

INTERCROPPING ALFALFA WITH CORN SILAGE

John H. Grabber, William R. Osterholz, David L. Bjorneburg, Heathcliffe Riday, Jose Luiz Carvalho de Souza Dias, Swetabh Patel, Damon L. Smith, Matthew D. Ruark, Kimberly A. Cassida, Erin E. Burns, Joseph G. Lauer, and Mark J. Renz¹

ABSTRACT

Alfalfa is often grown in crop rotations with corn silage to provide forage for dairy cattle and other livestock in northern regions of the United States, but the performance of this system is hampered by low establishment year yields of spring-seeded alfalfa and excessive loss of soil and nutrients during corn production. Over the last decade, scientists in Wisconsin and other states have developed improved methods for interseeding and establishing alfalfa with a corn silage companion crop. When proper management practices are used, establishment of alfalfa by interseeding into corn has the potential to double first year yields of alfalfa, increase overall forage production and profitability, and decrease soil and nutrient loss from cropland compared to conventional alfalfa-corn silage rotations. Key management steps for intercropping alfalfa with corn include choosing suitable field sites, properly amending soil, selecting suitable alfalfa varieties and corn hybrids, applying herbicides and other agrichemical treatments, and using appropriate planting and harvest management practices. Further research is still needed, however, to improve alfalfa establishment during wet growing conditions and to enhance nutrient uptake and yield of the corn silage companion crop.

Key Words: alfalfa, corn, forage, intercropping, management

INTRODUCTION

In the northern USA, establishment-year yields of spring-seeded alfalfa are low, often being one-half that of subsequent full-production years. Planting small grain, grass, or legume companion crops with alfalfa can improve forage yields in the establishment year, but the yield benefit is limited and often results in reduced forage quality. One way to bypass the low-yielding establishment year of alfalfa and to increase farm profitability would be to interseed alfalfa into corn silage. In this system, corn silage serves as a high-quality and high-yielding forage companion crop, while alfalfa initially serves as a cover crop to reduce soil and nutrient loss from cropland during and after corn production. With proper management, full production year yields of alfalfa established under corn are comparable to solo seeded stands. A primary focus in this production

¹ John H. Grabber (john.grabber@usda.gov) and Heathcliffe Riday (heathcliffe.riday@usda.gov) USDA-ARS U.S. Dairy Forage Research Center, Madison, WI; William R. Osterholz (will.osterholz@usda.gov), USDA-ARS Soil Drainage Research Unit, Columbus, OH; David L. Bjorneberg (dave.bjorneberg@usda.gov) USDA-ARS Northwest Irrigation & Soils Research Lab, Kimberly, ID; Jose Luiz Carvalho de Souza Dias (joseluizdias@arizona.edu), School of Plant Sciences, University of Arizona, Maricopa, AZ; Swetabh Patel (swetabh@ksu.edu), Northwest Research Extension Center, Kansas State University, Colby, KS; Damon L. Smith (damon.smith@wisc.edu), Dept of Plant Pathology, University of Wisconsin, Madison, WI; Matt D. Ruark (mdruark@wisc.edu), Dept of Soil Science, University of Wisconsin, Madison WI; Kimberly A. Cassida (cassida@msu.edu) and Erin E. Burns (burnser5@msu.edu), Dept. Plant, Soil and Microbial Sciences, Michigan State University, MI; Joseph J. Lauer (jglauer@wisc.edu) and Mark J. Renz (mrenz@wisc.edu) Dept of Agronomy, University of Wisconsin, Madison WI. **In:** Proceedings, 2022 World Alfalfa Congress, San Diego, CA, November 14–17. UC Cooperative Extension, Plant Sciences Department, University of California, Davis, CA 95616. (See <http://alfalfa.ucdavis.edu> for this and other alfalfa conference Proceedings.)

system should be to establish alfalfa at stand densities of 12 to 20 plants per square foot following corn harvest to maximize subsequent forage production. Our current recommendations for obtaining good establishment of alfalfa intercropped with corn silage are described below.

SELECTING A FIELD SITE

Growers should try alfalfa interseeding on a smaller field for several years while learning to properly implement and adapt the practice for conditions on their farm. Field sites must be suitable for good alfalfa production, with a soil pH of 6.6 or greater and good drainage. The soil should have a good water holding capacity or be irrigated if prone to drought. The site also must have a seedbed that is relatively smooth, firm, and free of excessive surface residues that would interfere with seeding alfalfa into corn. Interseeding should not be carried out in fields that are routinely wet and prone to soil compaction or rutting during corn silage harvest.

