UtahStateUniversity
PLANTS, SOILS & CLIMATE

September 2016 Bulletin 1 AG/Forages/2016-02pr

Establishing Birdsfoot Trefoil in the Mountain West

Joe E. Brummer, Dept. of Soil and Crop Sciences, Colorado State University
Jennifer W. MacAdam, Dept. of Plants, Soils and Climate, Utah State University
Glenn Shewmaker, Dept. of Plant, Soil, and Entomological Sciences, University of Idaho
M. Anowarul Islam, Dept. of Plant Sciences, University of Wyoming

Why Consider Planting Birdsfoot Trefoil?

Birdsfoot trefoil (*Lotus corniculatus*) is an underutilized forage legume in the Mountain West. It has several unique characteristics that make it worth considering, particularly for pasture. One of the key reasons to use birdsfoot trefoil is that it does not cause bloat when grazed as green, standing forage, even in pure stands. This is due to the presence of condensed tannins which bind with some of the soluble protein in the rumen during fermentation causing it to precipitate out, thus preventing formation of the stable foam which causes bloat (MacAdam et al., 2013). In addition to the tannins preventing bloat, they are also known to reduce parasite loads, decrease methane and ammonia emissions when fed to ruminant livestock, and increase animal gains and milk production due to more efficient utilization of the protein. Birdsfoot trefoil also contains higher concentrations of non-fibrous carbohydrates than alfalfa (MacAdam and Griggs, 2013), meaning that its ratio of protein-to-carbohydrates is more evenly matched for better ruminant nutrition. When considering its growth characteristics, birdsfoot trefoil thrives in the same soils and climate favored by alfalfa, but is more tolerant of low fertility, especially phosphorus, low pH, and poorly drained soils than alfalfa. It also holds its quality better compared to many other legumes and is a long-lived perennial that can reproduce by natural reseeding. One of the reasons more producers do not utilize birdsfoot trefoil is that they perceive it to be difficult to establish.

Cultivar Selection and Seeding Rate

One of the first decisions to make is which cultivar of birdsfoot trefoil to plant. Cultivar selection is not as straightforward as choosing an alfalfa cultivar. Trefoil cultivars are generally classified into two basic categories based on growth form: erect and semi-prostrate. Erect cultivars are well suited for hay production while the semi-prostrate ones work better for pasture. Norcen, a relatively erect cultivar released in the United States in 1981, has a broad genetic base which makes it adaptable to many different environments. It is very winter-hardy and persistent once established and has performed well when planted throughout the Mountain West (MacAdam and Griggs, 2013). Some cultivars contain higher concentrations of condensed tannins, which not only reduce bloat, but can also promote higher livestock gains and milk

production. Langille, developed in Canada, and Oberhaunstadter, developed in Germany, are two cultivars that contain higher concentrations of tannins, up to double the level of Norcen. Although seed of these two cultivars can be difficult to find, their potential to improve animal performance is worth the effort. Bruce and Bull are two newer cultivars developed in Canada that have not been widely planted in the Mountain West, but the wide range of birdsfoot trefoil cultivars tested to date have all been well-adapted to the region (MacAdam and Griggs, 2013). Excellent seedling vigor, winterhardiness, and good persistence under grazing are important qualities to look for in a cultivar. Regardless of the cultivar, be sure to plant certified seed. It is best not to plant the old Empire cultivar or seed labeled as Variety Not Stated (VNS) as these typically do not perform as well as certified seed of named cultivars.

The standard recommendation is to plant 6 pounds of pure live seed (PLS) per acre. If the seed is coated, this amounts to about 10 pounds of bulk seed per acre. Higher seeding rates have been shown to increase yields only during the first full year of production (Hunt et al., 2016), but due to the relatively high cost of trefoil seed, this may not be worth the investment. When planting in a mixture with grasses or interseeding into an existing stand, the full rate is recommended because seedling survival is reduced due to competitive effects from the grasses. To reduce competition when seeding in a mixture, it is best to either cross-drill the trefoil or plant it in alternate rows if possible.

