CROP ROTATION AND RESIDUES INFLUENCE N2O EMISSION AND N EFFICIENCY RATHER THAN TILLAGE UNDER A RAINFED MEDITERRANEAN AGRO-ECOSYSTEM

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Conservation tillage and crop rotation have spread during the last decades because promotes several positive effects (increase of soil organic content, reduction of soil erosion, and enhancement of carbon sequestration) (Six et al., 2004). However, these benefits could be partly counterbalanced by negative effects on the release of nitrous oxide (N2O) (Linn and Doran, 1984). There is a lack of data on long-term tillage system study, particularly in Mediterranean agro-ecosystems. The aim of this study was to evaluate the effects of long-term (>17 year) tillage systems (no tillage (NT), minimum tillage (MT) and conventional tillage (CT)); and crop rotation (wheat (W)-vetch (V)-barley (B)) versus wheat monoculture (M) on N2O emissions. Additionally, Yield-scaled N2O emissions (YSNE) and N uptake efficiency (NUpE) were assessed for each treatment.

Materials and Methods

The experiment was located in “Canaleja” field station (Madrid, Spain) on a sandy clay loam soil (Calcic Haploxeralf) under rainfed conditions. The experimental design was a three-replicated split-plot. Tillage was the main factor (plot) in a randomized complete block design and subplots (as secondary factor) were W, V, B and M, in a complete randomized design. Crops were sown at the beginning of November and harvested on 18th June. All subplots were fertilized with 70 kg N ha-1year-1, except vetch ones, split in two applications (at seeding and spring). Nitrous oxide emissions were sampled periodically by Static Closed Chamber method (Ábalos et al., 2012) and quantified by Gas Chromatography. Cereal N content was quantified by Elemental Analysis.

Results and Discussion

Nitrous oxide cumulative fluxes were similar between tillage treatments. Conversely, significant differences ($P < 0.05$) were found among crops, i.e. M showed higher N2O fluxes than cereals in rotation (Table 1). These results highlight the importance of the type of residue from the previous crop (wheat for M, vetch for B and fallow for W), that seems to be responsible for the differences observed among crops fertilized with the same N rates (Malhi and Lemke, 2007). Fluxes of N2O for legume non-fertilized crop were not significantly different to low N input fertilized cereals (Jensen et al., 2012). Yield-scaled N2O emissions were greater in M than in W (Table 1), regardless tillage system. However, B and V showed similar YSNE values for all tillage treatments.

According to NUpE, there were not significant differences for tillage systems and crops. Nevertheless, cereals in rotation showed higher values than M in all tillage treatments, whereas lower values in conservation tillage (MT and NT) were obtained in comparison with CT (Table 1). Mean Emission Factor (kg N2O ha-1 kg N min applied-1) in all treatments was around 0.1%, lower than IPCC default value (1%) because of climate, soil conditions and land management (rainfed and low N input) (Aguilera et al, 2013). Conclusion Taking into account N2O emissions, yields and N efficiency, rotation is a good alternative to improve sustainability of crops. Nevertheless, tillage treatments showed high variability, and is necessary to consider the best combination of both factors.

Table 1 Effect of tillage treatments and crop on N2O cumulative emission, NUpE and YSNE.

Effect	N_2O cumulative emission (mg N-N_2O m^{-2})	NUpE (kg N_{plant} kg Nmin $_{applied}^{-1}$ x 100)	YSNE (mg N-N_2O kg $grain^{-1}$)
Tillage x crop	ns	ns	ns
Tillage	ns	ns	ns
CT	18.4	125	51.9
MT	18.5	102	61.2
NT	17.4	102	71.1
S.E.	1.8	10	8.5
Crop	**	ns	**
M	23.1 a	92	81.0 a
W	15.4 b	116	41.8 b
B	14.8 b	120	–
V	19.0 ab	–	–
S.E.	1.6	11	7.0

Within a column, means followed by the same letter are not significantly different according to Fisher's LSD at a 0.05 probability level. *P< 0.05; ** P< 0.01; ns=not significant

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