

# Tillage Systems Influence Weed Seedbank Dynamics in Organic Vegetables

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## INTRODUCTION

- Weed seedbanks drive future weed pressure and long-term management challenges in organic vegetable systems.
- Organic vegetable production relies heavily on tillage due to limited herbicide options and high labor costs.
- Conservation tillage and cover crops can suppress aboveground weeds but may alter weed seedbank density and community composition.
- Understanding how tillage systems influence weed seedbanks is important for integrated weed management (IWM) in organic vegetable production.

### Hypothesis

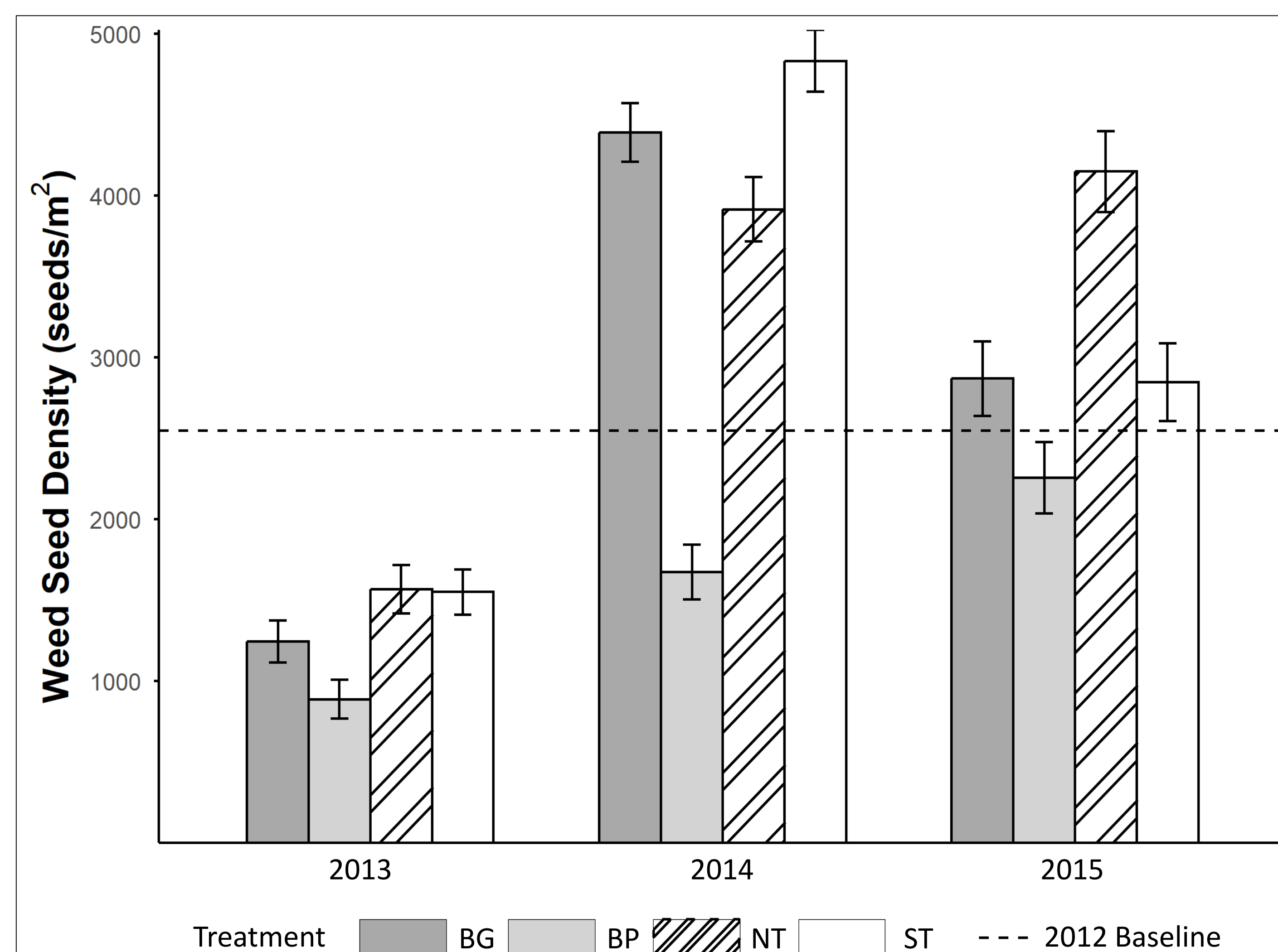
- Conservation tillage treatments will have higher weed seedbank densities than conventional tillage treatments due to reduced soil disturbance.

