



EGUsphere, referee comment RC1  
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## **Comment on egusphere-2022-511**

Anonymous Referee #1

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Referee 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, EGU Sphere, <https://doi.org/10.5194/egusphere-2022-511-RC1>, 2022

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The manuscript deals with important aspects of using Enhanced Efficiency Fertilizers – EEFs related to N-dynamics and N use efficiency, with focus on mixtures (blends) of urea with different EEFs, applied in sub-surface bands. The importance of such a research relates to: The Complex activity of N-dynamics associated with different EEFs (e.g., polymer coated urea-PCU, Plant-Oil coated Urea – POCU, Nitrification Inhibitors -NI with urea) under various chemo-physical conditions in different soils; Application modes; Efficiency of controlling N- release and dynamics; Agronomic cost effectiveness of different EEF technologies; And, environmental aspects related to NUE and to biodegradability of different EEF polymeric coatings (e.g., PCU vs. POCU). Better understating of the interactions between the various factors controlling N-dynamics and NUE can assist improved decision making related to: agronomic, environmental and cost effectiveness for better managing application of mixed EEFs in different soils.

The experiments are well conducted in a laboratory incubation system with 2 different soils under field capacity (FC) moisture. The results provided emphasize the differences induced in N-dynamics by the different urea sources and the two differing soils! And, provide insights to the options of using mixtures of urea with NI-urea and PCU and POCU, rather than using only PCU, which is the most expensive EEF and also based on non-biodegradable polymer coating.

Field capacity conditions (used in this work) may not cover potential changes in soil physical, chemical and biochemical conditions under crop grown field conditions, affected both by plant uptake and irrigation or rain events. This aspect is addressed in line 323, where the authors indicate that moisture dynamics may be an important factor challenging N- synchronization with crop demand. Possible examples for such events are shortly provided in section 3.4 where the authors mention that leaching due to heavy rainfall or extensive leaching may occur and affect the demand for technologies providing better control over N supply.

Considering the said above, I think that potential N losses due to gaseous emissions (ammonia, nitrous oxides, molecular N) are also an important factor to be mentioned/considered when investigating the improved approaches of using EEFs mixtures in different soils. Yet, surprisingly this option is not mentioned in the manuscript. It is indeed expected that band application may reduce part of the gaseous emissions; And yet, the increased pH levels after urea and NI-urea application (Figure 1) and the high initial ammonium levels (Figures 5 and 6) are expected to induce ammonia emissions (e.g. review of Pan et al. 2016, Agriculture, Ecosystems and Environment: 232:283-289). This indeed is more expected in the Ferrasol and can be intensified by NI applied with urea (e.g., Pan et al., 2016).

Since the manuscript does not provide an estimated or calculated mass-balance of the mineral-N applied in the different treatments, I tried to estimate it for the Urea and NI-Urea treatments. This was done on the basis of total nitrate-N produced after 60 DAI via Urea treatment in the Ferrasol (Figure S2) and the estimated values of nitrate-N and ammonium-N after 60 DAI roughly evaluated on the basis of Figure 5 (provides only rough estimates since the concentration range in the figure are very large : 0 to 3000 mg-N per kg soil!!!). Nitrate-N from Data in Fig. S2 is estimated in the range of 450+ mgN/pot! From Fig.5 the ammonium-N appears somewhat higher than the 450+ mgN/pot of nitrate-N. Yet, when considering that the total input of urea was 1350 mgN/pot a question is raised about the N balance: there seems to be unaccounted N in this treatment. A similar trend is observed for treatment of NI-urea after 60 DAI in the Ferrasol (Figs. S2 vs Fig.5). For treatments of PCU, POCC and 1:2 DMPP-urea:PCU in the same soil, both nitrate-N and ammonium-N appear to be higher (Apparently closer to the initial value of 1350 mgN/pot), but there is no N-balance estimation or calculation which indicates the levels of total mineral N in the soil after 60 days and its comparison to the initial N-input.

