BERSEEM CLOVER

Trifolium alexandrinum

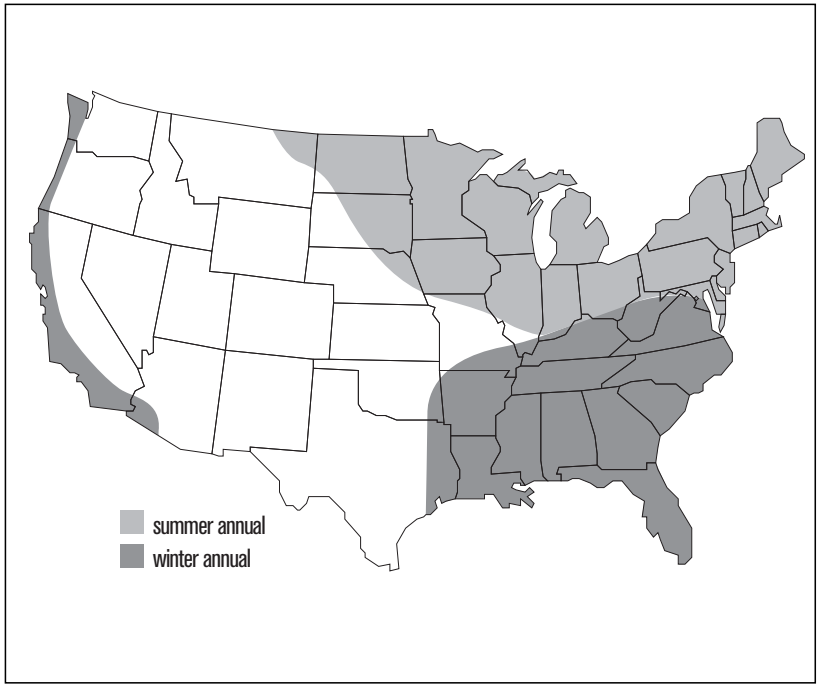
Also called: Egyptian clover

Type: summer annual or winter annual legume

Roles: suppress weeds, prevent erosion, green manure, chopped forage, grazing

Mix with: oats, ryegrass, small grains as nurse crops; as nurse crop for alfalfa

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



A fast-growing summer annual, berseem clover can produce up to 8 tons of forage under irrigation. It's a heavy N producer and the least winter hardy of all true annual clovers. This makes it an ideal winterkilled cover before corn or other nitrogen-demanding crops in Corn Belt rotations. Berseem clover draws down soil N early in its cycle. Once soil reserves are used up, it can fix 100 to 200 lb. N/A or more. It establishes well with an oat nurse crop, making it an excellent cover for small grain>corn>soybean rotations in the Midwest.

In Iowa, the cultivar BIGBEE compares favorably with alfalfa in its regrowth following small grain harvest, its feed value and its tolerance to drought and excess moisture (156). As a winter annual in California, irrigation usually is needed to allow berseem to achieve its full potential. Its peak growth period during the West Coast's rainy season and its highly efficient water use compare favorably to alfalfa as a high-producing forage and green manure.

BENEFITS

Green manure. Berseem clover is the fertility foundation of agriculture in the Nile Delta, and has nourished soils in the Mediterranean region for millennia. MULTICUT berseem clover averaged 280 lb. N/A in a six-year trial in California with six cuttings per year (162), and grew faster than BIGBEE in one Iowa report (155). Berseem is less prone to possible N leaching if grown to maturity without cutting, when it produces 100 to 125 lb. N/A. Top N fixation occurs when soils have less than 150 lb. N/A (162). A single cutting can yield

50 to 100 lb. topgrowth N/A. Berseem's dry matter N concentration is about 2.5 percent (162).

Biomass. Berseem clover produced the most biomass (6,550 lb./A) of five winter annual legumes in a two-year Louisiana test, and came in second to arrowleaf clover (*Trifolium vesiculosum*) in N, accumulating 190 lb. N/A to arrowleaf's 203 lb. N/A. Also tested were TIBBEE crimson clover, WOOGENELUP subterraneum clover and WOODFORD bigflower vetch. All but arrowleaf clover were able to set seed by May 13 and regrow in the fall, despite the herbicides used to suppress them in spring and to control weeds during summer (36).

