Review of tillage and cereal root disease research in South Australia

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Summary

Research in South Australia into the effects of tillage on cereal root disease began in the late 1970s. Three soil-borne diseases have been studied in detail: cereal cyst nematode, take-all (hay die) and *Rhizoctonia* (bare or purple patch). Reduced tillage appears to reduce disease caused by cereal cyst nematode and increase take-all and *Rhizoctonia*.

Discussion

South Australia has a long history of cereal root disease problems, the disease take-all (caused by *Gaeumannomyces graminis* (Sacc.) Arx & Olivier var. *tritici* Walker) being recognized as early as 1852. There has been a corresponding history of research on cereal root diseases but it is only since the late 1970s in response to growing interest in direct-drill farming practices that researchers focused their attention on the effects of tillage on root disease. Soil-borne root diseases, at this stage, were recognized as a major constraint to cereal production in the conventional farming system (Rovira and Ridge 1983). This paper aims to review the current research on cereal root diseases and tillage in South Australia.

Three diseases have been studied in detail in South Australia in relation to tillage practices: cereal cyst nematode (*Heterodera avenae* Woll.), take-all and *Rhizoctonia* (caused by *Rhizoctonia solani* Kühn).

Cereal cyst nematode

Rovira and Simon (1982) and Roget and Rovira (1985) reported that wheat sown by direct drilling had less root damage caused by cereal cyst nematode and subsequently lower numbers of 'white females' per root system and higher grain yield than wheat sown following cultivation (Table 1). In this trial direct drilling consisted of sowing 1 day after an application of Spray.seed (paraquat 50%, diquat 50%) to desiccate the volunteer pasture. Sowing was done with the Sirodrill (Venn *et al.* 1982) which was designed for minimum soil disturbance. A later trial showed that direct drilling with a conventional drill fitted with 15-cm shares produced similar results to the Sirodrill.

The mechanism most likely responsible for this effect of direct drilling is related to the presence of volunteer grasses actively growing to within 1 day of sowing. Nematode larvae already hatched can enter the roots of these grasses and are then unable to attack the roots of the wheat crop. Nematode larvae populations in volunteer grasses of 300 g^{-1} of root material have been measured (D. Roget, unpublished data).

Presently work on tillage and cereal cyst nematode is limited to monitoring the level of root damage under various tillage practices and rotations at the CSIRO Division of Soils site at Avon and by Dr R. Fawcett at the S.A. Department of Agriculture sites at Lameroo and Halbury.

Take-all

Rovira and Venn (1985) found the incidence of take-all to be higher in most years in direct-drilled wheat sown with the Sirodrill than in wheat sown following cultivation (Table 2). This applied over a range of rotations.

The higher incidence of take-all with direct drilling may be due to either less breakdown of the inoculum source due to reduced soil disturbance (Moore and Cook 1984) or may be related to increased numbers of barley-grass plants (*Hordeum glaucum* Sted.) that occur with direct drilling (Rovira 1987).

Interactions between tillage and rotation can occur in respect to the incidence of take-all (Table 3). Direct drilling resulted in lower disease incidence in continuous wheat and higher disease incidence in wheat/pasture rotations when compared to conventional tillage. A higher density of grasses in the pasture phase with direct drilling is the most likely cause of these results.

Research into the effects of tillage on take-all is continuing at the Division of Soils, CSIRO, with an emphasis on the influence of soil structure and water regimes as affected by tillage, stubble-handling techniques, deep ripping and application of gypsum.

Rhizoctonia

Rhizoctonia damage to crops has increased in southern Australia with the increased use of conservation tillage practices. In South Australia this has been reported by Rovira and Venn (1985) and Rovira (1986) who showed that wheat direct drilled using the Sirodrill had greater early root damage, increased area of patches of poor growth and reduced yields when compared to wheat sown following cultivation.

In later work the Sirodrill was compared with another direct drill treatment using a conventional drill with 18-cm shares (Table 4). The greater soil disturbance of the wide shares produced a small but significant reduction in root damage.

Roget *et al.* (in press) demonstrated that the presence of volunteer pasture growth close to sowing could increase the damage caused by *Rhizoctonia* (Table 5). The grass component of the volunteer pasture was suggested as being most important, as grasses dominated early growth. M.L. Evans, J. A. Dickinson and P. J. L. Whittle (S.A. Department of Agriculture) are commencing a program to study the effect of grass densities at sowing on damage to the cereal crop by *Rhizoctonia*.

Research is continuing at the Division of Soils, CSIRO, on the effect of tillage on *Rhizoctonia* and the relationship to available soil nitrogen. The studies will contrast two sites, one where tillage does and one where tillage does not reduce damage by *Rhizoctonia*.

Table 1 Effect of tillage on damage to wheat roots by *H. avenae* 6 weeks after sowing, numbers of females of *H. avenae* on the roots at anthesis and grain yield at Calomba, S.A.

Tillage	*H. avenae* root damage[A]	No. of females $plant^{-1}$	Grain yield ($t\ ha^{-1}$)
Conventional cultivation	4.6	59	0.85
Direct drill	3.2	23	1.23
l.s.d. ($P=0.05$)	0.8	29	0.27

[A]A rating of increasing severity of root damage from 0 to 5.

Table 2 Effect of tillage in a wheat/pasture rotation on the percentage of wheat plants with take-all lesions 6 to 10 weeks after sowing at Avon, S.A.

Year	Direct drill	Conventional cultivation
1979	55	57
1980	65	65
1981	13	5
1982	43	33
1984	47	33
1986	86	75

Table 3 Effect of tillage and rotation on the percentage of plants with take-all lesions 8 to 10 weeks after sowing at Kapunda, S.A.

Year	Wheat/Pasture		Wheat/Wheat		l.s.d. ($P>0.05$)
	DD[A]	CC[B]	DD	CC	
1985	47	23	46	59	24
1986	47	31	39	54	14

[A] DD, direct drilled.
[B] CC, conventional cultivation.

Table 4 Effect of tillage practice on the damage to roots by *Rhizoctonia*, the percentage area of patches of poor growth, plant weight at tillering and grain yield of wheat at Avon, S.A.

Tillage treatment	*Rhizoctonia* rating[A]	Dry wt plant^{-1} (g)	Patch area (%)	Yield (t ha^{-1})
Direct drill (Sirodrill)	2.6	0.9	34	2.0
Direct drill (18-cm shares)	2.1	0.9	28	2.1
Conventional cultivation	0.6	1.9	0	2.6
l.s.d. ($P=0.05$)	0.4	0.2	9	0.2

[A] A rating of increasing severity of root damage from 0 to 5.

Table 5 Effect of tillage practice and a period of chemical fallow on damage to roots by *Rhizoctonia* and plant weight 6 weeks after sowing and grain yield of wheat at Avon, S.A.

Tillage treatment	Chemical fallow	*Rhizoctonia* rating[A]	Dry weight plant^{-1} (g)	Yield (t ha^{-1})
Direct drill	–	2.9	0.7	1.2
(Sirodrill)	+[B]	2.1	2.3	2.2
Conventional	–	1.0	2.5	2.6
tillage	+	1.0	2.0	2.6
l.s.d. ($P=0.05$)		0.7	0.7	0.7

[A] A rating of increasing severity of root damage from 0 to 5.
[B] Chemical removal of volunteer pasture 32 days prior to sowing.

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