Climate change impact on crop productivity: legacy effect through plant-soil feedback

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Plant-soil feedbacks play a central role in nutrient cycling. Changes in crop productivity, resource allocation and nutrient uptake can impact soil nutrient availability in both the short- and long-term, through changes in organic matter input into the soil. Projected changes in atmospheric concentrations of CO2 and temperature have been shown to impact crop productivity. However, the short-term nature of most studies makes it difficult to assess the full extent of altered climate on crop productivity through plant-soil feedback, thus potentially limiting our ability to predict the long-term implications of these changes. Here, we examined the main and interactive effects of elevated CO2 (CE) and temperature (TE) on cotton productivity in a controlled environment over two seasons to assess whether crop response was affected by the legacy of these treatments through plant-soil feedback, or remained consistent. A positive effect of TE on cotton yield was consistent between both seasons. However, we found a large difference in yield response to CE at ambient temperature (TA) between the seasons, with a significant yield reduction in the second season. Crop and soil nutrient analyses revealed reductions in leaf nitrogen contents and soil nitrogen availability under CETA, while belowground carbon allocation (e.g. root biomass, root and soil C contents), soil respiration and microbial biomass were significantly increased by CE, suggesting that the reduction in soil N availability may be caused by increased microbial immobilisation of soil nitrogen. These results indicate that the positive effect of CE on crop productivity may be dampened by negative plant-soil feedbacks that reduce nitrogen availability in long-term. Further research is needed to identify the underlying mechanism that drives such feedback effects to develop effective adaptation strategies to ensure sustainable agricultural production in future climates.