Mining soil nitrogen threatens Australian wheat

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Abstract

Mining soil nitrogen reserves is threatening sustainable production in many wheat growing regions in Australia. By integrating national datasets, mass balance calculations and model simulations, this study expects to reveal the situation of mining soil nitrogen reserves across wheat growing regions, determine their lifespan under current nitrogen management practices, and provide solutions to the threat of mining soil nitrogen reserves. This should enable a more balanced use of fertiliser nitrogen and soil nitrogen reserves, which are essential for soil fertility, the wheat industry, and ultimately global food security.

Keywords: soil nitrogen, wheat, Australia

1. Introduction

Soil is the foundation for sustainable agricultural development but a non-renewable resource. Australia is experiencing increasing soil degradation and growing evidence of yield gaps due in part to inappropriate nitrogen (N) management practices. The problem of unsustainable mining of soil organic N reserves, notably in wheat cropping systems, has not been addressed. This is caused by the false sense of security that the soil is rich in N based on a "soil test" (which assesses pre-crop mineralisation of soil N). This results in insufficient N input to the soil to replenish the N taken up in the wheat grain, which is removed from the soil. Consequently, wheat production systems gradually mine the N reserves in the soil. Soil N reserves will be depleted if N replenishment is insufficient

2. Methods

The study integrates data mining with mass balance calculations and model simulations to unravel the unknowns associated with mining soil N, in particular how long Australian wheat production systems can be sustained. National data (literature, databases, reports) for Australian wheat cropping systems will be used to construct a database. The data collected will be used for calculating the partial N balance (PNB) of the agroecosystems. Agroecosystem models such as APSIM would also be applied to field sites with both short- and long-term (>10 years) data, and determine for how long soil organic N can sustain wheat production systems using long-term historic and projected climate data.

3. Preliminary results

Based on national statistics data, we observed an alarming phenomenon in Australia's fertilizer use in wheat production: during most of the recent 15 years, N-fertiliser addition to all of Australia's wheat production lands was substantially less than that needed to maintain the soil N reserves. In other words, Australian wheat production has been mining N from the soils in many wheat growing regions for many years. For the years where N input exceeded N removal (2002 and 2006), the relatively low rainfall caused low wheat production and low grain N removal from the land (Bureau of Meteorology, 2015). Using the database on national wheat trials, we found that ~70% of the calculated PNB in Australian wheat systems was > 1, an indicator of soil N being mined. We plotted the PNB against N application rate and found that the phenomenon of PNB > 1 mostly occurred

when the N rate was less than 80 kg N ha^{-1} (Fig. 1). The work is in progress for agroecosystem model optimization.

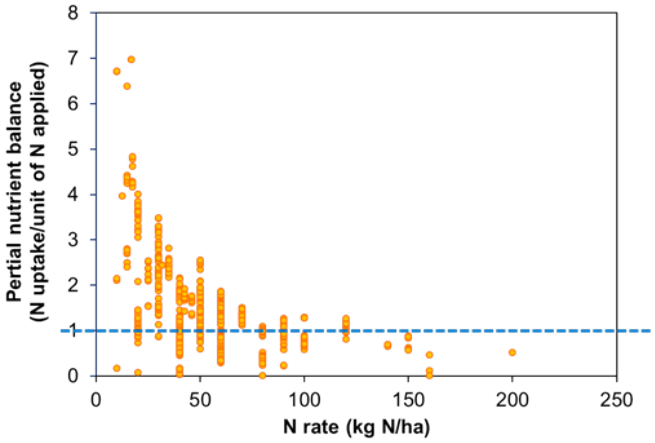

Fig. 1: Partial nutrient balance against N rate in Australian wheat systems

4. Significance

This study expects to rectify the imbalance between N input to and N output from Australian wheat production systems, which could otherwise lead to severe ecological and economic consequences.

Reference

Bureau of Meteorology 2015. Australian Bureau of Meteorology online database.