SWEETCLOVERS

Yellow sweetclover *(Melilotus officinalis)* and white sweetclover *(M. alba)*

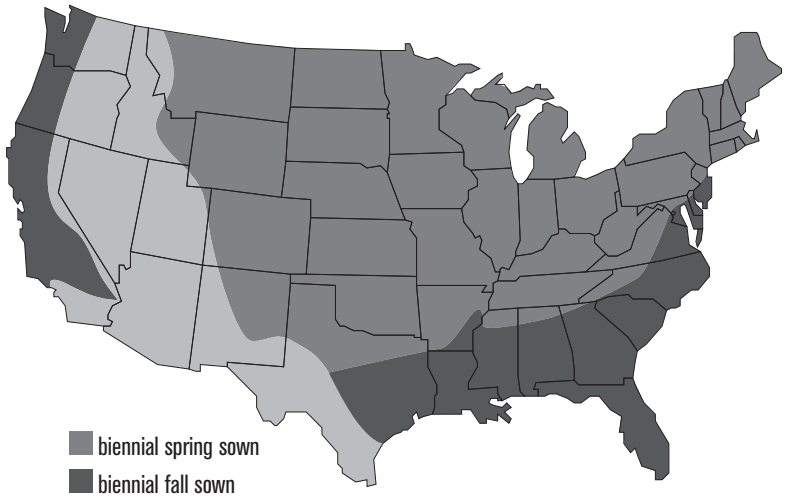
Also called: HUBAM (actually a cultivar of annual white sweetclover)

Type: biennial, summer annual or winter annual legume

Roles: soil builder, fertility source, subsoil aerator, weed suppressor, erosion preventer

Mix with: small grains, red clover

See charts, pp. 66 to 72, for ranking and management summary.



Within a single season on even marginally fertile soils, this tall-growing biennial produces abundant biomass and moderate amounts of nitrogen as it thrusts a taproot and branches deep into subsoil layers. Given fertile soils and a second season, it lives up to its full potential for nitrogen and organic matter production. Early in the second year it provides new top growth to protect the soil surface as its roots anchor the soil profile. It is the most drought-tolerant of forage legumes, is quite winter-hardy and can extract from the soil then release phosphorus, potassium and other micronutrients that are otherwise unavailable to crops.

Sweetclover thrives in temperate regions wherever summers are mild. *Annual* sweetclovers (HUBAM is the most well known) work best in the Deep South, from Texas to Georgia. There, they establish more quickly than the biennial types and produce more biomass in the seeding year in southern regions.

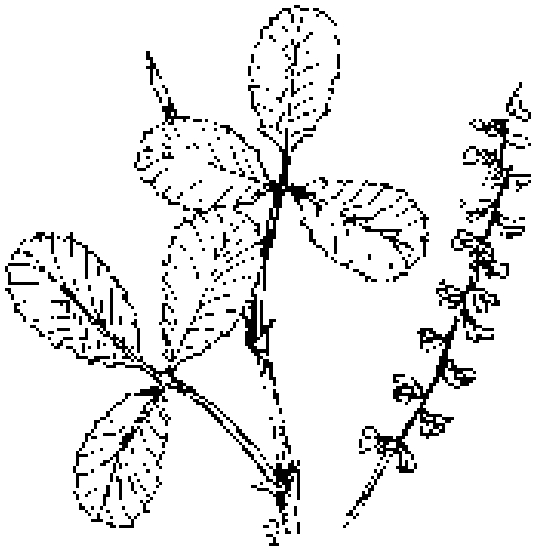
In this chapter, "sweetclover" refers to *biennial* types unless otherwise noted.

Sweetclover was the king of green manures and grazing legumes in the South and later throughout the Midwest in the first half of this century. Sweetclover is used as a cover crop most commonly now in the Plains region, with little use in California.

Types

Biennial *yellow* sweetclover can produce up to 24 inches of vegetative growth and 2.5 tons dry matter/A in its establishment year. During the second year, plants may reach 8 feet tall. Root mass and penetration (to 5 feet) are greatest at the end of dormancy in early spring, then gradually dissipate through the season (443).

A distinguishing sweetclover feature is bracts of tiny blooms through much of its second year. *White* biennial sweetclovers are taller, more coarsely stemmed, less drought tolerant, and produce less biomass in both the seeding and second years. White types bloom 10 to 14 days later than yellow, but bloom for a longer season. They reportedly establish more readily in New York (450). Tall, stemmy cultivars are better for soil improvement (120, 361, 422).



