Interactive comment on "Scale and space dependencies of soil Nitrogen variability" by Ana M. Tarquis et al.

Anonymous Referee #1

The manuscript explores the effect of the N fertilizer applied to a previous horticultural crop on the subsequent, unfertilized, wheat crop: the different response of weight and nitrogen content of the cereal. The differences shown by the wheat crop after the fertilization of the previous crop were already examined by several of the authors using the wavelet technique (Milne et al. 2010). The new aspect considered in this manuscript is the separation between the whole plant and the grain. The authors discussed some results like the different answer of grain weight compared to plant weight which might be due to physiological reasons, as for instance an upper threshold for grain yield, which could be similar to what Hawkesford (2014) indicates in his figures 2 and 3.

Thank you very much for your comments. At Milne et al. (2010) the work was centered in plant weight (wheat weight or PW) and in this manuscript we study plant weight (PW), plant Nitrogen content (PN), grain weight (wheat yield or GW) and grain Nitrogen content (GN).

Thank you for the reference of Hawkesford (2014) that we have included in this work.

Nevertheless the authors do not try to search for the reasons of the different behavior of the whole plant and the grain, but they show that the differences observed in their data, figures 3B and 3D of the manuscript, could be appreciated too with the multifractal analysis using the transect sampling.

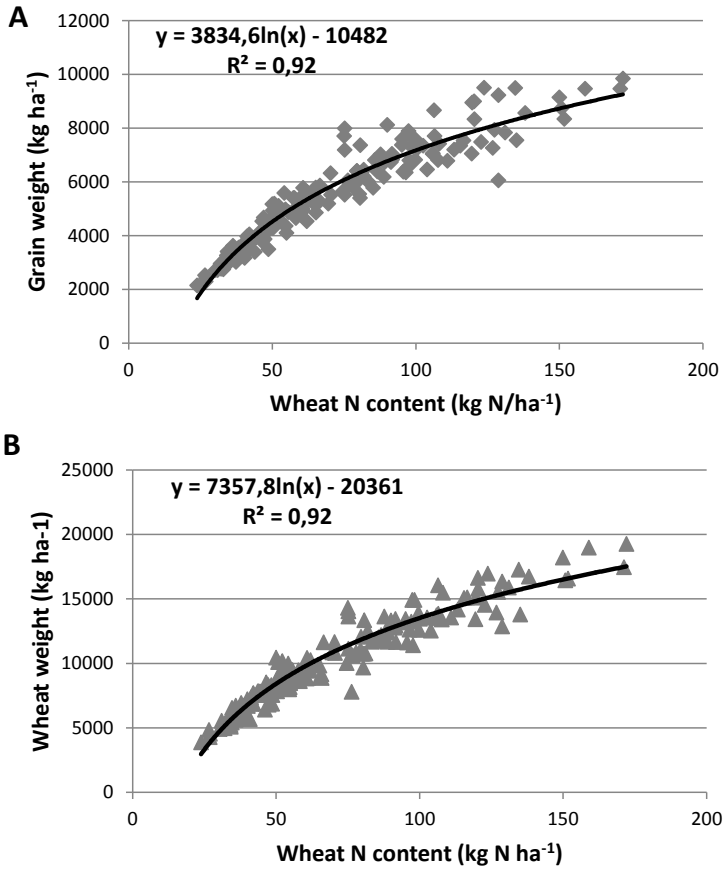
We wanted to apply a multifractal analysis and the relative entropy to compare the behaviour of these four variables. However, we have included the relations between variables to improve the discussion in section 3.1:

The positive effect of increasing grain weight together with the additional benefit of increasing wheat N content with increasing N application is shown in Fig. 5A. Moreover, the same positive effect of N addition was observed, increasing wheat weight together with increasing wheat N content (Fig. 5B). Closer inspection of Fig. 4 reveals that the variability was much higher when the N application was higher.

Barraclough et al. (2010), in an experiment with N fertilization applied homogenously directly to the wheat crop, found that much of the additional N taken up by the plant (PN) is manifested in higher yield (GW), although we remark again that in this work, the N application was performed in the melon crop experiment, through fertigation on crop lines, and the wheat crop did not receive any N fertilization and was not irrigated.

