RESISTANCE OF TIMOTHY CULTIVARS TO HETEROSPORIUM PHLEI, DRECHSLERA PHLEI, AND FROST INJURY[1]

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Abstract

Although none of 44 cultivars of timothy, Phleum pratense L. and P. nodosum L., showed complete resistance to Heterosporium phlei Gregory in a mild, artificially induced field epidemic of leaf spot disease, some appeared significantly less susceptible than others. The absence of complete mature plant resistance in eight strains was confirmed in growth chamber pathogenicity tests. There was no good correlation between frost injury and resistance to H. phlei. The abundance of overwintering inoculum on crop debris is perhaps more important as an epidemiological factor than frost damage. The destruction of this inoculum by hay removal or careful field burning and the use of less susceptible cultivars and fertilization are possible control measures requiring further testing. Natural infection with Urechslera phlei (Graham) Shoemaker was very light and was not correlated with resistance to H. phlei or with the other characters. There were good positive correlations between severity of frost injury and plant vigor, frost injury and earliness of heading, and between plant vigor and earliness of heading.

Introduction

Timothy, Phleum pratense L. and P. nodosum L., is grown primarily as a seed crop in Saskatchewan. Lack of resistance to drought and soil salinity mitigate against its common use for hay and pasture (13). A leaf spot of timothy caused by Heterosporium phlei Gregory (5) was observed causing severe damage to seed crops of the 'Climax' cultivar in the seed-growing district in northeastern Saskatchewan in 1967 and 1968 (unpublished data). Although timothy is generally regarded as winter hardy (13), early spring frosts may cause considerable leaf injury. Such injury and abundant carry-over of inoculum on the heavy straw from the previous crop were considered to be contributory factors in the 1967 epidemic in Saskatchewan. It was been reported that the disease reduced forage yields. Tsutomu and Takeshi (12), who controlled Heterosporium leaf spot by applications of a dithiocarbamate fungicide, found that the disease reduced crude protein in leaves by 26% and in whole shoots by 7%. Depressed yields of forage were ascribed to the disease in Nova Scotia (3).

Drechslera phlei (Graham) Shoemaker, syn. Helminthosporium dictyoides Drechsler var. phlei Graham (4), is the cause of a leaf spot (streak) of timothy in Europe and North America (4,10). The disease appears to be of little importance in Saskatchewan seed crops. However, heavy seed infection has been found in samples from eastern Canada, U.S.A., and Europe (11), so the disease is probably of greater importance where Saskatchewan timothy seed may be used.

This paper reports on the 1969 field reaction of 44 cultivars of P. pratense and P. nodosum from various countries to H. phlei, D. phlei, and frost. Cultivars were also rated for general vigor, abundance of seed heads, and earliness of heading to determine whether these characters were correlated with disease resistance.

Materials and methods

Plant material

After a health test (11), seed of cultivars (Table 1) with satisfactory germination was dressed with a captan dressing at 0.2% seed weight (8) to reduce the risk of introducing alien pathogens. A field test with six replicates was planted at Saskatoon on May 29, 1968. Seed was sown at 1 cm depth in rows 30 cm apart at the rate of 6.5 g/3 m row. Six infector rows of untreated 'Climax' were sown around the perimeter of each replicate.

Plot inoculation

All plants were mown with a sickle-bar mower on August 28, and the hay was left to serve as a substrate for H. phlei. Isolates of the fungus were cultured on potato dextrose agar for 3 weeks. A distilled water suspension containing 3.25 x 10 spores/ml was prepared and applied to the test area with a pneumatic sprayer on September 3 at the rate df 8 litres/400 m . The plots were sprayed in two directions to improve eveness of cover. Light rain followed the application of the inoculum, and the weather was

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cool (max. 15C) and dull for the next 2 days. The pathogenicity of the inoculum used in the field was checked on timothy plants in an infection chamber.

Rating for disease, plant vigor, and heading

The leaf spots caused by H. phlei and D. phlei were rated on 10 plants per row; frost injury, general plant vigor, earliness of heading, and abundance of seed heads were appraised on a row basis. A rating scale of 0 to 4 was used, 0 indicating no disease and 4 very severe disease. A zero rating also denoted lowest frost injury, plant vigor, fewest seed heads, and latest heading, while 4 was the opposite extreme. All ratings were made between June 27 and 29, 1969 except for seed head abundance, which was scored on July 16.

