Root diseases as a major constraint in high rainfall cropping systems

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Introduction

In the high rainfall regions of Western Australia there are two root diseases which are major constraints to cropping. The most important of these, take-all caused by Gaeumannomyces graminis var. tritici Walker, causes major reductions in yield for both wheat and barley (1). Take-all also affects oats, cereal rye and triticale but losses in W.A. due to this disease on these species are minimal.

The other important disease is rhizoctonia bare patch (caused by patch forming strains of Rhizoctonia solani Kuhn). This disease is becoming an important constraint to cropping of both cereals and lupins, especially in the eastern part of the region (2).

Other root diseases of cereals that have been recorded include fusarium crown rot (caused by Fusarium graminearum Schwabe), common root rot (Bipolaris sorokiniana Shoem.) and cereal cyst nematode (Heterodera avenae Wollenweber) but none of these are important constraints to cropping of cereals. The importance of pythium root rots (Pythium spp.) is unknown.

Apart from rhizoctonia bare patch, there are two important root diseases of lupins in W.A. Some strains of R. solani (other than patch forming strains) cause root and hypocotyl rot while Pleiochaeta setosa (Kirchn.) Hughes, the cause of brown spot, also causes a severe root rot of lupins. Currently, both diseases are of limited importance in the southern high rainfall area (Sweetingham pers. comm.). However if lupins become a major crop in this area, both diseases have the potential to become a significant problem.

In this paper I will concentrate on take-all and rhizoctonia bare patch of wheat and barley.

Take-all

Take-all causes major constraints to cropping of wheat and barley in the high rainfall areas for three reasons. These are:

- Reduction in yield.
- Reduction in potential cropping due to fear of yield loss.
- Cost of control.

Yield reductions due to take-all

A survey of wheat and barley root diseases in the W.A. cereal belt was conducted annually from 1973 to 1983 inclusive. A map showing expected levels of take-all was constructed using the results of the survey (Figure 1). Take-all incidence ranged from 3% in a northern dry zone to 57% in a wet southern zone (MacNish unpub. data).

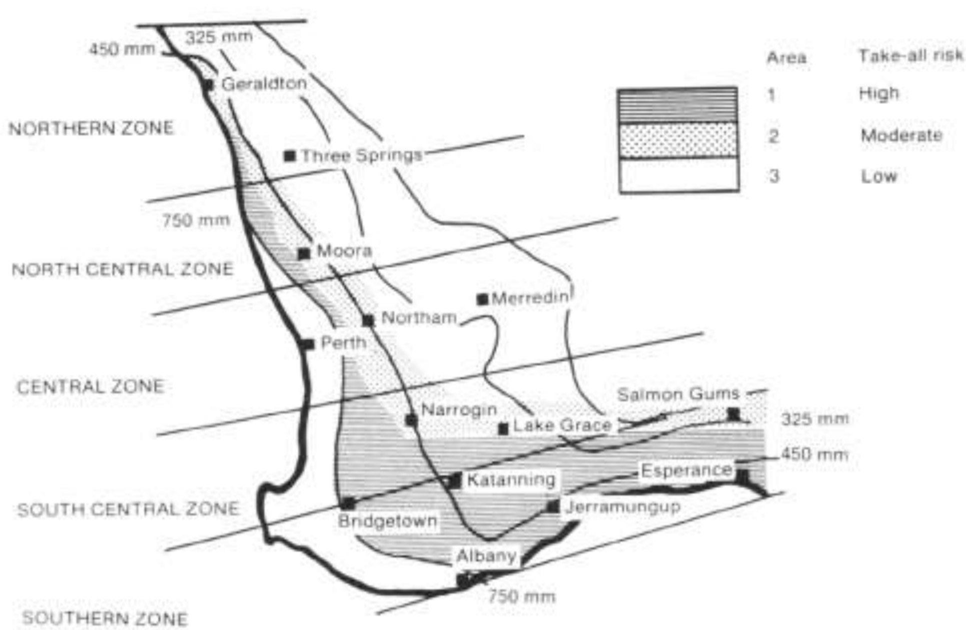

Fig. 1 Location and expected level uptake-all in Western Australia.

Although the survey can be used to estimate yield losses in other parts of the cereal belt, the very limited cropping in the high rainfall region prevents the use of the survey to estimate yield losses. (I am defining the high rainfall region as that area between the 750 and 450mm isohyets in the southern central and southern zones shown in Figure 1). However data available from both the Esperance Downs and Mount Barker research stations give an indication of the potential yield loss in this region in the absence of take-all. Results from three experiments are shown in Tables 1 and 2. Although take-all was not eliminated, yield increases with greatly reduced levels of take-all ranged from 133 to 350%. It is acknowledged that some of the increases in yield shown in these examples may be due in part to factors other than take-all control (e.g. nitrogen). Despite this it is clear that take-all is a major constraint to crop yield in these experiments.

Reduction in potential cropping due to take-all

Although there are large areas of arable land suitable for cropping within the high rainfall region, wheat makes up less than 3% of the state's cropping to wheat (3). This poor record is not due solely to root diseases, but farmer experience of heavy losses due to take-all is one reason cropping is so limited.

