ROLE OF A GRASS/MEDIC LEY IN THE CROPPING SYSTEM OF NORTH-WESTERN NSW

A.M. Bowman[1], K.Y. Chan[2], J. J. Friend[1] and R. Van de Ven[3]

[1]NSW Agriculture, Trangie, 2823, [2]NSW Agriculture, Wagga Wagga, 2678 and [3]NSW Agriculture, Orange, 2800

Abstract

A pasture ley, consisting of 5 years of summer growing perennial grass (*Astrebla lappacea*) and a temperate annual legume (*Medicago truncatulata*) was sown in a wheat cropping system at two sites near Walgett. The soil at both sites was a self-mulching clay, one a sodic grey clay and one a brown clay, which were shown to have declining organic carbon, mineralisable nitrogen and physical soil structure under the continuous cropping system in place at the time. However despite significant soil improvements, particularly at the brown soil site during the pasture ley phase, there were small benefits to the wheat crop (in terms of grain yield or protein response) in the 2 years following the ley.

Key Words: Crop/pasture rotation, self-mulching soils, low rainfall

Significant declines in the chemical and physical properties of the self-mulching clay soils of the cereal cropping region around Walgett (30°01' S, 148°07' E) in north western New South Wales have been well documented (1). The continuous wheat cropping system that has been dominant in the region is obviously not sustainable into the future in terms of soil structure or fertility, nor in terms of wheat yield and protein. Pasture species evaluation in the last decade (3) has identified suitable summer growing perennial grasses and annual medic species that could form the basis of a pasture ley in this low rainfall (annual average rainfall = 474 mm) cropping environment.

Methodology

Two experimental sites were established near Walgett in 1989 to investigate the changes in soil properties under the crop and pasture phases of a rotation and the effect of a pasture ley on the yield and protein of subsequent wheat crops. One site Namoi View was on a self-mulching brown clay 30 km south-east of Walgett while the second, Talbarear was on a self-mulching sodic grey clay 15 km east of Walgett. The sites consist-ed of old cropping paddocks (13 years continuous cropp-ing at Namoi View and 22 years at Talbarear) along side natural/native pasture paddocks.

At each site there were two fenced blocks, separated by 1 km, each containing 3 replicates of 6 treatments, 3 of which are discussed in this paper: old cropping country under continuous cropping (CC), old cropping country returned to a pasture ley from 1989 until 1994 followed by a cropping phase (CPC) and native pasture country (which was comprised of perennial summer grasses, naturalised medic and annual broadleaf and grass weeds) cropped since 1989 (PC). There were 6 replicates of each treatment with plots of 30 m by 6 m, with borders of 3 m between each replicate.

The wheat cropping plots were sown to cv. Hartog in 1989 and cv. Sunco every year thereafter, following two to three workings with either a disc or chisel plough each summer, a possible fallow spray with Round-up_ and the application of pre-emergents Glean_ and Avadex_ in most years. The stubble was not burnt and no fertilisers were ever applied.

The pasture ley consisted of Mitchell grass (*Astrebla lappacea*) sown with a bandseeder into a cultivated seedbed at 10 kg/ha in the spring of 1990, and over-sown again in the summer of 1991. A mix of cv. Sephi and cv. Jemalong barrel medic (*Medicago truncatula*) was broadcast onto the plots and harrowed to cover in autumn 1989 and 1990 at 8 kg/ha. The legumes were not inoculated. The pasture was not grazed but slashed when dry matter production warranted, usually after the pasture dry matter cuts were taken. Slashed material was left to lie on the plots. Twice a year, in spring (to best measure the

contribution of the annual medic component contribution) and autumn (after the spring/ summer growth period of the perennial grass), yield and composition (by dry weight) of the pasture plots was measured.

Soil measurements were taken at sowing each year after all the cultivation operations had been completed.? Soil structural stability (by wet sieving) and hydraulic properties were measured, as was pH, electrical con-ductivity, organic carbon and mineralisable nitrogen. Crop measurements were made during the growth period (plant number, tiller counts, NIR measurements) and at harvest (grain yield, protein, grains per head, grain weight, head number). Soil moisture measurements were taken with a neutron probe at sowing each year to a depth of 120 cm.

Results

Soil Characterisation

Initial characterisation found significantly lower organic carbon in the cropped soils (CC) than the pasture soils (PP) at both sites, with the largest differences in the top 10 cm. Significant declines in organic carbon under cropping were detected to 80 cm. In general, Namoi View (brown clay) had higher organic carbon than? Talbarear (grey clay) in both the pasture and cropped areas and was considered an inherently more fertile soil. Corresponding to the differences in organic carbon, the cropped soils had significantly lower total nitrogen than the pasture soils. The cropped soils had higher pH than the pasture soils: for the top 10 cm the difference was 0.4 pH unit for the brown clay and 0.2 pH unit for the grey clay. The pasture soils also had significantly higher aggregate stability than the cropped soils, higher air-filled porosity and higher oxygen flux density.

Soil amelioration with a pasture ley

Measurements in 1994, after the CPC treatment was returned to a crop phase, showed the following improve-ments: there was a significant increase (26%) in organic carbon in the 0-5 cm layer detected at Namoi View by 1992, 2 years after the pasture ley was sown. Corresponding to increases in organic carbon, significant increases in mineralisable nitrogen were also detected (68% increase). Improvement in soil structure under the pasture ley was also found and in the third year of the pasture phase the structural stability of the surface soil of the CPC plots had increased to 83% of the permanent native pasture (PP) plots. However, no significant changes in soil properties were detected at Talbarear? even after four years of pasture.