Table 1. Ratings of 44 cultivars of timothy for resistance to Heterosporium phlei, Drechslera phlei, and frost injury and for plant vigor, earliness of heading, and abundance of seed heads

Cultivar or strain	Country of origin	Average rating* per plant or row					
		H. phlei	D. phlei	Frost injury	Plant vigor	Heading earliness	Heading abundance
S-50	U.K.	1.25	0.00	1.42	2.50	2.33	2.17
Timo	Holland	1.17	0.25	1.83	2.42	1.33	2.17
Vertas	Holland	1.08	0.33	2.83	1.58	0.25	1.00
9-s	Canada	1.00	0.25	1.92	2.67	2.50	1.50
Tiger	U.S.A.	1.00	0.50	2.33	1.75	1.00	0.67
Veng	Holland	0.92	0.67	2.53	1.92	1.00	1.00
Clair	U.S.A.	0.92	0.50	1.92	2.58	2.42	1.17
Lofar	Holland	0.83	0.33	2.08	2.42	1.58	2.50
CIV Tuss.	Holland	0.83	0.42	2.08	1.92	1.50	1.50
Champ	Canada	0.83	0.75	1.92	2.50	2.08	1.50
S-51	U.K.	0.83	0.58	2.75	2.00	0.92	1.17
Evergreen	Sweden	0.75	0.08	1.33	2.67	1.83	1.33
Bottnia 2	Sweden	0.75	0.25	1.92	2.25	2.08	1.67
Heidimij	Holland	0.75	0.33	2.42	2.00	0.42	1.67
32-4	France	0.75	0.33	2.75	1.50	0.58	1.67
Barenza early hay	Holland	0.75	0.50	2.16	2.33	2.42	2.33
S-48	U.K.	0.75	0.08	2.75	1.75	0.25	2.17
Taca Trif. S65	Sweden	0.67	0.25	1.58	2.58	2.75	2.17
Eskimo	Holland	0.67	0.42	2.00	2.16	2.25	2.00
Sceempter	Holland	0.67	0.08	2.67	1.58	0.08	2.33
CIV 34	Holland	0.67	0.50	1.75	2.58	2.83	0.83
Climax (U.S.A.)	Canada	0.67	0.58	1.42	2.58	2.42	1.00
Wisconsin T4	U.S.A.	0.67	0.33	1.50	2.58	2.33	1.83
Wisconsin T1	U.S.A.	0.67	0.33	1.33	2.67	2.25	0.67
Panther	U.S.A.	0.67	0.17	2.42	1.83	1.17	1.83
2-S	Canada	0.67	0.50	1.83	2.50	2.42	1.67
Topas Otofte	Denmark	0.58	0.25	1.50	2.58	2.00	3.00
Kahu	New Zealand	0.58	0.25	2.00	2.33	1.25	2.17
King	Holland	0.58	0.50	2.67	1.83	0.42	1.83
Samo	Holland	0.58	0.17	2.83	1.25	0.58	1.67
S-352	U.K.	0.58	0.50	1.50	2.75	2.75	1.33
Combi	Holland	0.58	0.42	2.33	2.08	0.58	1.67
Drummond	Canada	0.58	0.42	2.08	2.33	1.25	1.83
Bounty	Canada	0.58	0.58	1.83	2.42	2.00	1.00
Erecta RVP	Belgium	0.50	0.25	1.67	2.58	2.42	1.50
Barenza late hay	Holland	0.50	0.33	2.25	2.00	0.50	1.83
Jacoba	Holland	0.50	0.25	2.50	1.83	1.17	1.83
Climax (Can.)	Canada	0.50	0.42	1.33	2.75	2.50	1.50
T41	U.S.A.	0.50	0.17	1.83	2.58	2.17	1.00
Essex	U.S.A.	0.50	1.08	1.50	2.33	1.75	1.17
Common (U.S.)	U.S.A.	0.50	0.42	1.75	2.50	2.33	1.33
Labelle	Canada	0.50	0.42	1.58	2.58	1.83	0.83
L 84	Italy	0.50	0.50	2.00	2.58	2.42	1.17
Bero	Sweden	0.42	0.33	2.00	2.33	2.08	2.00
Grand Mean		0.70	0.35	2.01	2.26	1.66	1.59
L.S.D. 5%		0.35	0.37	0.64	0.59	0.69	1.03
1%		0.47	0.49	0.81	0.78	0.91	1.37
Mean of							
8 Canadian cultivars		0.67	0.49	1.74	2.54	2.13	1.35
16 N. American cultivars		0.67	0.40	1.78	2.44	2.03	1.28
28 Other cultivars		0.71	0.32	2.15	2.15	1.44	1.77