SOIL FERTILITY

Total available nitrogen from manure and commercial fertilizer should be at the upper end of rates permitted by nutrient management plans for corn silage. Based on soil test results, apply lime, phosphorus, potassium, boron, and sulfur to meet the crop nutrient needs for both corn silage and seeding-year alfalfa. Alfalfa seedlings will take up some applied nitrogen, so applying a high proportion of nitrogen in starter fertilizer (or possibly in deep-banded manure or fertilizer under the corn row) may help to favor nitrogen uptake by corn. For example, apply a starter fertilizer at corn planting to provide 50-20-20 lbs per acre of nitrogen, P₂O₅, and K₂O in a 2 x 2 placement. Growers should be prepared to sidedress additional nitrogen along the corn row, particularly if lower rates of available nitrogen are applied before or during planting or if nitrogen is lost due to excessive rainfall. After corn harvest, fertilize alfalfa according to soil test recommendations to support stand persistence and high forage yields. Alfalfa will readily take up any residual nitrate in the soil profile after corn harvest. Further research is, however, needed to refine fertilizer management for corn grown with interseeded alfalfa.

PROPER TIMING FOR CORN PLANTING AND ALFALFA INTERSEEDING

Alfalfa can be established under early or late planted corn. Interseeding within three days of corn planting will give the best establishment of alfalfa. If corn is planted early and exposed to prolonged cool conditions at or below 50°F, then consider delaying alfalfa interseeding until corn emergence (VE stage). This timing will reduce alfalfa competition with slow-growing corn and often improves corn silage yield while providing good establishment of alfalfa. Seeding alfalfa several days or weeks before corn planting is not advised because alfalfa will be too competitive with corn and reduce silage yield. Interseeding should not be attempted if the soil profile is excessively dry unless ample rainfall is expected or cropland can be irrigated. Under prolonged dry soil conditions, alfalfa establishment will be uneven, or if established, alfalfa seedlings will be too competitive with corn for soil moisture. In this case, producers should focus on growing corn without alfalfa, and then plant alfalfa in a conventional manner the following spring.

CORN SILAGE HYBRID, SEEDING RATE, AND HARVEST

The hybrid used for intercropping should have good to excellent agronomic traits, including protection from corn rootworm. Some light must penetrate the corn canopy from July until corn harvest to help sustain alfalfa growth. Harvesting corn in late August or early September is also necessary to allow interseeded alfalfa adequate time to regrow and improve winter survival. To accomplish this, growers should plant short season, moderate stature hybrids in rows spaced 30 inches apart at a target harvest density of 25,000 to 30,000 plants per acre. Our work in southern

Wisconsin and southern Idaho suggests 100- to 102-day hybrids work well if planted in early May. The combined effects of moderate population and early harvest of corn, along with modest reductions in corn growth due to competition from alfalfa, will likely reduce silage yield by about 10 to 15% compared to high density solo-seed corn harvested in mid to late September. Although planting corn in widely spaced rows (e.g. 60-inches apart) may improve light penetration and alfalfa establishment, this must be balanced against further reductions in corn silage yield. Conversely, narrow-row corn (e.g. 20-inch spacing) should be avoided because it allows less light penetration to sustain alfalfa growth. Avoid harvesting corn silage if fields are wet as compaction will damage or kill alfalfa plants. Our current research is aiming to identify specific hybrid traits that are associated with improved yield of corn silage grown with interseeded alfalfa.

ALFALFA ESTABLISHMENT

Proper seeding is critical for good alfalfa stand establishment and the suppression of weeds under corn. Plant alfalfa about ¼ to ½ inch deep in corn inter rows using a drill with press wheels, a seeding rate of 16 lbs per acre of pure live seed, and a row spacing between 6 to 10 inches. Adjust seeding rates to account for coatings, low germination, and high proportions of hard seed. Alfalfa can be drilled across corn rows as long as care is taken to ensure that germinating corn is not disturbed. If a corrugated roller seeder must be used, plant alfalfa first into a properly tilled and smoothed seedbed and then immediately plant corn. Our studies in Wisconsin have shown the following alfalfa varieties establish relatively well under corn: 55H94, 55H96, Hybriforce 3400, Hybriforce 3420, Hybriforce 4400, 54Q14, 54Q29, 55V50, FSG403LR, FSG329, Spredor 5, WL359RR.LH, RR Vamoose, FSG430RR.LH, 431RRLH, 55VR08, 54VR10, L-457HD+, and L-451APH2+. Alfalfa varieties with high resistance to multiple races of *Aphanomyces* should be used in areas where this disease is common. Our most recent work suggests alfalfa can be bred for improved establishment under corn and hopefully varieties specifically developed for interseeding will soon become available.

