

STUBBLE MANAGEMENT INFLUENCES NITROGEN UPTAKE AND YIELD IN SUBTERRANEAN CLOVER/WHEAT ROTATIONS

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Abstract

Lupins have become unreliable for intensive cropping rotations in NE Victoria and southern NSW due to the high incidence of root rot diseases. An alternative source of nitrogen (N) for subsequent wheat crops is the use of pure subterranean clover swards. A long-term wheat/grain legume rotation under different stubble management (standing, shredded, burnt or incorporated) was split for pure sub clover leys of 1 and 2 years in rotation with wheat in 1995. Despite significantly less early dry matter production where stubble was retained, either standing or shredded, N uptake and yield of sub clover hay cut in 1995 averaged approximately 100 kg N/ha and 5 t/ha, respectively. Wheat yields (2-3 t/ha) and N uptake of wheat in 1996, following 1 year of sub-clover, tended to be greater where stubble was burnt. Wheat yields in 1996 were lower than the growing season rainfall potential due to removal of the subclover as a hay.

Key words: stubble, nitrogen, subterranean clover, rotation, wheat

Stubble retention was introduced with conservation cropping to reduce soil loss and structure decline under intensive cereal/grain legume rotations. Previously, cultivation and stubble burning had provided conditions favourable to nitrogen loss during waterlogging and ignition (4). Lupins were the primary grain legume for rotation with wheat in acid soils, as they could be grown in retained stubbles with out net depletion of soil N and low risk of cereal disease. However, the high incidence of root rot diseases in lupins in NE Victoria and southern NSW has forced farmers to reconsider legume options in rotation with cereals.

The subclover ley pasture system has traditionally provided a long-term rotation with cereal cropping (1). Recent research at AV Rutherglen has shown wheat yield increases from 3 t/ha up to 6 t/ha, where the grasses were removed in the last 1-2 years of a 4 year pasture ley (3). However, this was shown for a regime of stubble burning only. A pure legume sub clover ley grown as a properly managed, short-term crop (1-2 years) is a potential alternative to grain legumes in rotation with cereals. Previous work has indicated that cereal yield responses to a single year of subclover were similar to that of lupins under stubble mulching with direct drilling or incorporation (2). Pasture legumes are capable of fixing quantities of N in proportion to the amount of above ground biomass and leaf area (3) and can potentially fix larger amounts of N when conserved as fodder instead of being grazed. This work identified the impact of stubble management on the N balance and yield in short-term subclover/wheat rotations.

Materials and methods

Cereals and grain legumes were grown in a 2 year rotation for 10 years at Rutherglen in NE Victoria under 4 different stubble treatments (standing, shredded, burnt and incorporated). Each stubble treatment consisted of 2 adjacent (3 x 15 m) plots, randomly assigned for subclover in a 1 (CW) or 2 (CCW) year rotation with wheat in 4 replicates of a randomised complete block design. Plots were direct drilled with sub clover (cv. Trikkala) at 20 kg seed/ha and phosphorus (P) fertiliser at 20 kg/ha in 1995 using a triple disc seeder. Weeds were removed with Brodal™ and Sertin-Plus™. In 1996, wheat (cv. Dollarbird) was sown at 90 kg/ha with 20 kg P/ha. Grasses and subclover in the wheat were suppressed with Ally™.

Soil samples were taken to 50 cm depth on 19 Jan., 1995. The sample depth was increased to 80 cm at harvest on 13 Nov., 1995, and repeated on 30 Jan., 1997, following wheat. Total N (Leco combustion) and mineral N (Kjeldahl or 1M CaCl₂ extract for auto-analyser) were determined on all soil samples. Subclover emergence was counted on 5 Jun., 1995, and 21 Mar., 1996, and dry matter (DM) yield as silage (13 Oct., 1995) and hay (13 Nov., 1995) was determined from 5 quadrats (30 x 30 cm) cut to

ground level and oven dried at 70 °C. Wheat N status was determined from sap nitrate expressed from 3 cm of basal stem taken from 20 randomly selected plants at the 7 leaf stage (7 Aug., 1996). DM and yield in wheat was measured from 5 samples (0.5 m of row) on 12 Dec., 1996. Subclover was sampled for yield on 22 Aug., 1996. Total N was determined on all plant samples using a Kjeldahl digestion. Data was analysed using ANOVA.

Results and discussion

Above average April to October growing season rainfall of 490 mm and 466 mm occurred in 1995 and 1996, respectively. Conditions in 1995 resulted in an average subclover establishment of 200 plants/m², with no significant difference ($P < 0.05$) between treatments. Stubble retention significantly favoured subclover plant density in 1996 (Table 1). In 1995, herbage production from subclover as silage was significantly greater for stubble burnt and stubble incorporated treatments compared to stubble retention (Table 1). However, subclover as hay produced 5.45 t/ha of dry matter averaged across treatments, with no significant difference ($P < 0.05$) in herbage DM or N content. N uptake in subclover hay was ultimately 109 kg N/ha at 2 % N content. Removal of the subclover as hay in 1995 limited the N uptake of wheat and its capacity to achieve the yield potential in CW (Table 1). Wheat yields in the burnt stubble treatment tended to be higher than for stubble retention and were approximately 50 % of the yield potential of 5.34 t/ha, based on a water use efficiency of 15 kg/ha/mm rainfall.

Table 1: Subclover emergence and dry matter production (1995, 1996) and wheat yield and N uptake in 1996 following different stubble management treatments at Rutherglen.

Stubble Treatment	Sub clover density (plants/m) ²		Subclover DM (t/ha)		Subclover DM (t/ha) 22/8/96	Wheat yield (t/ha) 16/12/96	Wheat N uptake (kg/ha) 16/12/96	
	5/6/95	21/3/96	silage	hay			Grain	Stem/leaf
			13/10/95	13/11/95				
Standing	210	796 a	3.44 c	5.32	1.79 b	2.57 b	35.2	5.6
Shredded	176	772 a	3.45 c	5.45	2.08 b	2.68 ab	31.0	5.6
Burnt	209	557 b	4.79 a	5.50	3.37 a	3.16 a	37.2	6.2
Incorporated	206	601 b	4.10 b	5.54	1.83 b	2.81 ab	37.3	6.8
Isd ($P < 0.05$)	ns	139	0.58	ns	0.82	0.503	ns	ns

ns = not significant; means followed by the same letter within a column are not significantly different

Heenan *et al.* (2) measured higher N uptake of approximately 90 kg/ha by wheat over an 8 year period of direct drilled/stubble mulch and cultivated/stubble mulch treatments under a CW rotation.

Conclusion

Stubble retention reduced initial growth of pure subclover in both single (1995) and consecutive seasons (1995, 1996) compared to stubble burning. A trend towards increased grain yield of wheat in CW may have resulted from these differences by providing additional N. Removal of N in sub clover as hay limited the potential wheat yield in a single year compared to results found elsewhere in grazed pasture systems.

Acknowledgments

We are grateful to David Pearce, Jeff Jones and Dale Grey for technical assistance and Jim Maden for statistical advice. This work was supported by the Grains Research and Development Corporation.

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