

PLANT PATHOGENS ON FLAG LEAVES AND SPIKES IN CANTERBURY WHEAT CROPS IN 1993/94.

M.G. CROMEY, H.J. BODDINGTON and M.A. MACE

*New Zealand Institute for Crop & Food Research,
Private Bag 4704, Christchurch.*

SUMMARY

Wheat crops (58) in Canterbury were surveyed during dough development (GS83-87). Samples of flag leaves and spikes were examined in the laboratory for the presence of fungal pathogens. Five pathogens were found on wheat leaves. *Didymella exitialis* was widespread, with a high incidence in many crops. *Leptosphaeria nodorum* was also common, although at a lower incidence. *Puccinia striiformis*, *Mycosphaerella graminicola*, and *Ascochyta* sp. were less common. Few pathogens were found on wheat spikes. *Puccinia striiformis* and *Fusarium* spp. were present in many crops, occasionally causing significant levels of shrivelled grain. Black point, caused by *Alternaria alternata*, and *Ascochyta* sp. were present in some crops. Flag leaves were sampled at intervals from three 'Otane' wheat crops from emergence until fully senesced. *Didymella exitialis* was regularly isolated from green (symptomless) tissue and perithecia of the fungus were found on necrotic regions of the leaves. *Puccinia striiformis* was present on some leaves, but severity was low. *Didymella exitialis* was the most common fungus identified on senesced leaves.

Keywords: *Puccinia striiformis*, *Didymella exitialis*, fungal pathogens, wheat, flag leaves, spikes

INTRODUCTION

Wheat (*Triticum aestivum* L.) crops are affected by a number of pathogens. Stripe rust (caused by *Puccinia striiformis* Westend. f. sp. *tritici*) has been a major focus for disease control efforts since it was first recorded in New Zealand in 1980 (Beresford 1982). While *P. striiformis* can be an important pathogen on flag leaves and spikes of wheat in New Zealand, causing significant losses in yield, other pathogens have also been recorded. *Didymella exitialis* (Morini) Muller has recently been recorded as a foliar pathogen of wheat in New Zealand, where it was common on crops approaching maturity (CromeY *et al.* 1994).

The incidence of pathogens on wheat flag leaves and spikes was determined by a survey of 58 Canterbury wheat crops in the 1993/94 season. In addition, three crops of 'Otane' wheat were sampled in detail to measure development of flag leaf pathogens.

MATERIALS AND METHODS

Survey

Flag leaves and spikes were collected from 58 Canterbury wheat crops between growth stages (GS) 83 - 87 (dough development; Zadoks *et al.* 1974). Fifty flag leaves and spikes were collected along a line through each crop, and examined in the laboratory. Cultivars were identified, where possible, through contact with the grower, or on crop, spike, and grain characteristics.

Leaves were examined visually and under a stereomicroscope for the presence of fungal pathogens. Identity of fungi was confirmed, where necessary, under a compound microscope. Twenty spikes were subsampled for close examination. Each floret was examined visually and under a stereomicroscope to identify pathogenic fungi, black point, and shrivelled or aborted grains.

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'Otane' crops

Three crops of 'Otane' wheat were selected for a detailed study of the development of pathogens on flag leaves from leaf emergence until they were fully senesced. The three crops were at Halswell, Overdale, and Lincoln, in Canterbury.

Fifty flag leaves were collected at random along a line through the crops at intervals of 2 to 4 weeks. Leaves were examined visually and under a stereomicroscope for the presence of fungal pathogens. The identity was confirmed, where necessary, under a compound microscope. The percent necrotic or senesced leaf area was recorded for each leaf with reference to standard area diagrams for the disease glume blotch (James 1971).

Ten green leaf pieces were cut from each of 10 leaves, surface sterilised in 1% sodium hypochlorite for 1 min., rinsed in sterile deionised water, and plated on potato dextrose agar (PDA), or PDA with 100 µg/ml chloramphenicol + 20 µg/ml streptomycin added to prevent growth of bacteria. Plates were incubated at 20°C, with a 12 h photoperiod. Fungi growing from leaf pieces were subcultured onto PDA after 3 days, incubated for 7 days as before, and then placed under near ultraviolet light, with a 12 h photoperiod to encourage sporulation. Fungal isolates were identified on spore and cultural characteristics.

RESULTS**Survey**

Didymella exitialis (present in all crops) and *Leptosphaeria nodorum* Mueller (in 84% of crops) were the most commonly recorded pathogens on flag leaves of commercial wheat crops (Table 1). *Puccinia striiformis*, *Mycosphaerella graminicola* (Fuckel) Schroeter and *Ascochyta* sp. were also commonly found. Mean incidence of *D. exitialis* (present on 91% of leaves sampled) and *L. nodorum* (on 27% of leaves) was also higher than for other pathogens in Canterbury crops. Incidence of other pathogens was 5% or less.

