

Maintaining soil organic carbon and crop yield with a clover ley

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There has been a considerable amount of research which has shown a close positive association between the maintenance of soil organic carbon (C) and crop yields (Poulton 1995). A rotation experiment to examine the contribution of legume leys to cropping system sustainability was established at Glen Innes in 1921 because it was realized then that the exploitative "all-cereal" rotations which were in vogue at that time were unsustainable. The ultimate objective of the experiment was to develop stable and productive crop rotations (Anon 1948). This paper describes the effect of a legume ley, in this case red clover, on levels of soil organic carbon (C). The association between C and yields of spring-sown oatsen hay in two contrasting rotations over the 45-year period from 1939 to 1984 is also discussed.

Methods

The experiment consists of seven rotations (i) maize/spring oats (MsO), (ii) maize/spring oats/red clover (MsOC), (iii) maize/maize/spring oats (MMsO), (iv) maize/maize/spring oats/red clover (MMsOC), (v) maize/spring oats/autumn oats (MsOaO), (vi) maize/spring oats/red clover/autumn oats (MsOCaO) and (vii) maize/spring oats/ autumn oats/red clover (MsOaOC). Conventional tillage methods which utilized mouldboard, disc and chisel ploughs were used and up until the late 1970's it was common for maize stover to have been burnt. Since that time the stover has been incorporated into the soil. Levels of soil organic C were determined (Walkely and Black 1934) for all rotations in 1939 and 1984 and yields of spring sown oatsen hay recorded.

Results and discussion

In 1984, rotations which did not contain clover (MsO, MsOaO, MMsO) had markedly lower levels of soil organic C (1.1, 1.27 and 1.14% C respectively), than rotations which did contain a ley. The ley rotations, MsOC, MsOCaO, MsOaOC, MMsOC contained 1.62, 1.53, 1.62 and 1.33% C respectively. It

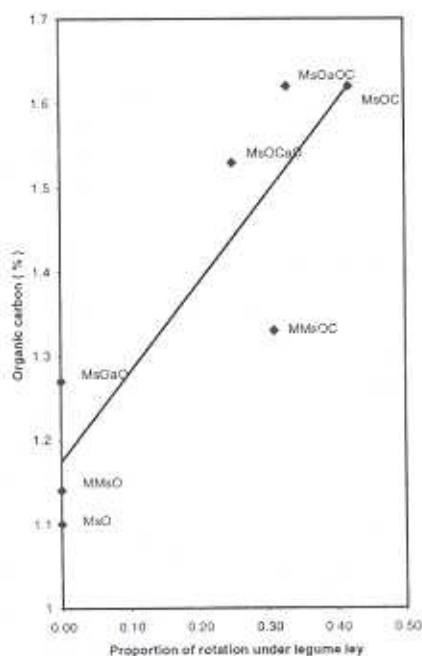


Figure 1. The relationship ($P > 0.01$) between the proportion of a rotation under legume ley and the level of soil organic carbon in 1984 in a long term rotation trial at Glen Innes, NSW. Symbols used are: M = Maize, C = Clover, sO = spring Oats, aO = autumn Oats.



is important to note that levels of organic C increased as the proportion of time under clover ley increased (Figure 1).

The presence of autumn oats also had a positive impact on soil organic C levels. In contrast, soil organic C levels declined as the frequency of maize cropping increased. Analysis of the yields indicated that legume leys were instrumental in maintaining crop yields (Norton *et al* 1995). Comparison of soil organic C levels and spring oat yields between the rotations MsOC and MsO over the period from 1939 to 1984 reveals the difference between a rotation in which production is sustainable and one in which it is not. In MsO, soil C levels declined from 1.96 to 1.1% and hay yield declined from 3790 to 1270 kg/ha. In contrast, soil C levels declined much less, from 1.83 to 1.62% in MsOC and this seemed to be associated with the maintenance of hay yields (4870 kg/ha in 1939 and 4600 kg/ha in 1984). These results clearly indicate that for productivity to be maintained in a low input cropping system, the rotation must contain a legume ley.

Acknowledgments

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