Response of Cocksfoot Cultivars to Natural Populations of *Rhynchosporium orthosporum* and *Puccinia striiformis* var. *dactylidis*[1]

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ABSTRACT

Scald, caused by *Rhynchosporium orthosporum* R. M. Caldwell, and stripe rust, caused by *Puccinia striiformis* Westend. var. *dactylidis* Manners are serious foliar diseases of cocksfoot (orchardgrass) (*Dactylis glomerata* L.) grown for seed. Severity of scald in 1985, 1986 and 1988 and stripe rust in 1989 and 1990 was assessed in ten cultivars of cocksfoot under natural field conditions. Differences in disease response among cultivars was found for both pathogens in each of the years of assessment. Scald assessment in 1985 and 1986 (rated 1 to 9 = worst) ranged from 2.8 to 6.8 and 3.0 to 7.5, respectively. In 1988, scald assessment (average percent scald among top four leaves) ranged from 46 to 69%. Cambria, Pennlate and Frontier were among the cultivars most resistant to scald. Stripe rust assessments (average percent of leaf rusted) ranged from 15 to 83% in 1989 and 2 to 50% in 1990. Cambria and Potomac were among the cultivars most resistant to stripe rust. Results from three years of field testing for scald assessments were highly correlated (r = 0.92; df = 8) as were the two years of field testing for stripe rust assessments (r = 0.91; df = 8). Variation among cultivars in reactions to these pathogens indicated a genetic potential for developing cocksfoot cultivars with improved disease resistance. The amount of disease resistance possessed by a cultivar may also assist in deciding whether to apply fungicides for disease control.

Additional index words: **seed production, forage grass, scald, stripe rust, leaf disease, orchardgrass, *Dactylis glomerata.***

INTRODUCTION

Scald, caused by *Rhynchosporium orthosporum* R.M. Caldwell, is a serious foliar disease of cocksfoot (*Dactylis glomerata* L.) (Caldwell, 1937). Two species of *Rhynchosporium* are recognised, *R. orthosporum* with cylindrical conidia and *R. secalis* with conidia apically obliquely beaked (Sprague, 1950). Caldwell (1937) recognised that *R. orthosporum* differs distinctly from *R. secalis*, and distinguished six physiological races of *R. secalis* by their ability to attack one of six hosts: rye (*Secale cereale* L.), barley (*Hordeum vulgare* L.), quackgrass (*Elytrigia repens* (L.) Nevski), smooth brome (*Bromis inermis* Leyss.), Canada wildrye (*Elymus canadensis* L.), or *Hordeum jubatum* L. In cocksfoot, leaf damage by scald ranges from moderate to severe, depending on the yearly variation in rainfall, and can be controlled in seed production fields by one or two applications of chlorothalonil before anthesis (Welty, 1991).

Stripe rust, caused by *Puccinia striiformis* Westend. var. *dactylidis* Manners occurs in cocksfoot in the British Isles, Russia, Iran, and India (Cumming, 1971), and was reported for the first time in Oregon in 1984 (Hardison, 1984). Manners (1960) reported that *Puccinia striiformis* from cocksfoot differs from *P. striiformis* var. *striiformis* from wheat (*Triticum aestivum* L.) primarily by the temperature optimum for urediniospore germination (var. *dactylidis* = 21 to 24°C; var. *striiformis* = 10 to 13°C) and the size of urediniospores (var. *dactylidis* = 21.1μ x 18.1μ; var. *striiformis* = 23.8μ x 19.8μ). He proposed the name *P. striiformis* var. *dactylidis* for stripe rust in cocksfoot. Niks (1959) reported that infection structures of var. *dactylidis* in cocksfoot differ in morphology from infection structures of var. *striiformis* in wheat, barley and *Elymus*, and var. *striiformis* f. sp. *poae* in *Poa pratensis* L., and supported the distinct taxonomic status within *P. striiformis*. In the Willamette Valley of Oregon where cocksfoot is grown for seed, scald is usually observed first in late-May to early-June. In 1984, 1986, and 1988, scald was severe and seed yields in chlorothalonil-treated plots (1754 or 1170 g a.i. ha^{-1}) were up to 55% higher than nontreated controls (Welty, 1991).