In Alberta legume trials, berseem clover averaged 3,750 lb. dry matter/A over three years at a site where hairy vetch and field peas produced 5,300 and 4,160 lb./A, respectively. With irrigation, berseem clover topped 19 other legumes at the same site with a mean yield of 5,500 lb. DM/A.

Smother crop. Planted with oats or annual ryegrass, berseem clover suppresses weeds well during establishment and regrowth after oat harvest.

Companion crop. Planted with oat, the two crops can be harvested together as silage, haylage or hay, depending on the crop's development stage. Berseem/oat haylage has very high feed quality if cut at oats' boot stage (157). Dry seasons favor development of an oat grain crop, after which berseem clover can be cut one, two or three times in the Midwest.

Quick growing. At 60° F, berseem clover will be ready to cut about 60 days after planting.

Legume nurse crop. Because of its quick germination (seven days), quick growth and winterkilling tendency, berseem clover can be used as **a nurse crop for alfalfa.**

Seed crop. Berseem produces up to 1,000 lb. seed/A if it is left to mature. Only BIGBEE berseem clover has hard seed that allows natural self-reseeding, and it reseeds too late for timely planting of most summer crops (103).

Grazing and forage crop. At 18 to 28 percent protein, young berseem clover is comparable to or better than crimson clover or alfalfa as feed. No cases of bloat from grazing berseem clover have been reported (158, 278). Forage quality remains acceptable until the onset of seed production. BIGBEE berseem clover and TIBBEE crimson produce more fall and winter growth than do other winter annual clovers in the South. BIGBEE continues producing longer into the spring than other legumes, extending cuttings into late May or early June in Mississippi (225).

MULTICUT berseem clover averaged 280 lb. N/A in a six-year California trial.

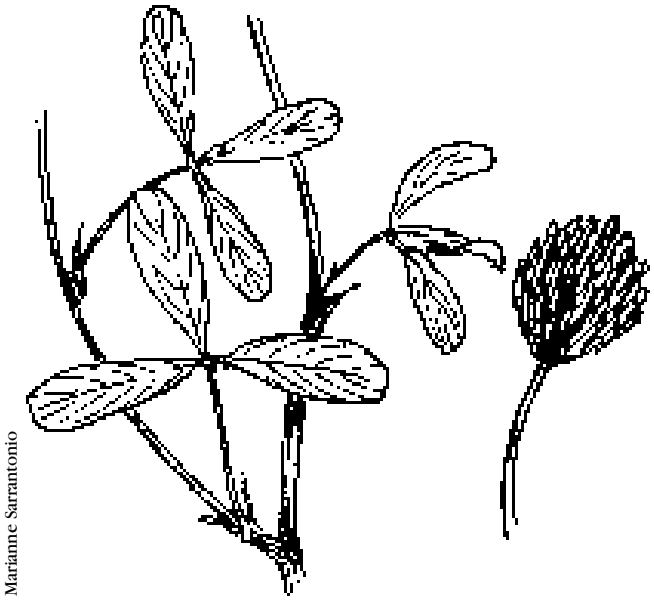
MANAGEMENT

Establishment

Berseem prefers slightly alkaline loam and silty soils but grows in all soil types except sands. Soil phosphorus can limit berseem clover growth. Fertilize with 60 to 100 lb. P_2O_5/A if soil tests below 20 ppm (162). Boron also may limit growth, so test soil to maintain levels (278). Berseem tolerates saline conditions better than alfalfa and red clover (120). Use R-type inoculant suitable for berseem clover and crimson clovers.

Broadcast or drill berseem seed alone or with spring grains onto a firm, well-prepared seedbed or closely cropped sod so that it is 1/4-inch deep with a light soil covering. To improve seed-soil contact and to maintain seed-zone moisture, cultipack or roll soil before and after broadcast seeding (162). Dry, loose soil will suppress germination.