This positive effect of N addition has been observed in numerous studies (Barraclough et al., 2010 and references therein). Several works determine the N optimum in the wheat crop, but in this study, the optimal N dose was not obtained because we sought to study the variability and the effect of the residual N resulting from N application to a previous melon crop months before.

Fig 5. Effect of N applied in previous melon crop on: A) grain weight and wheat N content; B) wheat weight and wheat N content; C) grain weight and grain N content.



The manuscript needs a major revision: the discussions and conclusions sections do not fully agree with the abstract, the discussion section requires a clarification, as well as other sections.

We have improved the discussion and conclusions sections as there were some mistakes.

Specific comments. There are several questions:

1. Given the dry period between November2006-April 2007, seen in figure 2, and the high grain yields of figure 3, did the wheat plants receive any irrigation? In the affirmative case was the N contribution computed?

No, the plants did not receive any irrigation. The yields were ranged between 3.7 and 7.5 t/ha following the Ministery of Agriculture statistics data.

2. The data of Table 1 require some additional explanation: if the 60% of the ETc is 251.8 mm why the irrigation volume in the W1 treatment was 344.1 mm?

We have included the explication to this in the text. The rainfall was negligible, so the water applied was calculated as the ratio between the ETc of the previous week and the efficiency of the system, which considers the salt tolerance of the crop, the quality of the irrigation, soil texture and the homogeneity of the irrigation system (Rincón and Giménez (1989)), estimated as 0.81 under the study conditions. This result, called theoretical irrigation (irrigation calculated), was divided by the number of days to obtain the daily irrigation requirements. The real irrigation was the amount of water registered on the water meter (irrigation applied).

Rincón, L., Giménez, M., 1989. Fertirrigación por goteo en melón. Fertilización 105, 55–56.

3. The explanations of Lines 10-18 of section 3.3, page 12 are not evident. The legend of the abscissa axes of figures 6, 7, and 8, should indicate the unit of the variable delta.

The figures mentioned are now are 7, 8 and 9 plot. We have now improved the captions of these figures clarifying that "δ" is the number of data points used and in the first figure (figure 7) has been translated into meters so the reader can follow the results better.

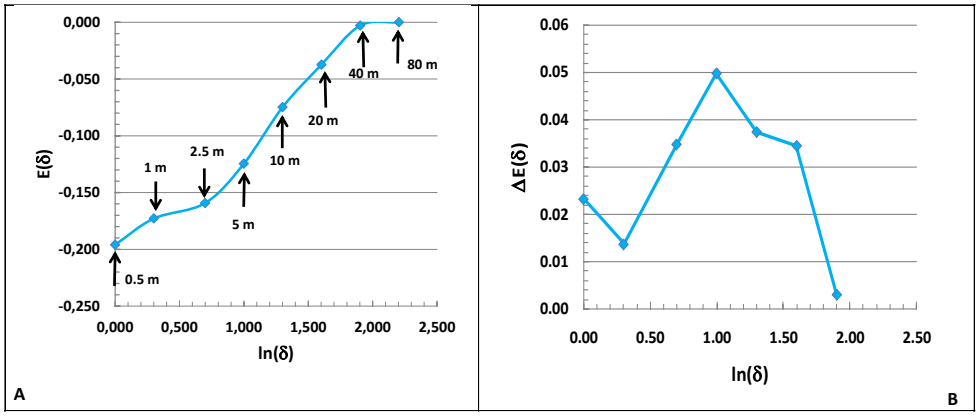


Fig 7. Entropy study: A) relative entropy, E(δ), of Nitrogen applied (Napp), B) increment of relative entropy, ΔE(δ), of Napp. The equivalent distance to the number of data points (δ) are marked in E(δ).

Fig 8. Relative entropy (E(δ)) respect to number of data points (δ) of: A) Grain Nitrogen content (*GN*), B) Grain Weight (*GW*), C) Wheat Nitrogen content (*PN*) and D) Wheat Weight (*PW*). Black lines represents *E*(δ) based on entropy dimension (D_1) of each variable.

