Effects of Different Pastures on Soil Quality

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Abstract

Changes in soil physical and chemical properties of degraded cropped soils after conversion to different pastures (annual ryegrass, medic, lucerne, Consol lovegrass) were monitored at three sites on the hardsetting red soils in Central western New South Wales (<500 mm annual rainfall). The annual pastures were less effective in increasing organic carbon when compared to the perennial pasture. Moreover, the increases were significant only in the top 0-2.5 cm even after 5 years under perennial pasture. The perennial pastures significantly increased hydraulic properties of the surface soil (ponded sorptivity increased 5 fold when compared to fallow). Lovegrass and lucerne were equally effective in promoting friability as well as water stability. However, lucerne was found to be more effective in increasing mineralisable nitrogen (up to 4.6 times that of lovegrass).

Key words soil structure, hardsetting soils, friability, available nitrogen

In central western New South Wales, potentially hardsetting soils are commonly used for cereal cropping. Under conventional tillage practice, in the absence of proper pasture phase, soil degradation occurs rapidly under cropping. Soil structural degradation tends to exacerbate the hardsetting problems of these soils (2,3), namely, high soil strength, poor infiltration, increased runoff and soil erosion problems, The effectiveness of pasture species like ryegrass in improving soil structure has been well documented (5). However, the effectiveness of other species are much less known, especially in the semi-arid areas (<500 mm annual rainfall).

Commencing in 1991, pasture leys were established on degraded cropping soils at three locations (Trangie, Narromine and Nyngan). The pasture species include annual ryegrass (*Lolium rigidum cv.* Wimmera), medic (*Medicago truncatulata cv.* sephi) as well as perennials, Consol lovegrass (*Eragrostis* curvula), buffel grass (*Cenchrus cilaris cv.* gayndah) and lucerne (*Medicago sativa cv.* Trifecta). This paper presents the changes in organic carbon, structural stability, friability and mineralisable nitrogen of the soil under the different pasture leys in comparison to the fallow plots as measured in 1995. The fallow plots were kept vegetation free throughout the experiment.

Methods

Soil organic carbon was determined by dry combustion method. Soil structural stability was determined by wet sieving. Friability was determined following (1). Mineralisable nitrogen was determined using the incubation method (4).

Results and discussion

Soil organic carbon and water stable aggregation

Significant increases in soil organic carbon levels were only found in the 0-2.5 cm and generally only for the perennial pasture and/or the mixture treatments when compared to the fallow. The increases were 24 % , 31 % and 47 % respectively for Nyngan (1.18 vs 0.95 %), Narromine (1.22 vs 0.93 %) and Trangie (1.19 vs 0.81 %)

Regression analysis indicated significant positive relationships between the amount of water stable macro-aggregates (>250 μ m) and soil organic carbon levels in the 0-2.5 cm layer for all the three sites. Annual ryegrass was not different from the fallow. Consol lovegrass was found to be particularly effective in promoting stability of 2.5-10 cm layer. At the Trangie site, the oldest site, the effect of pasture was evident to a depth of 20 cm in the case of Consol lovegrass + medic mix where a significantly higher stability than that of the fallow soil was detected.

Hydraulic Properties

With the exception of annual ryegrass, all the pasture soils had significantly higher sorptivity at the surface than the fallow soil when measured under ponded condition . On the other hand, similar sorptivity was found amongst the different pastures as well as that of the fallow soil when meaured at 1 cm suction. Therefore, the improvement in sorptivity was due to creation of macropores (> 3 mm) in the pasture soils .