Recommended seeding rates are 8 to 12 lb./A drilled or 15 to 20 lb./A broadcast. Excessive rates will create an overly thick stand that prevents tillering and spreading of the root crowns. Montana trials set the optimum seeding rate at about 8 lb./A drilled in 12-inch rows, with a higher rate in narrower rows where herbicides are not used to control weeds (442).


Marianne Sarrantonio

BERSEEM CLOVER (Trifolium alexandrinum)

Midwest. Seed after April 15 to avoid crop loss due to a late frost. Berseem frostseeded at 15 lb./A yields well in the upper Midwest. In southern Michigan, frostseeded berseem clover produced 1.5 T dry matter/A and 85 lb. N/A (373, 376), but frost risk is significant.

Iowa tests over four years showed that interseeded berseem and oats averaged 76 percent more dry matter (ranging from 19 to 150 percent) than oats alone. Underseeding berseem clover did not significantly reduce oat yields in another Iowa study. Seed early- to mid-April in Iowa (159).

When seeding a mixture, harvest goals affect variety selection and seeding rates, Iowa researchers have found. If establishment of an optimum berseem clover stand **for green manure** is most important, oat or other small grain crop seeded at about 1 bushel per acre will protect the young clover and help to break the soil crust. If **early forage** before green manuring is the goal, seed a mixture of 4 bu. oats and 15 lb.berseem/A. If **biomass quantity** is foremost, use a short-stalked, long-season oat. If **oat grain** production is primary, keep oat seeding rate the same, but select a short-season, tall variety to reduce the likelihood of berseem clover interfering with grain harvest (156).

Berseem clover also can be a late-summer crop. Planted in mid-August in the Corn Belt, it should grow about 15 inches before frost, provide winter erosion protection and break down quickly in spring to deliver N from its topgrowth and roots.

You can overseed berseem clover into standing small-grain crops, a method that has worked well in a series of on-farm tests in Iowa (155). Plant the berseem as late as three weeks after the grain crop germinates or after the tillering stage of winter-seeded small grains. Use a heavy seeding rate to compensate for reduced seed-soil contact. Frostseeding in late winter into winter wheat has not worked in several attempts in Pennsylvania (361) and Iowa.

Southeast. Fall planting in mild regions provides effective weed control as well as N and organic matter for a spring crop. Seed Aug. 25 to Oct. 15 in Mississippi or up to Dec.1 in Florida. For a cool-season grass mixture, plant 12 lb. berseem clover seed with 10 lb. orchardgrass or 20 lb. annual or perennial ryegrass/A (225).

West. Berseem does best in California's Central Valley when planted by the first or second week of October. If planting is delayed until November, seedlings will start more slowly in the cool of winter (162).

Field Management

Mowing for green manure. Clip whenever plants are 12 to 15 inches tall and basal shoots begin to grow. This will be 30 to 60 days after planting, depending on weather, field and moisture conditions. Mow again every 25 to 30 days to encourage growth of up to 4 T/A. Keep stubble height at least 3 to 4 inches tall, because plants regrow from lower stem branches.

To maximize dry matter production, cut as soon as basal bud regrowth reaches 2 inches (162). At the latest, clip before early flowering stage or plants will not regrow. Berseem clover responds best when field traffic is minimized (156).

Mowed berseem clover left in the field as green manure can hinder regrowth of the legume from its lower stems. To lessen this problem, flail or sickle-bar mow then rake or fluff with a tedder at intervals until regrowth commences.

Remember that berseem clover has a tap root and shallow 6- to 8-inch feeder root system (156). In thin plantings or well-drained soils, it can be susceptible to drought, a trait that could trigger mowing, grazing or killing earlier than originally planned (186).

Abundant soil N will restrict N fixation by berseem clover, but moderate amounts up to 150 lb. N/A did not limit annual fixation in north central California. Researchers explain that berseem clover draws heavily on soil N during early growth. When soil N was depleted in this test, berseem began fixing N rapidly until it produced seed and died (447).

Berseem made its N contribution to soil in the final third of its cutting cycle—regardless of initial soil N availability—in all six years of the study. Nitrogen fixation was closely correlated to a drop in water-use efficiency in the trial. After producing from 400 to 640 lb. of dry matter per acre-inch of water in the first four cuttings, production dropped to 300 lb. DM/A-in. for the final two cuttings (447).

