EFFECT OF METHOD OF TILLAGE ON LOSS OF CARBON FROM SOILS

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Abstract

Soils represent the largest terrestrial carbon (C) pool. Different tillage practices have been shown to result in variable losses of soil C. Among these, No-tillage is regarded as an effective management practice for conserving SOC and reducing soil CO_2 emissions. Overseas research shows that No-tillage practice could reduce CO_2 emissions by approximately 3 Mg CO_2 $ha^{-1}yr^{-1}$.

Quantitative information comparing soil CO_2 emissions with No-tillage and conventional tillage is limited in New Zealand. Furthermore, little quantitative information is available on the effect of soil and climatic conditions in modifying these emissions. This Ph.D. study evaluated the potential for Cross Slot® No-tillage cultivation to reduce CO_2 emissions from cropped soils in New Zealand conditions.

A series of preliminary experiments were conducted to establish a suitable chamber method to collect and measure CO_2 emissions from soil. The alkali trap method was selected for use in traditionally cultivated agricultural soils. Another experiment was conducted to test whether pressure fluctuations caused by wind velocity differentially influence soil CO_2 emissions from conventionally and Cross Slot® No-tillage cultivated soils. Carbon dioxide emissions from conventionally cultivated soils rapidly equilibrated to the onset of lower (negative) pressure, whereas CO_2 emissions from No-tillage soils took longer to equilibrate.

Experiments on the potential savings of soil C with Cross Slot® No-tillage cultivation (NT) compared to simulated tillage, measured in the laboratory showed reduced (between 113 and 393 kg CO_2-C ha^{-1}) CO_2 losses in three out of four soils. This reduction in CO_2 losses was further verified with measurements made for one of the soils at a field site during autumn and summer seasons. Overall the results of field studies suggest that Cross Slot® No-tillage cultivation reduced ~3.0 Mg CO_2 ha^{-1} compared with rotary tillage for combined autumn and summer sowings i.e. two cultivations.

A subsequent laboratory incubation study assessed CO_2 loss with different levels of residue addition to the four soils used in the previous laboratory and field experiments. A number of labile C fractions extracted from these soils were measured in an attempt to predict CO_2 losses. These did not show any relationship with the CO_2 respired during the incubation period. It was, therefore, not possible to develop a soil test to predict CO_2 losses using these extractions.

Modelling laboratory CO_2 respiration data for predicting the CO_2 losses from conventional and No-tillage soils was explored using relationships between short-term CO_2

respired and total CO_2 loss. The model developed from laboratory incubations was further improved with parameterising the soil temperature and moisture effects. The temperature and moisture sensitive model was used to predict the CO_2 emissions measured during the summer season. The model precisely predicted the amount of C lost from No-tillage soils but the amount predicted for rotary tilled soils was 30 per cent less than the amount of C that was lost in the field. Moreover, the model predicted C loss was higher for the No-tillage soils than the rotary tilled soils which was contradictory to the findings from the field study. Therefore, further work is required as the data obtained during this Ph.D. study was insufficient to provide, or develop a model that could be used to predict CO_2 loss from conventional and No-tillage cultivation in New Zealand soils.

DEDICATION

This work is dedicated to my wife Rupinder Kaur who gave me, more than strength, a reason to go on.

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Table of Contents

List of Tables

List of Figures

List of Plates