INFLUENCE OF SOME CULTURAL PRACTICES ON YELLOW LEAF BLIGHT OF MAIZE

J.C. Sutton,[1] A. Bootsma,[2] and T.J. Gillespie[3]

Abstract

Yellow leaf blight of maize (Zea mays) caused by Phyllosticta maydis was more severe in field plots with high than in those with low population densities. Air temperatures and dew duration in plots with widely differing population densities were similar. Blight was more severe in maize cultured with minimum tillage than with conventional tillage. The relationship of the amount of infected maize residues from previous growing seasons to blight severity is discussed.

Introduction

Yellow leaf blight, caused by Phyllosticta maydis Arny and Nelson (1), was widely distributed in Ontario in recent years (3, 6). The disease was usually minor and occurred in the form of scattered lesions, mostly on the lower leaves. Occasionally, however, severe blight developed and caused economic losses, particularly in qrain and silage maize.

Casual field observations indicated that cultural nractices influencing plant visor, the microclimate in the plant canopy, and the amount of maize debris from previous seasons remaining on the soil surface may be important in the development of severe outbreaks of blight. In the present study the influence of population density of maize plants and certain tillage nractices on the development of yellow leaf blight and the effect of population density on microclimate was examined.

Materials and methods

The effect of plant population densitv on blight severity was examined in the field at Elora, Ontario, in 1970.

Maize (Zea mays L.) var. Funks G-43, carrying Texas male-sterile cytoplasm, was planted by hand in field plots on May 27-23. In each nlot there were five parallel rows 76 cm (2.5 ft) apart and 7.6 m (25 ft) long. Kernels were sown at intervals of 18, 23, 28, and 36 cm within the row to give the equivalent of 73,360, 57,300, 46,330, and 36,339 nlants ner hectare (23,700, 23,200, 19,000, and 14,950 nlants per acre). Two kernels were sown at each spacing and plants were thinned to one per spacing after emergence. Ten plots were sown at each planting density. The nlants in five of these plots were later inoculated and those in the remaining plots served as noninoculated checks. Plots were arranged in a randomized comnlete block design. Spaces 5 ft. across between blocks were planted with barrier rows of maize continous with the rows within the blocks. The entire nlot area was surrounded by 107 m (350 ft) or more of maize, except on the northwest side where an 8-row border was planted.

Plants were inoculated With pycnidiospores obtained from P. maydis cultures grown on potato dextrose agar for 2 weeks under cool-white lights at approximately 22° C. Cultures were flooded with sterile water for 15 min and the spore suspensions diluted to give 1 x 10^5 spores per ml. Spore suspensions were atomized onto plants just before sunset on June 22 and again on June 28. Only nlants in the inner 3 rows of each treated plot were inoculated.

To minimize spread of inoculum between plots, zineb (3 lb 75% W.P. in 100 gal per acre) was applied at weekly intervals to plants in the outer rows of all plots, in the barrier rows between the blocks, and in four rows immediately surrounding the plot area. No symptoms of yellow leaf blight appeared on the treated plants.

Yellow leaf blight was assessed in plants in the center row of each plot on August 24. Three leaves of each plant at 30-45 cm, 105-120 cm (mid-canopy) and at about 180 cm (penultimate leaf) above ground level were rated for disease according to the scale of Horsfall and Barratt (5).

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1 Assistant Professor, Department of Enviromental Biology,

2 former Graduate Student, and

3 Assistant Professor, Department of Land Resource Science, Ontario Agricultural College, University of Guelph, Guelph, Ontario.

Possible differences in microclimate in plots of differing population densities was studied by monitoring temperature and duration of leaf wetness. Temperatures were measured during September 7–19 in two plots at each population density. A thermistor-based temperature sensor (2) was mounted at a height of 130 cm midway along the center row in each of the plots. The sensors provided mean air temperatures during four separate 12 min intervals in each hour. Data obtained from the two plots at each population density were averaged, and observations taken during the times of maximum and minimum air temperatures in each 24 hr period were used for comparative purposes. The duration of leaf wetness was monitored continously from August 13 to September 2, using sensors that respond to moisture by changes in electrical resistance (2). The wetness sensors were mounted at a height of 130 cm in the center row of each 2 replicate plots with plants spaced at 18, 23, and 36 cm intervals.

The relationships of tillage practices to blight severity was investigated in the field at Arkell, Ontario, in 1970. Blight severity was assessed in four areas of a single field with the following cultural histories: sod in 1969 and maize with conventional tillage (soil ploughed and disced in Spring) in 1970; maize with conventional tillage in 1969 and 1970, harvested as grain in 1969; maize with zero tillage in 1969 and 1970, harvested as silage in 1969. Maize had been grown with conventional tillage in 1968 in all plot areas except were sod was present in 1969. The areas of differing tillage were 201 m (660 ft) long, more than 122 m (400 ft) in width, and were separated by fallowed land at least 12 m (40 ft) wide. Maize hybrid 'Funks G-43' with Texas male-sterile cytoplasm was grown in both 1969 and 1970. In 1970 the maize was machine planted on May 10–11 in rows spaced at 76 cm (30 inch) intervals to give a population of about 51,900 plants per hectare (21,000 plants per acre). Standard fertilizer and herbicide treatments were used in the entire field. Blight was assessed on August 28. Three replicate transects in directions diagonal to that of the rows were made in each tillage area. In each transect, 30 plants at intervals of 5–6 paces were assessed for blight as above. Horsfall-Barratt ratings for each replicate plot of each treatment were summed and the average rating was converted to percent leaf area discolored using statistically adjusted conversion tables.