Small grain companion. Underseeded berseem clover provided about 1.2 T forage dry matter/A after oat harvest in Iowa. Removing the forage decreases the soil-saving ground cover and N contribution (159), trading soil and N benefits for attractive near-term income.

In the Midwest, greenchop an oat/berseem clover mixture when oat is at the pre-boot stage to avoid berseem clover going to seed early and, therefore, not producing maximum nitrogen. Oats have high crude protein at this stage. Monitor carefully during warm periods to avoid nitrogen toxicity.

A Montana study found that spring plantings of berseem clover will produce the most legume dry matter and N if clear seeded. If, however, you wish to maximize *total* dry matter and protein, seeding with oats is recommended. The oat nurse crop suppressed weeds well and increased total dry matter production by 50 to 100 percent regardless of whether plots were cut two, three or four times (434).

Killing

Berseem dies when exposed to temperatures below 20° F for several days, making winterkill a virtual certainty in Zone 7 and colder. This eliminates the need for herbicides or mechanical killing after a cold winter, and hastens delivery of nutrients to the soil.

The least winter hardy of the true annual clovers, berseem can be planted with oats in the Corn Belt and produce abundant N before winterkilling.

To kill berseem clover ahead of fall-planted crops, wait for it to die after blooming, use multiple diskings or apply herbicides. In mild areas, berseem clover grows vigorously through late spring. BIGBEE berseem clover remained vegetative until early May or later in an experiment at a northern Mississippi (Zone 7) site. Until it reaches full bloom, it will require either tillage or a combination of herbicides and mechanical controls to kill it.

In a northern Mississippi mechanical control study, BIGBEE berseem clover added the most dry matter after mid-April compared to hairy vetch, MT. BARKER subterranean clover and TIBBEE crimson clover. Berseem and hairy vetch remained vegetative until mid-May, but by early May, berseem clover and crimson had a considerable amount of stems laying down (105).

Rolling with 4-inch rollers killed less berseem clover than hairy vetch or crimson when the legumes had more than 10 inches of stem laying on the ground. Kill rate was more than 80 percent for the latter two crops, but only 53 percent for berseem clover. Without an application of atrazine two weeks prior to either flail mowing or rolling with coulters, the mechanical controls failed to kill more than 64 percent of the berseem clover until early May, when flailing achieved 93-percent control. Atrazine alone reduced the stand by 68 percent in early April, 72 percent in mid-April and 88 percent in early May (105).

Nodulation: Match Inoculant to Maximize N

With the help of nitrogen-fixing bacteria, legume cover crops can supply some or all of the N needed by succeeding crops. This nitrogen-producing team can't do the job right unless you carefully match the correct bacterial inoculant with your legume cover crop species.

Like other plants, legumes need nitrogen to grow. They can take it from the soil if enough is present in forms they can use. Legume roots also seek out specific strains of soil-dwelling bacteria that can "fix" nitrogen gas from the air for use by the plant. While many kinds of bacteria compete for space on legume roots, the root tissues will only begin this symbiotic N-fixing process when they encounter a specific species of rhizobium bacteria. Only particular strains of rhizobia provide optimum N production for each group of legumes.

When the root hairs find an acceptable bacterial match, they encircle the bacteria to create a nodule. These variously shaped lumps on the root surfaces range in size from a BB pellet to a kernel of corn. Their pinkish interiors are the visible sign that nitrogen fixation is at work.

Nitrogen gas (N_2) from air in the spaces between soil particles enters the nodule. The bacteria contribute an enzyme that helps convert the gas to ammonia (NH_3). The plant uses this form of N to make amino acids, the building blocks for proteins. In return, the host legume supplies the bacteria with carbohydrates to fuel the N-fixation process.

The rate of N fixation is determined largely by the genetic potential of the legume species and by the amount of plant-available N in the soil. Other environmental factors such as heat and moisture play a big role, as well. Fueling N fixation is an expensive proposition for the legume host, which may contribute up to 20 percent of its carbohydrate production to the root-dwelling bacteria. If the legume can take up free N from the soil, it won't put as much energy into producing nodules and feeding bacteria to fix nitrogen from the air.