AGRICHEMICAL TREATMENTS TO AID ALFALFA ESTABLISHMENT

We recommend applying micro-encapsulated acetochlor (e.g. Warrant[®] 1.5 qt/a) just after alfalfa emergence. Postemergence weed control will vary depending on the alfalfa variety and corn hybrid used. For Roundup Ready[®] systems, glyphosate is highly effective when weeds are 4 to 6 inches tall, and our experience suggests only one application is needed. If conventional alfalfa or corn is planted, we recommend bromoxynil (e.g. Moxy 2E[®]) applied when broadleaf weeds are 1 to 2 inches tall and after alfalfa has four trifoliolate leaves. Pendimethalin (e.g. Prowl H₂O[®]) may be used as a pre-emergent herbicide after alfalfa reaches the second trifoliolate stage and before it is 6 inches tall to provide some control of germinating annual grass and broadleaf weeds. The Roundup Ready[®] system should, however, be used on fields where summer annual grass weeds are routinely a problem unless glyphosate-resistant weeds are present.

Numerous studies in southern Wisconsin have found superior establishment of interseeded alfalfa is obtained by applying prohexadione-calcium (e.g. Kudos[®]) followed by fungicide (e.g. Priaxor[®]) and, if needed, insecticide (e.g. Warrior[®] II). These agrichemical treatments are required if corn silage yields are high (over 7 tons of dry matter per acre) and wet growing conditions favor foliar disease on alfalfa (Figure 1 and 2). Kudos[®] is registered for use in Wisconsin and Pennsylvania and should be applied at 12 oz per acre with labelled adjuvants in early- to mid-June when interseeded alfalfa is 4- to 12-inches tall, and corn is 1.5- to 2.5-feet tall. Kudos[®] application requires a nozzle spacing on conventional booms (or drop nozzles) to direct the spray onto alfalfa in the interrow area and away from corn. In Wisconsin, initial top growth of interseeded alfalfa dies back prematurely in

late summer due to heavy disease pressure underneath higher yielding corn. Recent research has shown that Priaxor[®] fungicide applied at 4 fl. oz per acre when corn is about 4 to 6 feet tall is effective for lessening foliar disease of interseeded alfalfa. A drop nozzle may work best for this application, but it is not required if the spray penetrates through the corn canopy to provide good coverage of alfalfa. If potato leafhopper nymphs are present in fields this suggests impacts may be high from this pest. In these cases, research has found insecticide applications such as Warrior[®] II eliminated impacts from this insect. Research suggests that if Kudos[®] cannot be applied, good stands can often be obtained by applying fungicide and insecticide if potato leaf hoppers are present.

Recent studies suggest treatment of interseeded alfalfa with prohexadione, fungicide, and insecticide is not needed in arid irrigated regions (e.g. Idaho) if other management practices described above are closely followed. The use of these agrichemicals may be reduced or omitted in eastern rainfed regions if pressure from disease or insects and yields of corn silage are low (e.g. less than 6 tons of dry matter per acre), or if wide row corn is grown. Further work is, however, needed to clearly define thresholds and scenarios where these agrichemical treatments are needed to ensure establishment of alfalfa intercropped with corn.

SUMMARY

Alfalfa can be successfully established in a corn silage companion crop to improve overall forage yields, profitability, and environmental outcomes if management practices described in this paper are closely followed. These practices include choosing fields well-suited for alfalfa production, properly amending soil, preparing a good seedbed, and planting corn at moderate populations for harvest in early September. A well-adapted alfalfa variety should be planted at normal seeding rates with a drill at or before the VE growth stage of corn. Good weed control, application of prohexadione, fungicide, and insecticide and efforts to minimize wheel traffic damage during corn silage harvest are also key factors favoring good alfalfa establishment. Additional research is underway with the aim of further improving alfalfa establishment, especially during wet growing conditions, and to improve fertilizer management and yield of corn silage in this system.