When comparing mineral-N for treatment DMPP-urea in the Ferrasol to that in the Vertisol: nitrate-N levels at 60 DAI appear close (450+/- mgN/pot), but ammonium-N appears to be significantly higher with the DMPP-urea compared to the urea treatment (Figure 5). This again, indicates that there is missing N in the urea treatment which should be shown and explained!

Considering such observations I think that the authors should provide a mineral N-balance calculation based on the measurements of N that they have done and accordingly try to evaluate in which treatments there might appear data of N losses, potentially, due to gaseous emissions. Under the experimental conditions (FC) ammonia has the potential to be the largest loss option and particularly in the Ferrasol. In Fig. S1, there is a clear reduction of nitrate-N in both tested soils without addition of fertilizers. This is particularly evident in the Vertisol where nitrate-N reduces from around 15 mgN/kg-soil to zero, thus indicating also potential losses due to denitrification under the experimental conditions!

Remarks for specific points in the text:

-Lines 285-287: " there appears to be little advantage in using a CRF, DMPP-urea or blends of the two (cf. urea), in soils of high permeability and poor chemical buffering" This

statement does not consider the potential gaseous losses (e.g. ammonia) which according to the above presented estimates indicate lower levels of missing mineral-N in the in EEF treatments (particularly with PCU, POCC and 1:2 DMPP-urea:PCU).

-Lines 330-332: " By 35 DAI, NH<sub>4</sub>-N concentrations in the 0 – 5 cm zone of the POCU band were slightly lower than that of PCU in the Vertisol, suggesting rapid nitrification of the NH<sub>4</sub>- N released earlier in the POCU treatment" Yet, this could also be a result of higher N-gaseous losses (e.g. ammonia or even potential denitrification when high levels of oxygen are consumed by the fast oxidation of nitrate to ammonium) which were not evaluated in the research.

-Lines 343-345: " The greater volumetric water content of the Vertisol at field capacity (cf. Ferralsol; Table 1) may have contributed to more rapid water uptake and hence more frequent rupturing of POCU granules, resulting in the initially higher urea-N and NH<sub>4</sub>-N concentrations in this soil (Figs. 4, 6)" This seems a bit problematic assumptions: Indeed the water content of the Vertisol at field capacity (FC) is higher, but the "water holding capacity" (water potential) at FC of the two soils is supposed to be close and this is the physical parameter which controls water uptake. Yet, since the POCU has a biodegradable coating, the microbial activity in the Vertisol (much heavier soil, with more organic C and N) may be higher and thus affect the stability and degradation of the POCU coating.

Lines 371-374: " The plant-oil coated urea product that was evaluated initially released more N due to a higher prevalence of 'burst' granules, which was likely an outcome of somewhat poorer tolerance of increased osmotic pressure within granules (cf. PCU). However, overall dynamics and proportions of N in mineral forms (NH<sub>4</sub> + and NO<sub>3</sub> - ) were similar to that of PCU, suggesting this technology may be a suitable option for managing the competing requirements....."

The conclusion is indeed right! And yet there were some differences between the POCU and PCU in terms of higher pH increases with POCU (Fig.1) particularly in the shorter time of 10 DAI which could affect ammonia losses (and possibly affect microbial activities). In Fig.3 much higher values of aqueous ammonia concentration were obtained with the POCU in the short range in the Vertisol which may also indicate potential of higher losses of gaseous ammonia. Such options were not considered/estimated in this work, and no N-balance was performed which could allow estimating N gaseous losses in the different treatments.

Remarks to figures:

Figure 4: Urea treatment is, expectedly, not presented in this figure, but it is introduced below with a circular dark symbol.

Figure 5: The maximal concentration levels in the figure are around 1000 mgN/kg soil, but the scale is 3000. It is recommended to use a lower scale for this soil, which will better enable estimating the trend and changes.

Figure 7: It presents the percentage of total recovered N in the soil and in the coated granules. Yet, it is not indicated on which basis are the data provided! Are they based on the total initial N input of 1350 mgN/pot. If that is the case, the data indicate 100% recovery of the initial N input!! Yet the figure is presented without any statistical analysis/information. Once there will be an estimated/calculated N-balance it is worse to provide clear information about the meaning of total recovered N and the way it is estimated at the end of the experiment.