is exhibited only in scattered years. In epiphytotic years when rust appears simultanteously in all parts of the state with infection rather uniform, then general rust spore showers from southern winds are known to be responsible. Data have been presented by Fletcher et. al. (5) and Fletcher (6) to prove that such spore showers occurred in 1952 and 1953, bringing rust from Texas and Oklahoma into the north central states at a critical period.

Without susceptibile oat varieties, spores can be no menace. However, in the oat states in 1953 many varieties were grown that possessed little or no resistance to the predominant races of crown and stem rust. A survey made by Sherf et. al. (10) indicated that 90 percent of our 1953 acreage was planted with Bond derivatives which lack resistance to these specific rust races. Consequently, with susceptible varieties growing on most of our acres, with abundant inoculum from buckthorn and the southern winds, and with a warm wet June the stage was set for the worst rust epiphytotic in Iowa history.

## Oat Rust Development in 1953

The oat crop was planted during the usual period of March 21 to April 15 and in spite of several cold periods emerged to give good stands in most of the state. Warm air and soil temperatures coupled with frequent rainfall permitted the crop to develop rapidly with succulent tissues.

The first aecial infection on *Rhamnus cathartica* was noted on May 8 near Colo, Nevada and Ames. In the course of a survey in Story, Hardin and Wright counties on May 19 all buckthorn plants were found to be heavily rusted, the degree of infection being in direct relation to the proximity to 1952 oat stubble. By May 25 many aecia were mature and aeciospores were being released. In addition to this source of rust inoculum from buckthorn, abundant urediospores of both rusts were being showered over most of Iowa by strong southerly winds from Texas and Oklahoma. Data provided by Fletcher (6) record the occurrence of these steady south winds blowing across Iowa at 10,000 feet from May 12 to 14. These winds with their spore content account for the general distribution pattern of rust over the state.

On June 4-5, accompanied by Drs. Murphy and Frey, of Iowa State College, a rust survey was made in north-central Iowa as far west as Marcus. Scattered single pustule uredia of both crown rust and stem rust were detected in all fields examined. However, more crown rust pustules were seen on oats in the vicinity of buckthorn hedges than where oats were far removed. As a result of this survey a news release was prepared predicting the likelihood of a widespread rust epiphytotic should the weather continue favorable for rust development. The environmental requirements permitting crown rust to thrive are well known. The optimum temperature range for urediospore germination and germ tube development is 62° to 71° F. Also, to permit germination, the spores must be in contact with free water either as droplets or in thin films. This moisture factor is more important than temperature. Mycelial development in the oat plant is favored by moderate to high temperature with high humidity. These requirements were well met in most of Iowa in June 1953. Climatological records (12) indicate this month was warm with above normal precipitation. The average temperature for the state, 73.2° F., was 3.7° above the normal for June. It was the eighth warmest June in eighty-one years and the second warmest in the last eighteen years. Likewise, precipitation was greater than usual, the state average being 5.31 inches which was 0.77 inches above the June normal. Central Iowa, as recorded at Ames, received 4.99 inches of rainfall which fell on 14 days of June. In addition, the dew periods when free moisture was present on oat leaf surfaces were unusually frequent (9).

**Table III.**

Occurrence and Duration of Dew or Free Water Deposition on Oat Plants. June 1-July 15, 1953, Ames Iowa. ([a])

| | Dew Period (Hours) | | Dew Period (Hours) | | Dew Period (Hours) |
|---|---|---|---|---|---|
| June 1 | 6 | June 16 | 1 | July 1 | 5 |
| June 2 | 6 | June 17 | 6 | July 2 | 3 |
| June 3 | 0 | June 18 | 0 | July 3 | 8 |
| June 4 | 3 | June 19 | 4 | July 4 | 3 |
| June 5 | 3 | June 20 | 8 | July 5 | 6 |
| June 6 | 9 | June 21 | 12 | July 6 | 5 |
| June 7 | 3 | June 22 | 8 | July 7 | 5 |
| June 8 | 4 | June 23 | 0 | July 8 | 6 |
| June 9 | 6 | June 24 | 0 | July 9 | 8 |
| June 10 | 4 | June 25 | 3 | July 10 | 5 |
| June 11 | 11 | June 26 | 8 | July 11 | 2 |
| June 12 | 9 | June 27 | 0 | July 12 | 0 |
| June 13 | 10 | June 28 | 10 | July 13 | 0 |
| June 14 | 8 | June 29 | 7 | July 14 | 3 |
| June 15 | 0 | June 30 | 8 | July 15 | 4 |
| Total Hours | 82 | | 75 | | 63 |

([a])Data courtesy of Dr. R. H. Shaw (Iowa State College) Air Force Contract 19 (604) 589.

Table III. indicates dew was present a total of 157 hours in June and 63 hours in the first half of July for a total of 220 hours of dew on the leaf surfaces. Further, there were 23 nights in June and 12 nights up to July 15 when dew was present for at least 3 hours duration. These dew data are very significant and useful in explaining the rapid build up, dissemination, and spread of both rusts during the period June 1 to July 15.