Stripe rust is usually observed first in mid- to late-June and often found on plants growing in low spots in the field or in soils that are not well drained. Wide-spread epidemics of stripe rust have not been observed in seed production fields in spring or summer since the disease was first observed. In July and August of 1987, stripe rust caused severe losses (estimated at 20 to 30%) in the second cutting of cocksfoot grown for forage in the Fraser Valley in eastern British Columbia, Canada (A. Buonassisi, 1987, *personal communication*). Between 1987 and 1989, no other

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widespread epidemics of stripe rust in cocksfoot were reported in Canada or elsewhere in northwest USA. In September 1989, an epidemic of stripe rust occurred in regrowth of cocksfoot in seed production fields in the Willamette Valley (R.E. Welty, *unpublished observations*). The disease was widespread and uniform throughout the Willamette Valley on autumn regrowth. When seed-heads were present (usually reproductive tillers that developed after harvest), pustules formed on culms, secondary branches of panicles, and on glumes.

The objective of this report is to summarise field observations of the response of ten cultivars of cocksfoot to natural populations of *R. orthosporum* and *P. striiformis* var. *dactylidis*.

MATERIALS AND METHODS

Cultivars

Ten cultivars of cocksfoot (Table 1) were established on 27 July 1984 by drill-seeding in a field of Woodburn silt-loam (fine silty, mixed, mesic Aquultic Argixeroll, on 0-3% slopes (pH 5.8) near Corvallis, OR. Rows were on 30 cm centres in a seed bed treated in autumn 1983 with diuron [N' - (3,4-dichlorophenyl) - N,N-dimethylurea] and in spring 1984 with glyphosate [N- (phosphonomethyl) glycine] to control weeds. Plots were 2.4 x 6 m with 1.2 m borders and alleys; cultivars were assigned to plots in a randomised complete block design. Lime and fertiliser were applied before seeds were sown and annually thereafter based on soil tests and nutrient recommendations. Normal management practices for seed production were followed, which included weed and insect control. When test plots were established, the ten cultivars were widely planted in the Willamette Valley and represented most of the area planted for certified seed production in Oregon (D. Brewer, *personal communication*).

Four replications of each cultivar were used for scald assessments; eight replications of each cultivar were used for stripe rust assessments.

Plots were irrigated twice (7.5 cm, total) in August, 1990, to increase soil water and dew formation to favour stripe rust development. No other irrigation was used.

Disease assessment

Scald symptoms in each cultivar were assessed several times during the growing season with the last score taken at anthesis, or when seeds were in the milk stage. Assessments were made in 1985 and 1986 by examining the collective area of entire plants at 10 locations within a plot and scoring on a scale of 1 to 9 (1 = slight disease on lower leaves; 9 = severe disease with all leaves showing symptoms). The scoring system was originally developed for leaf disease of wheat (Saari and Prescott, 1975). In 1988, scald assessments were made as the percentage of leaf area damaged by scald in the top four leaves of 10 tillers averaged for each plot compared with a standard area key devised by James (1971). Scald assessment dates were June 11, 1985, June 4, 1986, and June 8, 1988.

Stripe rust was assessed in a cluster of 10 to 15 leaves removed from ten locations within a plot for each cultivar. Stripe rust ratings were made on the most severely rusted leaves in the cluster using the modified Cobb scale as 0, 5, 10, 20, 40, 60, or 100% of the leaf area rusted (Stubbs, Prescott, Saari and Dugin, 1986). Ten scores were averaged for each plot. Stripe rust assessment dates were September 7, 1989, and October, 15, 1990.

Data Analysis

Disease scores for cultivars were subjected to analysis of variance (ANOVA), and means were compared by Duncan's New Multiple Range Test, with a protected F value (significant at $P < 0.05$).

Table 1. Average severity of scald and stripe rust (percent of leaf with pustules) in ten cocksfoot cultivars.

Cultivar	Scald severity 1985	1986	1988	Stripe rust severity 1989	1990	Mean
	Scores[1]		(%)	(%)	(%)	(%)
Cambria	2.8 a[2]	3.0 a	46 ab	15 a	2 a	9
Potomac	5.5 bcde	6.5 de	68 e	25 ab	2 a	14
Hallmark	6.3 de	7.5 e	69 e	34 bc	9 ab	22
Pennlate	4.0 ab	4.5 b	42 a	37 bc	10 ab	24
Aonami	5.8 cde	4.8 bc	53 bcd	48 cd	15 ab	32
Able	5.8 cde	5.0 bc	54 bcd	52 cd	10 abc	31
Sterling	6.8 e	6.5 de	68 e	58 d	21 bc	40
Juno	6.3 de	6.0 cd	65 e	63 d	13 c	38
Frontier	4.3 abc	4.3 ab	47 abc	63 d	23 c	43
Latar	5.0 bcd	4.5 b	64 e	83 e	50 d	67
F value	5.87	9.75	14.18	10.99	17.38	

[1] *Scald severity was scored in 1985 and 1986 on a scale of 1 to 9 with 9 = most severe.*
[2] *Means followed by the same letter within a column are not significantly different from each other at P < 0.05, Duncan's multiple range test.*