## OBJECTIVES

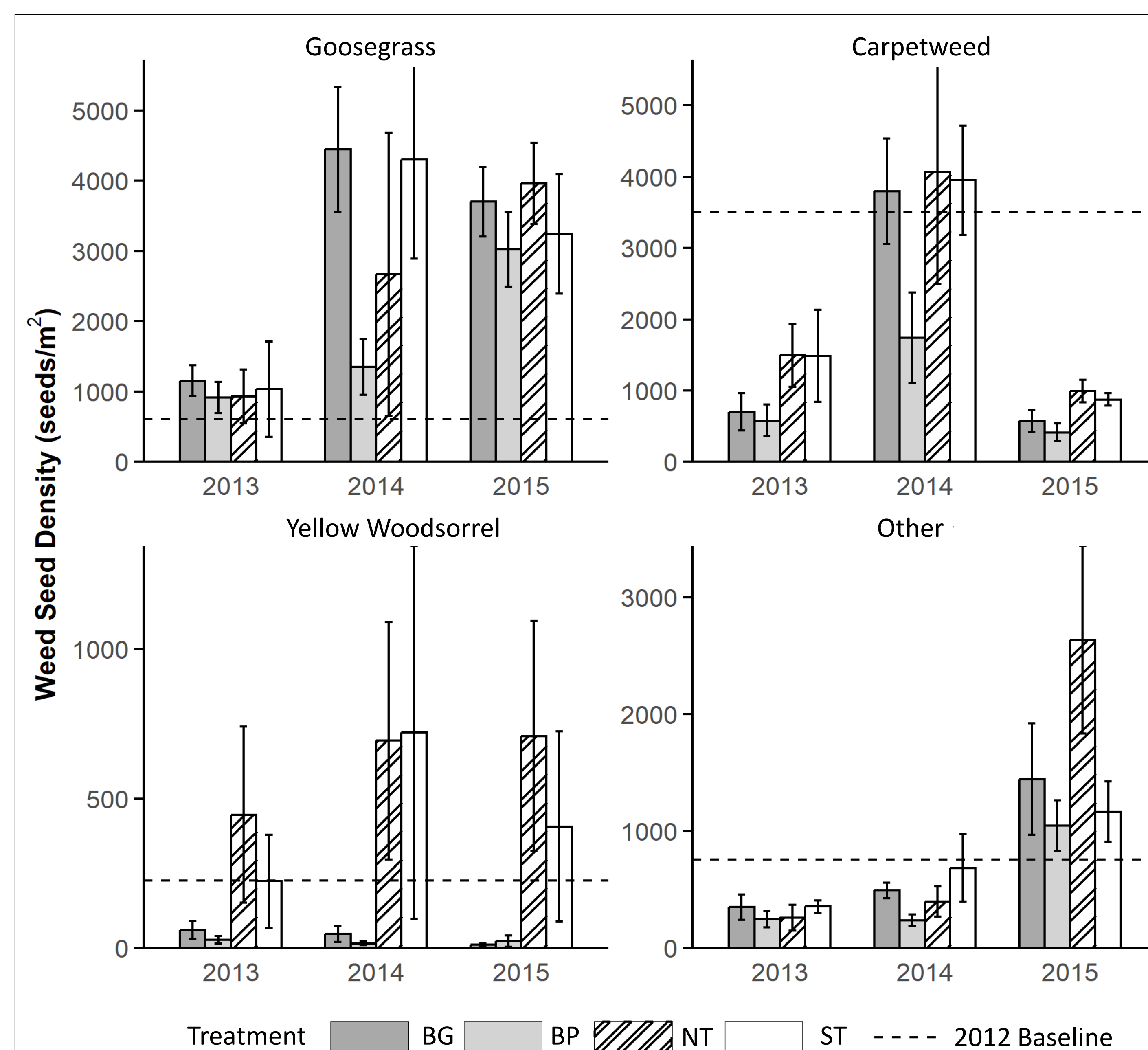
- Evaluate the influence of tillage on the germinable weed seedbank density and composition.
- Assess temporal changes in the weed seedbank community structure over multiple years during a transition to organic production.