Results

Blight was more severe in maize plots with high than with low population densities (Table 1). Symptoms were well-developed on only the lower leaves at the time when blight was estimated. Some lesions were present at mid-canopy level (105–120 cm) and few appeared on the upper leaves. Blight symptoms were observed on the lower leaves of noninoculated plants, especially those at the highest population density, but pycnidia failed to appear on most of the blighted leaves of noninoculated plants in the field or after incubation for 6–7 days in moist chambers.

Air temperatures in the maize population plots usually differed by less than 1° C. This was true on nights with heavy dew and thus strong radiative cooling, in days with more than 5 hr of bright sunlight and thus strong radiative heating, as well as on nights without dew and days with less than 5 hr bright sun. Measured temperature differences did not usually exceed the limits of accuracy (± 0.5° C) of the temperature sensing apparatus.

The times of the initiation of dew periods as seen with a hand lens on the maize leaves corresponded closely (< 15 min difference) with the detection of water by the wetness sensors.

There was little difference in dew duration in maize plots with different population densities (Table 2). The time of dew formation in these plots differed by less than 12 min in 14 of 15 periods studied. The average duration of the 15 measured dew

Table 1. Influence of plant spacing in the row on blight severity in maize inoculated and noninoculated with *Phyllosticta maydis*

Treatment	Distance of leaf above ground (cm)	Leaf area blighted (%) Plant spacing (cm) 18	23	28	36
Inoculated	30–45	39.0± 3.7*	28.9k10.1	10.4f5.1	8.8f5.1
Noninoculated	30–45	39.2±28.2	2.3± 0.8	3.2f1.4	4.2f2.8
Inoculated	105–120	1.3± 0.4	1.4± 0.2	1.3f0.3	1.4f0.1
Noninoculated	105–120	0.2± 0.3	0.1± 0.1	0.2f0.2	0.1±0.2

* Standard deviation.

Table 2. Eight representative periods of dew duration in canopies of maize plants spaced at different intervals in the row

Date of dew period	Dew duration (min)		
	Plant spacing (cm)		
	18	23	36
August			
14-15	777	761	774
16-17	726	766	739
20-21	750	753	771
21-22	754	766	794
23	343	355	365
27-28	694	715	755
28-29	693	714	730
31	310	282	266

periods in the plots also differed by less than 12 min. However in 11 of the 15 dew periods, wetness durations in plots with plants spaced at 36 cm intervals averaged 19 and 24 min longer than in those with plants spaced at 23 and 18 cm intervals, respectively. Slightly lower minimum temperatures in the lower population plots had resulted in more dew deposition to be evaporated in the morning. Observations with a hand lens indicated that the times of dew appearance and disappearance on leaves located 30-45 cm and at 105-120 cm above ground differed by less than 30 min. Dew disappeared 30-60 min earlier from leaves in the upper canopy than from those in the mid- and lower canopy.

Yellow leaf blight was strikingly more severe in maize cultured with zero tillage than with conventional tillage (Table 3). With zero tillage, blight severity was greater where the previous crop was harvested for grain than for silage. Disease severity was correlated with the amount of maize residues remaining on the soil surface from previous growing seasons.

Isolates of P. maydis collected from each of the plots and the isolate used for inoculating the plots with differing plant population densities showed similar virulence on maize var. 'Funks G-43'.

Discussion

The greater severity of yellow leaf blight in maize grown at high than at low population densities appears related to factors other than temperature and dew duration. Temperatures found in the different population density plots were notably similar. Gillespie and King (4) measured temperatures in the corn canopy and found that temperatures at 30 cm above ground were less than 0.3°C higher than at 130 cm during nignts with strong temperature inversion and heavy dew. Thus in the population density plots it is unlikely that important temperature differences existed between the 30-45 cm level, where disease was severe, and the 130 cm level where the temperature sensors were located and disease was mild. Because of the close synchrony of dew appearance and disappearance in maize grown at various population densities the observed differences in blight severity are not attributable to dew duration (2). Dew periods were measured late in the growing season when a greater diversity in dew duration in maize grown at differing population densities is expected than earlier in tne season when canopies are more open.

Stress factors related to intensive interplant competition may have contributed to enhanced disease severity in maize grown at high population densities. Marked symptoms indicative of nutrient deficiencies developed in the lower leaves of both inoculated and noninoculated plants spaced at 18 cm intervals in the row. Deficiencies of less intensity but of significance in host-parasite interactions may have existed in plants spaced at 23 cm intervals. P. maydis is considered a weak parasite (3) and appears to proliferate extensively on maize leaves that are physiologically weakened.

Table 3. Effect of recent cropping history and tillage practices in maize on yellow leaf blight development from natural sources of inoculum, 1970

1969 crop	Tillage practice for maize in 1969 and 1970	Mean % leaf area blighted		
		Distance (cm) of leaf lamina above ground		
		30-45	105-120	180+
Sod	Conventional	0.1	0.1	0.1
Maize for grain	Conventional	3.2± 0.9"	1.4f0.4	0.0
Maize for grain	Zero	56.4f12.8	11.6f3.7	0.6f.1
Maize for silage	Zero	27.2± 1.2	5.1f0.2	0.6f.l

* Standard deviation.

The correlation of blight severity with maize residues remaining on the soil surface confirms numerous field observations and indicates that the development of severe disease may be dependent upon large amounts of primary inoculum. This conclusion is supported by the restricted secondary development of yellow leaf blight that we have frequently observed in plants grown in field plots free from maize debris and inoculated once with suspensions of P. maydis spores. Repeated infections from inoculum derived from maize debris may reduce host resistance and allow greater proliferation of this weak parasite than in plants with fewer infections.

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