EFECT OF FOUR TILLAGE TREATMENTS ON EYESPOT (*Kabatiella zeae* Narita and Hiratsuka) DEVELOPMENT AND GRAIN YIELD IN MAIZE[1] /

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Resumen

Se estudió el efecto de cuatro sistemas de labranza sobre el desarrollo de la enfermedad causada por Kabatiella zeae *en dos híbridos de maíz (Pioneer 3780 y W64A x W117). Las parcelas en donde los residuos de maíz infectados del cultivo anterior se habían arado y enterrado durante el otoño presentaron la menor incidencia de la enfermedad.*

Las plantas en parcelas bajo un sistema de mínima labranza fueron las más afectadas. La cantidad de tejido enfermo en el híbrido W64A x W117 fue aproximadamente diez veces mayor que en Pioneer 3780. La severidad de la enfermedad no estuvo correlacionada con el rendimiento de grano en cada híbrido, lo cual indica que existieron otros factores (sequía, baja emergencia y ataque por gusanos de la raíz) que tuvieron un mayor efecto sobre el rendimiento. La enfermedad se incrementó rápidamente en todas las parcelas, incluyendo aquéllas en donde los residuos de maíz del cultivo anterior habían sido arados y enterrados. Sin embargo, en estas parcelas algún residuo permaneció sobre la superficie del suelo. Se sugiere que, debido a la naturaleza policíclica de la enfermedad, aún cantidades muy bajas de inóculo en los residuos de la siembra anterior son suficientes para producir una cantidad considerable de tejido enfermo al final del ciclo del cultivo actual. La dispersión aérea de los conidios pudo también ayudar a la generalización de la epidemia.

Introduction

Eyespot of maize, caused by *Kabatiella zeae* Narita and Hiratsuka, has spread to 12 countries in 21 years since reported for the first time in Japan in 1956 (2, 3, 4, 7, 9). The disease has been limited to the temperate zones, and in the Western Hemisphere it is prevalent in USA, Canada and Argentina (1, 3, 5).

The eyespot disease is important because it reduces the photosynthetic area of the plant, the quality of the seed and predisposes the plants to the attack by other diseases such as stalk rot and root rot (1, 2, 3, 6, 8, 9); the destructive potential of *K. zeae* was considered by Reifschanider and Amy (9) to be similar to that of *Helminthosporium turcicum* Ullstrup.

The eyespot disease is more severe in maize planted under minimum tillage practices since the fungus overwinters as stromatic hyphae in infected corn residues from the previous crop. These survival structures germinate and produce conidia that infect young corn plants early in the spring (1, 2, 4, 6, 9). Cool and humid conditions are especially favorable for the development of the disease (9).

The increasing popularity of reduced tillage systems has provided an opportunity for the disease to become more prominent (1, 2, 6), but there is a scarcity of information on the effect of different tillage practices on the development of the disease. This paper reports the effect of four tillage systems on subsequent eyespot development in a field where the disease was severe the previous year.

1 Received for publication on May 14, 1986.
This is a portion of a thesis submited by the author to the Graduate College of Iowa State University as partial fulfillment of the requirements for the M.Sc. degree. The author is grateful to Dr. C.A. Martinson for his help and advice in the realization of this work.

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Materials and methods

The experiment was conducted in 1981 near Ames, Iowa. During 1980, the susceptible hybrid W64A x W117 (6) was planted under minimum tillage practices in a field used the previous year for an eyespot experiment. By the end of the season, the hybrid was uniformly and heavily infected with the eyespot disease. In the fall of 1980 the field was plotted for a tillage experiment. There were four tillage treatments: 1) fall moldboard plow (20 cm deep); 2) no tillage; 3) fall chisel plow (30 cm deep); and 4) spring disking (10 cm deep). The fall-plowed plots were disked twice and smoothed by two passes with a spike harrow. The chisel plow plots were disked once in the spring and smoothed by two passes with a spike harrow. The spring disked plots were harrowed twice after the initial disking. The experiment was arranged as a completely randomized block design with six replications. Each block was 24.4 m wide by 97.6 m long, with four contiguous tillage plots (24.4 m x 24.4 m). Blocks were separated by 9.1 m alleyways of fallow soil.

