Investigating the fate and behaviour of nitrification inhibitors in soil systems

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Abstract

Intensive application of N-based fertilisers has become a common practise to achieve high crop yields. However, a large proportion of the applied N is lost to the surroundings causing unwanted consequences. Addition of nitrification inhibitors (NIs) has been recommended as a strategy to minimise N-losses and improve overall N-use efficiency. Current NIs have some limitations and their efficiency varies greatly depending upon environmental and edaphic variables. There is a little understanding for the reason behind these inconsistent responses. This study focuses on gaining a deeper understanding of the efficiency, fate and behaviour of NIs in soil systems through degradation studies.

Keywords: nitrification inhibitors, extraction, quantification, degradation.

1. Introduction

The current trend in the growth of global population projects an increased global food demand in the future. Increased use of synthetic N-based fertilisers has indeed led to higher crop yields. However, due to low nitrogen use efficiency a substantial fraction of the applied N is lost to the surrounding environment, via ammonia volatilisation, nitrate leaching and denitrification (Cameron et al., 2013).

Globally, the agricultural sector is responsible for over half of the anthropogenic N_2O emissions. Use of NIs has been recommended by IPCC as one of the efficient strategies to reduce N_2O emissions (IPCC, 2014). New and more efficient NIs are being developed to achieve productivity goals with minimal environmental damage.

2. Efficacy and Fate of Nitrification Inhibitors

Understanding the behaviour of NIs in terms of their activity and degradation is as important as developing new NIs.

2.1 Accelerated Weathering Studies

NIs are subjected to various alternating cycles of UV light, moisture, and elevated temperatures, and then analysed to study any structural changes.

2.2 Extraction and Quantification

For quantification of a NI in the soil, an effective NI extraction method from soil has been developed, enabling subsequent analysis by HPLC. Degradation products are identified through isolation and spectroscopic characterisation.

2.3 Soil Incubation Experiments

Soil incubation studies are conducted for a range of soils to ascertain the influence of soil type, pH, temperature and water content on inhibition activity and degradation behaviour of current and potential NIs (Fig. 1).

Percentage inhibition activity is determined from the ammonium and nitrate concentration. Headspace analysis enables the measurement of NI effectiveness in reducing N_2O emissions.

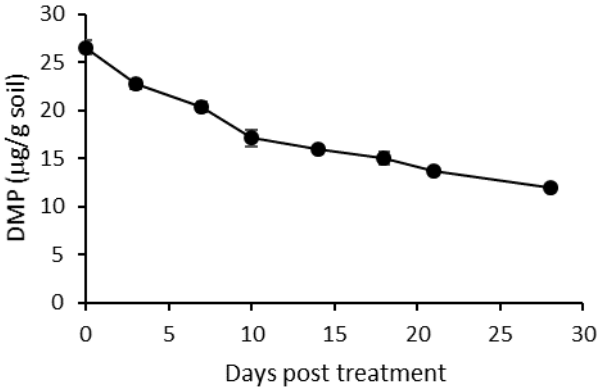

Fig. 1: 3,4-Dimethylpyrazole (current NI) concentration in soil samples over 28 days. Data is presented as mean ± standard error, n=3.

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