Functional Structure of the Seedbank Shows Weed Trait Gradients in Glyphosate-resistant Cropping Systems in the U.S.

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INTRODUCTION

Soil seedbanks have been recognized as one of the crucial components of agricultural ecosystems. However, studies on the shift in structure and biodiversity of soil seedbanks in herbicide-resistant cropping systems are limited, and a functional trait perspective of the soil seedbank is often overlooked

HYPOTHESIS AND OBJECTIVE

- We developed two hypotheses:
  (1) weed seedbank composition was determined by GR cropping system management and geographic region over time
  (2) applying a rotational GR cropping system would increase functional diversity
- Investigate the results of a six-year multi-field experiment and use functional properties of species in the seedbank to quantify the overall structure of traits which affect weed survival

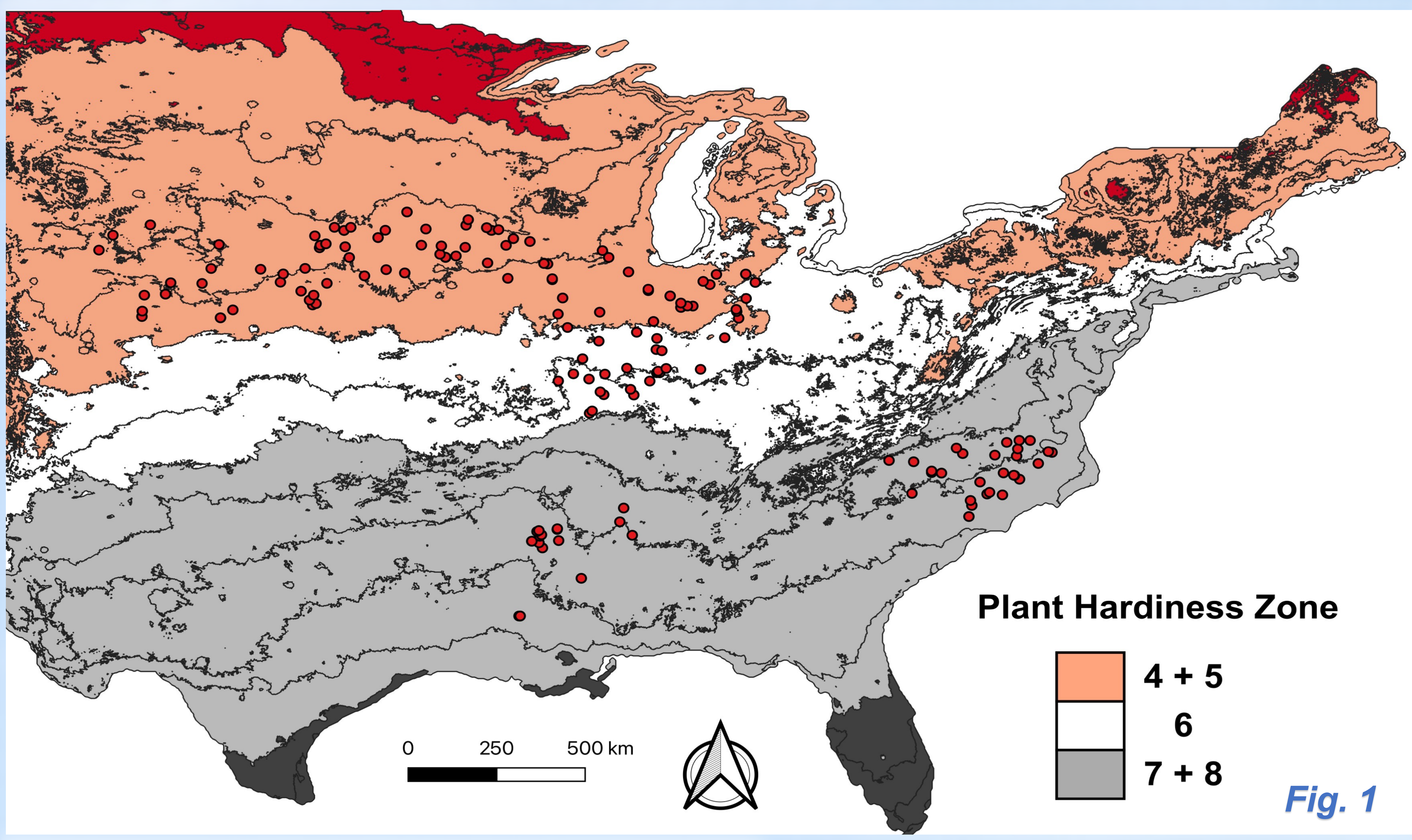
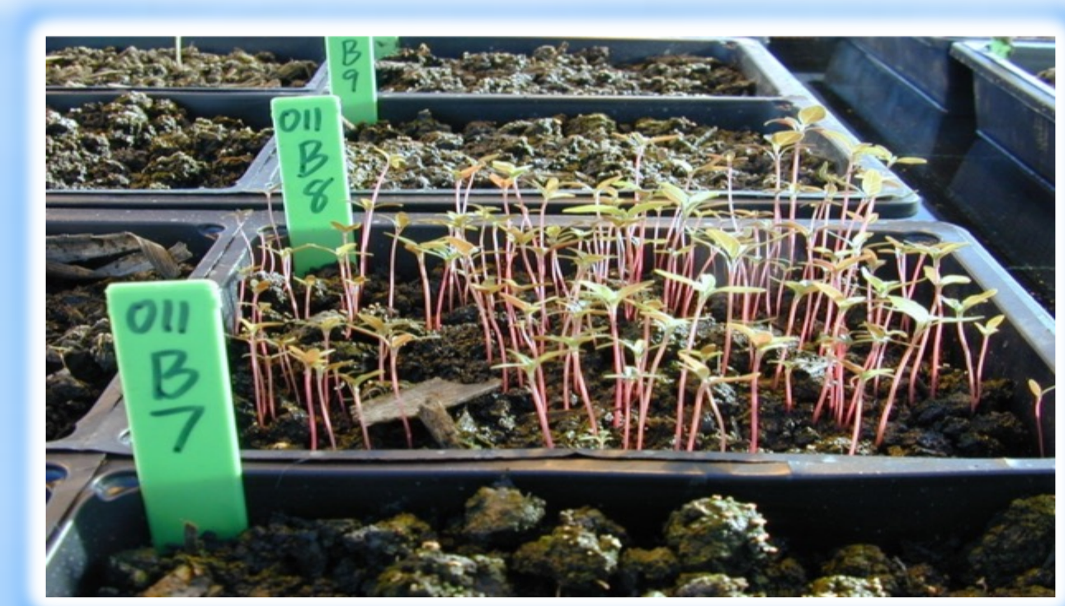


