UNIVERSITY OF WYOMING

Cooperative Extension Service
Department of Plant, Soil, and Insect Sciences
College of Agriculture

B-1047
March 1998

Alfalfa Stand Renovation: Reseed or Crop Rotation?

Alan M. Gray
UW Extension Forage Agronomist
Department Of Plant Sciences

Introduction

Plant density and yield of any stand of alfalfa will eventually decline, but rate of decline will be influenced by multiple factors including harvest and/or grazing management, irrigation practices, precipitation, soil fertility, soil type, weeds, insects, diseases and, in some instances, variety of alfalfa. A sparsely populated alfalfa stand tends to be more susceptible to invasion by less productive, undesirable grasses, and broad-leaved weeds. When an alfalfa stand thins and is invaded by weeds, total dry matter yield generally tends to decrease (Hesterman, 1986). Can **old** stands of alfalfa be thickened? How long after emergence can a **new** stand of thinly populated alfalfa be thickened? What problems are associated with the practice of following one stand of alfalfa with another ("back-to-back") without crop rotation? How important is crop rotation in alfalfa production?

Hay growers most concerned about alfalfa stand longevity are those who produce either for a cash hay market or for their own livestock. In Wyoming, cash hay producers also tend to manage alfalfa stands most intensively. They favor high-yielding varieties capable of producing three harvests, with two cuts taken as prime quality hay. These stands are normally expected to persist at least six years. Conversely, when alfalfa is produced by a livestock operation, stands are more likely to be harvested for 10 or more years and then rotated when yields decline due to invasion by less productive broad-leaved weeds or grasses. Livestock operations that produce hay generally go for tonnage rather than quality by taking only two hay crops and then grazing late summer regrowth after a hard freeze of 24 degrees Fahrenheit. Stand longevity is generally unimportant when alfalfa is used in short term rotations with beets, beans, barley, or corn.

Old Stands are Difficult to Thicken

Most alfalfa producers have attempted to thicken an old stand of thinly populated alfalfa by drilling seed directly into the stand. Predictably, the seed germinates and seedlings "appear" to be established, sometimes even between the crowns of plants in more densely populated areas of the stand. Invariably, most of

the new seedlings fail to become productive mature plants and eventually disappear. In some instances, seedlings **may establish** in areas of the field that were either nearly barren or had only a few alfalfa plants prior to re-seeding.

"Back-to-Back" Alfalfa Trials and Attempts to Thicken Old Stands

"Back-to-back" alfalfa is the practice of following one stand of alfalfa with another without crop rotation. Jennings (1994) investigated back-to-back alfalfa and time intervals required for returning to alfalfa after plowing down or killing an old stand with herbicides. He concluded that better stands result with 18-month and 12-month crop rotations than with one-month or two-week intervals between alfalfa stands. Six-month intervals of fall plowing and/or using herbicides followed by a return to alfalfa in the spring gave inconsistent results, but autotoxic compounds did appear to leach more quickly on sandy soils in one study. This supports a commonly held belief that sandy soils can be seeded sooner than fine-textured soils in a back-to-back approach.

Mueller-Warrent and Koch (1980) demonstrated that "a two to three week wait" to seed alfalfa after a spring application of glyphosate on "six old run-out stands of alfalfa" produced the "best stands" when compared to planting without waiting. Tesar (1993) found that "alfalfa could be reestablished without significant autotoxicity if seedings were made at least two weeks after plowing or three weeks after glyphosate application on established alfalfa or after seedling failure." Tesar also compared yields of "back-to-back" alfalfa to yields of alfalfa established on tilled, plowed-under corn stubble. Yields for the seedling year and the year following establishment were conditionally similar for both studies **when** back-to-back alfalfa was seeded on a tilled seedbed 14 days or more after plowing alfalfa or when sod-seeded 21 or more days after killing a previous alfalfa stand with a herbicide.

