

USABILITY OF NUTRIENTS RECOVERED FROM WASTEWATER FOR SOILLESS CULTIVATION

Anna Hendrike Hofmann^{1*}, Sica Louise Liesegang², Volkmar Keuter¹, Victor Takazi Katayama¹

¹Fraunhofer Institute for Environmental, Safety, and Energy Technology UMSICHT, Osterfelder Strasse 3, 46047 Oberhausen, Germany

²Institute of Water Infrastructure Resources, Technical University Kaiserslautern, Kaiserslautern, Germany

Phone* +49 208 8598-1651, E-mail* anna.hofmann@umsicht.fraunhofer.de, www.umsicht.fraunhofer.de

ISSUE

Great efforts have been made to develop technologies for recovering nutrients from wastewater treatment plants (WWTP). The majority of studies, however, has aimed to produce products for use in soil-based agriculture, which often do not satisfy the requirements of soilless cultivation systems, such as hydroponics.

OBJECTIVE

- Assessment of nutrients recovered on a pilot or large-scale from municipal wastewater for hydroponic usage.
- Make suggestions for alternative recovery approaches based on a WWTP nutrient balance to improve the recovery rate of hydroponic fertilizers.

REQUIREMENTS OF NUTRIENT SOLUTIONS

In hydroponics plants are supplied with water and nutrients via a nutrient solution, that is precisely prepared according to specified crop-related recipes by the following criteria:

- Full supply of macronutrients (N, P, K, S, Ca, Mg, Na) and micronutrients (Fe, Zn, Mn, Cu, B, Mo) in specific ratios,
- Usage of high soluble and plant-available nutrients,
- High level of purity.

