WATER AND NITROGEN FOOTPRINT IN AN IRRIGATED CROP UNDER MINERAL AND ORGANIC FERTILIZATION.

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In order to establish rational nitrogen (N) application and reduce groundwater contamination, a clearer understanding of the N distribution through the growing season and its balance is crucial. Excessive doses of N and/or water applied to fertigated crops involve a substantial risk of aquifer contamination by nitrate; but knowledge of N cycling and availability within the soil could assist in avoiding this excess. In central Spain, the main horticultural fertigated crop is the melon type ‘piel de sapo´ and it is cultivated in vulnerable zones to nitrate pollution (Directive 91/676/CEE). However, until few years ago there were not antecedents related to the optimization of nitrogen fertilization together with irrigation. Water and N footprint are indicators that allow assessing the impact generated by different agricultural practices, so they can be used to improve the management strategies in fertigated crop systems. The water footprint distinguishes between blue water (sources of water applied to the crop, like irrigation and precipitation), green water (water used by the crop and stored in the soil), and it is furthermore possible to quantify the impact of pollution by calculating the grey water, which is defined as the volume of polluted water created from the growing and production of crops. On the other hand, the N footprint considers green N (nitrogen consumed by the crops and stored in the soil), blue N (N available for crop, like N applied with mineral and/or organic fertilizers, N applied with irrigation water and N mineralized during the crop period), whereas grey N is the amount of N-NO3- washed from the soil to the aquifer. All these components are expressed as the ratio between the components of water or N footprint and the yield (m3 t-1 or kg N t-1 respectively). The objetives of this work were to evaluate the impact derivated from the use of different fertilizer practices in a melon crop using water and N footprint.

Materials and Methods

During successive years, a melon crop (Cucumis melo L.) was grown under field conditions applying mineral and organic fertilizers under drip irrigation. Different doses of ammonium nitrate were used as well as compost derived from the wine-distillery industry which is relevant in this area. The water needs were calculated using FAO method as $ETc = Kc \times ETo$ (Doorenbos and Pruitt, 1977); Kc, the crop coefficient used (Ribas et al., 1995) and ETo is the reference evapotranspiration calculated by the FAO Penman–Monteith method (Allen et al., 2002). Each growing season, N uptake by the crop was determined. To quantify the N leached to groundwater the drainage was calculated weekly using a water balance ($D = Irr + P - ETc - Rf \pm \Delta\theta v$ (Doorenbos and Pruitt, 1977), where D is drainage, Irr is the irrigation applied, P is the precipitation, Rf is runoff that is considered negligible and $\Delta\theta v$ is the variation of the volumetric soil water content between two consecutive week; as well as the concentration of nitrate in the soil solution. In adition, N in soil at the begining and at the end of the crop cycle was measured. With all these parameters, N mineralized during the crop period was estimated.

Results and Discussion

The variability observed on the water footprint between years pointed out that this indicator is closely related to the climatic conditions found in each growing season. As all the treatments were watered based on the crop requirements, differences in the water footprint were related to the yield. The highest doses of inorganic fertilizer (MF243 and MF393) resulted in higher components of the N footprint, because substantial amounts of available N forms were applied through fertigation without increasing the yield. This fact resulted in an increase of the grey N footprint, because this excess of nitrates was transported with the drainage water and poses a risk of groundwater contamination. However, the most part of N applied with the organic fertilizer is in organic form and need to be mineralized during the crop cycle to be available for the crop or washed through the soil profile. For this reason, although the highest amounts of N were applied with compost, the components of the N footprint remained lower with respect to the highest doses of inorganic fertilization due to a slow rate of N mineralization.

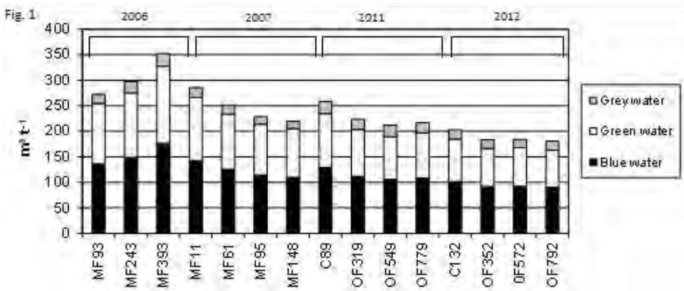

Figure 1. Water footprint for all the treatments (MF=mineral fertilizer (followed by kg N ha-1 applied with mineral fertilizer and irrigation water); C= control (followed by kg N ha-1 applied with irrigation water); OF=organic fertilizer (followed by kg N ha-1 applied with compost, considering N organic and N mineral, and irrigation water)).

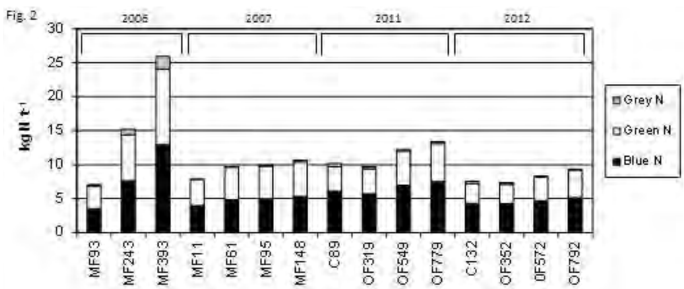

Figure 2. Nitrogen footprint for all the treatments (MF=mineral fertilizer (followed by kg N ha-1 applied with mineral fertilizer and irrigation water); C= control (followed by kg N ha-1 applied with irrigation water); OF=organic fertilizer (followed by kg N ha-1 applied with compost, considering N organic and N mineral, and irrigation water)).

Conclusions

Water footprint is dependent on the climate conditions of each growing season and the crop yield explains the differences obtained between treatments. The type of fertilizer as well as the application dose had an effect on the amount of the different components of the N footprint.

Acknowledgements

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