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The Short-Term Impact of Different Tillage Practices on Carbon Dioxide Emissions

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In Ireland, the agriculture sector is the largest contributor to national greenhouse gas emissions (GHG) and the identification of mitigation measures is a high priority. As management interventions that disturb the soil/vegetation are often considered to have a major impact on the GHG budget of cropland ecosystems we assessed the use of non-inversion/eco-tillage (ET), which reduces soil disturbance, as a potential mitigation measure. Conventional tillage (CT), involving ploughing and soil inversion in February to a depth of 0.20 – 0.25m, was compared with ET, which is associated with harrowing in September to a depth of 0.10 – 0.15m. The focus was on the initial soil carbon dioxide emissions (A_{CO2}) immediately after the two tillage activities (2min - 24h) and after one week, together with soil temperature, moisture and soil microbial activity measurements.Values are reported for 2011 and 2012 to consider inter-annual variations and comprised two CT and ET interventions. In both cases there was a peak of emissions immediately after the two tillage treatments that lasted for around one hour. This suggests the physical break-up of soil pores and soil air release through newly established soil gaseous pathways as the main driver. Rather surprisingly, however, despite the reduced soil disturbance, higher initial values for A_{CO2} were obtained for the ET treatment than for the CT treatment that was associated with the higher temperatures and soil microbial activity occurring in September, emphasizing the importance of timing on the impact of any tillage practices. Comparisons were also made between treatments with or without straw incorporation (+SI, -SI), as well as between the presence and absence of a sown winter cover crop (+CC, -CC). In general, the treatments +SI and +CC showed higher values of A_{CO2}, but inter-annual variations in climate can alter this pattern. The measurements indicate that the time between the start of straw or cover crop decomposition and the tillage date influences the intensity of A_{CO2} due to the related build-up of CO_2–enriched soil air that is eventually released during the tilling process. Our results show that the higher CO_2 emissions associated with the ET practice, as well as the +SI and +CC treatments, should be considered when deciding on an improved greenhouse gas management strategy for croplands.