Perennial legumes fix N during any time of active growth. In annual legumes, N fixation peaks at flowering. With seed formation, it ceases and the nodules slough from the roots. Rhizobia return to the soil environment to await their next encounter with legume roots. These bacteria remain viable in the soil for three to five years, but often at too low a level to provide optimum N-fixation when legumes return to the field.

If legume roots don't encounter their ideal bacterial match, they work with the best strains they can find. They just don't work as efficiently together and they produce less N. Inoculating seeds with the correct strain before planting is inexpensive insurance to make sure legumes perform up to their genetic potential. Clover inoculum, for example, costs just a few cents per pound of seed treated, or more for an enhanced sticker that buffers and feeds the seedling.

Pest Management

Avoid direct seeding small-seeded vegetables into fields where you have incorporated berseem clover within the past month, due to allelopathic compounds in the residue. Berseem clover, crimson clover and hairy vetch residue incorporated directly into the seed zone may suppress germination and seedling development of onion, carrot and tomato, based on lab tests (40).

Lygus bugs have been a serious problem in California seed production, and virus outbreaks can cause serious damage during wet springs where berseem grows as a winter annual. Where virus is a concern, use JOE BURTON, a resistant cul-

While they are alive, legumes release little or no nitrogen to the soil. The N in their roots, stalks, leaves and seeds becomes available when the plants die naturally or are killed by tillage, mowing or herbicide. This plant material becomes food for microbes, worms, insects and other decomposers.

Microorganisms mineralize, or convert, the complex "organic" forms of nitrogen in the plant material into inorganic ammonium and nitrate forms, once again making the N available to plants. How quickly the mineralization of N occurs is determined by a host of environmental and chemical factors. These will affect how much of that legume N is available to the next crop or has the potential to leach from the soil.

For more information about mineralization and how much you can reduce your N fertilizer rate for crops following legumes, see *How Much N?* (p. 22).

To get the most from your legume/bacteria combination:

- **Choose appropriate legume** species for your climate, soils and cropping system. Also, consider the amount of N it can deliver when you will need it.
- **Match inoculant** to the species of legume you are growing. See Chart 3B, *Planting* (p. 70) to determine the best inoculant to use.
- **Coat seed** with the inoculant just before planting. Use milk, weak sugar water or a commercial sticking agent to help the material stick to the seeds. Use only fresh inoculant (check the package's expiration date), and do not expose packages or inoculated seed to excessive heat or direct sunlight.

Mix the sticker with non-chlorinated water and add the inoculant to create a slurry, then thoroughly coat seeds. Seed should be dry enough to plant within half an hour.

Re-inoculate if you don't plant the seed within 48 hours. Mix small quantities in a five-gallon bucket or tub, either by hand or using a drill equipped with a paint-mixer attachment. For larger quantities, use special inoculant mixing hoppers or a cement mixer without baffles.

Gum arabic stickers with sugars and liming agents boost the chances for optimum nodulation over water-applied inoculant alone. Pre-inoculated ("rhizo-coated") seed weighs about one-third more than raw seed, so increase seeding rates accordingly.

Check nodulation as the plants approach bloom stage. Push a spade in the soil about 6 inches below the plant. Carefully lift the plant and soil, gently exposing roots and nodules. (Yanking roots from the soil usually strips off nodules). Wash gently in a bucket of water to see the extent of nodulation. Slice open nodules. A pink or reddish interior indicates active N-fixation. Remember, an overabundance of soil nitrogen from fertilizer, manure or compost can reduce nodulation.

For more information about nodulation, see two books by Marianne Sarrantonio: *Northeast Cover Crop Handbook* (361) and *Methodologies for Screening Soil-Improving Legumes* (360).

tivar. BIGBEE is susceptible to crown rot and other root diseases common to forage legume species (162).

Berseem, like other clovers, shows little resistance to root-knot nematode (*Meloidogyne* spp.). It seems to be particularly favored by rabbits (361).

