

FIELD EVALUATION OF CROWN RUST IN ANNUAL RYEGRASS POPULATIONS

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ABSTRACT

Crown rust (*Puccinia coronata* [Pers.] Cda.) is the most prevalent disease found on annual ryegrass (*Lolium multiflorum* L.) of the southeastern USA. Determination of crown rust resistance is difficult because of the erratic nature of infections at most locations. As crown rust is present at Gainesville, FL each year, a rust nursery was designed to evaluate rust resistance and susceptibility of annual ryegrass. Evaluation consists of periodic rust ratings of the seed crop and regrowth of part of each plot after cutting. Nursery results indicate the buildup of rust, including at the date of 90% heading (start of flowering), and rust on regrowth under high rust spore load for all ryegrass genotypes. A rust index based on rust ratings at the 90% heading date for two or more growing seasons is proposed to distinguish highly-resistant, resistant, susceptible and highly-susceptible ryegrass cultivars.

KEYWORDS

Ryegrass, crown rust, *Lolium multiflorum*, *Puccinia coronata*

INTRODUCTION

Crown rust is the most prevalent disease on annual ryegrass (*Lolium multiflorum* L.) in the annual ryegrass belt of the southeastern USA. The disease apparently over-summer in southern Florida and Texas, or at high elevations even further south. In late fall and winter, the crown rust inoculum spreads northward reaching the northeast and northwestern USA by late summer. The crown rust on annual ryegrass in Florida during April may be the same crown rust race that attack perennial ryegrass in New Jersey during August. Crown rust epidemics were mild following the development of the crown rust-resistant annual ryegrass cultivars, Gulf, Florida Rust Resistant and Magnolia. In the 1970's, crown rust began a come back as Marshall and a number of other crown rust-susceptible annual ryegrass cultivars were released as cultivars. A selection program began in 1984 at Gainesville to give crown rust resistance to Marshall which resulted in the cultivar Surrey (Prine et al., 1989). Breeding techniques for increasing crown rust resistance in annual ryegrass at the University of Florida is discussed in Prine et al., 1989 and Prine, 1991. In developing Surrey, it was determined that evaluation of crown rust was needed among commercial cultivars and experimental lines. Crown rust nursery results are described in earlier papers (Prine, 1991 and 1995). The purpose of this paper is to add additional results to the crown rust nursery reports from the earlier papers, and to evaluate the crown rust index.

MATERIALS AND METHODS

A typical crown rust nursery consists of various cultivars and genotypes of annual and perennial ryegrass planted in single-row plots 5 m in length. Plot rows were spaced 61 to 91 cm apart in a completely randomized block design with either four or five replications.

Entries in the rust nursery are cultivars and lines developed in Florida and also by other ryegrass breeders and seed companies wanting to test their ryegrasses for crown rust resistance. The nursery is planted on infertile Arredondo fine sandy soil (loamy, siliceous, hyperthermic Grossarenic Paleudults) on agronomy farms near the University of Florida campus at Gainesville, FL. If crown rust in the nursery is not observed, rusted leaves from ryegrass on the University of Florida campus lawns are collected, cut into small sections, and sprinkled on spreader rows in the nursery.

Rust-susceptible Marshall annual ryegrass and Manhattan perennial ryegrass are planted in two spreader rows on each side and through the middle of the nursery. Fertilizer consists of 336 to 448 kg ha⁻¹ of 5-10-20 (N-P₂O₅-K₂O) fertilizer preplant, followed by top-dressed periodically with ammonium nitrate in low amounts (10 to 20 kg N ha⁻¹) as needed to maintain good growth and foliage color and to produce minimum senescence of lower leaves. Irrigation water is applied during spring droughts to insure that leaves remain green.

Once significant rust symptoms (rating of 3.0 or higher) are observed, all entries are rated periodically for crown rust as the epidemic develops. To estimate date of 90% heading, plants are observed three or more times each week. Date of 90% heading usually also corresponds to the beginning of flowering (first anthers emerge). Development of the rust infection on different entries in relation to maturity (flowering) of the plants is determined from crown rust ratings nearest the date of 90% heading.

In early April, rust generally appears on the majority of entries. At this time, one-half of each plot row is mowed to 3 to 4 cm in height and allowed to regrow. The development of crown rust and other diseases is also rated on the regrowth. Maturity determinations and rust ratings are continued on the undisturbed portion of the row. Regrowth areas allow evaluation of crown rust-resistance on plant material of relatively the same age, although the earlier-maturing entries usually flower first in the regrowth plots.

The rust rating used for all trials are 0 = no rust to 10 = shoots 100% covered with rust. When leaf diseases other than rust occurred in the nursery at high enough infestations to rate, they are also rated.

RESULTS AND DISCUSSION

Crown rust ratings at various dates on seed crop and regrowth after April 4, 1994 and 90% heading date, in the normal crown rust season of 1993-94 is shown in Table 1 as an example of data collected on the rust nursery. The use of different rating dates allow one to follow build up of rust on different entries. The rust rating nearest the time of 90% heading (start of flowering) is thought to be critical as it tends to divide the plant growth between vegetative and fruiting stages. Ryegrasses which have early high rust infestations on vegetative growth have most damage to forage and seed production.

