Special Report

CEPHLOSS: A Computer Program to Help the Small Grain Producer in Montana

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Cephalosporium gramineum (Nisikado & Ikata) is an important soilborne pathogen of winter wheat (*Triticum aestivum* L.). The pathogen was first described in Montana 25 years ago (4). Since then, researchers in Montana and elsewhere have spent considerable time and resources studying the biology of the organism. Much of this information is published in a form not available or directly useful to the average small grain producer. Although few data are available on the economic consequences of Cephalosporium stripe in a commercial farming operation, estimated annual yield losses in Montana are in the millions of dollars.

One control measure is to delay fall seeding until soil temperature 10 cm below the surface is less than 13 C, thus reducing the root mass and the number of available sites for infection. Rotation is another important measure, since winter wheat is the only commercial crop affected by Cephalosporium stripe (1). Selecting the least susceptible cultivar is also a worthwhile option, even though most cultivars show little difference in susceptibility at the present time.

Data have been gathered on the effect of crop rotation on the incidence of Cephalosporium stripe, on the disease reaction of commonly grown cultivars, and on the cost of producing small grains in Montana. The purpose of our program was to determine how to integrate these data and answer the following questions:

1. Which cultivars are best suited for a particular cropping district?
2. Which cultivars are the least susceptible?
3. How will crop rotation affect the incidence of Cephalosporium stripe in a commercial field?
4. Using cost of production figures, how much *Cephalosporium* infection is necessary before rotation to either spring wheat or barley becomes economically desirable, since both return fewer dollars per acre than winter wheat?

We have previously described the effect of crop rotation on Cephalosporium stripe (3). We found the rate of straw decomposition to be the important factor in crop rotation, since the pathogen is not viable after the straw is decomposed. Under Montana cropping conditions, infested straw takes approximately 3 years to decompose sufficiently to reduce subsequent infection by two-thirds. With only a 1-year interval between winter wheat crops, infection increases twofold; 2 years between crops does not seem to have a significant effect on infection levels.

As part of our resistant germ plasm development program at Montana State University, we routinely screen all the commonly grown cultivars in the state (2). We rate the cultivars according to reaction to *Cephalosporium* under conditions of uniform inoculum pressure. Yields are expressed as a percentage of the noninoculated control, and this value is multiplied by the value obtained with the susceptible check cultivar Cheyenne (CI 8885). This "disease indicator" is used to rate each cultivar relative to a common check (Table 1).

Montana is divided into six crop production areas, and these areas are used to routinely test both commercial and experimental cultivars for yield and other agronomic properties. These data are used to rank recommended cultivars for yield, expressed as a percentage of the cultivar Cheyenne. The two percentages (disease indicator × yield) are multiplied together to arrive at the final yield ranking under conditions of equal inoculum density for each area. This yield index is used as an indication of how each cultivar when infected with *Cephalosporium* would yield relative to another under a variety of growing conditions (Table 1).

Data defining the economics of crop rotation are obtained with the use of the University of Nebraska's AGNET–CROPBUDGET program, which generates the cost of dryland small grain production for a number of locations. For Montana, the program assumes the norm to be a crop-fallow rotation with conventional stubble-mulch tillage. Depending on the cropping district, the average farm size varies from 120 to 800 ha. Average cost of production is based on averages from the previous 3 years. Values for winter wheat, spring wheat, and barley are obtained by using the default or average cost of production on a per-acre basis.

The CEPHLOSS program is written in Microsoft Basic, chosen because it is probably the interpreter being used with most microcomputers. In addition, programs written in this language are easy to modify and may be transferred between both CP/M and MS-DOS operating systems. This means the

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Table 1. Example of calculation of relative yield index[a] of commonly grown Montana cultivars

	Inoculated plots		Healthy plots			
			Bozeman		Moccasin	
Cultivar	Yield (% of control)	Disease indicator (% of Cheyenne)	Yield (% of Cheyenne)	Yield index	Yield (% of Cheyenne)	Yield index
Centurk	49.3	114	121	138	97	111
Cheyenne	43.4	100	100	100	100	100
Redwin	53.9	124	113	140	103	128
Winalta	47.3	109	106	115	103	112
Froid	41.2	95	95	91	100	95

[a] Yield index = disease indicator (% of Cheyenne in inoculated plots) × yield (% of Cheyenne in healthy plots) for each location.

Table 2. Example of cost of production figures in Gallatin County, Montana, in 1984

Crop	Cost per acre ($)	Yield per acre (bu)	Price per bushel ($)
Winter wheat	103.65	34	3.55
Spring wheat	101.75	27	3.67
Spring barley	110.58	41	2.11

program is usable on most computers on the market today.

The program is menu-driven. The only direct inputs needed from the operator are the current infection levels in the field, projected rotation schemes, and, if possible, accurate cost-of-production data. Numerous help messages are included to assist in clarifying how data are to be entered and what each section of the program accomplishes.

When the program is run, the producer is asked if detailed information is needed on how to determine the level of infection in the field, then is asked to enter the first four letters of the county in which the farm is located. This information is used to set up "default" data for cultivar reactions as well as production costs. At this point, the producer selects from three major options. He can obtain a listing of cultivar reactions or, if he is interested in how infection is influenced by rotation, he can input current infection levels and the rotation sequence anticipated before the next crop of winter wheat is grown. The program then calculates what level of infection and what percent yield loss might be anticipated in the next winter wheat crop. These data are retained in memory until replaced with new values.

The other important section examines costs of production. The producer is asked to enter production costs for winter wheat, spring wheat, and barley. The program also asks for historic yield values and selling prices for all three crops; if these values are not available, the program displays the average data for a particular growing area. The program then calculates what percent yield loss in the winter wheat crop is acceptable before rotation to either spring wheat or barley becomes economically desirable. If the data in Table 2 were inputted, for example, the program would determine that the winter wheat yield loss necessary before rotation becomes economically worthwhile would be 16.3% to rotate to spring wheat and 34.1% to rotate to spring barley. These data are also kept in memory until replaced with new values. After running through the program once, the producer can rerun the section on infection and vary the rotation sequence until a rotation is found that will keep the infection level in the field below the level at which switching crops is economically desirable. After running the program, the producer is given additional information on how to minimize yield losses due to Cephalosporium stripe, including planting date, fertilization, and stubble management.

The real strength of the CEPHLOSS program lies in determining the economic point at which the infection level becomes sufficiently high to justify rotation to a crop that usually returns fewer dollars per acre. We believe the program will not only help the small grain producer make informed decisions on factors affecting agronomic inputs but will also help maximize the dollar return to the farming community. We anticipate the program will be used by most of the county agents in Montana where winter wheat is grown and Cephalosporium stripe is a problem. We hope many private producers will also use the program.

The program is available free of charge from the first author. The only stipulation is that the request be accompanied by a 5 1/4-in. formatted disk and the name of the computer manufacturer.

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