At the Trangie site, the highest sorptivity was detected under lucerne/ryegrass pasture which was 5 times than of fallow (1.42 vs 0.29 mm /$h^{1/2}$), significantly higher than that of the lovegrass which was 2.4 times that of fallow. No significant difference between lucerne and lovegrass was detected at the other two sites. With the exception of Nyngan site, no difference in sorptivity was detectable at 10 cm. At Nyngan, sorptivity of Consol lovegrass at 10 cm was found to be significantly higher than the other pastures and the fallow

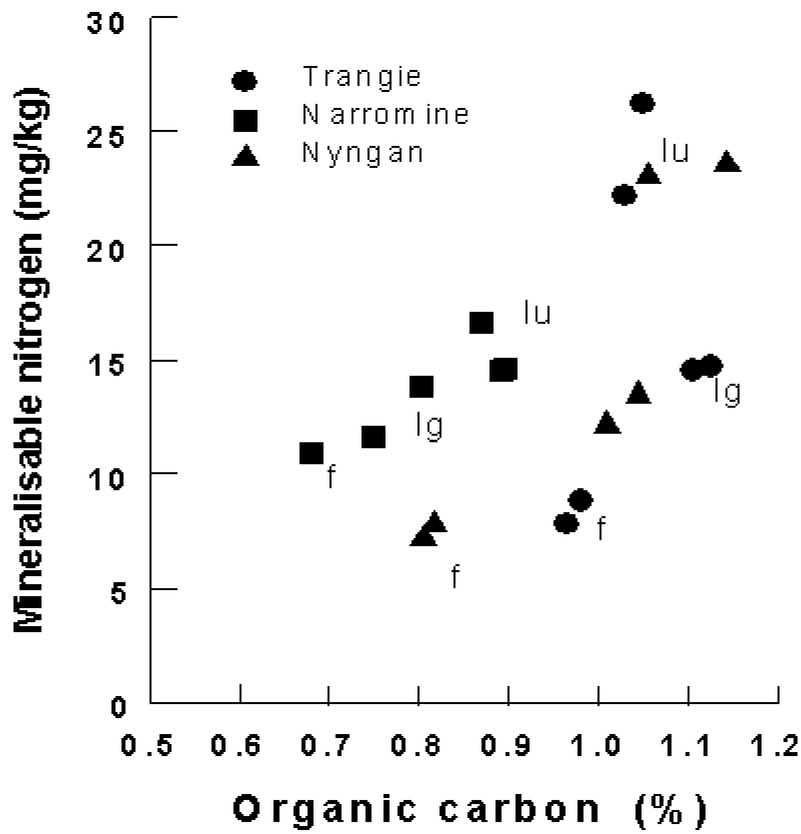
Table 1. Friability index and organic carbon of soils (0-10 cm) under different pastures

Site	Pasture	Friability? index	Organic carbon?? (g/100g)
Trangie	lucerne	0.22a*	1.04a
?	lovegrass	0.24a	1.12a
?	fallow	0.08b	0.97b
Narromine	lucerne	0.07a	0.89a
?	lovegrass	0.09a	0.84a
?	fallow	0.04a	0.71b
Nyngan	lucerne	0.18a	1.10a
?	lovegrass	0.18a	1.03a
?	fallow	0.08b	0.81b
?	native -?? 0 - 2.5 cm	0.38c	4.66c

?	native -?? 2.5 - 10 cm	0.19a	1.48d

(* values for the same soil followed by different letters are significant (P<0.05).

Lucerne versus Consol lovegrass



Mineralisable nitrogen : while organic carbon was similar between lucerne and lovegrass (~ 1 %) (Table 1), laboratory incubation studies indicated that the lucerne soils had significantly higher mineralisable nitrogen than that of lovegrass (Fig. 1). These indicate the higher effectiveness of lucerne pasture in increasing the nitrogen availability of these hardsetting red soils.

Friability : both lucerne and lovegrass (Table 1) were equally effective in improving friability when compared to the fallow (Table 1).

Conclusion

The perennial pastures in general were more effective than the annual pastures in increasing soil organic carbon levels and soil structural stability of hardsetting soils. However, in a semi-arid environment the rate of improvement was slow. Apart from incorporation of a pasture phase, soil management practices that maintain soil organic matter level and soil structure namely reduced tillage, stubble retention should also be adopted.

Acknowledgments

This research was supported financially by Grains Research and Development Corporation.

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