The agronomic utilisation of organic soil amendments

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Abstract
Organic amendments are becoming more commonly used in Australian agriculture despite a lack of scientific research to support the claims of manufacturers or to guide land managers in their application. These products have an influence on the carbon cycle in the soil in that they can be both a source of carbon and increase the rate of nutrient and carbon mineralisation in the soil. Three organic amendments, a seaweed extract (SWE), a liquid meat, blood and bone (LMBB) and a liquid humate (LH), were applied at two rates at the start of three consecutive cropping seasons in a complete randomised block design, in two fields in the Trangie area of the Macquarie Valley, situated in central western NSW, Australia. Soil samples were regularly collected from the experimental fields and analysed for microbial biomass, total carbon and resilient carbon (<53 µm soil fraction). Results indicate that there may be a stimulation of microbial biomass in the soil, potentially causing a decrease in total carbon content, but an increase in resilient carbon.

Key words
Microbial biomass, soil carbon, seaweed extract, humates, meat blood and bone meal

Introduction
Research has shown that the application of organic amendments can influence soil biological processes, soil carbon pools and the performance of crops (Atiyeh *et al.* 2002; Mondini *et al.* 2008; Rathore *et al.* 2009). However, there is a lack of scientific research into the utilisation of these products in broadacre agriculture in Australia. The available findings in scientific literature suggest that to perceive the benefits of organic amendments, the application rates must be significantly higher than those suggested by the manufacturers (Edmeades 2002). However, some of these products may potentially help improve or sustain soil health at relatively low application rates, through stimulating biological activity, enhancing nutrient and carbon cycling in the soil and potentially increasing the amount of organic carbon in the soil. The aim of this work is to identify any changes to soil carbon, structural and biological properties resulting from the addition of a number of organic amendments to the standard inputs of conventional broadacre irrigated agriculture.

Methods
Products were applied prior to planting each season for three consecutive growing seasons at two rates in a randomised complete block design in two fields in the area around Trangie in central western NSW. The fields were located on two properties, Byron and Buddah. The soil at Buddah is a grey vertosol, while the soil at Byron is a brown chromosol. SWE was applied at 20 and 40 L ha^{-1}, LMBB at 30 and 60 L ha^{-1}, and LH at 5 and 10 L ha^{-1}. The products were applied as an additional input to the standard operations of the farms. Soil samples were collected from 0 to 50 mm depth prior to harvest in the first two seasons and prior to the application of organic amendments and at monthly intervals during the third season. Samples were analysed for microbial biomass carbon (MBC), using a chloroform fumigation (Sparling *et al.* 1993), and for total carbon content, using an Elementar VarioMax CNS Analyser. Plant performance indictors, including boll retention in cotton, will be collected during and at the end of the third season of the field experiment.

Results
No significant difference in any of the measured soil properties was observed between the treatments. A rate effect was observed for both LMBB and the SWE, with both these showing an increase in microbial biomass with increasing application rates in November 2008 and September 2009 for LMBB (Figure 1). The higher application rate of 40 L ha^{-1} of SWE showed a lower microbial biomass in 2008 than at the rate of 20 L ha^{-1}, while in 2009 this result was reversed (Figure 1). In 2008 the LH treatment resulted in a greater microbial

biomass for the higher application rate of 10 L ha^{-1} compared to the LH applied at 5 L ha^{-1} with the reverse occurring in 2009 where the lower rate had the greater microbial biomass.

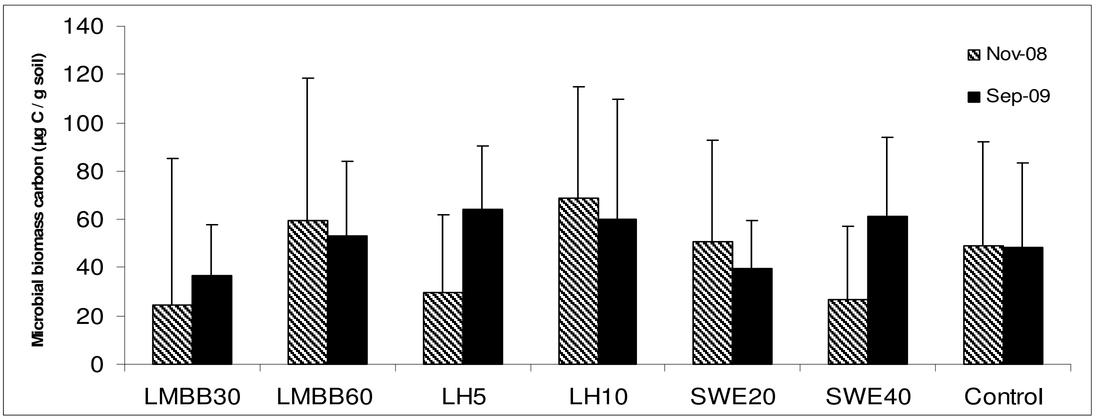

Figure 1. Microbial biomass carbon from soil samples collected from the Byron experimental field. November 2008 samples collected six months after the application of organic amendments and two weeks prior to harvest. September 2009 samples collected eight weeks after the application of organic amendments. LMBB30: liquid meat, blood and bone at 30 L ha^{-1}; LMBB60: liquid meat, blood and bone at 30 L ha^{-1}; LH5: Liquid humate at 5 L ha^{-1}; LH10: Liquid humate at 10 L ha^{-1}; SWE20: seaweed extract at 20 L ha^{-1}; SWE40: seaweed extract at 40 L ha^{-1}.

