Improving Forage-Legume Stand Establishment with New Seeding Methods

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Research Summary

Alfalfa and other forage legumes offer many benefits if incorporated into rotations with wheat and other grain- or seed-crops, but there has been a reluctance to incorporate forage legumes into livestock and crop production systems. This reluctance partially results from the inability to establish stands consistently using conventional seeding methods. The objective of this study is to develop seeding methods which result in consistent establishment of forage-legume stands across North Dakota. This research began in 2001 and will be implemented fully in 2002.

Introduction

Forage legumes are difficult to establish compared with many other crops. The small seed size of most forage legumes necessitates seeding at shallow depths, where the seed is vulnerable to soil water deficits resulting from evaporation (Sheaffer, 1989). Dehydration causes death once seeds germinate and radicle emergence occurs.

Adequate soil water and firm soil are prerequisites for successful germination of seed.

Emergence of alfalfa seedlings improved as planting depth and soil compaction increased from 0 to 1 inch because soil water and seed-soil contact increased progressively at greater depths (Triplett and Tesar, 1960). These data suggest that no-tillage (NT) systems may offer advantages compared with conventional till-plant (CT) systems, since soil water is conserved and soil compaction increases when tillage is decreased (Gauer et al., 1982).

Superior establishment of alfalfa occurred in NT compared with CT seedbeds in dry conditions (Allen and Entz, 1994). Yield was unaffected by tillage system, presumably because of compensatory growth by alfalfa plants in the CT treatments. Forage yield was reduced when alfalfa was seeded into heavy wheat residue in NT seedbeds under favorable moisture conditions, possibly because emerged seedlings were shaded by wheat residue. Legumes are less tolerant of shading than grass crops (Kendall and Stringer, 1985), and species must be identified that tolerate shading in heavy residue, NT environments.

Recommended planting dates for forage legumes vary by location but coincide with periods of favorable precipitation and temperature (Van Keuren and Hoveland, 1985). Early spring (mid-to late-April) generally is considered the optimal period for forage legume establishment in North Dakota. However, some legume species may be planted as late as early August in some years, provided that soil water conditions favor rapid germination (Meyer, 1999).

Frost- or dormant-seeding may be an alternative to early spring seeding in North Dakota. This practice (seeding before the soil freezes but late enough so that seed does not germinate) can be advantageous when precipitation prevents timely seeding in early spring. Preliminary data from a 6-yr study suggest that dormant seeding is a risky practice with forage legumes in eastern North Dakota (D. Meyer, per comm.). Alfalfa seeded in early November produced successful stands in only two of six years. Seed germinated in the fall and never emerged in two years, while seed germinated in the spring in two years but was later killed by low temperatures.

The development of polymer seed-coatings which delay the imbibition of water by seed until targeted environmental conditions develop suggests that forage legumes can be dormant-seeded successfully, particularly in no-till environments where surface soil temperature is relatively stable from late-fall through early-spring. Dormant-seeding polymer-coated canola and wheat seed is being studied in North Dakota, but similar research with forage-legume species is not being done. Work is needed to determine if polymer seed coatings improve the ability to dormant-seed forage legumes successfully, particularly when coupled with low-disturbance NT drills.

The objective of this study is to develop seeding methods which result in consistent establishment of forage-legume stands. Specifically, this study is designed to: (i) demonstrate that establishing forage legumes successfully is improved as tillage is reduced; (ii) demonstrate that a polymer seed-coating improves dormant-seeding success of forage legumes; and (iii) determine if the same of several competing methods produces the greatest establishment success among representatives of annual, biennial, and perennial forage-legume species.

Materials and Methods

Demonstrate that establishing forage legumes successfully is improved as tillage is reduced.

Forage-legume species will be sown in NT and CT seedbeds in late-fall/early winter at the NDSU Dickinson Research Extension Center and near Fargo. Accepted agronomic procedure will be used to seed and manage the study. Weeds will be controlled with herbicides selected on the basis of the weed species present at each location.