It is essential that birdsfoot trefoil seed be inoculated with the proper *Rhizobium* bacteria prior to seeding. Not only does this ensure nitrogen fixation, but in the process, significantly improves seedling vigor (Figure 1). Trefoil seed that is not inoculated will germinate, but the seedlings will exhibit a pale, greenish-yellow color and will remain small and stunted for a long period of time. If the seed purchased does not come pre-inoculated, powdered inoculant specific to birdsfoot trefoil should be purchased separately (usually in packets that treat 50 pounds of seed) and properly applied to the seed just prior to planting. Be sure to follow the directions on the packet to ensure that the inoculant sticks to the seed. Generally, the seed must be lightly wetted with water and some type of sticker applied before mixing with the dry inoculant.

Figure 1. This photo illustrates the slow growth of birdsfoot trefoil (after 7 weeks in the greenhouse) as well as the importance of inoculation. The pot on the left was inoculated with the appropriate *Rhizobium* bacteria while the pot on the right was not inoculated.

Establishment Considerations

Establishment of birdsfoot trefoil is a challenge because it has weak seedling vigor and does not compete well against weeds, companion crops, or established forages when interseeded into existing stands. However, it can be successfully established in mixtures with grasses (MacAdam, 2002; MacAdam and Griggs, 2006) or interseeded into established forage stands if appropriate methods are used to suppress the existing vegetation (Brummer et al., 2011). Seed size is about half that of alfalfa, averaging 375,000 to 420,000 seeds per pound, which partially contributes to the weak seedling vigor as well as making it difficult to place the seed at the proper depth. In order to improve establishment success, there are several factors to consider.

Because of the small seed size, planting into a firm seedbed is critical. The seeds do not contain enough stored energy to emerge from planting depths deeper than 1/2 inch (1/4 to 3/8 of an inch is generally better). When seeding into a clean-tilled seedbed, the use of a cultipacker or

roller harrow prior to seeding is a good way to firm the seedbed while breaking up any large clods at the same time (Figure 2). If you have sprinkler irrigation, a light irrigation prior to seeding is also a good way to settle the soil and achieve a firm seedbed. A good rule of thumb is that your boot impression should be barely visible (~1/4 inch deep) when you walk across the field prior to seeding - the firmer, the better!

Figure 2. Example of a cultipacker (top) and the firm seedbed (bottom) it can create prior to seeding into cultivated ground. Although a fine, firm seedbed is ideal in most situations, in this example, the soil is high in clay and it is actually good to see the small clods on the surface. If clay soils are worked too fine (i.e., powdery), they will form a hard crust following wetting from rain or irrigation which can impede emergence of birdsfoot trefoil seedlings.

Ensure proper seeding depth (no deeper than 1/2 inch) by using a drill equipped with some type of depth control. The most accurate control of depth can be achieved with depth bands affixed directly to the disk openers. This type of depth control results in fairly constant placement of the seed, especially if the soil surface is not flat and firm. Another common form of depth control involves the use of adjustable packer wheels. These follow the disk openers and have the advantage of being adjustable up and down to achieve different seeding depths based on the size of seeds being planted (small = shallower, large = deeper). The disadvantage is that seeding depth may not be consistent as the drill travels across the field. Since the packer wheels follow at some distance behind the disk openers, if they drop into a depression, then the disk openers penetrate deeper, placing the seed too deep, or conversely, if the packer wheels ride over a hump or ridge, then the disk openers raise up and may pull completely out of the soil, dropping the seed on the surface. This can lead to variable emergence of birdsfoot trefoil seedlings. It is critical when using a drill with this type of depth control that the field be as flat and firm as possible. When planting small-seeded forages like trefoil, it is advisable to stop the drill after the first 100 feet and look for seed in drill rows to determine actual seeding depth.

When planting into clean-tilled seedbeds, broadcast seeding trefoil is also a good option for establishment. The small, round, hard seeds of trefoil are easy to broadcast and the seed is distributed across more of the soil surface, reducing competition among seedlings, compared to drilling in which seeds are concentrated close together in rows. Seeding rates should generally be increased by 50 to 100% compared to recommended rates for drilling because seeding depth and seed-to-soil contact can be quite variable. Just as with drilling, the seedbed needs to be firm. A good approach is to cultipack the field in one direction, broad-

cast the seed, and then cultipack again at a perpendicular angle. A Brillion "Sure Stand" seeder is another method of broadcasting that packs the soil and meters the seed in one operation (Figure 3), although Brillion seeders can be more challenging to calibrate than drills.

Figure 3. A Brillion seeder which is ideal for planting birdsfoot trefoil into clean-tilled seedbeds.