Based on this study, Michigan State University prioritized the following guidelines for growers attempting back-to-back alfalfa: seed in early spring on a tilled seedbed after fall-plowing old alfalfa, spring or summer seed on a tilled seedbed at least two weeks after plowing alfalfa, sod-seed on erosion-prone soil in spring after a fall herbicide kill of alfalfa or in summer at least three weeks after killing alfalfa with a herbicide.

Old Alfalfa Stands Must be Sparsely Populated to be Effectively Re-seeded

Jennings (1994) conducted a five-year study in Missouri to determine how poor an alfalfa stand had to become to be effectively thickened by inter-seeding directly into the stand. The study revealed that residual alfalfa plants in an old stand could inhibit the permanent establishment of seedlings in an area about 15 to 16 inches in radius, and alfalfa plant density had to be as sparse as one plant per five square feet to adequately repopulate an old stand by reseeding. Even so, a grower might have to rotate a poorly populated stand to control weeds or adjust soil fertility.

Factors That May Influence Alfalfa Seedling Establishment and Persistence in Old Stand Alfalfa

Allelopathy and Autotoxicity

Allelopathy, a rather common phenomenon under field conditions, occurs when a plant produces a chemical compound that may inhibit germination of seed or growth of seedlings of the same (autotoxic)

or different species. For example, an unidentified toxic substance in the root of buffalo gourd can be lethal to young tomato and lettuce plants or inhibit germination of both radish and lettuce seeds. Other examples of plants that may suppress some weeds or crop seedlings under some conditions include the husks and roots of black walnut, wheat straw, winter rye, and the roots of tall fescue (Wheeler and Young, 1978; Gardner, 1985; Magdoff, 1993). Chung and Miller (1995) demonstrated that alfalfa contains water soluble substances that are both toxic to other species (allelopathy) and self-toxic (autotoxicity). Dornbos (et.al., 1990) indicated that mature alfalfa plants produce plant growth inhibitors (medicarpins) that interfere with the long-term establishment of alfalfa seedlings sown in close proximity to the crowns of mature alfalfa plants.

Competition

Juvenile plants are less competitive than mature plants. Deep-rooted, established alfalfa plants are better competitors for nutrients, water, and light than young seedlings. Well-established weeds may also compete with alfalfa seedlings unless undesirable plants are eradicated or chemically-suppressed immediately prior to reseeding.

Soil Fertility

Diminished soil fertility may shorten the longevity of an alfalfa stand. Has there been periodic testing to monitor the soil fertility of the stand? If not, then soil nutrient status in a old stand of alfalfa should be determined before attempting a return to alfalfa. Except in unusual circumstances, phosphorus (P) is the only major plant nutrient in Wyoming that requires replacement to maintain adequate soil fertility. Has there been a fertilizer maintenance program to restore soil P reserves removed by successive crops of hay? If soil fertility is limiting plant growth and remains uncorrected, the probable success of re-establishing an alfalfa stand is greatly diminished.

Diseases, Insects and Crop Rotation

The best defense against the buildup of high levels of disease-causing pathogens in the soil include crop rotation, alfalfa varieties with disease resistance, and the avoidance of excessively water-saturated soils, particularly if fine-textured and poorly drained. For the most part, disease-induced stand decline in Wyoming is a problem in irrigated, rather than dryland alfalfa. When diseases accelerate stand decline, a back-to-back planting of alfalfa would require. The use of disease resistant varieties. Even so, resistant varieties are unlikely to overcome auto-toxicity or other problems associated with stand decline and maintenance as discussed above.

If stand decline is accelerated by diseases, high populations of the responsible pathogens would probably remain in the soil unless diminished with crop rotation (Kehr et al, 1983). Old stand alfalfa plants that persist into new stand alfalfa might serve as disease reservoirs. To minimize disease carryover into a new stand, old plants might have to be eliminated by crop rotation. Once alfalfa diseases have been documented in an area, the use of disease resistant varieties is advisable. Furthermore, insect pest populations on alfalfa stands tend to increase over time. This, too, is diminished by crop rotation. Again, each or any combination of the factors mentioned above could minimize stand establishment or accelerate stand decline.