Marianne Sarrantonio

YELLOW SWEETCLOVER (Melilotus officinalis)

Both yellow and white sweetclover have cultivars bred for low levels of coumarin. This compound exists in bound form in the plant and poses no problem during grazing. However, coumarin can cause internal injury to cattle when they eat spoiled sweetclover hay or silage.

Annual sweetclover (*Melilotus alba var. annua*) is not frost tolerant, but can produce up to 9,000 lb. dry matter/A over a summer after being oversown into a grain crop or direct seeded with a spring grain nurse crop. The best-known annual sweetclover cultivar is HUBAM, a name often used for all annual white sweetclover. While its taproot is shorter and more slender than that of its biennial cousins, it still loosens subsoil compaction.

BENEFITS

Nutrient scavenger. Sweetclover appears to have a greater ability to extract potassium, phosphorus and other soil nutrients from insoluble minerals than most other cover crops. Root branches take in minerals from seldom-disturbed soil horizons, nutrients that become available as the tops and roots decompose (361).

Research in Saskatchewan during a 34-year period showed that phosphorus (P) availability increased in *subsoil* layers relative to *surface* layers, peaking at an 8-foot depth. Winter wheat and safflower, with deeper root systems than spring wheat, could tap the deep P buildup from the legume roots and fallow leaching, whereas spring wheat could not. The vesicular-arbuscular mycorrhizal (VAM) fungi associated with legume roots contribute to the increased P availability associated with sweetclover (69, 70).

N source. A traditional green manure crop in the upper Midwest before nitrogen fertilizer became widely available, sweetclover usually produces about 100 lb. N/A, but can produce up to 200 lb. N/A with good fertility and rainfall. In Ohio, it contained about 125 lb. N/A by May 15, increasing to 155 lb. by June 22. Illinois researchers reported more than 290 lb. N/A.

Abundant biomass. If planted in spring and then given two full seasons, biennial sweetclovers can produce 7,500 to 9,000 lb. dry matter/A (3,000 to 3,500 lb./A in the seeding year, and 4,500 to 5,500 lb./A the second). Second-year yields may go as high as 8,500 lb./A.

Hot-weather producer. Sweetclover has the greatest warm-weather biomass production of any legume, exceeding even alfalfa.

Soil structure builder. Kansas farmer Bill Granzow says sweetclover gives his soils higher organic matter, looser structure and better tilth. See *Sweetclover: Good Grazing, Great Green Manure* (p. 174). HUBAM annual sweetclover also improved soil quality and increased yield potential in 1996 New York trials (451).

Compaction fighter. Yellow sweetclover has a determinate taproot root up to 1 foot long with extensive branches that may penetrate 5 feet to aerate subsoils and lessen the negative effects of compaction on crops. White types have a strong tap root that is not determinate.

Drought survivor. Once established, sweetclover is the most drought tolerant of all cover crops that produce as much biomass. It is especially resilient in its second year, when it could do well in a dry spring during which it would be difficult to establish annual cover crops. The yellow type is less sensitive to drought and easier to establish in dry soils than the white type.

Attracts beneficial insects. Blossoms attract honeybees, tachinid flies and large predatory wasps, but not small wasps.

Widely acclimated. Self-reseeding sweetclover can be seen growing on nearly barren slopes, road rights-of-way, mining spoils and soils that have low fertility, moderate salinity or a pH above 6.0 (183). It also can tolerate a wide range of environments from sea level to 4,000 feet in altitude, including heavy soil, heat, insects, plant diseases (120) and as little as 6 inches of rain per year.

Livestock grazing or hay. If you need emergency forage, sweetclover has a first-year feed value similar to alfalfa, with greater volume of lesser quality in the second year.

MANAGEMENT

Establishment & Field Management

Sweetclover does well in the same soils as alfalfa. Loam soils with near-neutral pH are best. Like alfalfa, it will not thrive on poorly drained soils. For high yields, sweetclover needs P and K in the medium to high range. Deficient sulfur may limit its growth (153). Use an alfalfa/sweetclover inoculant.

In temperate areas of the Corn Belt, drill yellow sweetclover in pure stands at 8 to 15 lb./A or broadcast 15 to 20 lb./A, using the higher rate in dry or loose soils or if not incorporating.

In drier areas such as eastern North Dakota, trials of seeding rates from 2 to 20 lb./A showed that just 4 lb./A, broadcast or drilled, created an adequate sole-crop stand for maximum yield. Recommended rates in North Dakota are 4 to 6 lb./A drilled with small grains at small-grain planting, 5 to 8 lb./A broadcast and harrowed (sometimes in overseeding sunflowers), and 6 to 10 lb./A. broadcast without incorporating tillage (183).