For forages like birdsfoot trefoil that have weak seedling vigor, adequate soil phosphorus can significantly improve vigor and establishment through stimulation of root growth. It is imperative to get a soil test prior to seeding to check phosphorus levels and apply the recommended amount, if needed. Fields that have been used for alfalfa hay production are likely to be low in both phosphorus and potassium. For clean-tilled seedbeds, phosphorus should be applied and incorporated prior to seeding. Unlike nitrogen, phosphorus is slow to move into the soil, so incorporation is very important to ensure it is in the root zone for uptake as seedlings germinate and start to grow.

Broadcasting and incorporating phosphorus prior to seeding works fine, but it is even better to band phosphorus below the seed so roots grow directly into it. However, there are very few drills available that can band phosphorus below the seed while placing the seed at the proper depth. The best alternative for doing this is an end-wheel grain drill equipped with both a fertilizer and small seed box. Phosphorus fertilizer (~30 pounds per acre) is banded about 1.5 inches deep between the disk openers. Birdsfoot trefoil seed is metered through the small seed box into a tube that drops the seed on the soil surface about a foot behind and into the trench created by the disk openers. Packer wheels are best for firming the soil around the seed, but light drag chains will also work to obtain seed-to-soil contact. The one issue that can arise with this method is that the seed can end up being covered with too much soil even though it is placed on the surface. If the soil is soft, the disk openers can create a fairly deep trench that will melt down around the seed following rain or irrigation, burying it too deep. Again, a firm seedbed is essential to improve establishment success with this seeding method.

The decision to use a companion crop when seeding birdsfoot trefoil must be weighed carefully. Two common reasons for using companion crops are that they can be harvested for feed, thereby reducing production loses in the seeding year, and they can help control annual weeds. Although companion crops can effectively displace weeds, they can have the same negative effects on establishment unless properly managed (Figure 4). Following are some considerations if you decide to use a companion crop. Oats are one of the best companion crops to use, but the seeding rate must be kept low. No more than 20 pounds per acre of oats (15 pounds per acre is even better) should be seeded with the trefoil. At this rate, the oats are able to compete effectively with annual weeds while not competing too strongly with the establishing trefoil. Be sure to remove the oats at early heading to avoid light competition. If your goal in using the companion crop is primarily weed control, then cross

Figure 4. Birdsfoot trefoil was broadcast seeded in August at 18 pounds per acre with (upper) and without (lower) a companion crop of oats (48 pounds per acre) near Logan, Utah. These photos were taken the following growing season in early June and illustrate the impact the oats had on establishment and vigor of the trefoil plants.

drilling the oats works well. If your goal includes assisting the small trefoil seedlings to break through a heavy soil crust, then the oats must be seeded in the same row, so use of a low seeding rate is critical to reduce competition and improve establishment success. A good alternative to using a companion crop is to seed an annual cool- (e.g., small grains such as oats, wheat, or triticale) or warm-season (e.g., millet or sorghum-sudangrass) forage in the spring/early summer, harvest it for hay sometime in July, and then plant birdsfoot trefoil into the stubble in early August.

If an existing pasture is being completely renovated and reseeded using tillage, there is likely to be a large and viable weed seed bank in the soil. In this case, growing a small grain forage for one or two years, particularly if chemical weed control is not desirable (e.g., organic production), is a good option that will provide a source of feed while depleting the weed seed bank.

Birdsfoot trefoil can be successfully seeded in the spring, but weed control is critical. There are several preplant herbicides that can be used to control both annual grasses and broadleaf weeds including Balan 60DF® and Eptam®. For postemergent weed control, Butyrac® (2,4-DB) is labeled for control of certain annual broadleaf weeds in the seedling stage (do not apply to established stands!), and Pursuit® is labeled only in Utah for control of broadleaf weeds in both seedling and established stands. There are a number of herbicides for the control of grassy weeds in birdsfoot trefoil, including Select 2EC®, Select Max®, Intensity®, Intensity One®, and Poast®. Kerb 50-W® can be used in the late fall/early winter prior to the ground freezing to control annual grasses. For more detailed information on use of these herbicides, please read the label and/or see Prather (2014).

Since herbicide choices are limited for controlling broadleaf weeds in birdsfoot trefoil during establishment, mowing or green-chopping them to a height of 4-6 inches are good options. Initiate mowing when the weeds reach 10 to 15 inches in height, before competition becomes too intense and birdsfoot trefoil seedlings start to die. More than one mowing during the establishment year may be required. Once trefoil is established, it competes fairly well against weeds due to its somewhat prostrate growth form.

