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Mixtures of crop residue soil amendments provide non-additive benefits in arable cropping soil

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Crop residues are a valuable resource in terms of the calories, carbon and other nutrients they contain, but decomposition of residue amendments does not always translate into improved soil structure, nutrient availability, and fertility. Previous studies in forest systems have demonstrated enhanced decomposition rates of residue mixtures in relation to C/N ratios, possibly due to the release of nutrients from high-quality residues (low C/N ratio) enhancing the decomposition of low-quality residues (high C/N ratio) [1,2]. Applying this mechanism to arable cropping soils, mixtures of crop residue amendments could affect a range of beneficial soil properties such as nutrient availability, soil organic matter levels, and aggregate stability.

In this experiment low-quality cereal straw and woodchips were mixed with high-quality vegetable waste compost to test if non-additive benefits could be obtained from the mixture (i.e. mixture > sum of the parts). A field plot was set up on a fenland roddon (localised area of more mineral soil with lower crop yield) at a farm near Ely in Cambridgeshire, UK, an area of the country that is used for intensive horticultural production. Residues were applied before lettuce planting in a full-factorial experimental design. Properties indicative of soil structure and nutrient cycling were used to assess benefits from residue mixtures compared to single residues, including lettuce crop yield, soil respiration, soil aggregate stability and bulk density, soil C, available and mineralisable N, and available P, K and Mg.

Significant non-additive benefits were observed in soil organic matter and mineral nitrogen levels for the straw-compost mixture compared to straw and compost applied as individual residues. Addition of compost significantly increased soil available N, K and Mg levels ($P = 0.065$; 0.001; 0.008, respectively), which may suggest that higher nutrient availability improved the ability of decomposer organisms to degrade straw in the straw-compost mixture, resulting in enhanced levels of soil organic matter. Furthermore, bulk density tended to be lowered by the addition of the low-quality residues (woodchip and straw; $P = 0.062$), especially when combined with compost.

This study demonstrates that mixtures of crop residues can improve soil non-additively, beyond what would be expected from combinations of individual crop residue amendments. Thus, greater benefits can be achieved by removing, mixing, and re-applying crop residues, than by simply returning them to the soils in situ.

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