Necrotic tipping and yellowing of leaves in wheat (*cv*. Diamondbird) in southern New South Wales in 2001

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Abstract

Diamondbird wheat showed extensive necrotic tipping and yellowing of leaves at many sites in southern New South Wales during spring of the 2001 season. No disease was identified on leaf or root material, so further leaf samples were collected from 32 sites and were analysed for a range of nutrient concentrations. Several possible nutritional problems were identified at various sites, but no deficiency or toxicity was universally associated with the symptoms. We suggest that in the 2001 season the yellowing and necrosis of leaf tips was a physiological symptom in response to moisture stress. Any possible role of the leaf rust gene Lr34 in the symptoms was unclear.

Key Words

disease, leaf rust, nutrition

Introduction

Diamondbird wheat is a cultivar well adapted to southern and central NSW. It has yielded well in field trials and commercial production over many seasons. Diamondbird is tolerant of the acidic soils which occur in the higher rainfall eastern area of the wheatbelt (1). In the 2001 growing season Diamondbird wheat showed extensive leaf tipping and yellowing in southern New South Wales (NSW) in late August and early September. While these symptoms had been observed in previous seasons, their occurrence in 2001 was more extensive; the symptoms were more intense and appeared earlier in the growing season.

Diamondbird is a selection from Pavon and consequently shows the genetic trait of yellowing of the leaf. It also contains the gene for leaf rust resistance Lr 34 (and the linked Yr18 gene), which cause death of the leaf tip (2). The leaf tipping characteristic associated with Lr34 is known to have a yield penalty of 6% in Mexico if no leaf rust is present or where leaf rust is controlled by chemical means (3). In southern NSW, these symptoms of yellowing and leaf tip necrosis are observed on Diamondbird wheat in most seasons.

However, in the 2001 season the symptoms were particularly severe and agronomists became concerned that a disease or general nutritional problem was the cause of the severe symptoms. Samples were collected and examined for possible diseases. In late spring of 2001 leaf samples were collected from 32 crops which showed symptoms and were analysed for concentration of a wide range of elements, seeking to identify any possible nutrient deficiency and toxicity problems in the crops.

Methods

Symptoms of leaf yellowing and necrosis were observed in many wheat crops throughout southern NSW from mid August in 2001. Samples of affected plants were collected from 15 crops that were representative of crops showing leaf chlorosis and necrosis in an area from Deniliquin to Albury in the south and to Barmedman and Cootamundra in the north. Most crops were at late stem elongation to flag leaf emergence. The samples were examined for symptoms and signs of disease associated with the condition. Necrotic leaves were examined by microscopy for fungal fruiting bodies and then incubated at 100% humidity at room temperature (20?C) for 1–3 days before a second microscopic examination. Root systems were examined for their development and for lesions. Paddock histories including herbicide use were sought.

Further samples (Table 1) were collected for tissue analysis from Diamondbird crops that had chlorotic leaves with tip necrosis in late September when the crops were at the booting to heading stages of growth. The youngest emerged leaf blades (YEB) were collected by cutting with stainless steel scissors, handled with blue nitrile gloves that were free of powder and placed into kraft envelopes for dispatch to the analytical laboratory. The collections were made in September, 2001, and were analysed by Waite Analytical Services, Glen Osmond, South Australia for Fe, Mn, B, Cu, Zn, Ca, Mg, Na, K, P and S concentrations.

Results and Discussion

Symptoms occurred over an area of southern NSW bounded by Albury and Barham in the south, Hay and Hillston to the west, Condobolin in the north, and Cootamundra and Wagga in the east. The symptoms occurred mainly on the wheat cultivars ‘Diamondbird’ and ‘Dollarbird’, with fewer reports in ‘H45’. Both Dollarbird and Diamondbird carry the Lr34 gene, while H45 is likely to carry the gene (H Bariana, pers. comm.). Dollarbird and Diamondbird have over half their pedigree in common. H45 and Diamondbird share a common parent in *cv* Ciano.