Crop Systems

Flexible oats booster. In the Corn Belt, berseem clover seeded with oats helps diversify corn>soybean rotations, breaks pest cycles and provides some combination of grain and/or forage harvest, erosion control and N to the following corn crop. An added benefit is that it requires no tillage or herbicide to kill it in spring (159). Plant 4 bu. oats with 12 lb. berseem/A.

In a four-year Iowa study, planting berseem clover with oats increased net profit compared with oats alone. The clover was baled for forage and the underseeded oats were harvested for grain. Not calculated in the benefit were the 40 to 60 lb. N/A provided to the following corn crop or other soil-improvement benefits. The oats/ berseem mix produced 70 percent more biomass, increased subsequent corn yields by 10 percent and reduced weed competition compared with a year of oats alone (159).

Mow strips of berseem between vegetable rows and blow the clippings around the plants for mulch.

Pure berseem clover regrowth averaged 1.2 T dry matter/A, which can be used as forage or green manure. These options could help oats become an economically viable crop for Midwest crop/livestock farms in an era of decreasing government payments for corn and soybeans (159, 160).

Wheat companion. Berseem was one of six legume intercrops that improved productivity and profit of wheat and barley crops in low-N soils under irrigated conditions in northwestern Mexico. All of the legumes (including common and hairy vetch, crimson clover, New Zealand and Ladino white clover, and fava beans) provided multiple benefits without decreasing grain yield of 15 to 60 bu./A on the heavy clay soil.

Wheat and legumes were planted at normal monoculture rates with wheat in double rows about 8 inches apart atop 30-inch beds, and legumes in the furrows. In a second, related experiment, researchers found they could more than double total wheat productivity (grain and total dry matter) by interplanting 24-inch strips of berseem clover or hairy vetch with double rows of wheat 8 inches apart. Control plots showed wheat planted at a greater density did not increase yield (350).

Vegetable overseeding. Berseem can be overseeded into spring vegetables in northern climates where it thrives at moderate temperatures and moisture. Berseem is well suited to a "mow and blow" system where strips of green manure are chopped and transferred to adjacent crop strips as a green manure and mulch (361).

Boost the N plow-down potential of old pastures or winter-killed alfalfa by no-tilling or interseeding berseem clover. Or, broadcast seed then incorporate with light harrowing.

COMPARATIVE NOTES

Berseem clover is:

- Not as drought-tolerant as alfalfa. Some cultivars can tolerate more soil moisture—but not waterlogging—than alfalfa or sweet clover
- Similar in seed size to crimson clover
- Bee-friendly because its white or ivory blossoms have no tripping mechanism.
- Because of its short roots, berseem clover does not use phosphorus to the depth that mature, perennial alfalfa does.
- Winterkilled berseem allows for earlier spring planting than winter-hardy annuals. As a dead organic mulch, it poses no moisture depletion risk, but may slow soil warming and drying compared to erosion-prone bare fallow.

Cultivars. BIGBEE berseem clover was selected from other traditional cultivars for its cold-tolerance, which is similar to crimson clover. Some of the strong winter production tendency found in non-winter hardy berseem clover was sacrificed to obtain BIGBEE's winter hardiness (162). Mature BIGBEE plants hold their seeds well and produce adequate hard seed for reseeding. Other berseem clover cultivars have less hard seed and will not dependably reseed (278).

California tests show MULTICUT berseem clover produces 20 to 25 percent more dry matter than BIGBEE. It has greater N-fixing ability, blooms later, and has a longer growing period than other varieties, but is not as cold tolerant as BIGBEE (162). JOE BURTON, developed from MULTICUT, is more cold tolerant.

In California, BIGBEE begins to flower in mid-May, about two weeks ahead of MULTICUT. MULTICUT grows faster and produces more dry matter in California conditions, averaging about 1.6 T/A more in a six-year study. When the five or six cuttings per year were clipped and removed, MULTICUT was about 6 inches taller at each clipping than other varieties (447). In Montana tests, BIGBEE out-yielded MULTICUT in eight of 13 locations (381).

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