Plots were slot-planted on April 30 with rows 76 cm apart and a planting population of about 59.300 kernels/ha. Each tillage plot was divided in half (16 rows/half) and the hybrids W64A x W117 (susceptible) and Pioneer 3780 (resistant) were planted in each subplot.

The severity of the eyespot disease was evaluated three times during the growing season on the ear leaf of ten plants in the two central rows of each hybrid. Severity was assessed by estimating the number of lesions/leaf.

The eight central rows of each subplot were harvested with a plot combine on September 24 for variety W64A x W117 and on September 29 for Pioneer 3780. Grain weight was measured during the harvesting and a sample of the grain was oven-dried (103° C for grain moisture determinations. Yield was corrected to a uniform 15.5% grain moisture content.

Results

The first disease data (Table 1) were taken at the early and late silking growth stage for Pioneer 3780 and W64A x W117, respectively. Eyespot disease was significantly higher for W64A x W117 than for Pioneer 3780, with eyespot lesion counts about 10 times higher for W64A x W117. Eyespot severity was lower in the fall-plowed plots than in the other plots. With W64A x W117 the disease was highest with no tillage. Any ranking of lesions/leaf by tillage treatment resulted in a similar ranking for both genotypes.

By the time of the second reading, the disease had increased much more for W64A x W117 than for Pioneer 3780 (Table 1). The tillage effect was restricted to a comparison of fall-plowed with any of the conservation tillage treatments. Differences in disease among conservation tillage treatments were not significant (Table 1). There was a large disease increase in the fall-plowed plots with the highly susceptible hybrid. The differences in lesions/leaf between the conservation tillage treatments and the fall-plowed treatment were about 800-900 and 60-130 lesions/leaf for W64A x W117 and Pioneer 3780, respectively.

Table 1. Means for number of lesions on the ear leaf at three observation times, grain yield, and grain moisture content at harvest on two maize hybrids grown under four tillage systems.

Hybrid	Tillage	No. of lesions/leaf			kg/ha	Moisture %
		July 20	Aug. 14	Sep. 6		
Pioneer 3780	Fall plow	12 b*	29 b	441 c	7 838 a	25.4 ab
Pioneer 3780	No-till	88 a	162 a	1 346 a	7 609 a	26 2 a
Pioneer 3780	Fall chisel plow	50 a	86 a	910 b	7 550 a	24 9 b
Pioneer 3780	Sping disk	60 a	164 a	934 b	8 470 a	23 3 c
Means		53	110	908	7 867.3	24 9
W64A x W117	Fall plow	164 c	890 b	4 466 b	7 099 a	23 0
W64A x W117	No-till	765 a	1 774 a	6 003 a	6 616 a	24 1
W64A x W117	Fall chisel plow	539 b	1 772 a	6 173 a	6 794 a	21.8 bc
W64A x W117	Spring disk	599 ab	1 808 a	6 322 a	7 307 a	21 4 c
Means		517	1 561	5 741	6 954.1	22.6

* Ducan's Multiple Range Test; means in the same column followed by the same letter are not significantly different. The test was done separately for each hybrid and each reading time using the error term from the analysis of the experiment as a randomized complete block for each hybrid.

The third reading on disease severity was made when both hybrids were physiologically mature. The disease had spread throughout the field, but still the differences between the two hybrids were highly significant and the differences between conservation tillage treatments and the fall-plowed treatment remained distinct (Table 1). With Pioneer 3780, the no-till treatment was more diseased than the other tillage treatment.

Differences in yield due to tillage treatments were non-significant (Table 1). The yields of the two hybrids were significantly different; Pioneer 3780 yielded an average of 913 kg/ha more than W64A x W117.