Fig 9. Increment of relative entropy (ΔE(δ)) respect to number of data points (δ) of: A) Grain Nitrogen content (*GN*), B) Grain Weight (*GW*), C) Wheat Nitrogen content (*PN*) and D) Wheat Weight (*PW*). Black lines represents Δ*E*(δ) based on entropy dimension (D_1) of each variable.

Also we have clarified more the text:

The increments of the *E*(δ) (Δ*E*(δ)), between two consecutives scales, calculated for Napp and the four variables are shown in Fig. 7B and Fig. 9, respectively. *PN*, *GW* and *PW* present a similar scaling trend, with a maximum structure revealed at scale δ=10, corresponding to a distance of 5 m. This behaviour is the same found in Napp in the melon crop. In the case of *GN*, the maximum structure is found at δ=20 (10 m), indicating that the interaction of other factors influences in this variation, and the Napp is not the main one.

All the values of $\Delta E(\delta)$ at the smallest scales, δ=5, 2 and 1 (2.5, 1 and 0.5 m respectively), show an increase, giving the second maximum value for *GN*, *GW* and *PW*. This result suggests that at those scales, the variation is mainly due to the melon cropping lines, as the uptake of the applied nitrogen by this crop left a lower amount of available nitrogen for the wheat crop. In the case of *PN*, the second maximum was found at δ=20 (10 m) followed by the one at the smallest scales, δ=2 and 1 (1 and 0.5 m), as in the other variables.

4. The use of the English language must be thoroughly revised.

It has been revised and a certificate of the translator is included.

Technical corrections:

Page 1, Line 2: According to Milne et al. (2010) M.C. Cartagena super-index 3 should be 4. Done.

Page 4, Line 14: The authors must indicate what UH mean. Done.

Page 4, Line 15: write 6,953 km2 and 3,192 km2. Done.

Page 4, Line 16: delete 'caliche'. Done.

Page 4, Lines 19-22: rewrite the two sentences. Done.

Page 5, Lines 12-13: the soil could belong to the xeralf suborder, and might have a petrocalcic horizon, but it does not necessarily mean that the soil can be classified as written in the manuscript. We are sorry; there was a mistake in the classification of the soil. We have corrected it.

Page 6, Line 1: if the plant density for wheat is written in plants m-2 in page 7 line , why do not use similar units here: 4.44 plants m-2? Well, the density to melon crop is 0.444 plans m-2, so this unit is not used very much.

Page 6, Line 8: what does DAT stand for? We have removed DAT in all the paper.

Page 8, Line 18: write 'The probability is' instead of 'We now perform a weighted sum over all segments that yield to' Done.

Page 17, Line 1: insert the reference Soil Survey Staff 1999 Done.

Table 1: is it necessary? Table 1: the question might be irrelevant but why the numbers are not equal to those of Table 1 of Milne et al. (2010)? Table 1: if the Table is kept in the manuscript the third, fourth, sixth, and ninth columns could be deleted. The relevant information could be reduced to the ETo, kc, and rain depth

data. **We have removed the indicated columns and have corrected the mistakes. The nine columns have not been removed because the referee 3 did not understand the N treatments, so the nine columns is necessary to clarify the N treatments.**

Table 1. The treatments applied to the melon crop, total irrigation (applied irrigation, taking initial establishment irrigation into account, in the different treatments: 60% ETc (W1), 100% ETc (W2) and 140% ETc (W3) (15 to 104 DAT)) and applied nitrogen information. From Milne et al. (2010) with permission.

Treatment		Irrigation (mm)	N applied (kg N ha^{-1})		
Irrigation	Fertilizer		Irrigation water	Fertilizer	Total
W1	N0	342.6	55.58	0	55.58
	N1			150	205.58
	N2			300	355.58
W2	N0	552.9	92.78	0	92.78
	N1			150	242.78
	N2			300	392.78
W3	N0	755.9	129.46	0	129.46
	N1			150	279.46
	N2			300	429.46

Reference:

Hawkesford, M.J. 2010. Reducing the reliance on nitrogen fertilizer for wheat production. J. Cereal Sci. 59:276-283.

Included now in the manuscript.