Mid to late summer seedings are often preferable to spring seedings because competition from annual weeds is not as intense. However, as trefoil is slow to establish, it must be planted at least 2 weeks earlier than more vigorous legumes like alfalfa when seeded in late summer. For many areas, this means seeding no later than August 15. This allows enough time for seedlings to achieve sufficient growth (3 to 4 leaf stage, ~4 inches in height) and survive the winter.

The final consideration is irrigation management. Half the battle with obtaining a stand of trefoil is getting the seeds to germinate and the seedlings to break through the soil surface. For the first 2 weeks following planting, apply light, frequent applications of water with the goal of keeping the soil surface moist. This is especially important on heavier, clay-texture soils to avoid issues with crusting and may require irrigating every 1 to 3 days if possible. Once the seedlings have emerged, it is still important to water lightly once or twice per week for another 4-6 weeks to give the root system time to develop sufficiently.

Interseeding Methods

Birdsfoot trefoil can be interseeded into existing grass stands, but because of its weak seedling vigor, there are several key elements that must be given attention in order to increase the probability of successful stand establishment. The biggest factor is to suppress the existing vegetation prior to seeding. This is a must and can be accomplished using several different methods.

The most successful method is to apply Roundup® herbicide about two weeks prior to seeding (Figure 5). This length of time is needed to allow the chemical to deactivate before the seeds germinate, especially if there is an accumulation of organic matter on the soil surface. Roundup® is a non-selective, systemic herbicide that is supposed to kill most grass and broadleaf plants. However, when applied at "light" (sublethal) rates, it will generally just suppress most well-established perennials, especially grasses like smooth brome, orchardgrass, and tall fescue, for a period of time, giving the trefoil enough time to establish.

Figure 5. Irrigated grass hayfield near Kimberly, Idaho, just prior to interseeding birdsfoot trefoil in the spring. The photo illustrates suppression of the existing grass by close mowing (~3 inches) or spraying with Roundup® 2 weeks prior to seeding at 32 ounces per acre compared to no suppression (control). The field was dominated by orchardgrass which fully recovered by the following growing season.

Depending on your location, length of the growing season, and what point in the season that Roundup® is actually applied, some or all of that year's production may be sacrificed. The rate of Roundup® to use and its ultimate effectiveness will depend on the species present, their stage of growth, time of year, and whether they are experiencing water or nutrient stress. Rates will generally vary from as little as 16 ounces per acre, which will suppress grasses like Kentucky bluegrass, to 32-48 ounces per acre, which are often needed to suppress grasses like tall fescue and smooth brome. Many people are hesitant to apply Roundup® at the higher rates, but most perennial grasses will re-

cover by the next growing season. Keep in mind that if you apply a lighter rate and the existing vegetation comes back too quickly, you can always top it with a mower at 4-6 inches or lightly graze it with livestock for a short period of time.

Other methods of suppressing the existing vegetation include light tillage such as disking or rototilling (just deep enough to scuff the tops off the grasses), flail mowing at ground level, and heavy grazing (do not graze more than 7 days following seeding to avoid trampling of seedlings). Effectiveness of these methods is related to how long the existing vegetation remains suppressed (i.e., how quickly regrowth occurs). Heavy grazing is generally the least effective, followed by flail mowing which is intermediate, and then light tillage which is the most effective of these methods.

Spring is a good time to interseed trefoil because it allows the full growing season for plants to establish. The main drawback with this approach is that the existing vegetation is growing most vigorously at this time of year and competes strongly with the trefoil seedlings. Suppression of the existing vegetation is a must for successful stand establishment (Figure 6). Another option is to interseed later in the summer following heavy grazing during the first half of the season or a mid-summer hay crop. With this approach, you can obtain a partial forage crop, plus regrowth of cool-season grasses will be slower and primarily vegetative at this time of the year, so competition is reduced, especially for light. Birdsfoot trefoil has been successfully interseeded at this time of year without the need for any additional suppression. With this approach, interseeding should occur around the first of August and no later than the 15th to allow time for seedling establishment.

Figure 6. Birdsfoot trefoil 1 year after it was successfully interseeded into a smooth brome dominated hayfield near Fort Collins, Colorado. The brome was suppressed by spraying 32 ounces per acre of Roundup® 2 weeks prior to seeding in early May.

