Effect of Residue Management Method on Incidence of Cephalosporium Stripe Under Continuous Winter Wheat Production

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ABSTRACT


A 3-yr field experiment was conducted to compare the effect of five different wheat residue management practices (burn and disk, plow, disk, chop and disk, and direct-drill) on the incidence of Cephalosporium stripe (Cs) disease. Wheat was continuously cropped and the same management method used each year. Three-year averages of percentage Cs infection for the treatments were: burn and disk = 12.8, plow = 24.2, disk = 29.6, chop and disk = 36.7, and direct-drill = 46. Burning wheat stubble was the most effective disposal method for reducing Cs after a severe outbreak under a continuous winter wheat production regime. After 3 yr of plowing, Cs incidence was the same as after 3 yr of burning; therefore, continuous plowing is expected to effectively help maintain low disease losses. On the other hand, reduced tillage (direct-drill) is expected to maintain high levels of Cs under continuous cropping.

Cephalosporium stripe (Cs) is a vascular disease of winter wheat (Triticum aestivum L.) caused by the soilborne fungus Cephalosporium graminum Nisikado & Ikata (Cg) [=Hymenula cerealis Ell. & Ev.). It was first reported in Kansas in 1972 (15) and has since increased in severity to become a major wheat disease. Cs is most important in the central one-third of the state, where winter wheat is continuously cropped. From 1976 through 1982, Cs caused an estimated average annual yield loss in Kansas of about 5 million bushels (12) and has been a primary yield-reducing factor in some areas.

C. graminum is a root-infecting, systemic pathogen of winter cereals but is not a problem in spring cereals (13). It survives between crops in straw from plants parasitically colonized during the previous cropping season. Large numbers of spores are produced from this food base (3) during fall and winter, occasionally resulting in more than 10⁷ propagules per gram of soil (14). Entry into plant roots occurs either by spore germination and direct penetration after root freezing (1) or by passive spore uptake after root wounds caused by soil heaving (4,9). After infection, the fungus systemically invades the plant during the spring, resulting in straw infected with Cg at the end of the season. The fungus can survive in infested straw for 2–3 yr (7,14), but rotations to nonhosts for longer periods result in straw decomposition, Cg death (5,14), and effective Cs control (7,13).

Wiese and Ravenscroft (14) reported that both straw removal and plowing reduced Cg soil populations and incidence of Cs compared with diskjng. In a 2-yr rotation regime, Latin et al (7) reported more Cs in no-till than in conventional tillage plots, demonstrating that residue management can affect Cs incidence. This study was undertaken to extend these findings by using a multiple-year, continuous-cropping regime to compare five different primary residue management practices for effect on incidence of Cs.

MATERIALS AND METHODS

A field at the Kansas State University Harvey County Experiment Field near Hesston, KS, was selected for the study. The field consisted of Ladysmith silty clay loam soil (pH 5.3) in the fourth consecutive year of winter wheat production and was naturally infested with Cg. To ensure uniform infestation, an area measuring 30.5 × 183 m was seeded on 19 September 1978 with Newton (CI 17715) wheat (67 kg/ha) and oat kernels colonized by Cg (10 g/6-m drill row) (8). On 8 May 1979 (heading complete), the site was divided into 20 plots, each 9.1 × 30.5 m, with 150 randomly selected tillers per plot collected and Cs incidence determined by examining leaves and sheaths for characteristic yellow stripes (2).

Immediately after harvest (3 July 1979) one of the following primary tillage treatments was applied to each plot in a randomized block design with four replicates: 1) residue burned, then tandem-disked; 2) residue moldboard plowed to a depth of 30 cm; 3) residue tandem-disked; 4) residue chopped with a rotary mower, then tandem-disked; and 5) residue left undisturbed (direct-drill).

During the next three consecutive years, Newton wheat (67 kg/ha) was planted across the plot area in the last week of September with a John Deere Power-Till Drill (John Deere Co., Moline, IL 61265); however, no further additions of Cg-colonized oat kernels were made.