After collecting on rust data at 90% heading from 1988-1989 season through 1993-94 season, a crown rust index was devised based on the average rust rating at 90% heading for 2 or more years (Prine, 1995). A rust index of 0-3 indicates high rust resistance, 3-5 rust resistance, 5-7 rust susceptibility and above 7 high rust susceptibility. Rust indexes for period of 1988-1989 through 1994-1995 is shown in Table 2. In 1994-95 season our index ran into trouble when an unusually early and virulent rust epiphytic occurred and rust ratings were much higher than normal at 90% flowering. Examination of data showed the rust ratings made May 29, 1995 corresponded closely to rust index of previous seasons, so we used these values in Table 2.

In 1995-96, the crown rust did not show up until near the end of the ryegrass growing season and no rust ratings were made on rust nursery. We went from the worst rust season in 1995 to a near no-rust season in 1996. The rust index thus has short comings. The greater the number of years in determination of index, the more dependable is the index, however, 2 or 3 normal rust years appear adequate.

Ryegrass breeders and seed companies are encouraged to test their ryegrass populations before they release the ryegrass cultivar. A cultivar should not be sold in Southeast USA without crown rust resistance. The crown rust index should become an important factor in annual ryegrass evaluation. The rust nursery also gives insight to the earliness and lateness of buildup of crown rust for each entry. It is probably not necessary to evaluate rust resistance in a stable ryegrass population after a 2 or 3 year index, except for an occasional check to see if resistance is changing due to appearance of a new race of crown rust or some shift in genetics of the ryegrass.

REFERENCES

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Table 1

Crown rust ratings on seed crop growth and regrowth of annual ryegrasses at Gainesville, FL on various dates during the spring of 1994, planted 26 October 1993.

| Ryegrass cultivar or line | 90% heading date | Crown rust ratings† (mean of 5 replications) | | | | | | |
|---------------------------|------------------|--|--------|-------|-------|-------------------------|------|-----|
| | | Seed crop | | | | Regrowth after April 4‡ | | |
| | | 3/30 | 4/4 | 4/10 | 4/15 | 4/18 | 4/28 | 5/2 |
| Gulf | 4/4 | 0.9 | (1.5)# | 2.4 | 4.4 | 5.6 | 3.5 | 5.3 |
| Marshall | 4/14 | 3.1 | 4.7 | 6.4 | (7.8) | 8.9 | 8.0 | 8.7 |
| FL X1993 LR(elite) | 4/9 | 0.7 | 1.2 | (1.7) | 2.5 | 3.4 | 2.4 | 3.3 |
| Southern Star | 4/7 | 1.2 | 1.7 | (2.6) | 4.2 | 5.4 | 4.8 | 6.0 |
| Jackson | 4/7 | 1.1 | 1.6 | (2.5) | 3.5 | 5.6 | 3.3 | 4.2 |
| Passerel | 4/17 | 2.7 | 4.1 | 6.0 | 7.7 | (8.6) | 7.5 | 8.4 |
| FL X1986 LR | 4/7 | 0.9 | 1.4 | (2.0) | 3.4 | 4.5 | 3.6 | 4.5 |
| Surrey | 4/3 | 1.0 | (1.6) | 2.4 | 3.4 | 4.9 | 3.8 | 4.6 |
| Florida 80 | 3/31 | (1.2) | 2.0 | 2.9 | 4.6 | ¶ | 3.9 | 5.0 |
| Florida Rust Resistant | 3/26 | (1.6) | 2.9 | 4.2 | 6.0 | ¶ | 6.1 | 6.8 |
| FL X1993 (FXF)ER(S) | 3/28 | (1.1) | 1.8 | 2.8 | 4.4 | 6.3 | 5.8 | 6.4 |
| FL X1993 (GXS)MR(S) | 4/5 | 0.9 | (1.5) | 2.2 | 3.2 | 4.9 | 3.6 | 4.6 |
| FL X1993 AR-90-300(S) | 4/7 | 0.9 | 1.5 | (2.1) | 3.2 | 5.1 | 4.9 | 5.4 |
| TAM 90 [TX AES] | 4/5 | 1.2 | (2.1) | 3.3 | 5.3 | 6.4 | 4.4 | 5.5 |
| TX R-91-A7 | 4/7 | 1.1 | 1.7 | (2.8) | 4.8 | 6.8 | 5.5 | 6.3 |
| TX R-91-A8 | 4/4 | 1.2 | (2.2) | 3.4 | 5.7 | 7.3 | 5.2 | 6.3 |
| Rio | 4/9 | 0.8 | 1.6 | (2.3) | 3.4 | 4.8 | 4.2 | 4.9 |
| NCSU 91 | 4/7 | 1.9 | 3.2 | (5.2) | 8.0 | 8.8 | 7.7 | 8.8 |
| WVPB AR 93-101 | 4/8 | 1.4 | 2.1 | (3.0) | 4.2 | 6.2 | 5.6 | 6.5 |
| Big Daddy§ | 4/10 | 0.8 | 1.4 | (1.9) | 3.2 | 4.3 | 3.6 | 4.0 |
| Hurricane | 4/13 | 1.0 | 1.7 | 2.4 | (3.9) | 5.3 | 5.3 | 6.1 |

†Rust rating: 0 = no rust to 10 = shoot completely covered with crown rust.