Because populations of pathogenic organisms tend to increase when a monoculture of the same crop is produced year after year on the same site, the importance of crop rotation can not be overstated. Declining yields, insects, parasitic nematodes, weeds, and diseases associated with insects, viruses, and fungi can be eliminated or diminished with crop rotation (Magdoff, 1993). Even alfalfa, an extremely resilient, long-lived perennial, is not immune to intensive harvest management or grazing, declining soil fertility, increasing pathogenic pressures, and other environmental factors. A good stand of alfalfa improves soil tilth and increases soil nitrogen and organic matter levels, but stand decline is inevitable. Rotation to another crop can be an opportunity to further improve soil fertility, tilth, and yields while controlling weeds and diseases. In some instances, crop rotation might be required anyway if land-leveling or adjustments to irrigation equipment or water management practices are necessary to correct drainage problems or saturated soils.

Rotation of annual or perennial, or shallow or deep-rooted crops allows incorporation of soil amendments and avoids or corrects depletion of nutrients in localized areas. Perennial grass and legume forage crops benefit from rotation because entire root systems are reestablished and relocated. In the case of alfalfa, crop rotation allows for an adjustment in levels of soil phosphorus, an immobile nutrient more effectively utilized and available to the plant when soil-incorpo rated than if top-dressed on an existing stand. And finally, crop rotation may influence forage quality by avoiding or curtailing damaging populations of insects, diseases, and weeds.

What about Breeding Varieties Resistant to Allelopathy?

Because some alfalfa varieties appear to be more auto-toxic than others (Behling, 1994), some researchers propose to eliminate the problem with plant breeding. Unfortunately, this rather intriguing approach does not solve problems associated with soil fertility, weed competition, or the build-up of disease and insect populations in old stands.

Can a New Stand of Alfalfa be Thickened?

An alfalfa plant breeder and hay grower in the Wind River Basin who has produced alfalfa for nearly 50 years (Carroll Riggs, personal communication, 1996) believes that alfalfa stands in. Wyoming do not become strongly autotoxic until about 12 months after initial stand emergence. Many alfalfa producers in western Wyoming use this apparent window of opportunity to thicken thin stands by sowing additional seed within the period. And while this generally accepted practice has not been refuted or validated by independent research, experience seems to indicate that spring-seeded stands can be thickened within 12 months, particularly if additional seed is sown by late winter or very early spring before newly established alfalfa plants break dormancy. A common establishment practice in Wyoming is to spring-seed alfalfa with oats or barley that are harvested for grain in August, or with oats and Austrian-winter peas that are harvested in July as a forage crop. If spring-sown alfalfa is seeded with an oats or barley companion crop and the result is an unsatisfactory alfalfa stand in late July or early August, additional alfalfa seed could be sown after baling and removing most of the small grain stubble. Additional seed should be stubble-drilled into the existing thin-stand alfalfa and irrigated immediately (preferably by August 10 through 15 at elevations of 5,500 feet or lower) to allow seedlings to germinate and produce at least three trifolilolate leaves before a killing freeze of 24 degrees Fahrenheit. Third trifolilolate seedlings normally have sufficient growth to survive the winter. Autotoxicity does not appear to be a factor in stand establishment under these circumstances.

Will Seed Treated with Chemical or Biological Fungicides Overcome Diseases or Allelopathy in Old Stand Alfalfa?

Chemical fungicides are sometimes applied to alfalfa seed to prevent or reduce damping-off in seedlings. Alfalfa seedling mortality may occur with exposure to high populations of a soilborne fungus *(Phytophthora megasperma*), the organism that also causes alfalfa root rot in old stands. When heavy-textured soils are saturated under high temperature conditions, damping-off of alfalfa seedlings by this fungus can be serious. To avoid the problem, seed is sometimes treated with Metalazyl, a systemic chemical fungicide known by the trade names of Apron and Ridimil. This practice, however, is normally associated with establishing new stand alfalfa in rotation with a different crop.