Follow all pesticide label restrictions. Mention of a trademark or proprietary product does not constitute a guarantee or warranty of the product by the USDA and does not imply its approval to the exclusion of other products that may also be suitable. USDA is an equal opportunity provider and employer.

REFERENCES FOR FURTHER INFORMATION

- Grabber, J.H., Osterholz, W.R., Riday, H., Cassida, K.A., Williamson, J.A., Renz, M. (2021). Differential survival of alfalfa varieties interseeded into corn silage. *Crop Science*. 61: 1797-1808.
- Grabber, J.H., Smith, D.L., Osterholz, W.R., Renz, M. (2021). Establishment and first year yield of interseeded alfalfa as influenced by corn plant density and treatment with prohexadione, fungicide and insecticide. *Agronomy*. 11: 243.
- Osterholz, W.R., Dias, J.L.C.S., Grabber, J.H., Renz, M.J. (2021). PRE- and POST-applied herbicide options for alfalfa interseeded with corn silage. *Weed Technology*. 35: 263-270.
- Osterholz, W.R., Renz, M.J., Grabber, J.H. (2020). Alfalfa establishment by interseeding with silage corn projected to increase profitability of corn silage-alfalfa rotations. *Agronomy Journal*. 112: 4120-4132.

Osterholz, W.R., Renz, M.J., Jokela, W.E., Grabber, J.H. (2019). Interseeded alfalfa reduces soil and nutrient runoff losses during and after corn silage production. *Journal of Soil and Water Conservation*. 74:85-90.

Osterholz, W.R., Ruark, M.D., Renz, M., Grabber, J.H. (2021). Benefits of alfalfa interseeding include reduced residual soil nitrate pools following corn production. *Agricultural and Environmental Letters*. 6:e20053.

Osterholz, W.R., Ruark, M.D., Renz, M.J., Grabber, J.H. (2021). Interseeding alfalfa into corn silage increases corn N fertilizer demand and increases system yield. *Agronomy for Sustainable Development*. 41:58.

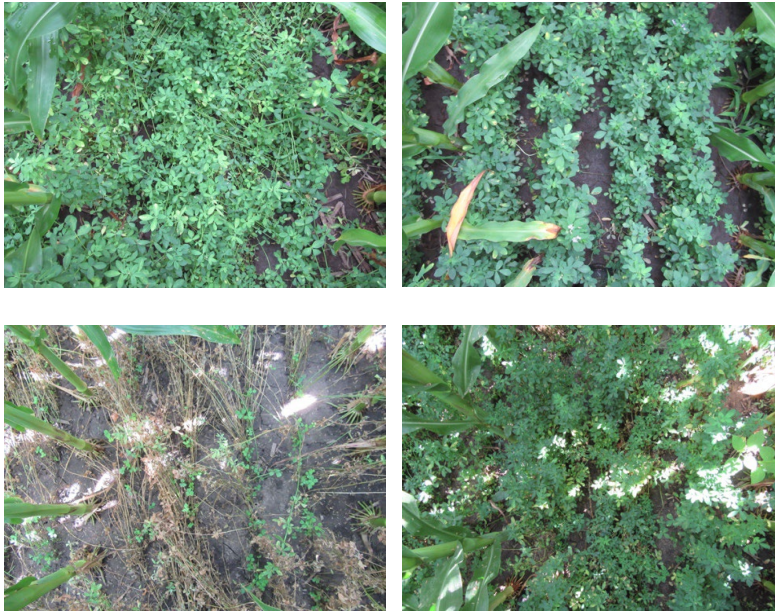


Figure 1. Normal appearance of interseeded alfalfa in July (top photos) and August (bottom photos) under corn. Alfalfa seedlings grown without agrichemicals have tall stems, weak roots, and die back due to disease and insect pressure (left photos). Alfalfa treated with Kudos[®] followed by fungicide and insecticide has improved survival due to more compact, healthier top growth and larger roots (right photos). Penetration of light through the corn canopy also favors alfalfa survival.



Figure 2. Typical appearance of interseeded alfalfa in late fall when established during near- normal growing conditions (top photos) or wet conditions that favored aggressive corn growth, alfalfa disease, and wheel traffic damage at corn harvest (bottom photos). Alfalfa undergoes substantial or complete stand loss when established without agrichemicals (left photos). Establishment was greatly improved by applying Kudos[®] followed by fungicide and insecticide (right photos).