## METHODS

- The study was conducted at the Central Maryland Research and Education Center on a field transitioning into organic production, using a randomized complete block design with four treatments and four replications.
- Treatments included four tillage systems used with winter cover crops: no-till (NT), strip-till (ST), bare ground (BG), and black plastic mulch (BP).
- BG was conventional tillage without surface mulch, whereas BP was conventional tillage with black plastic mulch.
- Tillage treatments were maintained in the same plots each year to evaluate cumulative effects over time.
- A winter cover crop mixture of tillage radish, crimson clover, and cereal rye was established each fall and flail-mowed in spring before tillage or planting, depending on treatment.
- Weed seedbank samples were collected annually in late April or early May using 0–10 cm soil cores and quantified with the greenhouse tray emergence method.
- Seedbank density was analyzed using ANOVA and generalized linear mixed models, and community composition was evaluated using NMDS based on Bray–Curtis dissimilarity.



**Figure 1.** Mean weed seedbank density (seeds  $m^{-2} \pm SE$ ) by tillage treatment from 2013–2015. The dashed horizontal line represents the pre-treatment baseline mean measured in 2012.



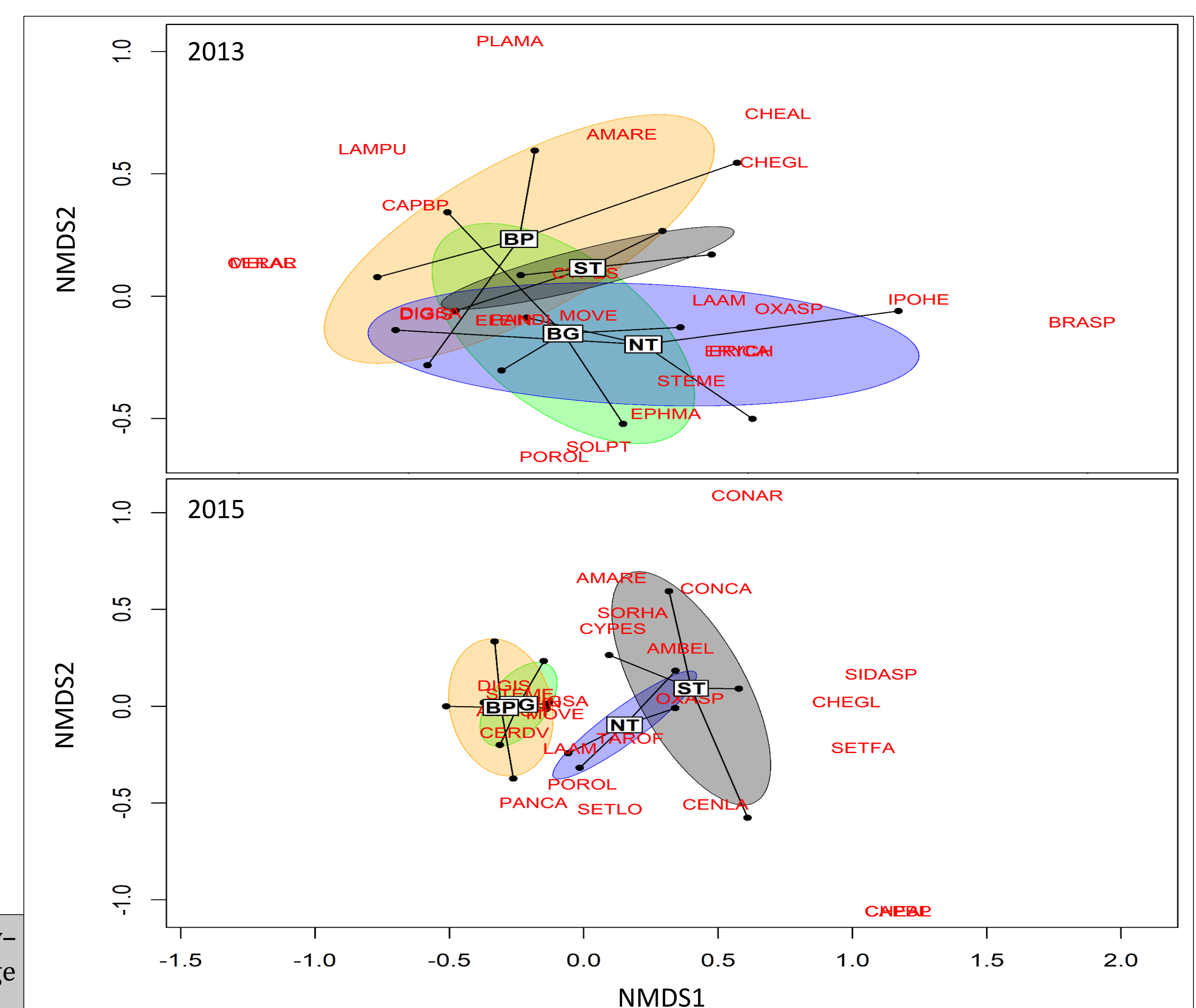
**Figure 2.** Mean seedbank densities (seeds  $m^{-2} \pm SE$ ) of goosegrass, carpetweed, yellow woodsorrel, and other (pooled less abundant weed species) across tillage treatments from 2013 to 2015. The dashed horizontal line indicates the pre-treatment baseline mean measured in 2012.

## RESULTS

- Weed seedbank density differed by tillage treatment and year, with NT and ST maintaining higher densities and BP consistently having the lowest density from 2013–2015 (Fig. 1).
