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Native cover crops and timing of planting: Effects on ^{15}N uptake, weed invasion and prairie establishment

Abstract: Cover crops have been used for several purposes in prairie restorations. This project looked at whether the assumed benefits are supported by research results.

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Budget:
$8,380 for year one

Q Do cover crops help to lower weed invasion, establish native prairie vegetation, and prevent nitrogen loss to nearby water bodies?

A The best choices for meeting these objectives are no cover crop or Canada wildrye as a cover crop.

ECOLOGY

Background

Planting cover crops to simultaneously establish native prairie seedlings and prevent weed invasion has become a common management practice for prairie plantings. The underlying assumption is that the cover plant will act as a nurse plant to prairie seedlings and will have a positive effect on seedling recruitment by increasing weed suppression and lowering the harmful effects of high evaporation and light availabilities. Cover crops also could reduce the amount of soil erosion that occurs during planting. This potentially could lead to decreased weed biomass and increased prairie establishment in restoration planting situations.

However, evidence supporting these benefits is largely anecdotal and has not been universally accepted. Further scientific evidence is needed on the efficacy of cover crops for this use. Do they reduce weed biomass? Do they have a facilitative or competitive effect on prairie establishment?

Objectives of the project were to determine if:

- Native cover crop species facilitate the growth and establishment of native Iowa grassland species, and
- Native cover crops positively affect native grassland species establishment and negatively affect weeds by keeping nitrogen (N) in the system and away from the weeds and out of water bodies.

Approach and methods

As part of an ongoing project, investigators have varied the cover crops and timing of seeding to determine whether prairie establishment will be affected by different treatments. Several native species have potential to serve as cover crops. During the 2004 and 2005 growing seasons, five native species were established as cover crops at two ISU research farm sites (ISU Horticulture Farm in Story County and Western Research Farm in Monona County). A second experiment varied cover crops and timing of seeding in a split-plot design. In both experiments, investigators measured weed and prairie establishment from a seed mix of 29 other prairie species that were added to the cover crop plots. The seed mixes consisted of common warm and cool season grass and forb prairie species.

A ^{15}N labeling study was conducted on the native species cover crop plots in 2006 and 2007. Half-square meter plots were injected with ^{15}N tracer and researchers measured the amount of N that was taken up across cover crop treatments by the plots as a whole, sown prairie seeds and weeds. Cover crops could potentially reduce the amount of nutrients that is taken up by the weeds which would reduce N loss from the system.

Cover crop plots showing black-eyed susan. Pictured are graduate students Dave Losure and Kevin Day, and undergraduate student Kim Wahl.

Results and discussion

In the first experiment, prairie plant establishment was low due to invasion by crown vetch at the Horticulture Farm and smooth brome at the Western Research Farm. Total N uptake, as determined by retention of the ^{15}N tracer in vegetation, litter, soil and roots, did not differ significantly among cover crop treatments. Results showed that N loss to nearby water bodies is not likely to be reduced by having cover crops. All treatments had similar plant cover, whether from sown or non-sown species. Investigators believe the results suggest that any kind of perennial plant cover will cause N to be retained in the system at the same rates.

The second experiment had significant prairie establishment by 2007. Cover crop treatments had different amounts of weed biomass in both spring and fall plantings, and reductions were greatest when treatments matched the optimal growing period of each cover crop. Canada wildrye had significantly less exotic weed establishment than did the control plots. None of the other cover crops significantly lowered exotic weed establishment.

Prairie species from the seed mix tended to be less abundant in the cover crop plots than in the control plots, although this was statistically significant only for side-oats grama. The lower prairie establishment with side-oats grama is opposite for what would be predicted if this species was acting as a nurse plant for prairie species.

There were even larger differences among the timing and priority effect treatments. Spring planting supported much higher establishment of both warm season species and prairie forbs (cold season species), which was not what was expected. Lower establishment of prairie species in fall-seeded plots was associated with high abundance of smooth brome and other introduced cool season grasses.

The priority effect treatment, where the prairie mix was added in the growing season after the cover crops were seeded, was meant to mimic a management regime where weeds were controlled initially with the cover crop species and the prairie mix was over-seeded onto the cover crop at a later date. However, only the Canada wildrye controlled weeds, and little to no prairie establishment occurred with over-seeding during the year after cover crop establishment.

Conclusions

Cover crops showed some benefits in reducing weed biomass, but this ran counter to their tendency to inhibit establishment of prairie species. Control plots had as high or higher prairie plant establishment as the cover crop plots. This suggests that cover crops were not acting as nurse plants. Cover crop effects on N retention were neutral.

If a cover crop is to be used, Canada wildrye would be recommended. It reduced weed establishment and did not significantly lower prairie species establishment. Side-oats grama was the poorest performing cover crop species. It reduced prairie species establishment significantly below that seen in the control plots, and it showed only marginal resistance to weeds.

Prairie establishment was highest when prairie seeds were added in the spring at the beginning of the project. Very little prairie establishment occurred when cover crops were over-seeded during the following growing season.

The quick establishment of prairie species in spring-planted plots was associated with reduced weed biomass in year 3. This suggests that speedy establishment of prairie species will help plantings resist exotic weed invasions.

It is worth noting that this work was done in disked brome fields, not in fields formerly planted in annual crops, which usually have fewer perennial weeds. Fall seeding in these fields may lead to greater establishment of prairie forbs than what was shown in the project. Further research is needed to determine how previous land use affects restoration outcomes.

Impact of results

The project investigators recommend that when plantings are done in former brome fields, prairie establishment will be highest with spring plantings without a native cover crop, or in spring plantings with Canada wildrye as a cover crop.

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Education and outreach

Findings were presented at the annual meeting of the American Society of Agronomy and the Soil Science Society of America in Houston, Texas in 2008. Plots also are used as demonstration plots for the Restoration Ecology class at Iowa State University.

Leveraged funds

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