‡One half of each plot row was mowed at 4 cm height on 4 April and allowed to regrow for these ratings.

§ Tetraploid cultivar or line.

¶ Too mature for a rust rating.

#Parentheses placed around the rust rating nearest the 90% heading (beginning of flowering) date.

Table 2

Crown rust ratings and 1995 rust index of selected annual and perennial ryegrass entries on the date nearest 90% heading during the 1988-89 to 1994-95 growing seasons.‡

| Ryegrass cultivar or line | Mean crown rust rating at 90% heading (start of flowering) | | | | | | | 1995 rust index* | Rust rated (Yrs) |
|-----------------------------------|--|---------|---------|---------|---------|---------|---------|------------------|------------------|
| | Growing season | | | | | | | | |
| | 1988-89 | 1989-90 | 1990-91 | 1991-92 | 1992-93 | 1993-94 | 1994-95 | | |
| Gulf | | 1.6 | 3.6 | 2.1 | 2.4 | 1.5 | 3.2 | 2.40 | (6) |
| Marshall | 7.5 | 7.6 | 9.2 | 6.3 | 8.9 | 7.8 | 8.3 | 7.94 | (7) |
| FL X1990-94 LR (elite) | | | (2.8) | (1.5) | (2.5) | (1.7) | (1.6) | 2.02 | (5) |
| Southern Star | | 2.3 | 3.3 | | | 2.6 | 2.7 | 2.72 | (3) |
| Jackson | 3.0 | 1.8 | 2.8 | 2.0 | 2.8 | 2.5 | 2.0 | 2.41 | (7) |
| Surrey | 3.1 | 0.9 | 2.8 | 2.0 | 3.1 | 1.6 | 2.5 | 2.29 | (7) |
| Florida 80 | 3.1 | 1.3 | 2.5 | 1.5 | 2.1 | 1.2 | 2.5 | 2.03 | (7) |
| Florida Rust Resistant | | 1.5 | 2.4 | 1.5 | 2.0 | 1.6 | | 1.80 | (5) |
| FL X (FXF)ER(S) | | | | | (2.0) | (1.1) | (2.4) | 1.83 | (3) |
| FL X (GXS)MR(S) | | | | | (2.5) | (1.5) | (2.4) | 2.13 | (3) |
| TAM 90 | (3.5)¶ | (3.1) | (3.6) | 2.6 | 2.1 | 2.1 | 3.1 | 2.87 | (7) |
| Rio | | (2.3) | (3.3) | 2.6 | 3.5 | 2.3 | 2.6 | 2.77 | (6) |
| WVPB AR 93-101 | | | | | | (3.0) | (3.3) | 3.15 | (2) |
| Big Daddy | | | | (2.4) | (2.6) | (1.9) | 2.3 | 2.30 | (4) |
| Hurricane | | | | (3.4) | | (3.9) | 3.0 | 3.43 | (3) |
| Rustmaster | 4.1 | 1.3 | 3.4 | 1.9 | 4.3 | | | 3.00 | (5) |
| FL X1992 + 1994 B7 | | | | | (3.5) | | (2.7) | 3.10 | (2) |
| Manhattan † | | 8.5 | 9.2 | 7.3 | 8.9 | | | 8.48 | (4) |
| Nutriblend | | 1.4 | 3.9 | 3.1 | | | | 2.80 | (3) |
| Tetrablend 444 | | 2.1 | 3.5 | 2.8 | | | | 2.87 | (4) |
| WVPB AR-90-300 | | | | (4.0) | (2.5) | (2.1) | (3.2) | 2.95 | (4) |
| Magnolia | 6.1 | 3.0 | 4.0 | | | | | 4.37 | (3) |
| Concord† | 3.3 | 4.1 | 4.1 | | | | | 3.83 | (3) |
| Grazer | (6.1) | | | | | | 6.4 | 6.25 | (2) |
| Number of replications in nursery | 4 | 4 | 4 | 4 | 4 | 5 | 5 | | |

† Did not flower, so used last rust rating in April for the seed crop.

‡ Perennial ryegrass entries except Manhattan, and experimental annual ryegrass entries for only a single year and not indicated for continuation to cultivar release were omitted. Several multiple entries per year of the same genotype were averaged to a single entry.

§ Rust ratings were all made March 29 instead of 90% heading due to severe rust epidemic.

¶ Parentheses () indicates that this was an experimental germplasm prior to its naming as cultivar.

* Rust index of 0-3 is highly resistant, 3-5 is resistant, 5-7 susceptible and above 7 highly susceptible to crown rust.