An excessively dense stand will create spindly stalks that don't branch or root to the degree that plants do in normal seedings. Further, the plants will tend to lodge and lay over, increasing the risk of diseases. So for maximum effect of subsoil penetration or snow trapping, go with a lighter seeding rate.

Sweetclover produces 50 percent or more hard seed that can lie in soil for 20 years without germinating. Commercial seed is scarified to break this non-porous seedcoat and allow moisture to trigger germination. If you use unscarified seed, check hardseed count on the tag and do not count on more than 25 percent germination from the hardseed portion. The need for scarification to produce an adequate stand may be over-rated, however. The process had no effect on germination in six years of field testing in North Dakota—even when planting 70 percent hard seed still in seed pods.

Winter-hardy and drought tolerant, this biennial can produce up to 200 lb. N/A with good fertility and rainfall.

Seed at a depth of 1/4 to 1/2 inch in medium to heavy textured soils, and 1/2 to 1.0 inch on sandy soils. Seeding too deeply is a common cause of poor establishment.

Seed *annual* white sweetclover at 15 to 30 pounds per acre. Expect 70 to 90 lb. N/A from 4,000 to 5,000 lb. dry matter/A on well-drained, clay loam soils with neutral to alkaline pH.

A press-wheel drill with a grass seed attachment and a seed agitator is suitable for planting sweetclover into a firm seedbed. If the seedbed is too loose to allow the drill to regulate seeding depth, run the seed spouts from the grass and legume boxes to drop seed behind the double-disk opener and in front of the press wheels. Light, shallow harrowing can safely firm the seedbed and incorporate seed (183).

In the Canadian Northern Plains, dribble the seed through drill box hoses directly in front of the presswheels for quick and easy establishment (32).

If your press-wheel drill has no legume box or grass-seed attachment, you can mix the legume and small grain seed, but mix seed often due to settling. Reduce competition between the crops by seeding a part of the companion crop first, then seed a mix of the clover seed and the balance of the grain seed at right angles (183).

Sweetclover: Good Grazing, Great Green Manure

Bill Granzow taps biennial yellow sweetclover to enhance soil tilth, control erosion and prevent subsoil from becoming compacted. He uses common varieties, either from the elevator or one his father originally bought from a neighbor.

Granzow, of Herington, Kan., produces no-till grain and runs cattle in an area midway between Wichita and Manhattan in the east-central part of the state. Granzow overseeds sweetclover into winter wheat in December or January at 12 to 15 lb./A using a rotary broadcaster mounted on his pickup. Sometimes he asks the local grain cooperative to mix the seed with his urea fertilizer for the wheat. There's no extra charge for seed application. Alternately, Granzow plants sweetclover at the same rate with March-seeded oats.

Yellow sweetclover has overgrown Granzow's wheat only when the wheat stand is thin and abnormally heavy rains delay harvest. The minimal problem is even rarer in oats, he says.

He uses yellow sweetclover with the companion wheat crop in four possible ways, depending on what the field needs or what other value he wants to maximize. For each, he lets the clover grow untouched after wheat harvest for the duration of the seeding year. He used to disk the sweetclover at least twice to kill it. Now 100% no-till, he sprays with Roundup and "a little bit of 2,4-D." Second-year options include:

- **Grazing/green manure.** Turn in livestock when the clover reaches 4 inches tall, let them graze for several weeks, spray to kill, then plant grain sorghum within a couple of days. He feeds an anti-bloat medication to keep cattle healthy on the lush legume forage.
- **Quick green manure.** Spray after it has grown 3 to 4 inches, then plant sorghum. This method contributes about 60 pounds of N to the soil. He knocks back persistent re-growing sweetclover crowns in the sorghum by adding 2, 4-D or Banvel to the postemerge herbicide mix.
- **Green manure/fallow.** Kill at mid- to full bloom, leave fallow over summer, then plant wheat again in fall. This method provides about 120 lb. N/A, according to estimates from Kansas State University.
- **Seed crop.** He windrows the plants when about 50 percent of the seedpods have turned black, then runs the stalks through his combine. To remove all of the hulls, he runs the seed through the combine a second or third time.

Despite the heavy growth in the second year, yellow sweetclover matures and dies back naturally. If the residue is heavy, he sets the drill a bit deeper for planting.