Disease incidence was determined each year for each plot at growth stage 10.5 (heading complete [6]) as described previously (2). Grain yields were determined by harvesting 4 m from the center of each plot with a combine and adjusting weights to 10% moisture. Disease incidence and yield data were analyzed for significance ($P = 0.05$) by Duncan's multiple range test.

Harvest occurred during the last week of June or first week of July, depending upon crop maturity, and primary tillage treatments were performed within 9 days of harvest. A plot received the same primary residue management treatment each year, and for treatments 1–4, weeds were controlled during the summer by diskjng all plots when necessary. Weeds were controlled between wheat crops in treatment 5 by applying glyphosate at 0.8 kg a.i./ha. Standard seedbed preparation practices were applied for treatments 1–4. During the growing seasons, standard fertilizer and herbicide programs for dryland winter wheat production were followed, with all treatments receiving the same program.

RESULTS

Cs occurred uniformly across the site in the spring of 1979 before initiation of the different residue management regimes. Incidences ranged from 53 to 62%. During the first year after the different management practices, the burning treatment resulted in significantly less Cs than all other treatments (Table 1); however, Cs incidence after three consecutive years of moldboard plowing was virtually the same as after three consecutive years of burning. Direct-drilling consistently resulted in highest Cs...
Table 1. Effect of winter wheat residue management method on incidence of Cephalosporium stripe disease under a continuous cropping production regime

<table>
<thead>
<tr>
<th>Residue disposal method</th>
<th>Percentage stripe infection*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1980</td>
</tr>
<tr>
<td>Burn and disk</td>
<td>18.0</td>
</tr>
<tr>
<td>Plow</td>
<td>39.0</td>
</tr>
<tr>
<td>Disk</td>
<td>42.3</td>
</tr>
<tr>
<td>Chop and disk</td>
<td>52.8</td>
</tr>
<tr>
<td>Direct-drill</td>
<td>54.8</td>
</tr>
</tbody>
</table>

* Determined after heading process complete by looking for characteristic yellow stripes on a minimum of 150 randomly selected tillers per plot. Values are means of four replicates, and if followed by common letters within a column, are not significantly (P = 0.05) different according to Duncan's multiple range test.

Residue burned and disked after harvest, then disked as needed before seeding.

Residue burned and disked after harvest, then disked as needed before seeding.

Residue disked after harvest, then disked as needed before seeding.

Residue chopped with a rotary mower before being disked after harvest, then disked as needed.

Residue left undisturbed after harvest.

Incidence (Table 1) and was significantly greater all 3 yr than the burn and plow treatments and significantly greater than the disk treatment the last 2 yr. Chopping the residue to reduce particle size before disked did not significantly affect Cs incidence compared with disked alone. Three-year averages for the five tillage treatments were: burn and disk = 12.8%, plow = 24.2%, disk = 29.6%, chop and disk = 36.1%, and direct-drill = 46%.

Average yields (kg/ha) for the residue management practices during the 3 yr were: burn and disk = 1,308, plow = 1,290, disk = 1,238, chop and disk = 1,224, and direct-drill = 777.

There were no significant differences among treatments, except the yield of the direct-drill treatment was significantly (P = 0.05) less than in all other treatments. Yields were affected by environmental factors and by natural infestations of pests other than Cs, including tan spot disease (Pyrenophora tritici-repentis) (Drechs.). speckled leaf blotch disease (Septoria tritici) Rob. in Desm.) and downy brome grass (Bromus tectorum L.).

In areas where soil erosion, soil moisture, and fuel conservation are important, the residue-disposal practices described are not used and large amounts of crop residue are left on the soil surface. Latin et al. (7) reported severe Cs in their "no-till" plots even though they were using a 2-yr winter wheat/spring pea rotation. Our results indicate that reduced-tillage practices under continuous wheat production will maintain high levels of Cs incidence. Even during 1982, which was not conducive to Cs in south central Kansas (12), 20-25% yield loss from this disease (2,11) was sustained in the direct-drill treatment. During years conducive to Cs development (1980 and 1981), losses of 40-45% occurred. It is clear that alternate disease control measures such as host resistance (9) are necessary to prevent heavy Cs losses under reduced-tillage situations.

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LITERATURE CITED