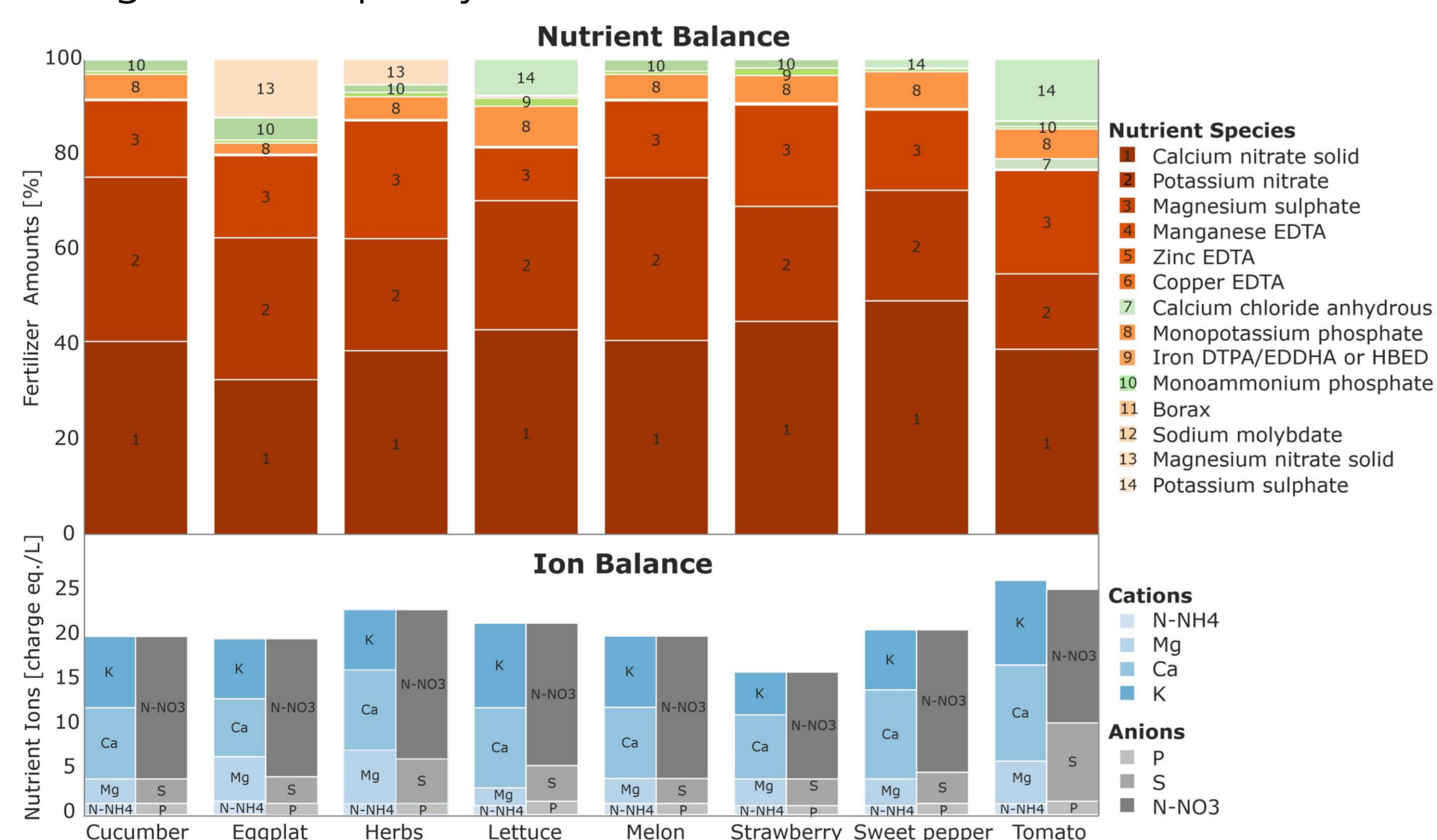


Fig. 1: Fertilizer amounts and ion balance of nutrient solutions for crops cultivated in soilless systems²

Initial data obtained from:

¹ Resh, H. M. (2016): Hydroponic Food Production. A Definitive Guidebook for the Advanced Home Gardener and the Commercial Hydroponic Grower, Seventh Edition. 7th ed. Baton Rouge: CRC Press.

² van der Lugt, G. (2016): Nutrient solutions for greenhouse crops. Published by Yara

³ Keuter, V.; Deck, S.; Giesenkamp, H.; Gonglach, D.; Katayama, V. T.; Liesegang, S. et al. (2021): Significance and Vision of Nutrient Recovery for Sustainable City Food Systems in Germany by 2050. In: Sustainability 13 (19), S. 10772. DOI: 10.3390/su131910772.

PRODUCT ASSESSMENT

It was found that less than one-third of hydroponic fertilizers* can currently be recovered. Recovery of appropriate potassium and nitrate fertilizers, which account for more than 60 % of the total nutrient amount used in soilless cultivation, remains limited (Fig. 2).

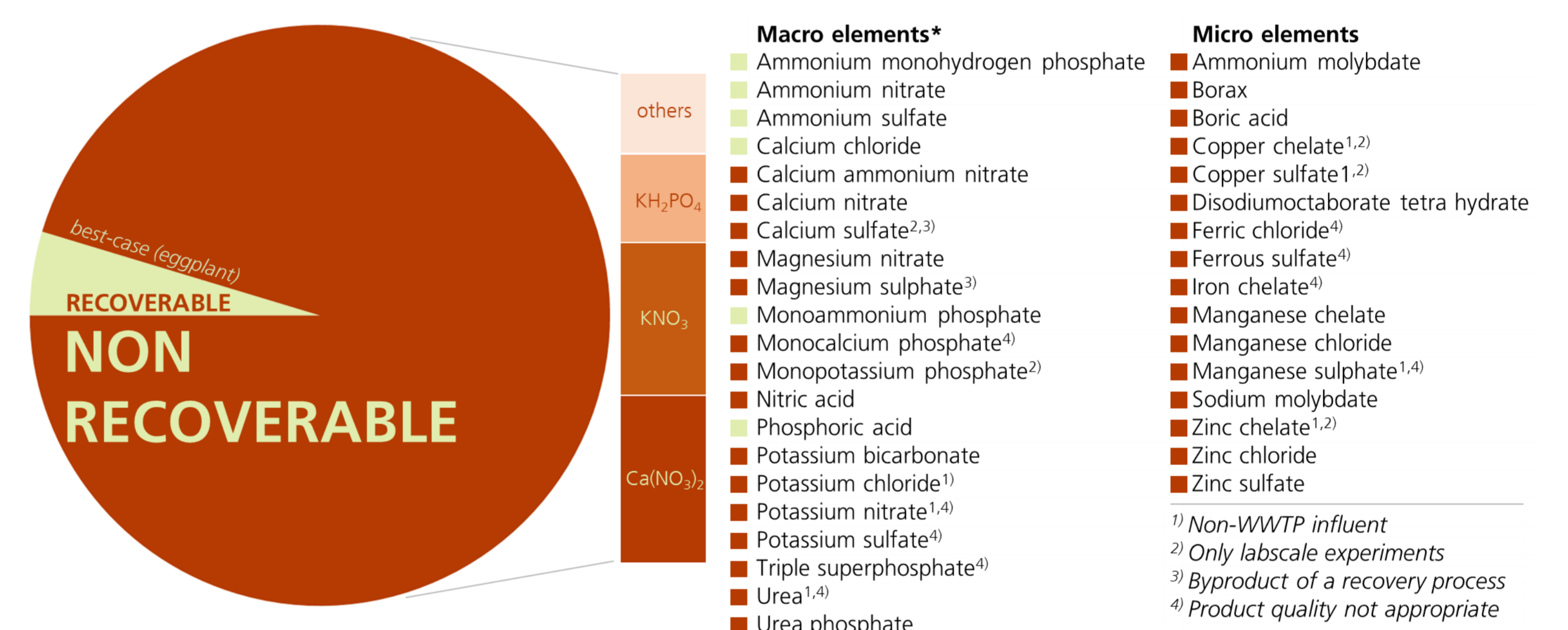


Fig. 2: Recoverability of fertilizers commonly used in hydroponics^{1,2}

OTHER RECOVERY APPROACHES

Because most of the non-recoverable nutrients are highly soluble, extraction in liquid form as a multi-nutrient fertilizer by membrane processes is likely to be an interesting option for both technological and energetic reasons. For this purpose, however, nutrient ratios in the feedstock should be as close as possible to the requirements. Based on these considerations, sludge liquor is one promising feed. To maximize recovery, however, the pretreated main stream should be used, which necessitates a rethinking of current WWTPs (Fig. 3).

