Leaching of dissolved nitrogen and carbon from winter cover crop in Mediterranean Central Chile

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Abstract

The main aim of this study was to examine the combined effects of nitrogen (N) fertilisation during the maize (*Zm*) cropping and cover crop (*CC*) inclusions vs *Zm*- fallow on dissolved inorganic N (DIN), dissolved organic N (DON), total dissolved N (TDN) and dissolved organic carbon (DOC) leaching from a coarse textured soil in Mediterranean Chile. We found that crop rotation with *Zm*, optimal N fertilisation (250 kg N ha^{-1}) and a grass *CC* had significantly lower DIN and TDN loads than all other *Zm*-fallow treatments due to a combination effect of lower percolation and DIN and TDN concentrations.

Keywords: Agriculture, Water quality, Non-point pollution.

1. Introduction

Although DIN has been identified as the main form of N leaching in agricultural soils, recent studies include DON leaching as another important N loss pathway from agroecosystems (Salazar et al. 2019). Establishment of *CC* during the intercropping period of *Zm* by replacing bare fallows (*F*) in autumn-winter season has been proposed to counteract the negative impacts of N leaching under Mediterranean climatic conditions (Salazar et al. 2017). However, most soils in such agroecosystems are depleted of their antecedent soil organic carbon (SOC) pool and inclusion of *CC* can enhance SOC and microbial activity, hence increasing the risk of DON and also DOC leaching. Our study examined the combined effects of inorganic N fertilisation during the *Zm* cropping and *CC* inclusions on DIN, DON, TDN and DOC leaching from a coarse textured soil in Mediterranean Chile.

2. Material and methods

The study was conducted on microplots (2.65 m x 4 m) at the Antumapu Experimental Station located in Santiago (33°34'S, 70°38'W). A total of 52 microplots (13 treatments x 4 replicates) were established and monitored over a period of 3 years (August 2015 to September 2018) to evaluate dissolved forms leaching from: 1) continuous F (*F-F*) compared with a continuous *CC* of *Lolium multiflorum* (*Lm-Lm*) or *Trifolium repens* (*Tr-Tr*), with 0 or 150 kg N ha^{-1} applied; and 2) *Zm-F* and *Zm*-CC rotations with two different N doses (250 or 400 kg N ha^{-1}) for the *Zm* and CC (*Lm* and/or *Tr*). Samples of soil solution percolating from full stop® set at 50 cm depth were taking periodically for measuring dissolved form concentrations. The DIN, DON, TDN and DOC loads were calculated as the product of cumulative percolated volume measured with a Drain Gauge G3 lysimeter Decagon® and N and C forms concentrations in the leachates.

3. Discussion and conclusions

We found that during the autumn-winter season the *F-F* compared with a continuous *CC* generated the highest DIN loads (314 kg ha^{-1}) and the lowest DON loads (1 kg ha^{-1}); Lm_{150N}-*Lm* registered the lowest DIN and DOC loads with 4 and 42 kg ha^{-1}, respectively; whereas the highest DON loads was found in the Tr_{0N}-*Tr*. In treatments that had *Zm* and N fertilization during spring-summer, we found that Zm_{400N}-*Tr*

had the highest DIN load (164 kg ha^{-1}) and *Zm*$_{250N}$-*Lm* the lowest DIN load (6 kg ha^{-1}); *Zm*$_{250N}$-*F* and *Zm*$_{250N}$-*Tr* showed the highest DON load (10 kg ha^{-1} both) and *Zm*$_{400N}$-*F* the lowest DON load (0≈ kg ha^{-1}); whereas *Zm*$_{400N}$-*Tr* and *Zm*$_{400N}$-*Lm*+*Tr* showed the highest DOC load (67 kg ha^{-1} both) and *Zm*$_{250N}$-*Lm*+*Tr* the lowest DOC load (24 kg ha^{-1}).

We found that crop rotation with *Zm*, optimal N fertilisation (250 kg N ha^{-1}) and a grass CC (*L. multiflorum*) had significantly lower DIN and TDN loads than all other maize-fallow treatments due to a combination effect of lower percolation and DIN and TDN concentrations (Fig. 1). The results support the suggestion that under continuous CC leaching of DON and DOC is mainly affected by greater litter production and microbial processing of the fresh organic matter.

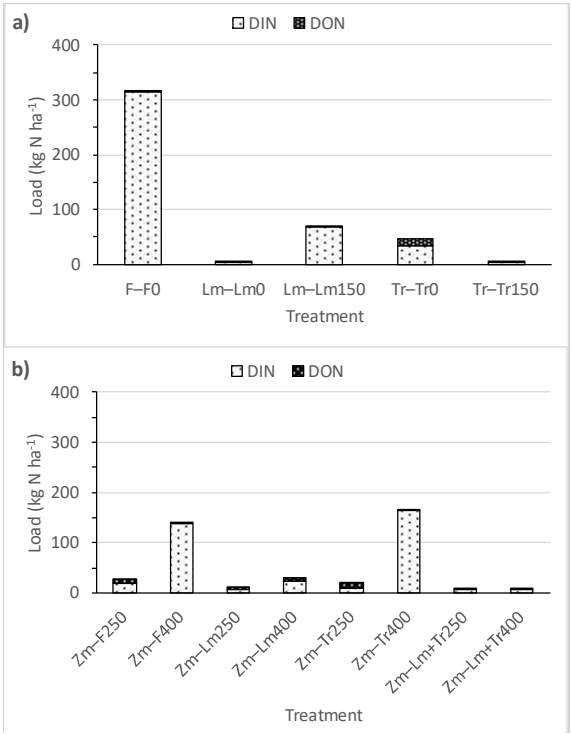

Fig. 1 DIN and DON loads in a) continuous F (F-F) vs continuous *CC* of *Lolium multiflorum* (Lm-Lm) or *Trifolium repens* (Tr-Tr), with 0 or 150 kg N ha^{-1} applied; and b) *Zm*-F vs *Zm*-*CC* rotations with two different N doses (250 or 400 kg N ha^{-1}).

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References

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