The soil changes on the virgin pasture country that was put into cropping in 1989 (PC) were also monitored. Conversion of this pasture land to cropping led to large decreases in organic carbon, and the largest decrease (compared to PP soils) occurred in the first year of cropping at Namoi View . Changes in subsequent years were small. For the grey clay site, organic carbon was similar for CC and PC treatments. Similar trends were found for changes in mineralisable nitrogen. There was also a marked decrease in water stability of the PC soil at Namoi View after the first season of cropping but subsequent decline was slow. For the CC plots there was no decline in stability for the 5 years of cropping until 1993. Stability of the grey clay at Talbarear was sign-ificantly lower than at Namoi View and no significant difference was detected at that site between the different treatments. Neutron probe measurements showed that CC plots always had more stored moisture at sowing each year than PC or CPC plots.

Productivity of the pasture ley

The pasture ley at Talbarear showed an increase in the perennial grass component from 1990 until 1993 from 8% to 40% of the sward and a small increase in the medic component of 1% to 5%. There was always a large but fluctuating annual grass component, mostly annual phalaris (*Phalaris aquatica*). The pasture ley at Namoi View had a large increase in the Mitchell grass component over the ley phase (from 4 to 70% of the sward) and an increase in the medic component from 1% to 35%. There was however a large annual grass component often present (mainly barley grass, *Hordeum lepori-num*).

The pasture at Namoi View was more productive with dry matter yields ranging, on average, from 5.5 t/ha in autumn to 3 t/ha in spring over the 4 years. At Talbarear? dry matter ranged from 2.8 t/ha to 1.2 t/ha.

Crop results

The anticipated return to wheat in 1994 did not occur due to drought conditions and all the plots were fallowed through until the 1995 season. Protein levels on all plots at Namoi View were high following the drought year but dropped in 1996 (Table 1). While there was no significant difference between treatments in 1995, in 1996 the protein of the CPC treatment was 0.7% higher than the CC plots. Grain yield for Namoi View was also higher from the CPC plots than the CC plots in 1996 but in neither year reached the yields still being obtained from the pasture country that had been cropped only since 1989 (PC).

At Talbarear the yield and protein, in 1995, following the pasture ley was significantly lower than that from the CC treatment and much lower than the PC treatment. In 1996 CPC yields were high, probably in response to the unusually high number of plants that established in this treatment (Table 1), but protein still did not reach the PC treatment protein levels.

Further analysis of the data found a strong correlation between grain yield and in-crop rainfall. Grain protein at Namoi View was correlated to soil nitrate at 10-20 cm depth in 1996 and this relationship was uniform across treatments (there was a 0.068% (+ or - 0.17%) increase in grain protein for every unit increase in soil nitrate). There no relationship was found between grain protein and soil nitrate in 1995, following the 1994 drought. There was a correlation between soil nitrate and grain protein for Talbarear in 1995 (however it was not very strong, for every unit increase in soil nitrogen there was 0.77%, + or - 0.043%, increase in protein) and again in 1996. In 1996 this relationship varied between treat-ments. No relationship was found between either grain yield or grain protein and the stored moisture available at sowing each year.

Discussion

Our results highlight the importance of soil organic matter in maintaining the chemical and physical fertility of these soils. A significant linear relationship was established between organic carbon and mineralisable nitrogen (2) therefore available nitrogen in these soils can be determined by soil organic carbon levels. The response of grain protein to soil nitrate levels therefore will depend on the quantity of organic matter contribut-ed by the pasture ley.

Our results demonstrated the effectiveness of a pasture phase consisting of Mitchell grass and medic in increasing both organic carbon and mineralisable nitro-gen at the brown clay site after 4 years. The results also highlight the importance of soil organic carbon in maintaining structural stability of these soils as water stability of macro-aggregates increased significantly with increasing organic carbon. However these improvements were evident only in the brown clay and not the grey clay. Furthermore the improvement occurred only in the top 5 cm. Changes in fertility and stability occur at a much slower rate in the deeper soil layers and improve-ment is dependent on the productivity of the pasture.

Although soil structure improved under the pasture ley there was little evidence of a grain yield response to this. Although there appeared to be no impeded drainage in the PC plots and improved drainage in the CPC plots, the CC plots continued to store more soil moisture over the fallow period. On a short-fallow cropping system, as in this study, this is not as important, as yield was shown to respond primarily to in-crop rainfall, however on a long-fallow system it may become more important.

The productivity of the pasture at Talbarear was very poor and this likely contributed to the lack of difference to soil fertility measured between the treatments at the end of the ley phase. Further work (A. Bowman and J. Brockwell, unpublished data) has shown there were negligible nitrogen-fixing *Rhizobia* found in the soil from this site and hence N fixation by the medic com-ponent of the pasture was very low.

Conclusion

The benefit of the pasture phase, in this environment, to the following wheat crops, despite significant improvements in soil properties, was small in the two years following the ley. However the benefit at the brown clay site was much greater than for the grey clay site. The inherent fertility of the soil and the productivity of the pasture during the ley are both important to the response of the subsequent wheat crops.

Acknowledgements

Technical assistance was provided throughout this project by Greg Rummery, Craig Watson, Bob Ashley, Rob Peever, Scott Finemore and Warren Smith. The work was funded by the Grains Research and Develop-ment Corporation.

References

1. Chan, K.Y., the late Hodgson, A.S. and Bowman, A.M. 1995. *Trop. Grass.*, **29**, 210-217

2. Chan, K.Y., Bowman, A.M. and Friend, J.J. 1997. *Trop. Grass.*, **31**, 145-155

3. McDonald, W. 1995. (editor). Pastures for Livestock Pro-duction, North-West Plains, 5th Ed.,? *NSW Agriculture*.