He rates fall sweetclover hay from the seeding year as "acceptable forage." He's aware that moldy sweetclover hay contains coumarin, a compound that can kill cattle, but he's never encountered the problem. Second-year yellow sweetclover makes silage at initial to mid-bloom stage with 16 percent protein on a dry matter basis.

"Mixed with grass hay or other silage, it makes an excellent feed," he says, adding value to its cover crop benefits and giving him farming flexiblity.

Updated in 2007 by Andy Clark

Spring seeding provides yellow sweetclover ample time to develop an extensive root system and store high levels of nutrients and carbohydrates necessary for over-wintering and robust spring growth. It grows slowly the first 60 days (153). Where weeds would be controlled by mowing, no-till spring seeding in small grain stubble works well.

Broadcast seeding for pure sweetclover stands works in higher rainfall areas in early spring where soil moisture is adequate for seven to 10 days after planting. No-till seeding works well in small grain stubble.

Frostseeding into winter grains allows a harvest of at least one crop during the life cycle of the sweetclover and helps control weeds while the sweetclover establishes. Apply sweetclover seed before rapid stem elongation of the grain. Cut grain rate about one-third when planting the crops together.

Sweetclover spring seeded with oats exhibited poor regrowth after oat harvest in two years of a Wisconsin study. To establish a sweetclover cover crop in this way, the researchers found sweetclover did not fare well in years when the combine head had to be run low to pick up lodged oats. When oats remained upright (sacrificing some straw for a higher cut), sweetclover grew adequately (402).

You can plow down spring-planted yellow sweetclover in late fall of the planting year to cash in early on up to half its N contribution and a bit less than half its biomass.

Plant biennial sweetclover through late summer where winters are mild, north through Zone 6. Plant at least six weeks before frost so roots can develop enough to avoid winter heaving. In the Northern Plains into Canada, it should be planted by late August.

First-year management. Seeding year harvest or clipping is usually discouraged, because the energy for first-year regrowth comes directly from photosynthesis (provided by the few remaining leaves), not root reserves (361, 402).

Top growth peaks in late summer as the plant's main taproot continues to grow and thicken. Second-year growth comes from crown buds that form about an inch below the soil surface. Avoid mowing or grazing of sweetclover in the six- to seven-week period prior to frost when it is building final winter reserves. Root production practically doubles between Oct. 1 and freeze-up.

Sweetclover establishes well when sown with winter grains in fall, but it can outgrow the grain in a wet season and complicate harvest.

Second-year management. After it breaks winter dormancy, sweetclover adds explosive and vigorous growth. Stems can reach 8 feet before flowering, but if left to mature, the stems become woody and difficult to manage. Plants may grow extremely tall in a "sweetclover year" with high rainfall and moderate temperatures.

Nearly all growth the second year is topgrowth, and it seems to come at the expense of root mass. From March to August in Ohio, records show topgrowth increasing tenfold while root production *decreased* by 75 percent (443). All crown buds initiate growth in spring. If you want regrowth after cutting, leave plenty of stem buds on 6 to 12 inches of stubble. You increase the risk of killing the sweetclover plant by mowing heavier stands, at shorter heights, and/or at later growth stages, especially after bloom (183).

Before it breaks dormancy, sweetclover can withstand flooding for about 10 days without significant stand loss. Once it starts growing, however, flooding will kill the plants (183).

Killing

For best results ahead of a summer crop or fallow, kill sweetclover in the second year after seeding when stalks are 6 to 10 inches tall (183, 361). It can be killed by mowing, cultivating or disking once it reaches late bloom stage (32). Killing sweetclover before bud stage has several benefits: 80 percent of the potential N is present; N release is quick because the plant is still quite vegetative with a high N percentage in young stalks and roots; and moisture loss is halted without reducing N contribution. Sweetclover may regrow from healthy crowns if incorporated before the end of dormancy. For optimum full-season organic mat-

ter contribution, mow prior to blossom stage whenever sweetclover reaches 12 to 24 inches high before final incorporation or termination (361). Mowing or grazing at bloom can kill the plants.

In dryland areas, the optimum termination date for a green manure varies with moisture conditions. In a spring wheat>fallow rotation in Saskatchewan, sweetclover incorporated in mid-June of a dry year provided 80 percent more N the following spring than it did when incorporated in early July or mid-July—even though it yielded up to a third less biomass at the June date. Mineralization from sweetclover usually peaks about a year after it is killed. The potential rate of N release decreases as plants mature and is affected by soil moisture content (147).

During its second season, yellow sweetclover can grow 8 feet tall while roots penetrate 5 feet deep.

