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Interactive comment on "Nitrogen use efficiency and N_2O and NH_3 losses attributed to three fertiliser types applied to an intensively managed silage crop" *by* Nicholas Cowan et al.

Anonymous Referee #2

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This study presents results on the effect of three different N fertilizers application on silage crop. The focus of the study is an urea fertilizer that is coated with an urease inhibitor, which is commercially available. The authors studied its effect, compared to other two commonly used fertilizers, on crop yield, NUE (and other crop quality measures), and NH3 and N2O losses. Using an urease inhibitor is a potential strategy to reduce NH3 emission and to improve crop yield. This study addresses an important question but I do have some concerns and I hope that my suggestions help to improve the manuscript.

The results presented on yields/NUE are not conclusive, which was attributed to the

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large variability between the two years and several harvests. I assume the authors analysed the effect of fertilizer on yields/NUE across the two sites and five fertilization events (here statistical analysis is not adequately described) and did not a find a significant difference compared to the unfertilized control. But when taking a closer look at the individual fertilization events/harvests, I can see that at the Upper Joiner Field in 2017 there was a strong difference between the control and fertilized plots for the first harvest. The fertilizer effect decreased with the second and third fertilization event though. At the other site in 2016, it seems that there was only a positive effect after the first fertilization event. At the Engineers site 2016 it is possible that it was a N-rich site (for whatever reason), which is supported by the fact that the yields were very high at those sites. In turn, at the Upper Joiner Field N may not have been sufficient to satisfy plant N demand in the first place, showing a positive fertilizer effect, but with repeated fertilizer additions N limitation of plants may have decreased. Considering this, I believe the manuscript could benefit from a different statistical analysis and not just considering the average across both sites and all harvest.

This also brings me to emphasize that in several places the description and results of statistical analyses, especially that of the effect of fertilizer type, are missing. Please see also my specific comments below.

The introduction focuses largely on the general, big problems of fertilizer application and the part, which should guide the reader, actually comes too short: What is expected from the different fertilizer types? What are the underlying mechanism? I understand that the urea fertilizer coated with urease inhibitor is meant to reduce NH3 emissions but I do not understand “the pollution swapping”, meaning that it should increase net N2O fluxes (L86-88 and L373-375). In general, the authors should elaborate on what is known specifically regarding the different fertilizer types (and not only mention that there have been some studies) and should explain why one would expect certain fertilizer effects on NH3 emission and net N2O fluxes in the introduction. And based on this, the authors need to formulate hypotheses.

The other crop quality measures, crude protein, ME, MAD and D value are barely mentioned. These variables also need to be explained: What do they mean in this context? Why did you choose them? I also suggest to explain the expected effect of fertilizer type on crop quality measures in the introduction. Presentation of statistical analyses of those variables is also missing.

One of the main message of this study is that the urea fertilizer coated with an urease inhibitor is the better choice in terms of N pollution because NH3 emission were strongly reduced compared to the urea fertilizer and N2O rates were lower compared to ammonium nitrate. However, NH3 emissions were only monitored over two weeks after each fertilization event, which I would assume could match the period when the urease inhibitor is effective. But what happens when the inhibitor becomes ineffective? Basically my question is: how long is such inhibitor effective in the soil and how does this compare to the duration of NH3 emission observation? How would the NH3 emission look like if it would have been monitored over a longer period than two weeks?

Specific comments

Fig. 3: Different order of fertilizers compared to the other tables and figures is confusing.

Fig. 4: Why is the median and not the mean plotted? Are there no error bars plotted or are they smaller than the symbols? One data point for ammonium in the urea treatment for the second fertilization event in 2016 looks like an outlier to me. If not then consider to use a break in the y-axis because the other data points are not readable due to the scaling. I suggest to use repeated measures ANOVA to analyse the effect of fertilizer type on extractable ammonium and nitrate concentrations.

L25: Delete “and” after ammonia (NH3).

L32: Delete “the” in “the urea”.

L33: Delete “The” in “The urea coated”

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L62: Comma missing before dC/dt.

L238: Delete one “over” and consider re-writing this sentences.

L273: How can you conclude here that meteorological conditions were affecting yields differently in both years?

L284: Data on ME, MAD and D value are not shown in Table 2 or anywhere else.

L327: How long were sheep grazing at the Upper Joiner Field in 2017? Were they also excluded from the plots one month before start of the experiment?

L334: On a log-normal scale? I do not understand this in this context.

L338 & 341: Nitrate does not decay. Describe it as a decrease in concentration over time.

L355-357: That’s speculation. Your experiment does not allow to conclude this.

L367-370: Here again: Description of statistical analysis is missing and no results of the statistical analysis are given.

L378-379: Here again: Description of statistical analysis is missing and no results of the statistical analysis are given.

L393-394: Re-write this sentence: “. . .fallen considerably in magnitude come harvest”?

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