Birdsfoot trefoil seedlings are sensitive to reduced light levels and light competition should not be overlooked when interseeding. When shaded by the existing overstory plants, interseeded trefoil seedlings quickly turn a light greenish-yellow color and become long and spindly. When the overstory is eventually removed and the seedlings are exposed to direct sunlight, wind, etc., they are very delicate and often shrivel up and die. In a hay operation, something as simple as removing the crop 2 weeks earlier than normal can alleviate shading and significantly improve establishment success by as much as 10 times (0.5 versus 5.5 plants per square foot). This result was achieved by interseeding trefoil in May with no additional suppression of the existing grasses, illus-

trating the impact of reducing light competition on establishment. After interseeding into a pasture, flash grazing, the practice of briefly grazing a pasture with a high concentration of livestock, can be used to remove the overstory while minimizing damage to the seedlings by trampling.

When interseeding, it is critical to apply light, frequent applications of irrigation water for the first 6-8 weeks to favor growth of the trefoil and not the existing vegetation. Remember that you are investing time, seed, etc., into establishing trefoil into your existing grass stand and you must be willing to sacrifice at least some yield from the existing stand.

Conclusions

Birdsfoot trefoil has several advantages that make it worth considering for pasture and hay production in the Mountain West. Most importantly, its high nutritive value combined with ruminant-friendly tannins will support livestock production without risk of bloat, while it fixes nitrogen to increase production in the entire pasture. Producers may decide not to use birdsfoot trefoil because its slow seedling growth results in poor competition with weeds in the establishment year. In reality, birdsfoot trefoil is no more difficult to establish than other small-seeded forages, with stands of irrigated birdsfoot trefoil typically reaching their full yield potential in the year following planting. By paying close attention to the well-known methods used for establishing any small-seeded forage and having a little patience, you will be rewarded with a productive, high-quality, long-lived forage that will greatly improve your pasture or hayfield.

References

Brummer, J., G. Shewmaker, and C. Engel. 2011. Challenges and benefits of interseeding legumes into grass dominated stands. *In:* Proceedings, 2011 Western Alfalfa & Forage Conference, Las Vegas, NV, UC Coop. Ext., Plant Sciences Department, Univ. of California, Davis, CA. Available online at http://alfalfa.ucdavis.edu/+symposium/2011/index.aspx.

Hunt, S.R., J.W. MacAdam, and T.C. Griggs. 2016. Seeding rate, oat companion crop, and planting season effects on irrigated organic birdsfoot trefoil stands in the Mountain West United States. Crop Sci. 56:463–473.

MacAdam, J.W. 2002. Grass and forage legume mixes – What's hot and what's not! p. 79-88. *In:* J.E. Brummer and C.H. Pearson (ed.), Proceedings of the Intermountain Forage Symposium. Colorado State Univ., Tech. Bull. LTB 02-1, Fort Collins, CO.

MacAdam, J.W. and T.C. Griggs. 2006. Performance of birdsfoot trefoil, white clover, and other legume-grass mixtures under irrigation in the Intermountain West U.S.A. *In:* A. Popay (ed.), Proceedings of the New Zealand Grassland Association 64: 355-359.

MacAdam, J.W. and T.C. Griggs. 2013. Irrigated birdsfoot trefoil variety trial: Forage nutritive value. Utah State Univ. Ext. Fact Sheet AG/Forages/2013-02pr, Logan, UT. Available online at: http://extension.usu.edu/files/publications/publication/AG_Forages__2013-01pr.pdf.

MacAdam, J.W., J. Brummer, A. Islam, and G. Shewmaker. 2013. The benefits of tannin-containing forages. Utah State Univ. Ext. Fact Sheet AG/Forages/2013-03pr, Logan, UT. Available online at: http://extension.usu.edu/files/publications/publication/AG_Forages_2013-03pr.pdf.

Prather, T. 2014. Birdsfoot Trefoil, p. F-19–F-20. *In:* E. Peachey, editor, Pacific Northwest Weed Management Handbook, Section F – Forage and Seed Crops. Oregon State University, Corvallis, OR.

PERENNIAL LEGUME PASTURES

References to pesticide products in this publication are for your convenience and are not an endorsement of one product over similar products. You are responsible for using pesticides according to the manufacturer's current label directions. Follow directions exactly to protect the environment and people from pesticide exposure. Failure to do so violates the law.

EXTENSION
UtahStateUniversity