In this study, the differences in N release were consistent in years of normal precipitation, but were less pronounced. Little N mineralization occurred in the incorporation year. Nitrogen addition peaked in the following year, and has been shown to continue over seven years following yellow sweetclover (147).

In northern spring wheat areas of North Dakota, yellow sweetclover is usually terminated in early June just at the onset of bloom, when it reaches 2 to 3 feet tall. This point is a compromise between cover crop gain (in dry matter and N) and water consumption. A quick kill from tillage or haying is more expensive and labor-intensive than chemical desiccation, but it stops moisture-robbing transpiration more quickly (153).

Grazing is another way to manage second-year sweetclover before incorporation. Start early in the season with a high stocking rate of cattle to stay ahead of rapid growth. Bloat potential is slightly less than with alfalfa (153).

Pest Management

Sweetclover is a rather poor competitor in its establishment year, making it difficult to establish pure sweetclover in a field with significant weed pressure. Once established, it provides effective weed control during the first fall and spring of fallow, whether or not it is harvested for hay, incorporated or left on the soil surface (33).

Sweetclover residue is said to be allelopathic against kochia, Russia thistle, dandelion, perennial sowthistle, stinkweed and green foxtail. Repeated mowing of yellow sweetclover that is then left to mature is reported to have eradicated Canada thistle. Letting sweetclover bloom and go to seed dries out soil throughout the profile, depleting the root reserves of weeds.

Sweetclover weevil (*Sitonia cylindricollis*) is a major pest in some areas, destroying stands by defoliating newly emerged seedlings. Long rotations can reduce damage, an important factor for organic farmers who depend on sweetclover fertility and soil improvements. In the worst years of an apparent 12 to 15-year weevil cycle in his area, "every sweetclover plant across the countryside is destroyed," according to organic farmer David Podoll, Fullerton, N.D. "Then the weevil population crashes, followed by a few years where they're not a problem, then they begin to rebuild."

Cultural practices have not helped change the cycle, but planting early with a non-competitive nurse crop (flax or small grains) gives sweetclover plants the best chance to survive weevil foraging, Podoll says. Further research is needed to develop management techniques to control the weevil.

In a three-year Michigan trial of crop rotations to decrease economic losses to nematodes, a yellow sweetclover (YSC)>YSC>potato sequence out-yielded other combinations of rye, corn, sorghum-sudangrass and alfalfa. Two years of clover or alfalfa followed by potatoes led to a yield response equivalent to application of a nematicide for control of premature potato vine death (78). Legume-supplied N coupled with an overall nutrient balance and enhanced cation exchange capacity from the cover crop are thought to be involved in suppressing nematode damage (271).

Crop Systems

In the moderately dry regions of the central and northern Great Plains, "green fallow" systems with water-efficient legumes can be substituted for bare-ground or stubble mulch fallow. In fallow years, no cash crop is planted with the intent of recovering soil moisture, breaking disease or weed cycles and maximizing yields of following cash crops. The retained residue of "brown" fallow lessens the erosion and evaporation of tillage-intensive "black fallow," but "green fallow" offers even more benefits in terms of soil biological life, biodiversity, beneficial insect habitat, possible harvestable crops and alternate forages.

Rapeseed (*Brassica campestris*) is a summer annual cash crop in the dryland West that can serve as a nurse crop for sweetclover. A Saskatchewan study of seeding rates showed optimum clover yield came when sweetclover was sown at 9 lb./A and rapeseed was sown at 4.5 lb./A. The mixture allows an adequate stand of sweetclover that provides soil protection after the low-residue rapeseed (255).

Sole-cropped oilseed species (rapeseed, sunflower, crambe and safflower) require herbicides for weed control. Many of these materials are compatible with legumes, offering a post-emergent weed-control option if the covers do not adequately suppress weeds. The covers greatly reduce the erosion potential after oilseed crops, which leave little residue over winter (153).

Interplanting works with tall crops. A Wisconsin researcher reported success drilling sweetclover between the rows when corn was 6 to 12 inches tall. Overseeding sweetclover into sweet corn works even better due to greater light penetration.

Soil water availability at cover crop planting and depletion during growth are always a concern in semi-arid regions. The potential benefits must be balanced against possible negative effects on the cash crop.

Sweetclover overseeded into sunflowers at last cultivation succeed about half the time, North Dakota trials show. Dry conditions or poor seed-to-soil contact were the main reasons for not getting a stand. A heavier seeding rate or earlier planting will tend to increase stand. Band-seeding sweetclover over the row with an insecticide box at sunflower planting proved more successful in the trial. The method also permits between-row cultivation (153).