Fig. 1

MATERIALS AND METHODS

- Study sites (*Fig. 1*): Illinois (n = 27), Indiana (n = 25), Iowa (n = 30), Mississippi (n = 18), Nebraska (n = 28), and North Carolina (n = 28)
- Sites had a minimum 3-year agronomic history of the following cropping systems:
  (i) a single continuous glyphosate-resistant (GR) crop,
  (ii) a rotation of two GR crops,
  (iii) a GR crop rotated with a non-GR crop
- Functional traits were retrieved for each weed species recorded in the seedbank such as seed mass (SM)
- To compare differences in community composition between geographic regions in GR soybean cropping systems, non-metric multidimensional scaling (NMDS) ordinations from the sites were applied with BMP weed management strategies
- To assess the effects of hardiness zone, cropping system, and year, functional diversity pattern of the soil seedbank was examined with Linear Mixed Models (LMMs)



RESULTS

I. Multivariate analysis (NMDS)

A. Geography (latitude and longitude) were significant vectors (*Fig. 2a*)

B. Small-seeded forbs were most likely to be found in hardiness zone 8, including henbit (*Lamium amplexicaule* L., LAMAM), common purslane (*Portulaca oleracea* L., POROL), carpetweed (*Mollugo verticillata* L., MOLVE), and prickly sida (*Sida spinosa* L., SIDSP) (*Fig. 2b*)

