Using Lucerne to Improve the Reliability of Cropping on Waterlogged Soils

MH McCallum[1], MB Peoples[1], RR Gault[1], JF Angus[1], JA Kirkegaard[1], T Green[2], and HP Cresswell[2]

[1]CSIRO Plant Industry, Canberra, ACT.
[2]CSIRO Land and Water, Canberra, ACT.

ABSTRACT

Lucerne has the ability to effectively dewater soils that are prone to waterlogging, and may improve the macroporosity and infiltration rate of dense subsoil via large biopores that remain after lucerne is removed. This can delay or even prevent the impact of waterlogging on a following annual crop.

KEY WORDS

Lucerne, phase farming, intercropping, subsoil, macropores, infiltration.

INTRODUCTION

Productivity losses due to waterlogging are a major problem for grain-growers farming on duplex and heavy clay soils in the cropping regions of SE Australia with 500-600 mm average annual rainfall. Waterlogging can typically cause grain yield losses of 10-50% or even total crop failure in severe circumstances. Incorporating a deep-rooted perennial plant e.g. lucerne, into these farming systems may delay or even prevent the onset of waterlogging through drying or ‘dewatering’ the soil profile, and by improving macroporosity and water infiltration into the subsoil (2). This research aims to quantify these potential benefits and evaluate lucerne-based farming systems on these waterlogging-prone soils.

MATERIALS AND METHODS

The data presented in this paper are from two field sites located near Temora and Grogan in southern NSW. At Grogan, the soil water content and wheat yields of two types of lucerne-based farming systems are being compared to continuous cropping (predominantly canola-wheat rotations). Phase farming refers to the periodic rotation of annual crops (3-5 years) with lucerne pasture (2-4 years). Intercropping is a system whereby crops are direct drilled into existing lucerne stands (3), in this case a 6 year-old stand. In addition, a preliminary investigation of soil structural changes due to lucerne was conducted on a duplex soil near Temora. Measurements of macropores and infiltration at the top of the B horizon on two plots (3 year-old stands of lucerne or annual grass/subclover mix) were made using the methods previously employed by Cresswell and Kirkegaard at the site (2).

RESULTS AND DISCUSSION

There have been clear differences in the extent of soil water extraction by a range of rotational systems (Table 1). All lucerne-based systems were drier than continuous cropping, and the intercrop system was significantly drier than phase farming in 1999. This was largely because of partial recharge of the soil profile by out-of-season (December to March) rainfall. Lucerne was removed at two different times (early-November 1999, and late- April 2000) prior to cropping (June sowing) at the Grogan site in 2000. The dewatering effect was enhanced when lucerne was removed later (Table 1).

Table 1. Plant available soil water (0.2-1.0 m) at/near sowing and wheat yields at Grogan, NSW.

Rotation/System	Soil water (mm)	Wheat yield (t/ha)
1998		

Phase farming: 1st crop (Mar 98 removal)	27	5.9
Continuous cropping	69	2.9
lsd (5%)	*28*	*0.4*
1999		
Phase farming: 1st crop (Dec 98 removal)	64	3.7
Intercropping	26	3.9
Continuous cropping	102	3.6
lsd (5%)	*25*	*ns*
2000		
Phase farming: 1st crop (Apr 00 removal)	0	-
Phase farming: 1st crop (Nov 99 removal)	66	-
Intercropping	0	-
Continuous cropping	103	-
lsd (5%)	*18*	

Phase farming increased wheat yield in 1998 (Table 1) largely due to reduced waterlogging in the wet winter (Table 2). Under continuous cropping, prolonged periods of standing water at the soil surface were evident during winter and early spring. By contrast, no standing water was observed in wheat after lucerne, and grain yield was double that of wheat in a continuous cropping system. Waterlogging was not a constraint to crop production in 1999 due to a drier than average season (Table 2) and no dewatering-related yield benefits were observed (Table 1).

Table 2. Rainfall (mm) data for the experimental site at Grogan, NSW.

Year	Total for year	Growing season rainfall (Apr-Nov)	May-Aug*
Average	525	355	170
1998	560	485	270
1999	600	320	125

*waterlogging tends to be most severe when May-Aug rainfall exceeds 250 mm

From the preliminary soil studies near Temora, the number and size of macropores were greater where lucerne had been grown, due mainly to the presence of large biopores (up to 10 mm in diameter) containing decaying lucerne taproots (Table 3). Improved macroporosity after lucerne increased the rate soil water movement into the subsoil (Table 3). A drier soil profile in combination with improved subsoil macroporosity may explain the observed differences between the two wheat crops at Grogan in 1998. The physical and biological impacts of these biopores are the subject of further investigation.

Table 3. Soil measurements at the top of the B horizon on a duplex soil.

Measurement	annual species	lucerne
Macropores (>2 mm) / m^2	125 (21)	181 (10)
Average macropore size (mm)	2.8 (0.3)	3.7 (0.5)
Time to ponding (min)*	7.3 (0.8)	20.8 (6.3)
Steady-state infiltration (mm/hr)*	3.0 (1.0)	7.3 (0.8)

* using a drip infiltrometer

Note: number in parenthesis is the standard error of mean

Removing lucerne as late as possible before a cropping phase or not removing it at all (intercropping) appears to enhance the dewatering effect. However, crop yield and quality may be decreased due to reduced mineralisation of lucerne root residues resulting in an inadequate N supply, and to water stress in dry seasons (1, 3). In intercropping systems, grain quality may also be downgraded due to contamination from lucerne pods, and herbicide options for broadleaf weed control will be limited. These management issues need to be addressed.

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