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

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ABSTRACT

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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 gramineum* 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. gramineum 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 10^5 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 wounding caused by soil heaving (4,9). After infection, the fungus systemically invades the plant during the spring, resulting in straw infested 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 disking. 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.

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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 disking 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

Residue disposal method	Percentage stripe infection[u]		
	1980	1981	1982
Burn and disk[v]	18.0 a	17.4 a	3.0 a
Plow[w]	39.0 b	30.1 ab	3.6 a
Disk[x]	42.3 bc	33.5 b	13.1 ab
Chop and disk[y]	52.8 c	39.7 b	17.5 bc
Direct-drill[z]	54.8 c	54.4 c	28.8 c

[u] 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.

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

[w] Residue moldboard plowed to a depth of 30 cm after harvest, then disked as needed before seeding.

[x] Residue disked after harvest, then disked as needed before seeding.

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

[z] 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 disking treatment the last 2 yr. Chopping the residue to reduce particle size before disking did not significantly affect Cs incidence compared with disking alone. Three-year averages for the five tillage treatments were: burn and disk = 12.8%, plow = 24.2%, disk = 29.6%, chop and disk = 36.7%, 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 = 1,122, and direct-drill = 777. There were no significant differences among treatments, except the yields of the direct-drill treatment were significantly ($P = 0.05$) less than in all other treatments. Yields were affected by abiotic factors and by natural infestations of pests other than Cs, including tan spot disease (*Pyrenophora tritici-repentis* (Died.) Drechs.), speckled leaf blotch disease (*Septoria tritici* Rob. in Desm.) and downy brome grass (*Bromus tectorum* L.).

DISCUSSION

Results of this study showed that after an outbreak of Cs under continuous winter wheat production, burning wheat residue was the most effective disposal method to minimize disease incidence the next season. The effectiveness of the burning treatment may partially explain the relatively widespread use of this practice by growers in the central district of Kansas, where Cs is frequently a yield-reducing factor.

Deep plowing wheat residue immediately after harvest was the next best disposal method for minimizing Cs incidence in continuous wheat after a severe disease outbreak. This finding is consistent with other reports (10,14) showing reduced Cs after plowing. Results of this study, however, showed that three consecutive years of moldboard plowing reduced Cs incidence to a level approaching that of three consecutive years of burning. Although burning was more effective in initially reducing Cs after severe disease, plowing eventually resulted in similar control. Thus, for fields in areas where Cs frequently occurs but where levels of the disease are low (eg, after crop rotation or burning), continual plowing may be expected to maintain low losses from Cs.

The chopping treatment followed by disking was employed in an attempt to reduce residue particle size and possibly hasten its microbial decomposition. Because *Cg* rapidly dies out as residue is decomposed (5), this was expected to reduce Cs incidence. Under Kansas conditions, this treatment had no significant effect on incidence compared with disking alone. Perhaps chopping straw will reduce Cs in areas where the environment is more conducive to refuse decay during the summer or where there are longer periods between susceptible crops.

The type of residue management practice employed affects many biotic and abiotic parameters associated with wheat production. Several naturally occurring pest infestations were observed during our study and these were not uniformly distributed across the field because they are affected by residue management (13). These and other nonuniform yield-reducing factors make direct comparison of Cs incidence with yield inappropriate. Nevertheless, Cs incidence values (Table 1) for treatments within a given year are reported to be good estimators of relative yield loss caused by Cs (2).

C. gramineum has the capacity to produce large numbers of soilborne spores when conditions are favorable; however, spore production is confined to the soil surface and to a depth of 7.6 cm (14). Although *Cg* can multiply in soil apart from straw (14), spore production from straw is of primary importance (3,14). Results of this and other (7,10,14) studies show that residue management practices applied to control Cs should destroy, remove, or reduce the amount of refuse left in the top 7.6 cm of soil to limit *Cg* inoculum production and stripe incidence during the next cropping season.

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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