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Comment on egusphere-2022-511

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Community comment on "Impact of contrasting fertilizer technologies on N dynamics from subsurface bands of "pure" or blended fertilizer applications" by Chelsea K. Janke and Michael J. Bell, EGUsphere, https://doi.org/10.5194/egusphere-2022-511-CC1, 2022

This manuscript presents a detailed experiment investigating the interactions between banding and the characteristics of different enhanced efficiency fertilisers including blends of controlled-release fertilisers and nitrification inhibitors on NH4 and NO3 outcomes. This is important as blends have received little research attention to date and the aspects of fertiliser placement have not often been studied in this detail – often they are just tested agronomically.

The experimental design is novel and described thoroughly and in great detail. The results include not only NH4 and NO3 observations within the fertosphere and in concentrical bands around it, but also urea, aqueous NH3 and supporting information on pH and EC to characterise the soil conditions within which nitrification occurs. In addition, the dynamics are observed in two contrasting soils.

The authors do a great job to untangle the effects of slow release and nitrification inhibition by both the changed soil conditions following urea hydrolysis and the nitrification inhibitor. The story is quite complex though – requiring the reader to study the figures in detail and stay focussed for quite some time. Below a few suggestions that may make that easier for the reader.

In addition, I suggest to not get drawn into a discussion of why reduced N losses may not always translate into improved NUE (section 3.5 and parts of section 3.4). Aside from a note how banded application can delay availability of N, that discussion is not really informed by the results you present. The system aspects have been better handled elsewhere with modelling tools to untangle the complex interactions. The side story on biodegradable CRF coatings may at first also seem a little bit of a distraction from the main aim of evaluating the blends. However, it is good to get these results out in the open so that people can start to build a picture of their behaviour.

- Section 3.1: Minor edits
  - Shorten some of the sentences to make them easier to read
  - 206: remind the reader that the fertosphere you refer to is the inner circle of the figures
- Section 3.2: Minor changes to figures, inclusion of S2 and some extra discussion

  - The nitrate concentrations are difficult to see on the same scale as NH4 in Fig 5 and

6. The absence of an x-axis line exacerbates this. While it helps to see the contrast in concentrations between NH4 and NO3, I think it is more important to be able to see at a glance the differences in NO3 in time, with distance, and among products. Including the x-axis will also help visually.
    - Have you tried if figure designs like those used in Fig 3 and 4 would make it easier to see differences between products (i.e. separate figures for NO3 and NH4)? Online version could maybe also be in colour?
    - Figure S2 is quite central to understanding the text in this section. Hence, it should be included in the paper, along with a brief explanation how NO3 production was calculated.
    - Is there a possibility that the results in S2 do not represent all NO3 production, e.g. due to losses? (PCU/POCU are still releasing urea at DAI60, whereas urea and urea-DMPP have released all. Yet, the concentrations of NH4 and NO3 are lower in urea and urea-DMPP?) On the other hand Fig 7 suggests that all N was 100% recovered in either the granules or as mineral N in soil solution. Is that correct, or was only the proportion in the granules measured and related to the initial amount?
- Section 3.4: This is a good place to compare the results of this study and what they may suggest with the findings of field experiments that include crops etc.
    - Can include here the text at the start of section 3
    - Please include a reference to the results on which basis you conclude that there appears to be little advantage in using CRF/DMPP-urea/blends on the higher soil of poor chemical buffering. Was it on the basis of Fig S2? If so, that figure should be included inside the paper. If the similar NO3N production is a net effect that cannot account for any N losses, is it then the right conclusion that there seems little advantage? Possible N losses not accounted for would be worth a discussion here.
    - Contrast with field experiments that obtained benefit on the soils that your work might suggest wouldn't see benefits is a good discussion point. It allows a useful warning that wider system perspectives may overrule the fine scale effects of the bands. However, suggest to not get drawn into an interpretation of the experimental results and the wider system effects.
    - l.300 – note that the inability of the crop to take up the N causing losses of N later in the season was not caused by the slow release. It related to N being surplus to crop uptake potential (either for a period or for the season as a whole). Increased losses seen in some experiments later in the season could also relate only to the pathways they measured. They could come about if the CRF protected the N from losses along other pathways earlier on. If the crop is unable to use the initially 'saved' N, this can lead to the later N losses. Losses late in the season when crop uptake is low are likely a consequence of excess N unless the wrong release pattern was used.
- Section 3.5: your results do not contribute new evidence or insights to this discussion, so this should not be part of this paper. Implications for short and long season crops would require a more thorough analysis.
- Section 3.6: this section includes some speculation – suggest shortening and not get too deep into potential theories without having back-up evidence for them. Brief statements of possible explanations should suffice.
    - Is the POCU coating designed to swell and release via diffusion through the coating, or is its slow release associated with gradual breakdown, fragmentation of the coating? Are you in a position (i.e. have evidence) to distinguish between the two and conclude that the higher release was due to osmotic induced bursts based on visual observations of retrieved granules?
    - Unless there are contact issues, water absorption would be determined by gradient in water potential – not the water content. The potential gradients should be similar for the two soils given they were both at field capacity and primarily driven by the high concentration of urea inside.
    - The comment on earlier crop-availability of the N from POCU compared with PCU requires that the early differences in N dynamics were statistically significant and that you indicate (with data on crop N uptake) which crops have such early N

demand that the differences would have an impact.

- You mention on a few occasions (including in the Introduction and Conclusion) a concern that N delivery from CRFs may be too slow for early crop N demand. Crop N stress could indeed occur if there was a mismatch between release pattern and N uptake pattern or if the gap between them was too short to allow transformation of the released form of N into a crop-available form. However, I have not seen any studies demonstrating this happening. My understanding is that the early N demands for most field crops appear to be small and easily met by starter N and/or stored soil mineral N. Often the peak N demand period may not start until 30 or more days after sowing/planting. By then many of the commercial CRF would have released 30-50% of their N. A generic statement [that time of release and time required for transformations into a crop-available form need to be taken into account for synchronisation with crop uptake] can be made and would make sense given some of the banding effects seen. However, if you want to express it as a concern (or as an advantage of POCU, l.352), this will need to be backed up through comparison with crop N uptake data.
- Conclusions: A few suggestions for consideration:
  - Focus on the findings from this paper only
  - The aim of the paper was to find out whether the blends provided a case of being more than the sum of its parts so this should be a focus of the conclusion section.
  - Note the issues mentioned above on early season crop N demand, late N losses (indicates excess N relative to crop potential), and osmotic pressure causing burst.

Other editorial comments and suggestions:

- 219 – causal instead of casual
- 195-200: leave until later in Discussion – discuss first the results and do not upfront discount them. (Note Bell et al 2021 seems missing from ref list)
- Many sentences are quite long. Some could be simplified (e.g., "are deployed in fertilizer products which" in l.34-35 could be removed without changing the meaning of the sentence). In other places sentences can be broken up.
- It would also be useful to break up some of the paragraphs (e.g., l.65 – 94)
- Abstract - check for implications from any of the above comments