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MECHANOCHEMICAL SYNTHESIS OF UREA: SALICYLIC ACID COCRYSTAL AS A SUSTAINED RELEASED NITROGEN SOURCE

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Global agriculture and food and nutrition security are challenged by the premature decomposition of urea in the soil before plant uptake. Crystal engineering is a solution to reduce the nitrogen (N) loss from urea due to its high-water solubility. Thus, cocrystals of urea have recently gained interest as synthetic N fertilizers to reduce solubility barriers and release kinetics of urea. In this study, urea cocrystals with salicylic acid as the coformer was prepared using mechanochemistry *via* neat grinding and liquid-assisted grinding in both 1:1 and 2:1 stoichiometric ratio and subjected to solid state characterization techniques, including Powder X-ray diffraction (PXRD), Fourier transform Infrared spectroscopy (FTIR), and Thermogravimetric analysis (TGA). The results confirmed the formation of already reported 1:1 cocrystal while suggesting a possible new form of 2:1 urea: salicylic acid (U: SA) cocrystal. Results of the TGA confirmed the anhydrous and guest-free nature of cocrystals. PXRD patterns revealed the presence of a new crystalline phase which is different from a physical mixture of starting compounds. Shifting of peaks in FTIR spectra validated the formation of intermolecular amide–acid interactions in the cocrystal crystal structure. The release study was carried out using the reported 1:1 cocrystal system in soil (pH=5.9), and it took 10 days to elute around 85% of urea compared to commercial urea (8 days) confirming that U: SA cocrystal is a potential candidate for sustained-release nitrogen fertilizer. Reduced urea leaching in soil resulting from mechanochemical cocrystallization of urea with SA can be thereby indicated as a viable strategy towards improving N uptake in an efficient, eco-friendly, and less toxic method.

Keywords: Cocrystals, Mechanochemistry, Nitrogen loss, Sustained-release nitrogen fertilizers, Urea leaching