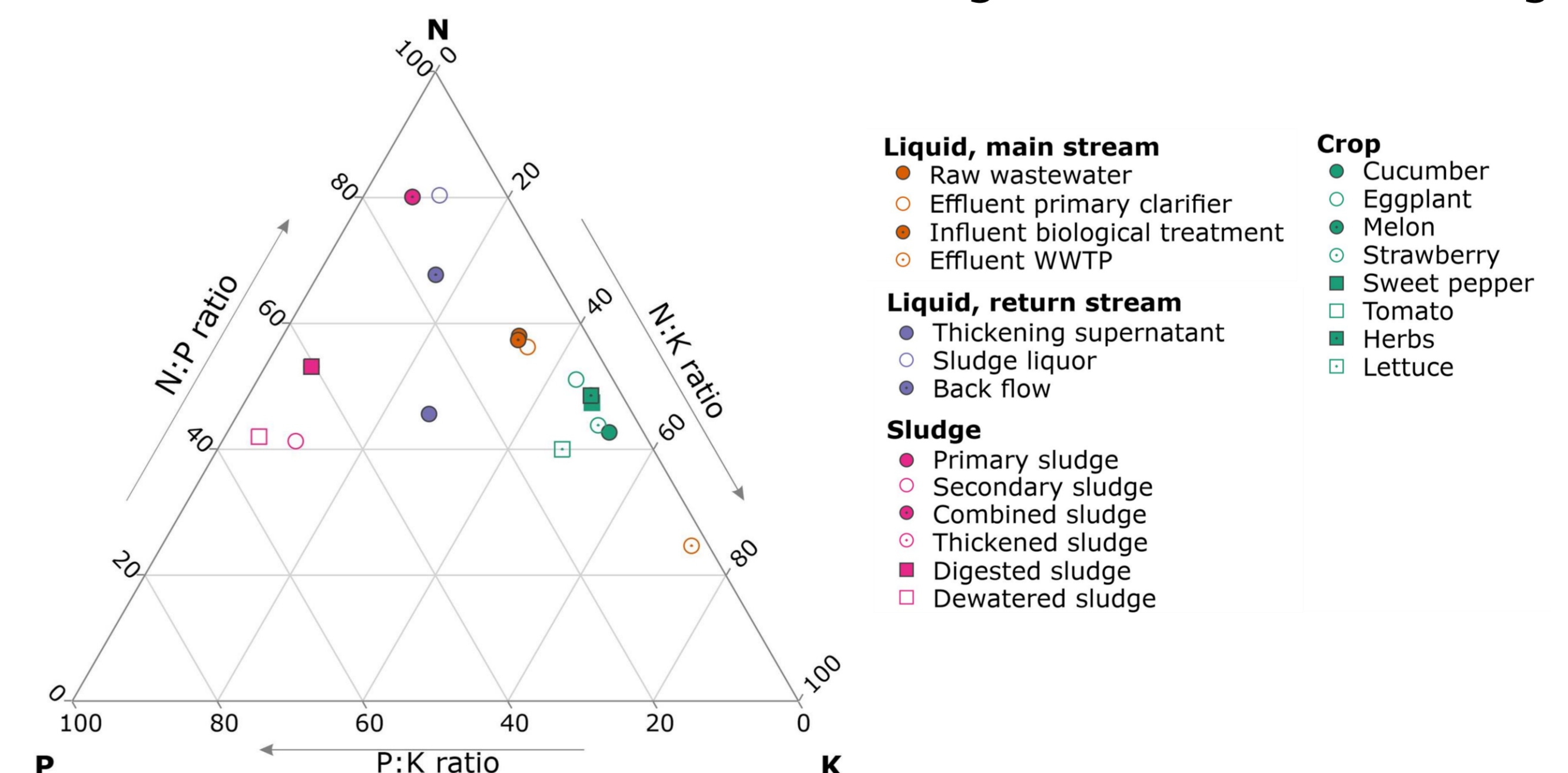


Fig. 3: Nutrient-Ratios (NPK) in wastewater and nutrient solutions^{2,3}

CONCLUSION

Hence, additional research into the recovery of main nutrient compounds as liquids from wastewater, including plant trials, is critical. Not only to improve the recovery rate of hydroponic fertilizers, but also to meet the market's increasing fertilizer demand. This can support WWTPs gradually transition from disposal facilities to resource providers.