By June 15 the average farmer could see that rust was prevalent in his oat fields as he walked through them. As the oats approached maturity more and more of the leaves were destroyed so that a poor fill of light grain resulted. During the first week of July many farmers in southern Iowa abandoned hopes of harvesting their oats for grain and either pastured the crop directly or cut it for hay. As harvesting progressed reports of poor yields and low test weight grain were frequent.

Excerpts from crop reports published in the Des Moines Tribune of July 22, 1953 (4) include, "combining of oats practically completed with average yield 10 to 12 bushels per acre (Albia); oat quality below average (Allison); small grain harvest nearly completed with light yields reported (Bedford); oat harvest shows light weight, poor color, and small yields (Burlington); Oats quality and yield poor due to rust damage (Corydon); and oats combining completed with yield about half of average (West Point)". A similar crop report published one week later included discouraging yields from Anamosa, Chariton, Clarion, Cresco, Davenport, Des Moines, Eldora, Fort Dodge, Garner, Manchester, Osceola, Vinton, and Waverly. Not only were yields low but test weights were correspondingly reduced. Many reports were received of 22, 24, 25 and 28 pounds per bushel when the usual test weight is approximately 35 pounds.

The most widely planted varieties, namely the Bond derivatives, were damaged by both crown rust and stem rust. Other varieties such as Mo. 0-205, Andrew, Ajax, and Branch yielded better because of tolerance to race 45 of crown rust and resistance to race 7 of stem rust.

The poor yields experienced at harvest were reflected in the estimated state yields as published in the Crop and Livestock News of the Iowa Crop and Livestock Reporting Service (1). Their July 1 estimate of 194,898,000 bushels (33 bu/A) was reduced to 153,556,000 bushels (26 bu/A) by August 1. The final oat production figure was placed at 154,648,000 bushels with a yield per harvested acre of 26 bushels. This is 27 percent less than harvested in 1952 and 25 percent less than the ten year average. The oat crop was the smallest since the dry year of 1934 both as to yield per acre and total production. Final rust damage was estimated by college pathologists and agronomists to be 30 percent for crown rust and 10 percent for stem rust.

## Outlook for Oat Production in the Future

Space does not permit adequate discussion of the changing physiologic rust race picture and its influence on oat yield prospects in future years. Plant breeders and pathologists are striving constantly to incorporate proven genetic resistance with other desirable qualities to achieve superior oat varieties. Progress is evident in new varieties such as Clintafe, Clintland, Mo. 0-205, and others which have good resistance to certain but not all rust races. However, since rust races fluctuate in relative prevalence every few years, with entirely new races arising, the breeders' task is never ending. Our present suggestions for rust control include the planting of several varieties possessing widely different types of genetic resistance, early planting in a well prepared seed bed, and eradication of the alternate hosts buckthorn and barberry. No chemical sprays, dusts, or seed treatments to prevent rust have been proven economically feasible as yet. Thus, the Iowa farmer must continue to face the possibility of extensive rust losses in certain years when environmental conditions are favorable for the development of these rust parasites.

**Literature Cited**

1. Anonymous, 1953. Iowa Crop and Livestock News. 13 (6)(7) Iowa Department of Agriculture, Division of Agricultural Statistics, Des Moines, Iowa.
2. Bary A. de, 1853, Untersuchungen uber die brandpilze. Pp. 144. Verlag von G. W. F. Muller. Berlin.
3. Corkle, M. A. and Melhus, I. E. 1941. The Earliest Known Epiphytotic of Rust in Iowa. Iowa Academy of Science Proc. 48: 147-157.
4. Des Moines Tribune, July 22, 1953.
5. Fletcher, D. G.; Lambert, E. B.; Nagler, K. M.; and Stakman, E. C., 1953. The Origin and Extent of a Regional Spore Shower of Wheat Stem Rust. Phytopathology 43 (9):471.
6. ..................1954. Personal Oral Communication.
7. Murphy, H. C., 1935. Effect of Crown Rust Infection on Yield and Water Requirement of Oats. Journal of Agricultural Research, 50(5): 387-411.
8. Pammel, L. H., 1907. Iowa State College Plant Disease Survey Card File. Botany Department, 1903-1907.
9. Shaw, R. H., 1953. Observation of Dew Deposition on Various Types of Cover. Progress Reports 2, 3 on Air Force Contract No. A. F. 19:(604)-589. Agronomy Department, Iowa State College, Ames, Iowa.
10. Sherf, Arden; Sylwester, E. P.; and Dyas, E. S., 1954. Facts About Iowa's 1953 Oat Plantings, Iowa Farm Science, 8(7):22-24.
11. Speer, R. P., 1890. Our Rusted and Blighted Wheat, Oats, and Barley in 1890. Iowa Agricultural Experiment Station, Bulletin No. 10.

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