RESULTS

Scald assessments (scores) among cultivars in 1985 and 1986 were significantly different ($P < 0.001$) and ranged from 2.8 to 6.8 and 3.0 to 7.5, respectively for the two years (Table 1). The cultivar x year interaction was not significant ($P < 0.389$). In 1988, scald assessments (percent leaf area damaged) among cultivars were significantly different ($P < 0.01$) and ranged from 46% to 69% (Table 1). Spearman's rank correlation was used to compare cultivar mean scald scores in 1985 and 1986 with percent scald damage in 1988. Scald assessments for cultivars among years were highly correlated ($r = .92$, $df = 8$). Cultivars Cambria, Pennlate, and Frontier were the most resistant to scald; cultivars Potomac, Hallmark, and Sterling were the most susceptible to scald.

Stripe rust assessments among cultivars were significantly different ($P < 0.01$) in both years and ranged from 15 to 83% in 1989, and 2 to 50% in 1990 (Table 1). When stripe rust scores for 1989 and 1990 were included in a combined ANOVA, cultivars were significantly different from each other ($P < 0.001$) and a significant interaction ($P < 0.011$) occurred between year x cultivar. Stripe rust was more severe in 1989 than 1990 and cultivars were significantly different from each other in both years ($P < 0.01$). Stripe rust assessments among cultivars between 1989 and 1990 were highly correlated ($r = .91$, $df = 8$) as determined by Spearman's rank correlation. Cultivars Cambria, Potomac, Hallmark, and Pennlate were among the most resistant to stripe rust; cultivars Frontier and Latar were among those most susceptible to stripe rust.

DISCUSSION

High r values for disease assessments among cultivars and years indicated the factor(s) contributing to different disease assessments were associated with inherent differences among these cultivars. This also indicated the natural strains of both pathogens apparently were stable during these years of testing.

Responses of these cultivars to natural populations of *R. orthosporum* and *P. striiformis* var. *dactylidis* were consistent among years. However, because symptoms or signs of scald and stripe rust were found on all cultivars, it is likely that there was variability within natural populations of both pathogens. Pathogenic races exist in *Rhynchosporium secalis* in barley (Xue, Hall and Falk, 1991) and *Puccinia striiformis* in wheat (Stubbs, 1984). If only one or a few cultivars were grown, natural selection might occur for strains of either pathogen resulting in a change in disease reaction of the cultivars. Cocksfoot is open-pollinated, and a shift in pathogenic races is likely to be slow because a cultivar is a heterogenous combination of several genotypes and there would be less pressure for selection toward pathogenic races.

During this study, several combinations of high and low disease severity were found for certain cultivars. For example, cv. Cambria had low disease ratings for scald and stem rust; cv. Latar had high disease ratings for both pathogens; cv. Potomac had a high disease rating for scald and a low disease rating for stripe rust; and cv. Frontier had a low disease rating for scald and a high disease rating for stripe rust. These data indicate that resistance and susceptibility is regulated by different genetic factors in the host or pathogen. Unfortunately, the genetic basis of host resistance or pathogenic races for these two fungi is unknown.

MacVicar and Childers (1955) reported that late-flowering types of cocksfoot have been selected for resistance to *Rhynchosporium (sic, secalis) orthosporum*; Breece (1966) compared stripe rust in two cultivars of cocksfoot and found cv. S-143 to have relatively less disease than cv. Latar. Our data support observations that cultivars of cocksfoot grown for seed in Oregon also vary in their disease response to scald and stripe rust. Cocksfoot cultivars have been reported with resistance to other fungal pathogens, including *Mastigosporium rubricosum* (Hardison, 1984), *Stagonospora arenaria* (Graham, 1952; Zeiders, Berg and Sherwood, 1984), and *Cercosporidium (Scolecotrichum) graminis* (Graham, Zeiders and Braverman, 1963). A goal to develop cultivars with stable multiple-disease resistance to several fungus pathogens is attainable. This has been done with other open-pollinated crops, including cereal rye (Cotter and Levine, 1932), maize and sorghum (Hooker, 1985), and lucerne (USDA, 1984). However, the effort and investment required to determine the genetics of pathogen resistance in cocksfoot or to determine and characterise pathogenic races may not be worthwhile at this time.

Fungicides are the most common and effective way to control leaf diseases in forage grasses grown for seed, especially when more than one fungal pathogen occurs in the same plant (Horeman, 1989; Rolston, Hampton, Hare and Falloon, 1989; Welty, 1991). Knowledge of scald or stripe rust resistance in a cultivar may be useful in determining whether to apply a fungicide for disease control.

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