Didymella exitialis affected the greatest proportion of senesced leaf tissue (mean of 25%; Table 1), while *L. nodorum* was the next most severe pathogen (1.5% leaf area affected). While *L. nodorum* was common on flag leaves, it seldom covered large areas of the leaf, and only four crops were recorded with 5% or greater leaf area affected. Glume blotch (caused by *L. nodorum*) symptoms were rare on flag leaves before senescence.

TABLE 1: Pathogens on flag leaves of Canterbury wheat crops in the 1993/94 season (total of 58 crops surveyed).

	% crops affected	Mean % incidence	Mean % leaf area affected
<i>Didymella exitialis</i>	100	91 (54-100) ¹	23.0 (0.2-80)
<i>Puccinia striiformis</i>	17	7 (0-100)	0.4 (0-5)
<i>Leptosphaeria nodorum</i>	86	27 (0-97)	1.8 (0-10)
<i>Mycosphaerella graminicola</i>	36	4 (0-51)	0.1 (0-6)
<i>Ascochyta</i> sp.	38	4 (0-39)	0.1 (0-0.2)

¹ (range)

Some differences were recorded between cultivars in the incidence and severity of pathogens on flag leaves. *Didymella exitialis* was common on flag leaves of all cultivars. *Puccinia striiformis* was found only on 'Otane', 'Brock' and 'Awatere'. The incidence and severity of *L. nodorum* was highest on 'Sapphire' (42% incidence, with a mean of 2.2% leaf area affected), with a range of 18 - 42% incidence, and 0.7 - 2.2% leaf area affected. While *M. graminicola* was not common on leaves, the cultivars 'Domino' and 'Sapphire' were most often infected. Severity of infection was low on all cultivars, although a single crop of 'Domino' had 6% leaf area affected by this pathogen (all other crops had less than 1% leaf area affected).

Puccinia striiformis was the most common pathogen recorded on wheat spikes (Table 2), being present in 42% of crops surveyed, and with up to 36% of florets affected. Symptoms of head blight (bleached spikelets and pink mould), caused by *Fusarium* spp., were also common in crops, although at a low incidence. The incidence of *Fusarium* within grains has not yet been determined. Pycnidia of *Ascochyta* sp. were seen occasionally, although few grains were affected.

Black point was identified in 24% of crops, but incidence within crops was mostly low, reaching a maximum of 9% in one crop. Shrivelled or aborted grains were recorded in most crops. Eleven of the 84 crops had over 10% shrivelled or aborted primary grains, and four of these had over 20%. Affected florets were scattered throughout spikes and not concentrated at particular locations. In some crops, florets with head blight caused by *Fusarium* spp. had shrivelled or aborted grains, but in most cases, these grains were not associated with any recognisable pathogen. Where shrivelling and abortion was common, severely affected spikes were often blackened with saprophytic fungi such as *Cladosporium* spp.

TABLE 2: Pathogens, black point, and shrivelled grain in wheat spikes in Canterbury crops in the 1993/94 season (total of 84 crops surveyed).

	% crops affected	Mean % florets affected (all crops)	% florets affected (affected crops)	
			mean	range
<i>Puccinia striiformis</i>	42	1.7	4.2	0.1-36
<i>Fusarium</i> spp.	36	<1	<1	0-5
<i>Ascochyta</i> sp.	6	<1	<1	<1
Black point	24	0.5	2.2	0.1-9
Shrivelled/aborted grain	98	6.9	7.7	0.2-2.6

There were some differences between cultivars in the proportion of florets affected by pathogens. 'Otane' crops were most severely affected by *P. striiformis* in spikes (mean of 3.5% infected florets), with less than 1% of florets affected in other cultivars. Mean proportions of *Fusarium*-affected florets did not reach 1% for any cultivar. There were only small differences between cultivars in the proportions of shrivelled or aborted grains.

Otane crops

Leaf scorch or blotching and senescence was first recorded (Table 3) on flag leaves of the three 'Otane' crops between GS 61 and 69 (anthesis). Senescence was complete by GS 83 (early dough). *Didymella exitialis* was first isolated from green leaves at GS 61 (beginning of anthesis), and was increasingly isolated until leaf senescence was advanced and green tissue was no longer available for isolation.