News articles in the popular press (HPJ, 1994; Kessler, 1994) sometimes promote the notion that the problem of permanently establishing new alfalfa seedlings into an old depleted stand might be associated more with buildup of soilborne fungi than with autotoxicity. Therefore, some have suggested a double rate application of Metalazyl to alfalfa seed to overcome the problem. This was investigated by Kansas State University (Curt Thompson, personal communication, 1995) and the USDA Agricultural Research Service in Idaho (Dave Carter, personal communication, 1995). Neither study was able to demonstrate a positive response. Another controversy developed recently in regard to inoculating alfalfa seed with a registered biological fungicide, *Bacillus subtilli*s, (Tradename: Kodiak). Kodiak is registered primarily for control of Pythium, Rhizoctonia, and early season Phytophthora for a broad group of agricultural seeds. Kodiak vendors theorize that seed inoculated with this product should be more resistant to pathogenic fungi because *Bacillus subtillis* is thought to become a “root site occupier” that competes with pathogenic organisms. This approach may have merit in the control of damping-off of alfalfa seedlings due to Phytophthora, but it has not been verified. Furthermore, the potential effects of *Bacillus subtillis* on root-nodulating, nitrogen-fixing bacteria or on vesicular-arbuscular mycorrhiza (fungus) that create beneficial symbiotic relationships with alfalfa roots should also be investigated. Again, this product might be an effective approach to control diseases, but problems associated with allelopathy remain. The above mentioned studies in Kansas and Idaho that addressed double rate applications of Metalazyl also investigated the effectiveness of Kodiak to overcome allelopathy. Again, results were disappointing for all treatments. No report on the project was available or planned because there was nothing positive to report. The Idaho researcher indicated that alfalfa seed germination in the established stand was substantial, but persistence of new alfalfa plants by the end of the season was not impressive. Consequently, the practice was not recommended. In the Idaho study new plants were observed to persist where the old stand was extremely thin or non-existent, but this observation was not unusual and was also reported in the Missouri study. Indeed, biological and chemical fungicides may have positive roles in the establishment of **new** stand alfalfa, but soilborne diseases and autotoxicity problems in **old** stand alfalfa appear to be controlled better with crop rotation.

When Should an Alfalfa Stand be Rotated?

A decision to replace an old alfalfa stand or keep it another year should be based on economics (Hesterman, 1987). Even so, the decision to eliminate a stand of alfalfa is sometimes ruled more by a crop rotation schedule than by stand productivity. For instance, an alfalfa grower on a regular program of crop rotation may not have the luxury of allowing an unusually persistent and productive stand to remain an additional year, particularly when the productivity of a younger stand is declining at a different rate than an older stand. An out-of-sequence crop rotation program may expose a grower to the possibility of having too much alfalfa ground out of production in one growing season.

The most reliable indications of stand productivity are field-by-field histories that reveal when stand yields are peaking, leveling, or declining. For intensively managed alfalfa, peak yields are normally achieved during the season that begins 12 months after a spring establishment or 20 months after a stand is fall-seeded. Yields may plateau for several years but stand decline is inevitable. Season-long hay tonnage records on a field-by-field basis each year will allow a grower to monitor yield trends and declines over several years. Unfortunately, historical yield data on a field-by-field basis may not be available in many situations.

The need to reseed or rotate a stand of alfalfa cannot always be verified by either stand age or plant density alone. When alfalfa stands have been well-managed and fertilized, many alfalfa varieties have produced yields of seven and a half tons per acre or more after 10 years (Hesterman, 1986). Furthermore, high yields have been observed with as few as two to five plants per square foot in Michigan. In one case, a 10-year-old stand produced over eight tons per acre of dry matter yield with only 1.9 plants per square foot. In some instances, stand uniformity can be more important than stand density. For example, large areas in a field that have only a few. Plants can probably be reseeded, particularly if the remainder of the stand has a plant density of two to five plants per square foot.

