Diversity of plants had little impact on parasitoid control of soybean aphid. To test the effect of biodiversity on biological control of soybean aphid, we used 3 year-old prairie plots within soybean fields. We compared soybean aphid density and parasitoid abundance adjacent to prairie plots and open soybean fields by 2 parasitoid species – Aphelinus glycines and A. certus. Both of these species are Asian in origin, but A. certus has ‘migrated’ on its own and A. glycines is being purposely released for establishment against the soybean aphid. In 2015 we released 120,000 A. glycines across 8 field sites and had excellent recapture of this parasitoid up to 22 mummies per plant after 2 to 4 generations (46 days). For plant soybean aphid densities were higher adjacent to prairie plots on the third sampling date (Fig 1a) while densities of both parasitoid species were not significantly affected by the presence of adjacent prairies (Fig. 1c). This, provision of prairies adjacent to soybean fields did not improve biological control of soybean aphid in our study. In addition, we discovered a hyperparasitism of the Aphelinus spp. at our site (a hyperparasitoid is a parasitoid of other parasitoid species) (Fig. 1b). The levels of hyperparasitism (and parasitoids) were so low however, that it is not likely that higher hyperparasitism near prairies is responsible for the overall higher aphid densities adjacent to prairies. A. glycines has not established in North America despite mass releases in 2013 through 2017.

Sustainable biological control of the soybean aphid: Effects of plant diversity, management practices, and overwintering on Aphelinus parasitoids in North America.

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Regional maps show soybean aphids tend toward the north, and are tracked well by parasitoids. Regional surveys for soybean aphids and Aphelinus certus mummies rely on colleagues across the 12 state Midwest region. Three surveys over the summer of 2017 showed the aphids were found first in the northern tier of states, which also had the greatest aphid numbers as well as the highest density of Aphelinus. The darkest green indicates aphid densities above the spraying threshold of 250 aphids per plant.

Parasitoids control early season soybean aphids similar to neonicotinoid seed treatments. Neonicotinoid seed treatments are almost ubiquitous in conventional soybean fields, despite the academic and regulatory advice that they are 1. unneeded and 2. not targeted against the greatest pest, soybean aphid, which usually affects soybean after the neonicotinoid timelines are gone from the plants. However, the early season colonization of soybean by aphids and aphid parasitoids might be reduced by neonicotinoids, limiting biological control and thereby measurable impact of neonicotinoid seed treatment on Aphelinus cerinus, even in the early season, but an impact of the seed treatment on A. glycines. The impact on A. glycines was both subtle (smaller body size, Fig. 2c) and lethal (reduced mummy production, see red stars, Fig. 2b). We also showed that in the early season, 4 weeks after planting, Aphelinus parasitoids reduced aphid numbers equal to the insecticide seed treatment (red circles, Fig. 2a).

Overwintering in Minnesota and Iowa does not limit parasitoids. Soybean aphids overwinter on European buckthorn, and there is evidence that some soybean aphid parasitoids do as well. Soybean aphids can migrate hundreds of kilometers, and recently parasitized winged soybean aphids exhibit normal flight behavior and thus parasitoids may hitch a ride to buckthorn sites to overwinter. Adult parasitoids may disperse in the Fall as well, and we documented a sharp increase in migration at the end of soybean season when the plants are almost completely senesced. We also found Aphelinus mummies on soybean very late in the season suggesting the possibility of overwintering within soybean fields. An examination of leaf litter from soybean fields found both A. certus and A. glycines can overwinter in fields. We evaluated overwintering success by placing diapausing Aphelinus mummies in winter conditions along a transect from northern Minnesota to southeastern Iowa. We placed mummies at ground level and at 1 m above ground, at solar level within buckthorn shrubs. A. certus overwintered successfully across all sites in the leaf litter habitat which has a moderated temperature due to the lack of snow cover (Fig. 3a). Overwintering success of A. glycines was lower overall and showed a general trend with patterns similar to those of A. cerinus (Fig. 3b).

Resistant soybean varieties don’t affect parasitoids. Resistant soybean varieties have been developed through traditional breeding, with Rpg (Resistance to Aphylus glycines) strains first reported in 2006, though they have not been widely marketed. We compared parasitism rates in Rpg soybean with near isoline non-Rpg. The Rpg variety reduced aphid numbers throughout the season, and there was no measurable effect on parasitism by Aphelinus. 2017 was a year of low aphid densities, which may explain the low recapture of A. glycines despite releases of 2500 mummies in each of 16 soybean plots.