- Four species accounted for >88% of the germinable seedbank across treatments: carpetweed, goosegrass, yellow woodsorrel, fall panicum.
- Species responses varied by tillage treatment, with carpetweed more abundant in conservation tillage and goosegrass and fall panicum more prevalent in conventional tillage (Fig. 2).
- NMDS showed little treatment separation in 2013, but clear divergence in community composition by 2015, with conservation tillage (NT, ST) separating from conventional tillage (BG, BP) (Fig. 3).

## MANAGEMENT IMPLICATIONS

- Conservation tillage treatments (NT & ST) averaged 45% greater seedbank density than conventional treatments, indicating that additional weed suppression tactics may be needed when disturbance is reduced.
- The black plastic mulch treatment consistently had the smallest seedbanks, indicating that physical barriers can limit seedbank replenishment over time.
- Tillage intensity can influence which weeds become dominant, so tillage decisions should account for potential shifts in weed pressure.
- Weed communities became more distinct over time, indicating that tillage effects on the seedbank may require several seasons to fully develop.



**Figure 3.** Weed seedbank community composition in 2013 and 2015 shown by NMDS based on Bray–Curtis dissimilarity. Points represent plots, white squares indicate treatment centroids for four tillage treatments (BG, BP, NT, ST), and ellipses show 95% confidence intervals.