Relationships between yield-to-stem or crown counts per square foot have been developed in other regions (Barnhart 1995) but may not be appropriate for Wyoming conditions. However, as a point of reference, a procedure to determine alfalfa stand adequacy (stem count method) has been developed by the University of Wisconsin. The stem count procedure is based on the assumption that the “harvested unit” is the alfalfa stem and that “yield per area” is directly related to the number of stems present in that area (Barnhart 1995). Research in the upper Midwest reveals that an average of 55 stems or more per square foot is necessary to assure that alfalfa stand density is not limiting yield. An economic procedure to determine if an alfalfa stand should be retained or replaced is outlined by Hesterman (1987) and referenced below.

Summary

Predictably, yield and plant density of any stand of alfalfa eventually decline. Old stands are difficult to thicken with additional alfalfa seed due to buildup of pathogenic organisms in the soil, declining availability of phosphorus, invasion by undesirable grasses and broad leaved weeds, and autotoxicity. The success of “back to back” alfalfa, the practice of following an old stand with a new stand of alfalfa without crop rotation, varies considerably. Good stands of alfalfa are more consistently achieved with crop rotation. The reestablishment of alfalfa with stand-to-stand planting intervals of 18 to 24 months appear to produce better stands than intervals of only a few weeks or months. Crop rotation disrupts the build-up of disease causing organisms by eliminating alfalfa host plants, allows for weed control and adjustments in soil fertility, and avoids autotoxicity problems. Alfalfa seed that has been sown into old stands after treatment with chemical and biological fungicides does not appear to overcome autotoxicity associated with mature plants or overcome stand decline due to diseases. New stand alfalfa may not become strongly autotoxic until about 12 months after initial stand emergence. Some alfalfa producers use this apparent window of opportunity to thicken thin stands by sowing additional seed within 12 months of initial seeding.

References

Barnhardt, S. “The tough decision: Is it a ‘Keeper’” *Alfalfa Talk*, Vol. 15 (1995), No. 2. Certified Alfalfa Seed Council.

Behling, Ann. “Seed alfalfa after alfalfa?” *Hay and Forage Grower*, Vol. 9 (1994), No. 2, p. 67.

Chung, I. M. and D. A. Miller. “Natural herbicide potential of alfalfa residue on selected weed species.” *Agronomy Journal*, 87 (1995): 920-925.

Dornbos, D.L., G.F. Spencer, and R.W. Miller. “Medicarpin delays alfalfa seed germination and seedling growth.” *Crop Science*, 30 (1990): 162-166.

Kehr, W.R., J.E. Watkins, and R.L.Ogden. “Alfalfa establishment and production with continuous alfalfa and following soybeans.” *Agronomy Journal*, 75 (1983): 435-438.

Kessler, K. “Nonstop alfalfa.” *Furrow*, Vol 99 (1994), Issue 1, p. 21.

Gardner, Frank. *Physiology of Crop Plants*. p.176. Iowa State University Press. 176.

Hesterman, O. “Should this stand of alfalfa be replaced?” *Hay and Forage Grower*, Vol 2 (1987), No 3, p. 6.

Jennings, J. “Impact of soil texture on alfalfa autotoxicity.” In *Proceedings of Twenty-fourth National Alfalfa Symposium: Alfalfa: A Valued Crop*, February 24-25, 1994, pp. 55-61. Certified Alfalfa Seed Council.

Magdoff, Fred. *Building soils for better crops: Organic matter management*, pp. 90-102. University of Nebraska Press. 1993.

Mueller-Warrant, G.W., and D.W. Koch. “Renovation of old stands with tillage,” p. 110. In *Agronomy Abstracts*, ASA, Madison, WI. 1980.

Tesar, M.B. “Delayed seeding of alfalfa avoids autotoxicity after plowing or glyphosate treatment of established stands.” *Agronomy Journal*. 85 (1993): 256-263. “ Thin alfalfa stands can benefit from interseeding.” *High Plains Journal*. May 23, 1994. Dodge City, Kansas.

Wheeler, G.L., and J.F. Young. *Arkansas Farm Research*, p.6. 1978.

Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Edna L. McBreen, Director, Cooperative Extension Service, University of Wyoming, Laramie, WY 82071-3354.
3-98