* All ratings were made on a 0 to 4 scale, where 0 was *no* disease, or no frost injury, lowest vigor, fewest seed heads, and 4 the extreme opposite. 0 was latest heading and 4 earliest.

Results and discussion

Timothy plants inoculated with the spore suspension and placed in an infection chamber showed leaf lesions in 6 days, which was also the time required for slight leaf spotting to develop in the field. Heterosporium leaf spots were easily found on many of the cultivars, but no D. phlei lesions were seen in 1968. Ratings of the test made in 1969 are given in Table 1.

Although none of the cultivars showed complete resistance to H. phlei, some were significantly less susceptible than others. There was little difference apparent in the reactions of cultivars of North American, Canadian, and other origins (Table 1). Tsutomu and Takeshi in Japan (12) found in one test that none of 12 cultivars showed great resistance to this pathogen, but 'Essex' was least susceptible. In another test, 'S-50' was the most severely spotted of seven cultivars. They found also that 'Climax' of Canadian and U.S. origin showed considerable differences in susceptibility. Similar results were obtained with these cultivars in the test reported here. Resistance to H. phlei was examined further by screening in growth chambers 500 plants of the Canadian 'Climax', 'Bounty' (1), and 'Champ' (2) cultivars and of five lines from the U.S.S.R. The plants were tested in flights, with uninfected survivors from earlier ones being reinoculated. This mitigated against disease escape. No cultivars remained free from disease although several clones of 'Bounty' were only slightly affected. Possibly these may form the basis of a resistant cultivar.

Leaf spot caused by D. phlei was quite light on the test plots in 1969. Cultivars of P. nodosum, 'S-50' and 'Evergreen', and 'S-48', 'Sceempter' and 'Essex' of P. pratense showed little or no infection. The inoculum for this infection may have come from the infector plants of 'Climax' since the seed of all test cultivars was treated and there were no other stands of timothy in the vicinity.

Generally, North American cultivars were slightly superior to those from other sources in resistance to frost injury (Table 1). Canadian cultivars scored well.

There were no significant correlations between the ratings for the two diseases or between these and the other agronomic characters. There were good positive correlations between severity of frost injury and plant vigor, r = 0.659, and between frost injury and earliness of heading, r = 0.661. This indicated that those cultivars which produced early growth in spring or were early in heading were also susceptible to early spring frost damage. Canadian and U.S. cultivars showed greater plant vigor and were considerably earlier in heading out than those from other sources, but the former generally produced less abundant seed heads (Table 1). This may be related to the fact that many of the North American cultivars were late hay types (1,2,6). There was also a good correlation, r = 0.661, between plant vigor and earliness of heading.

The absence of correlation between frost injury and leaf spot ratings for H. phlei suggests that these are not linked epidemiologically, as was previously considered in the epidemics in northeastern Saskatchewan. The abundance of overwintering inoculum on crop debris may be the important factor in determining disease severity. The fungus overwinters as mycelium in tissues (12) and spores are produced sparingly on lesions. According to Horsfall (7) and Jacques (9), these will germinate at temperatures as low as 3C, while Narita and Sakuma found that spores may be produced at low temperatures and high humidity under snow (12). The same workers reported that sporulation was more abundant on parts of the plant deficient in magnesium and potassium than on normal parts. The disease was partly controlled by appropriate applications of fertilizer containing nitrogen, phosphate, and potassium. The burning of crop debris may be a means of controlling the disease, but its physiological effect on the plants is uncertain. Severe thinning has resulted in seed crops in Saskatchewan following burninq, probably due to damage to growing points.

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