Didymella exitialis perithecia were first recorded on flag leaves in the Halswell crop on 14.12.93 at GS 61 when less than 10% of the leaf area was senesced. Perithecia were associated with areas of leaf scorch, and later more generally with senesced leaf tissue. Incidence of *D. exitialis* perithecia on flag leaves increased until, when leaves were fully senesced, perithecia were present on 80-100% of flag leaves and covered much of the leaf area. *Puccinia striiformis* pustules were recorded on flag leaves in all three crops by GS 69.

DISCUSSION

The 1993/94 wheat growing season in Canterbury was marked by a cool wet November and December, with a harvest 2 to 4 weeks later than usual. The harvest of ripe crops was frequently delayed by intermittent rain over the harvest period. It was therefore expected that pathogens preferring cool, wet weather for development would be favoured.

TABLE 3: Occurrence of *Didymella exitialis* on flag leaves of three commercial crops of 'Otane' wheat in Canterbury in the 1993/94 season.

	Date	Growth stage	% area blotched or senesced	<i>Didymella exitialis</i>	
				% leaves isolated from	% leaves with perithecia
Halswell	19 Nov.	53	0	0	0
	30 Nov.	61	0	10	0
	14 Dec.	69	9	20	10
	30 Dec.	75	51	0	0
	12 Jan.	83	100	-	90
	12 Feb.	87	100	-	90
Overdale	19 Nov.	57	1	0	0
	30 Nov.	61	0	20	0
	14 Dec.	69	25	0	0
	31 Dec.	83	100	-	80
	25 Jan.	87	100	-	80
Lincoln	19 Nov.	53	0	0	0
	29 Nov.	59	0	0	0
	14 Dec.	65	3	10	0
	31 Dec.	75	20	60	0
	12 Jan.	83	100	-	90
	12 Feb.	87	100	-	100

Didymella exitialis was by far the most common pathogen on flag leaves of commercial wheat crops in Canterbury in the 1993/94 season, and developed extensively in flag leaves of the three 'Otane' crops sampled regularly. The isolation of *D. exitialis* from symptomless leaves demonstrates that infection occurs before leaf senescence, and could represent an endophytic association (Sieber *et al.* 1988), or a latent infection. Perithecia were found only on senesced tissue, initially associated with symptoms of leaf scorch, but later they covered much of the leaf. *Didymella exitialis* was isolated from green leaves up to a month before perithecia formed on leaves, suggesting that there can be an extensive period of colonisation of leaves before sporulation. The fungus appears to be a weak pathogen and may hasten senescence of wheat leaves (Cromey *et al.* 1994). Future crop loss assessment studies are planned to determine effects of *D. exitialis* on wheat yields.

Only six crops had 5% or more of flag leaf area affected by pathogens other than *D. exitialis* (four with *L. nodorum*, and one each with *P. striiformis* and *M. graminicola*). The low severity of these pathogens may reflect widespread foliar application of fungicides between spike emergence and flowering. Yield losses due to *M. graminicola* probably occur earlier than this, when infection is most common (Cromey *et al.* 1993).

Differences between cultivars in their resistance to diseases are apparent from the survey results. The occurrence of *P. striiformis* in the survey closely matched the relative resistance to stripe rust of the cultivars in trials (M.G. Cromey; unpublished data). Similarly, 'Domino' has been shown to be highly susceptible to speckled leaf blotch (caused by *M. graminicola*).

Puccinia striiformis was the most common pathogen recorded in wheat spikes, where it can have a substantial effect on yield. Grains in infected florets can weigh up to 77% less than grains in uninfected florets (Cromey 1989a). The wheat cultivar 'Otane', which was most commonly affected, has been shown to be susceptible in the spike to *P. striiformis*, while showing a good degree of adult plant resistance on leaves (Cromey 1989b).

Fusarium spp. were also common in wheat spikes. The low incidence of head scab symptoms may under-estimate the importance of this fungus, since its occurrence in wheat grains, where toxins could occur, was not assessed.

Blackpoint incidence is affected by both cultivar and climate during ripening (Cromey and Mulholland 1988). The cool, damp, late season and delayed harvest was probably conducive to blackpoint since rainfall during seed maturation favours the disease (Wiese 1977). The low levels of blackpoint recorded in the 1993/94 season suggests that the resistance of current wheat cultivars is adequate. While blackpointed wheat can be rejected for milling because of the potential for colour-grade in the flour, it is unlikely that blackpoint was sufficiently severe for any of the crops surveyed to have been rejected.

Shrivelled and aborted grains were common in wheat crops, although the incidence in most crops was low. While these symptoms can be caused by pathogens such as *P. striiformis* or *Fusarium* spp., it is likely that much of the grain shrivelling was due to physiological causes.

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