Even though legume green manures in another North Dakota study used about 2.8 inches (rainfall equivalent) more water than fallow, they led to a 1-inch equivalent increase over fallow in soil water content in the top 3 inches of soil the following spring (14).

Sweetclover is the best producing warm-season forage legume, even topping alfalfa.

One green fallow option is planting yellow sweetclover with spring barley or spring peas. This is challenging, however, because barley can be overly competitive while herbicide compatibility is a concern with the peas.

Further north into the Canadian Great Plains, sweetclover depleted soil moisture by September of year 1, but by May of year 2, soil moisture was greater due to snow trapping, increased infiltration and reduced evaporation (32).

Fred Kirschenmann of Windsor, N.D., controls spring weed flushes on his fallow after sunflowers with an initial shallow chisel plowing then a rod weeder pass or two before planting sweetclover with a nurse crop of buckwheat or oats (or millet, if there is less soil moisture). He harvests buckwheat, hoping for a 900 lb./A yield, then lets the clover grow and overwinter. In early summer, when he begins to see yellow blossoms, he disks the cover, lets it dry, then runs a wide-blade sweep plow just below the surface to cut apart the crowns. The biomass contribution of the sweetclover fallow builds up organic matter, he says, in contrast to the black-fallow route of burning up organic matter to release N. Preventing humus depletion holds back the dreaded kochia weed.

In temperate areas you can overseed spring broccoli with HUBAM annual sweetclover, let the cover grow during summer, then till it in before

planting a fall crop. Alternatively, you can allow it to winterkill for a thick, lasting mulch.

In Pennsylvania, Eric and Anne Nordell seed sweetclover after early vegetables (in June or July) and allow it to grow throughout the summer. It puts down a deep taproot before winter, fixes nitrogen and may bring nutrients to the soil surface from deep in the soil profile. See *Full-Year Covers Tackle Tough Weeds*, p. 38.

Other Options

First-year forage has the same palatability and feeding value as alfalfa, although harvest can reduce second-year vigor. Second-year forage is of lower quality and becomes less palatable as plants mature, but may total 2 to 3 tons per acre (120).

Sweetclover tolerates a wide range of harsh environments, poor soils and pests.

Growers report seed yield of 200 to 400 lb./A in North Dakota. Minimize shattering of seedpods by swathing sweetclover when 30 to 60 percent of its pods are brown or black. Pollinating insects are required for good seed yield (183).

Hard seed that escapes harvest will remain in the soil seed bank, but organic farmer Rich Mazour of Deweese, Neb., sees that as a plus. A 20- to 30-percent stand in his native grass pastures comes on early each spring, giving his cattle early grazing. Once warm-season grasses start to grow, they keep the clover in check. In tilled fields, sweep cultivators and residue-management tillage implements take care of sweetclovers with other tap-rooted "resident vegetation," Mazour says.

COMPARATIVE NOTES

Sweetclover and other deep-rooted biennial and perennial legumes are not suited for the most severely drought-prone soils, as their excessive soil moisture use will depress yield of subsequent wheat crops for years to come (163).

When planting sweetclover after wheat harvest, weeds can become a problem. An organic farmer in northeastern Kansas reports that to kill cocklebur, he has to mow lower than the sweetclover can tolerate. Annual alfalfa can tolerate low mowing (205).

After 90 days' growth in a North Dakota dryland legume comparison, a June planting of yellow sweetclover produced dry matter and N comparable to alfalfa and lespedeza (*Lespedeza stipulacea Maxim*). Subclover, fava beans (*Vicia faba*) and field peas had the best overall N-fixing efficiency in the dryland setting because of quick early season growth and good water use efficiency (331).

Cultivars. Yellow cultivars include MADRID, which is noted for its good vigor and production, and its relative resistance to fall freezes. GOLDTOP has excellent seedling vigor, matures two weeks later, provides larger yields of higher quality forage and has a larger seed than MADRID (361). Yellow common and YUKON joined GOLDTOP and MADRID—all high-coumarin types—as the highest yielding cultivars in a six-year North Dakota test (269).

Leading white biennial cultivars are DENTA, POLARA and ARCTIC. POLARA and ARCTIC are adapted to very cold winters. Best for grazing are the lower-producing, low-coumarin cultivars DENTA and POLARA (white) and NORGOLD (yellow).

Seed sources. See *Seed Suppliers* (p. 195).