Although no significant difference in tillering was observed in September 2009, tillering was higher in all treated plots (Figure 2). Similarly, although not significant an increase in average plant height in treated experimental plots was observed in September 2009 (Figure 2). Results are pending, to be completed by December 2009, for MBC, total and resilient soil carbon and crop yields for both experimental fields.

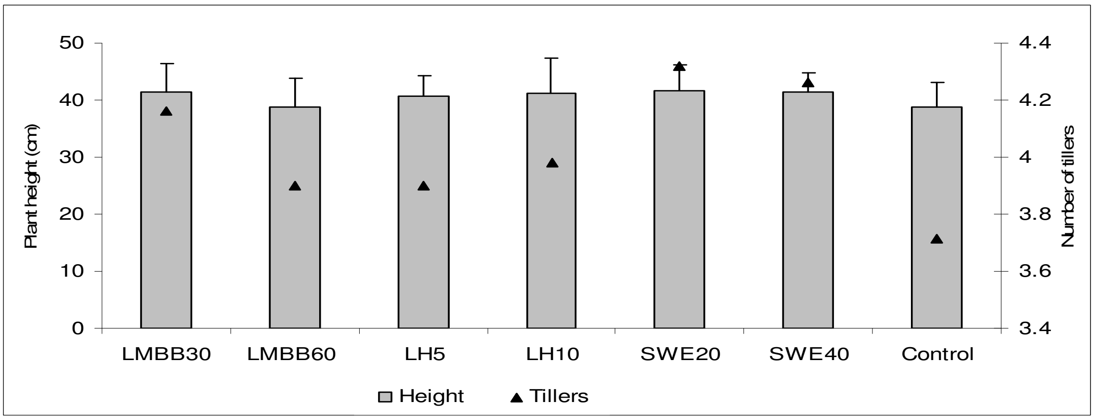

Figure 2. Wheat plant heights and average number of tillers per plant from the experimental field at Byron in September 2009 eight weeks after application of organic amendments. LMBB30: liquid meat, blood and bone at 30 L ha^{-1}; LMBB60: liquid meat, blood and bone at 30 L ha^{-1}; LH5: Liquid humate at 5 L ha^{-1}; LH10: Liquid humate at 10 L ha^{-1}; SWE20: seaweed extract at 20 L ha^{-1}; SWE40: seaweed extract at 40 L ha^{-1}.

Discussion

The application of organic amendments appears to have a rather transient influence on microbial biomass. However, this has an influence on the total carbon content, potentially influencing the amount of resilient carbon in the soil. The stimulation of microbial activity and increased biomass resulting from the application of organic amendments is a common finding in research (Marinari *et al.* 2007; Mondini *et al.* 2008). The results of this study suggest that the application of organic amendments may increase the level of microbial activity in the soil, and that this effect increases with increasing rates of application. However, the application of both the SWE and the LH appeared to have the opposite effect in September 2009 compared to November 2008.
Of the three organic amendments utilised in this research, LMBB is has the greatest nutrient potential, containing

approximately 8% nitrogen. The manufacturers of the SWE claim that it contains less than 0.1% nitrogen and the LH less than 0.5%. This would suggest that the increase in plant height and tillering resulting from the application of LMBB is possibly due to the nutritive effects of the organic amendment, while those resulting from the SWE and LH could possibly be related to plant-growth promoting activity of these amendments. The application of SWE aims to increase plant biomass through the actions of the plant-growth promoting hormones cytokinin and auxins, which are present in this type of product (Rathore *et al.* 2009). The activity of humic molecules has also been shown to have a similar influence on some crops (Eyheraguibel *et al.* 2008) and thus may be responsible for the increased height and tillering of the wheat. However, the application of the LH may also have resulted in an improvement in soil structural condition, which may have led to enhanced plant performance. Results pending will determine the structural condition, total carbon content and resilient carbon content of the soil from 0 to 50 mm depth.

Conclusion

Although pending results are critical to drawing conclusions from this research, the findings thus far indicate that the application of organic amendments as an additional input to conventional irrigated farming systems can result in improved crop performance. The stimulation of microbial activity may lead to an increase in the rate of mineralisation occurring and the rate of organic matter decomposition occurring in the soil. If adequate organic matter is not available to microbial species as a source of carbon, there is the potential that the more resilient forms of carbon in the soil may be utilised, thus leading to a decline in soil carbon content over time. This is most likely to occur where the organic amendments provide a source of easily available energy to microorganisms, such as LMBB. If properly managed there is also the potential to increase the amount of stable humic substances in the soil through increased decomposition of organic matter. The application of organic amendments must therefore be further investigated to ensure that they do not lead to a decline in soil health.

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