Table 1. Take-all incidence and severity, and yield for wheat grown after various crops at Esperance Downs (1976-77) or Mount Barker (1985-86) research stations.

Cropping sequence		Esperance Downs Take-all Incid-ence[A] %	Sever-ity[A] %	Yield t/ha	Mount Barke Take-all Incid-ence %	Sever-ity %	Yi t/
Wheat	Wheat	100[aB]	87[a]	0.6[a]	76[a]	43[a]	1.
Pasture	Wheat	98[a]	53[b]	1.3[b]	-	-	-
Oat	Wheat	88[b]	30[c]	1.8[c]	-	-	-
Ch.fall.[C]	Wheat	51[c]	16[d]	2.1[d]	31[b]	14[b]	2.
Lupin	Wheat	47[c]	10[a]	2.2[d]	30[b]	12[b]	2.
Pea	Wheat	-	-	-	28[b]	10[b]	2.

[A] Incidence is the percentage of all plants infected while severity is the percentage of all plants with more than 25% of the root systems discoloured.
[B] Figures with the same letters are not significantly different at P=0.05.
[C] Chemical fallow.

Table 2. Take-all severity and yield for wheat grown as continuous wheat with sodium nitrate (50 kg N/ha) or as wheat lupin rotations (without nitrogen) at the Mount Barker research station.

Cropping[A] sequence		Take-all severity[B] %	Yield t/ha
1981	1982		
Wheat	Wheat	62	1.4
Lupin	Lupin	9	2.9
1982	1983		
Wheat	Wheat	77	1.2
Lupin	Wheat	19	2.7
1983	1984		
Wheat	Wheat	71	1.3
Lupin	Wheat	15	2.2

[A] Results extracted from three cropping sequences (i.e. WWWW, LWLW & WLWL).
[B] Severity is the percentage of all plants with more than 25% of the root system discoloured.

Cost of controlling take-all

There are direct and indirect costs attributed to controlling take-all. Strategies for the control of take-all in W.A. have been developed (1). Briefly the strategies are:

- In the year prior to cropping, reduce (or preferably remove) grass from the pasture by herbicides and stock management.
- If the level of take-all is expected to be very high, use a grass free cleaning crop such as lupins, peas, rapeseed or oats in the year before cropping.
- If wheat or barley must be grown on a take-all prone area, sow barley rather than wheat.
- If nitrogen is to be applied, use an ammonium form of nitrogen at 25 to 45 kilograms of nitrogen per hectare.
- Avoid sowing wheat or barley immediately after breaking up the first flush of weeds. Allow a short fallow period for breakdown of any infected trash.
- Encourage good crop growth by reducing weed competition and by supplying adequate fertilisers.

- Consider using a short pasture phase in a cropping rotation to prevent a buildup of grassy pasture.

Costs associated with these strategies include:

- Grass control in pasture prior to cropping has the immediate cost of the selective herbicide, it's application and the removal of stock from the field. After spraying there can be reduced stock carrying capacity, especially in dry years (Thorne pers. comm.), and a greater risk of wind erosion in the summer months due to the absence of grass trash.
- The use of cleaning crops may have an initial cost of reduced income as these crops are often less profitable than stock or cereals. Cleaning crops such as lupins and peas tend to require a higher level of management inputs than cereal crops and while the prices are higher (per tonne) this is offset by the generally much lower yields.
- If ammonium nitrogen is used at sowing for take-all reduction then it's major function is as a disease control agent and not a source of nitrogen. Thus the amount of nitrogen applied may be more than is required for maximum yield if take-all was not present.
- Delays in sowing to allow breakdown of infected trash may be extremely costly with late sowing leading to reduced yields (4).

Rhizoctonia bare patch

The constraints on cropping due to rhizoctonia bare patch are the losses in yield and the costs of control. In general losses are directly proportional to patch area x reduction in yield within the patches. Thus losses are determined by the area of patch within an individual field and the severity of the disease within the patches. Both of these parameters vary considerably between field and the latter often varies within the same field. Another method of determining yield loss is to sample the entire field and relate rhizoctonia root rot incidence to yield. Using this method it has been shown on the Esperance Downs research station that there is a 17.3 kg/ha drop in wheat yield for each 1% increase in rhizoctonia root rot (5).

The control of rhizoctonia bare patch also has direct and indirect costs. At present this disease cannot be eliminated (6) but it can be significantly reduced by cultivation (6,7). Rhizoctonia bare patch becomes a problem with shallow or light cultivation and becomes worse with zero or minimum tillage. Thus a major cost is the need for thorough cultivation with the indirect costs of erosion risks associated with such practices.

References

1. MacNish, G.C. 1980. Journal of Agriculture, Western Australia 21 48-51.

2. MacNish, G.C. 1986. Journal of Agriculture, Western Australia 27 91-95.

3. Australian Bureau of Statistics.

4. Perry, M., Anderson, W. and Delane, R. 1989. Journal of Agriculture, Western Australia 30 26-29.

5. MacNish, G.C. and Fang, C.S. 1987. Australian Journal of Experimental Agriculture 27 671-677.

6. MacNish, G.C. 1985. Plant Pathology 34 175-181.

7. Jarvis, R.J. and Brennan, R.F. 1986. Australian Journal of Experimental Agriculture 26 703-708.

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