Plant symptoms and presence of biotic and abiotic pathogens

Affected crops first showed a distinct yellowing over the whole crop. The yellowing began at the tips of the upper leaves and progressed to affect the whole leaf. Necrosis followed yellowing, beginning at the leaf tip of the upper leaf and sometimes progressing to the whole leaf (Fig 1). The leaf yellowing symptoms were initially similar to those caused by barley yellow dwarf virus (4). However, the rapid development of leaf necrosis and the uniform development of symptoms within the crop were not consistent with this viral disease.

No fruiting bodies of fungal pathogens were observed on fresh leaves or on leaves incubated at high humidity. The saprophytic fungus *Alternaria* sp. fruited abundantly on incubated dead leaves. Roots of affected plants appeared normal, with no lesions from root rotting fungi or pathogenic nematodes.

Paddock history showed no consistent association of the symptoms with any herbicide use. Although the herbicide Logran? was used on most affected crops, it was also widely used on many other crops that did not show symptoms.

Figure 1 General crop symptoms and individual leaf symptoms in Diamondbird wheat, (photos, K Condon)

Nutritional analysis

No abnormal concentrations of nutrients were universally associated with the symptoms (Table 1). Some sites in the western areas (lower average annual rainfall) appeared to have low K concentrations (Barham and Griffith; Table 1; <23000 mg/kg in the YEB; cited by Reuter and Robinson, 5). In the high rainfall wheatbelt (Cootamundra, Albury) plant Mg concentration was low (<1200 mg/kg), but was probably not deficient; deficiency is probably at <1000 mg/kg. Low Mg in cereals has been observed over many seasons on the acidic soils of the eastern higher rainfall wheatbelt. Both low K and Mg could potentially give a yellowing of the older leaves and so may exacerbate the general yellowing symptom in Diamondbird but the symptoms of interest to us were on the younger upper leaves. Low Zn concentrations (<14 mg/kg) also occurred at Griffith, Lockhart and Cootamundra. The lowest values at Lockhart (<10 mg/g) may well be deficient. Sulphur concentrations were in the range 2100 to 4900 mg/kg and unlikely to be deficient.

The data set also contains some low P concentrations (critical 2100 to 2300 mg/kg) at Condobolin and Griffith, and marginal Ca concentrations (<1800 mg/kg) at Cootamundra. N deficiency is the most obvious candidate to induce yellowing of older leaves. Unfortunately, there were no analyses for N. Presumably, most farm advisers who collected these samples believed that the N fertiliser application to the crops we examined was adequate.

Interestingly there is also low B in the high rainfall wheatbelt (adequate, 3 – 25 mg/kg). This deficiency would affect the young leaves. Boron deficiency has been recorded on some soils of the tablelands and slopes of NSW in subterranean clover and lucerne. In subterranean clover, B deficiency reduced seed set far more than dry matter production (6).

The samples had Fe, Mn and Na concentrations with the ranges 51 to 153, 54 to 171 and 12 to 210 mg/kg respectively. In these samples Na was not toxic (< 5000 mg/kg) and in our experience Mn is adequate (19 mg/kg) and not toxic; concentrations > 300 mg/kg can cause toxicity in varieties sensitive to Mn toxicity. Fe has been has been quoted as adequate at 10 mg/kg and toxic when >300 mg/kg

Table 1. The concentrations (mg/kg) in youngest emerged leaves of Diamondbird wheat collected in September 2001 in southern NSW. The location of the nearest township and its long term average annual rainfall are shown.

District	Rainfall annua(annual)	Ca	Mg	K	B	Cu	Zn	P
Albury	769	2300	1220	29000	3.2	5.7	18.7	3300
Albury	769	2400	1100	32000	3.3	4.4	16.9	3300
Albury	769	2200	1140	36000	3.5	5.5	21.0	3600
Albury	769	2100	1160	32000	4.2	4.2	18.5	3300
Cootamundra	629	2100	1200	39000	2.7	5.0	17.2	4200
Cootamundra	629	1640	1160	31000	3.8	4.2	15.2	3600