Plots will be arranged in a randomized and replicated study (i.e. treatments will be arranged in a split split-plot with treatments replicated four times; tillage systems will comprise whole plots; seeding dates will comprise subplots, and legume-forage species will comprise sub-subplots). Tillage plots will be 40 x 120 ft at Dickinson; plot dimensions will be smaller at the other location. Conventional-till plots will be worked in the fall until < 30% residue cover remains prior to dormant-seeding. No tillage will occur prior to sowing in NT plots. Seed will be sown in both NT and CT plots using a JD-750 low-disturbance planter with a grass-seed box at Dickinson, and with low-disturbance small-plot planters at the other location.

Plant population will be determined by counting emerged legume plants at 12 locations in a 5.4-ft^2 (0.5-m^2) to 21.5-ft^2 (2-m^2) area, depending on location, in NT and CT plots at 10, 20, 30, and 40 days after spring warmup. Plant development stage will be determined by counting the number of fully emerged trifoliolate leaves on 10 plants randomly selected at these same times.

Above-ground dry matter production will be determined by harvesting biomass in a 20-ft^2 (1.9-m^2) area at 12 different locations in each NT and CT plot with a small-plot forage harvester. A 900-g subsample will be dried at 122^oF (50^oC) until a constant weight and recorded. Forage composition will be determined by harvesting biomass from a 5.4-ft^2 area at 12 different locations in each tillage plot and separating into legume and weed fractions.

A simple budgeting approach will be used to compare net income produced by contrasting forage treatments. This approach will enable treatments to be ranked from most to least profitable.

Data will be analyzed by ANOVA (SAS Institute, Inc., 1985). Tillage, establishment methods, and legume cultivars will be considered fixed effects, while blocks and locations will be considered random. Where *F* tests indicate significant differences between whole plots, subplots, and sub-subplots, means will be separated using Fischer's protected LSD at $P < .05$.

Demonstrate that a polymer seed-coating improves dormant-seeding success of forage legumes.

Forage legume species will be sown using 4 different strategies in both NT and CT plots: (i) dormant-seeding polymer-coated seed when soil temperature at a 1-in (2.5-cm) depth remains 40^oF over a 3-d period or by 15 November, whichever occurs first; (ii) dormant-seeding non-coated seed at the same depth as in (i) but when the soil temperature remains 36^oF over a 5-d period preceding sowing or by 1 December, whichever occurs first; (iii) seeding non-coated seed at spring warm-up (soil temperature at a 1-in depth remains 40^oF over a 3-d period preceding sowing); and (iv) seeding non-coated seed when soil temperature at a 1-in depth remains 50^oF over a 3-d period preceding sowing. Planting-date subplots will be 40 x 30 ft at Dickinson and smaller at Fargo.

Soil temperature at a 1-in depth will be recorded at 6-h intervals from the date of dormant seeding until 30 d after the late-spring seeding date from dormant-seeded polymer-coated treatments in both NT and CT plots in two blocks at both Dickinson and Fargo (Hobo® H8 Pro Series, Onset Computer Corp., Bourne, MA). Plant population, forage yield, and forage composition will be determined as described for

Objective a, but from 3 locations in each planting-date subplot (vs. 12 locations in each tillage whole plot). Data will be analyzed as described under objective a.

Determine if the same of several competing methods produces the greatest establishment success among representatives of annual, biennial, and perennial forage-legume species.

Alfalfa (cv. 'Ladak'), common yellow-flowered sweetclover, and black medic (cv. 'George') will be established in forage-legume species sub-subplots. Legume plant population will be determined from the center of each forage-legume species sub-subplot as described under Objective a. Forage yield and composition will be determined in each forage-legume species sub-subplots as described under Objective a. Analyses of agronomic and economic data will be done as described under Objective a.

Results and Discussion

Tillage treatments were imposed prior to dormant-seeding legume species in late November and early December in 2001. The legume species also will be sown in early-April to late-May in the spring. Plant population and development stage data will be collected from 10 to 40 days after the first spring planting at each location. Forage production and composition will be determined in early- to mid-summer, depending on the number of harvests and the location. Data analysis will be completed by 31 August and a final report will be available by 1 October.

Acknowledgments

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