The partial correlation between level of disease and yield was negative, but non-significant for the three disease reading dates.

No tilled plots had higher grain moisture content at harvest than the other treatment (Table 1). The spring disk treatment which appeared to have the highest yields had the lowest grain moisture. The correlation between disease index and moisture content was positive, but non-significant.

Discussion

Conservation tillage relies on surface residues from the previous crop to be effective in soil erosion control and this can affect the onset and development of several maize diseases (6). The severity of the eyespot disease is related directly to the amount of infected residues on the soil surface (6), therefore any tillage that buries plant residues should reduce the initial inoculum (1, 2, 3, 6). Clean plowing normally buries most of the debris and hastens biological degradation of the residues before spring planting. Chisel plowing and disking will leave much of the debris on the soil surface (6).

In this study, various tillage operations were employed in a field that had severe eyespot the previous year. The non-till plots exhibited more disease than the other three treatments at the time of the first reading, but a considerable amount of disease was also detected on the plots that were moldboard plowed. Some spread of the pathogen may have occurred from plot to plot, but the moldboard plots were not free of surface maize residues, which may have provided enough inoculum for the onset of the epidemic.

The magnitude of the second and third disease readings indicated that there was a rapid build-up of the disease in the experimental plots. By the time of the third rating the disease on W64A x W117 was fairly uniform across the field. This behavior is characteristics of a multicycle type of disease developing in a susceptible genotype under the appropiate environmental conditions (11).

Arny *et al* (1) observed that clear plowing reduced early infection by eyespot, but that the disease also increased in clear plowed fields and where corn was not planted the previous year.

Pioneer 3780 is a late hybrid and exhibited a higher degree of resistance than W64A x W117, which is early in maturity. Some other authors (1) have also observed an apparent relationship between early host maturity and susceptibility to eyespot disease.

There were no significant differences in dry grain yield among tillage treatments. The partial correlation between amount of disease and final yield was negative as expected, but low and non-significant for all the three disease assessment dates. It is clear that factors other than eyespot had a greater influence on yields. The consistently higher yields in the spring-disked plot can be explained partially by moisture availability in the seed zone after planting. Seedlings in these plots emerged quicker and more evenly than seedlings in the plowed or no-till treatments. Spring disking of the previously undistured soil may bring up moisture for adequate germination and emergence (6). Martinson (6) was able to relate yield loss to eyespot disease severity when other tillage effects were eliminated and disease level was established by artificial inoculations.

Pencic and Rozenfeld (8) observed a low correlation between disease intensity and grain yield in several host genotypes. They (8) thought that the disease index was not always a reliable indicator of the potential damage by the eyespot fungus, but rather increase in the number of barren plants.

The early death of diseased tissue usually results in lower moisture at harvest (6). In this study the non-tillage plots had more disease and a higher moisture level at harvest. These differences in grain moisture among treatments probably were due to other effects of the tillage operations, one being the erratic emergence of the plots in some treatments and not primarily due to eyespot disease.

Summary

A field cropped the previous season in maize that was severely affected with eyespot disease was subdivided to get four tillage treatments: 1) fall plow,

2) no-till, 3) fall chisel plow and 4) spring disking. Two maize hybrids (Pioneer 3780 and W64A x W117) were planted on the subplots. The plants in the no-till plots were the most severely affected by eyespot and the plants in fall moldboard plowed plots had the least disease. The disease built up rapidly in all plots, including the fall moldboard plowed plots, which had some surface residue. The W64A x W117 hybrid had about ten times more disease than Pioneer 3780 at every sampling date. There was no correlation between dry grain yield and eyespot severity. It was clear that factors other than eyespot (drought, poor emergence, and root worm infestation) had a greater effect on yield. It is suggested that, due to the polycycle nature of the disease, even low amounts of infected maize residues on the soil could have led to considerable amounts of disease later in the season on all plots, including moldboard plowed plots. Aerial dispersion of conidia among plots may have also occurred and caused a more generalized attack by the fungus.

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