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

Marjke Struijk | Simon Mortimer | Andrew P. Whitmore (Rothamsted Research) | Tom Sizmur

**Introduction**

Crop residues are valuable resources produced in arable cropping systems in terms of the calories, carbon and other nutrients they contain, but in situ decomposition of residue amendments does not always lead to improved soil structure, nutrient availability, or fertility. Previous studies in forest and grassland systems have demonstrated enhanced decomposition rates with chemically heterogeneous litter mixtures (i.e. a blend of high- and low-quality litters), attributed to (a) a transfer of nutrients between different litters; (b) litter compounds directly affecting decomposer community; or (c) more diverse microbial conditions. This study aims to identify if these mechanisms could be exploited to obtain greater benefits from crop residues as soil amendments in an arable cropping soil. Higher decomposition is hypothesised if mixtures rather than individual soil amendments are used, such that (H1) N is temporarily locked up as labile N is decomposed (Box 1); and (H2) more SOM is added to the soil.

**Experimental set-up**

**Field site**

Individual and mixtures of soil amendments (wheat straw, woodchips and vegetable waste compost) were incorporated into 6 m x 2 m plots in a full factorial randomised block design before planting with a crop of gem lettuce (Table 1).

**Assessment of benefits**

- Effects of organic amendments on soil properties indicative of soil structure and nutrient cycling:
  - Lettuce crop yield, soil respiration, soil aggregate stability, bulk density, soil C, available and potentially mineralisable N, and available P, K and Mg.
  - Calculation of non-additive effects:
    - Synergism = mix > sum of parts
    - Antagonism = mix < sum of parts

**Table 1.** Experimental design with four factors and six treatments, n=4 (CN)

<table>
<thead>
<tr>
<th>RESIDUE</th>
<th>COMPOST</th>
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<tbody>
<tr>
<td>Straw</td>
<td>Woodchip</td>
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<tr>
<td>Straw</td>
<td>Woodchip</td>
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<tr>
<td>Straw (41)%</td>
<td>Woodchip &amp; compost (41)%</td>
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<tr>
<th>% additive effect</th>
<th>Available N</th>
<th>Potentially mineralisable N</th>
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<tbody>
<tr>
<td>% non-additive effect</td>
<td>Soil N (mg kg dry soil)</td>
<td>Biomass produced (g dry weight)</td>
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**Results**

**Synergies**

- Significant non-additive increases in SOM and mineral N (resp. p = 0.028; 0.032) from straw-compost mix (Fig. 1).
- Mostly similar trends from both amendment mixes, but none are significant. Probably due to slower decomposition and release of nutrients of woodchip-compost mix (Fig. 1).

**Soil nutrients**

- Compost in mix or individually increased soil mineral N and K and Mg levels (resp. p = 0.005; 0.001; 0.008) (Figs. 2, 3).

**Soil physical properties and crop yield**

- Bulk density seems lower when low-quality residues were incorporated in the soil amendment (p = 0.062) (Fig. 4).
- No observable impact on aggregate stability or yield, which is not surprising considering the duration of the experiment (44 days) (Figs. 4, 5).

**Box 1: decomposition and soil C and N dynamics**

**Theory**

Initial N demand is high when labile C is mineralised → temporary lockup of available N → decrease in microbial N demand as more recalcitrant C is decomposed → return of mineral N to the soil.

This experiment: Synergies from straw-compost mixture (N and SOM) + N levels from straw-compost mix exceeding control treatment → suggests that labile C in the mix was decomposed and assimilated in the SOM fraction.

**Conclusions**

- N lockup not observed in mixtures (H2); non-additive SOM increase seen for the straw-compost mixture only (H1).
- Mixing crop residues can improve soil non-additively.
- Greater benefits could be obtained from crop residue amendments by removing, mixing and re-applying by simply returning them to the soils in situ.

**References**


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**Contact information**

- Department of Geography and Environmental Science, University of Reading, Whiteknights, RG6 6AY, Reading, United Kingdom.
- Email: marjke.struijk@reading.ac.uk