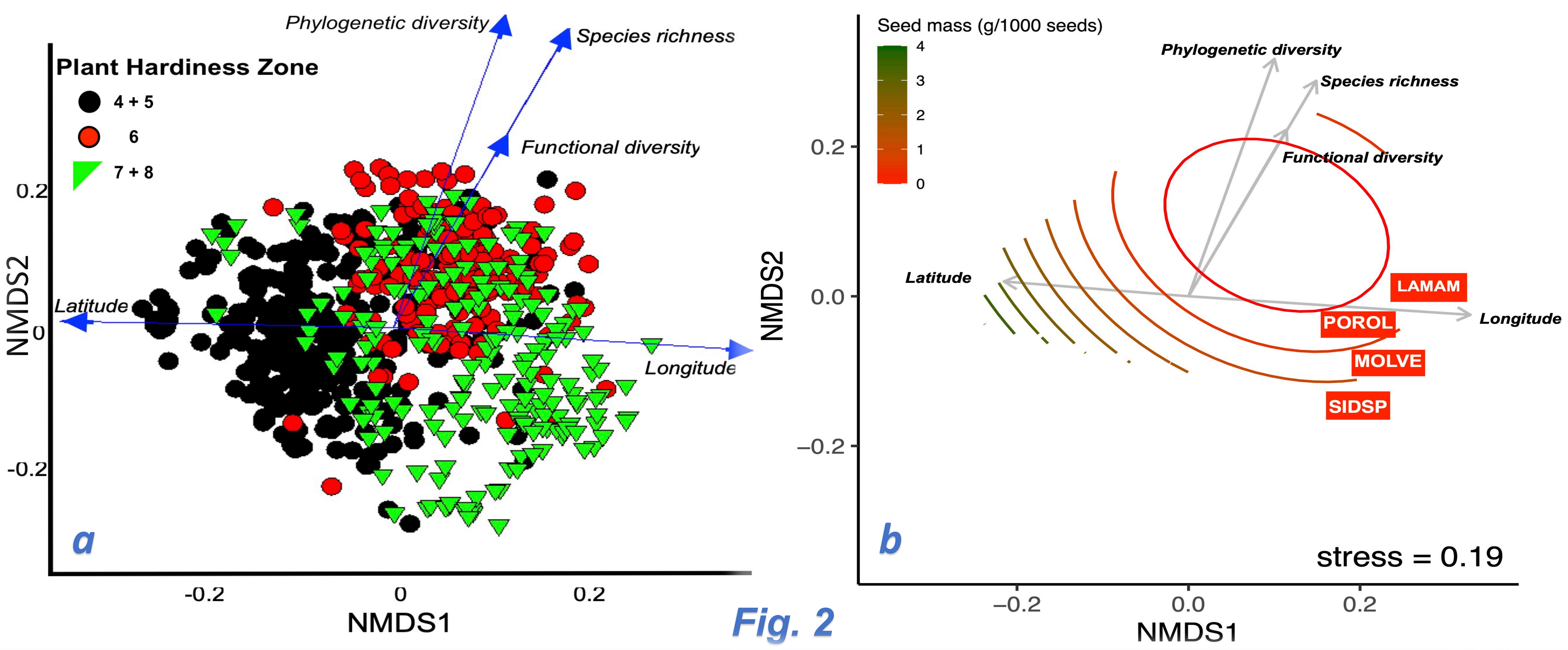


Fig. 2

II. Univariate analysis (LMMs)

A. There was a hardiness zone × year interaction effect ($F_{10,1488.1}$=2.51, $p < 0.001$, *Fig. 3*) mainly resulting from the geographical differences between high latitudinal regions (Zone = 4 + 5 + 6) and low latitudinal regions (Zone 7 + 8)

B. Seedbank functional diversity (FDsesmpd) was unaffected by cropping system treatment ($F_{2,1488.1}$=1.63, $p > 0.05$)