Cootamundra	629	1970	1090	31000	3.3	4.8	13.1	3700
Temora	535	4800	1960	26000	5.7	4.8	18.2	2200
Temora	535	4100	1690	24000	4.9	5.6	15.8	2800
Temora	535	4100	2900	17800	14.0	6.8	15.7	2400
Temora	535	3600	2600	18000	15.5	6.0	14.5	2200
Lockhart	491	5000	1970	20000	6.1	3.6	11.9	2300
Lockhart	491	4000	2100	21000	5.7	3.8	9.8	2200
Lockhart	491	4400	2400	20000	15.8	5.1	12.1	2800
Lockhart	491	4100	1280	17600	3.5	2.6	11.4	1870
Lockhart	491	3100	1090	13100	3.4	2.8	9.5	1540
Lockhart	491	4600	1740	16200	4.2	3.9	14.1	1990
Lockhart	491	3800	1700	24000	6.2	2.3	12.4	2400
Condobolin	473	2700	1510	36000	6.1	6.2	16.2	2300
Condobolin	473	2700	1400	24000	6.6	6.3	17.0	2700
Barham	408	3400	2000	24000	15.8	5.5	15.1	2600
Barham	408	3400	2100	23000	15.6	5.5	14.8	2800
Barham	408	3600	2400	21000	19.1	5.5	15.7	2600
Griffith	406	3600	1910	23000	7.3	3.3	12.5	2100
Griffith	406	4600	2400	20000	9.5	4.4	17.4	2900

Yanco	394	3300	1570	30000	5.4	5.4	22	3200
Yanco	394	2400	1580	28000	6.2	3.9	22	3000
Yanco	394	3100	1840	28000	8.2	5.1	22	3100
Hillston	367	2900	1610	37000	5.9	7.2	30	3700
Hillston	367	2000	1470	39000	7.6	6.0	26	3600
Hillston	367	2400	1410	45000	4.5	5.7	26	3600
Hay	366	2600	2200	22000	12.8	5.3	13.1	2600
Adequate range from (5)	n.a.	>2000	>1000	>23000	3 – 25	1.7 – 25	10 – 70	2100–5000

Performance of Diamondbird wheat

Diamondbird is well adapted to southern NSW and has given good yields in field trials and commercial production over many seasons. The yields of Diamondbird have been higher by 5% than the yields of Janz in 136 late stage variety evaluation experiments throughout the seasons 1992 to 2001 in south eastern NSW and equal in 127 experiments in western NSW (Table 2). Janz has significantly out yielded Diamondbird in 1997 in western NSW. The role of the symptoms we report in lowering of grain yield in Diamondbird in 2001 is unclear but did not decrease yield significantly compared to Janz in that season. In the southeast, the 5% yield advantage of Diamondbird was not apparent in 2001.

Table 2. Yield of *cv*. Diamondbird wheat relative to *cv* Janz (%), and the grain yield (t/ha in parentheses) of *cv* Janz in the seasons 1995 to 2001 and in the longer term (1992–2001) in late stage variety evaluation trials in the southern area of New South Wales.

	Season							
Area	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**1992-2001**
South east	113%* (4.76)	99% n.s. (5.63)	97% n.s. (4.01)	109%*** (5.34)	102%* (6.01)	113%*** (5.58)	98% n.s. (5.25)	105%*** (4.95)
South west	110%** (3.25)	99%n.s. (2.84)	93%* (3.32)	99% n.s. (3.83)	103% n.s. (4.37)	110%** (4.12)	97% n.s. (4.91)	102% n.s. (3.86)

*, $P \leq 0.05$; **, $P \leq 0.01$; ***, $P \leq 0.001$; n.s., not significant

Conclusion

There is no evidence that the symptoms of the yellowing and tipping seen in Diamondbird in the 2001 were caused by disease or a single nutritional problem. However, various possible deficiencies may have contributed to the intensity of the symptoms in some paddocks. Nitrogen deficiency has not been eliminated as a factor.

More generally, the symptoms that occurred in 2001 are known to occur in Diamondbird in most seasons with some yellowing and death of the leaf tip shortly after flowering. In addition, there is a characteristic yellowing of leaf tips in varieties related to the wheat Pavon and this includes Diamondbird. However in 2001 season these symptoms have occurred earlier in the season and were more severe. The effect was quite widespread across southern NSW and occurred on a wide range of soil types making a single nutrient deficiency or toxicity an unlikely general cause. It is possible that the symptom reported here is a response to the dry August of 2001. Any contribution of the Lr34 rust resistance gene, and the linked Yr18 gene, to the symptom is unclear as other varieties with these genes (eg. Janz) did not display the symptoms reported here.

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