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Assessing Effect of Manure and Chemical Fertilizer on Net Primary Production, Soil Respiration and Carbon Budget in Winter Wheat (*Triticum aestivum* L.) Ecosystem under Mashhad Climatic Condition

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Introduction

The imbalance between anthropogenic emissions of CO_2 and the sequestration of CO_2 from the atmosphere by ecosystems has led to an increase in the average concentration of this greenhouse gas (GHG) in the atmosphere. Enhancing carbon sequestration in soil is an important issue to reduce net flux of carbon dioxide to the atmosphere. Soil organic carbon content is obtained from the difference between carbon input resulting from plant biomass and carbon losses the soil through different ways including soil respiration. CO_2 emission varies largely during the year and is considerably affected by management type. The goal of this investigation was to study the effects of application of manure and chemical fertilizer on CO_2 flux and carbon balance in agricultural system.

Materials and Methods

In order to evaluate the carbon dynamics and effect of fertilizer and manure management on soil respiration and carbon budget for winter wheat, an experiment was conducted as a randomized complete block design with three replications in research field of Faculty of Agriculture of Ferdowsi University of Mashhad for two years of 2010-2011 and 2011-2012. The experimental treatments were 150 and 250 kg chemical nitrogen (N1 and N2), manure (M), manure plus chemical nitrogen (F-M) and control (C). CO_2 emission was measured six times during growth season and to minimize daily temperature variation error, the measurement was performed between 8 to 11 am. Chambers length and diameter were 50 cm and 30 cm, respectively and their edges were held down 3 cm in soil in time of sampling so that no plant live mass was present in the chamber. Carbon budgets were estimated for two years using an ecological technique.

Results and Discussion

The net primary production (NPP) was significantly higher in the F2 and F-M treatments with 6467 and 6294kg ha^{-1} in the first year and 6260 and 6410 kg ha^{-1} in the second year, respectively. The highest shoot to root ratio was obtained in F2 and the lowest was observed in control plot with 5.1 and 5.2 for first and second years, respectively. The trend of CO_2 flux as 250, 220, 200, 170, 160 and 155 mg C m^{-2} h^{-1} was gained in the F-M, M, F2, F1 and root-excluded plots, respectively. In general, manure treatments had the highest heterotrophic respiration. The highest of annual soil respiration and heterotrophic respiration were also in M-F treatment with 3257 and 1150 kg C ha^{-1} for the first year and 3310, 1250 kgC ha^{-1} in second year, respectively. The annual NPP was 5000 and 5000 kg C ha^{-1} $year^{-1}$ for M-F, 5077 and 5100 kgC ha^{-1} $year^{-1}$ in F1 and 2065 and 1865 kg C ha^{-1} $year^{-1}$ for the control treatment in 2010 and 2011, respectively. The range of annual net biome production (NBP) in the fertilizer and control treatments ranged from -400 to -150 kg C ha^{-1} $year^{-1}$, suggesting the loss of carbon in the field. On the other hand, NBP in the M was 1400 and 1200 kg C ha^{-1} $year^{-1}$ in 2010 and 2011, respectively and the M-F was 1300 and 1100 kgC ha^{-1} $year^{-1}$ in 2010 and 2011, respectively.

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Conclusion

The results of this experiment showed that in the wheat ecosystem, the carbon emission is higher than the carbon entry into the soil. The results also indicated that manure application in agro-ecosystems is a necessary approach to mitigate carbon losses in the winter wheat ecosystem and the results indicated a high correlation (> 0.9) between soil temperature and CO_2 flux which was positive and exponential. Soil respiration increased under the influence of fertilizer treatments (both chemical fertilizer and manure) but, the main reason for the increased soil respiration under application of chemical fertilizers was autotrophic respiration. While both respiration of autotrophic and heterotrophic increased in manure treatment.

Keywords: Heterotrophic respiration, Net biome production, Net ecosystem production, Net primary production, Soil respiration