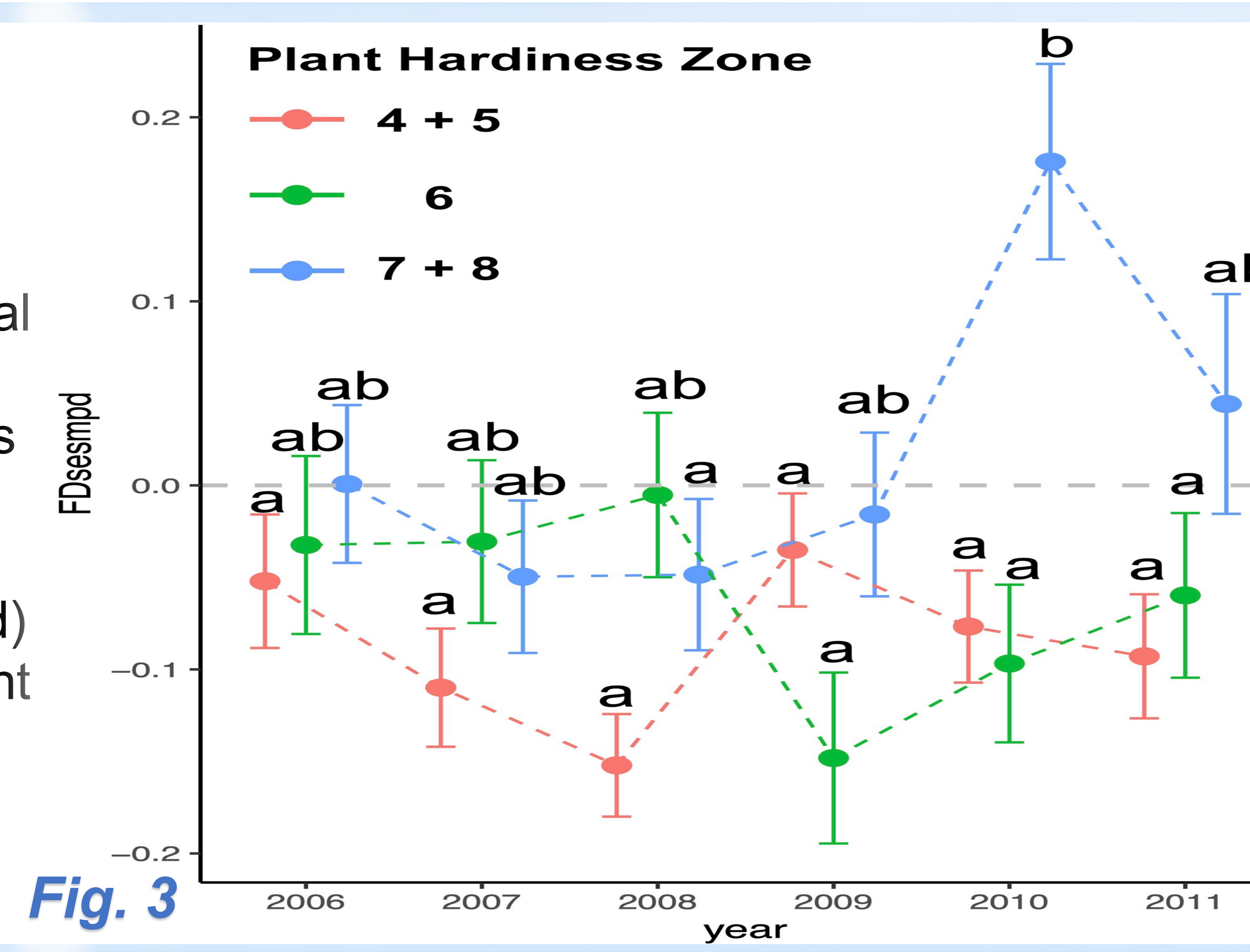


Fig. 3

DISCUSSION

- Functional composition of the weed seedbank was spatially associated with geographic factors
- The functional diversity values fell closely around the reference line at zero, indicating that cropping system may not be a seedbank assembly driver influencing belowground biodiversity

IMPLICATIONS

- Utilize functional plant attributes to develop appropriate agricultural management strategies
- Cultural practices (e.g., selection of competitive cultivars, seeding rate acceleration, and row spacing regulation) favor the weed suppression capacity of the crop by affecting the canopy architectural traits, such as specific leaf area, canopy density, and plant maximum height

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