pastures australia

A collaboration between AWI, GRDC, MLA, RIRDC and Dairy Australia

Bokhara clover

Scientific name(s)

Melilotus albus

Strengths

- Tolerates drought, salinity and moderate waterlogging
- Good seed production
- High herbage production and nutritive value
- Excellent honey plant
- Excellent soil improver
- Strong taproot reported to lessen clay pan issues
- Capacity to fill summer autumn feed gap

Limitations

- Weed potential
- Variation in levels of undesirable plant compounds, particularly coumarin (0-5.73% DM) with capability to taint grain and animal products and cause internal bleeding in livestock.

Plant description

Plant: Polymorphic herbaceous annual or biennial legume, growing to 0.3 to 2.6m tall, large tap root, upright or ascending habit. Growth is predominately spring to autumn.

Stems: Stems can be coarse or fine, grooved or channelled, usually pubescent or with soft hairs near the tip.

Leaves: Leaves glabrous, alternate, stipulate, trifoliate. Leaflets of lower leaves broadly ovate, obovate or rhomboidal, rounded or truncate at the tip, irregularly dentate, 1.5 to 5cm long. Upper leaflets narrowly oblong to lanceolate, usually rounded or truncate at the tip, dentate to almost entire.

Flowers: Corolla white 4-6mm on a raceme usually 40-80 flowers per raceme, rarely 120. Raceme usually 8-15 cm long and up to 28cm long in some annual varieties. Calyx 2 to2.5 mm long, teeth as long as tube, rarely shorter. Wings and standard more or less equal and longer than keel. Flowers indeterminately.

Pods: 3 to 5 mm long, ovoid to obovoid, mucronate glaborous, reticulate wrinkled, black, greyish brown or tawny when ripe, with 1 seed.

Seeds: Seeds oval, 2 to 2.5 mm long, 1.5 mm broad, yellow or rarely greenish-yellow. 3.95 to 5.75 mg. Average weight for 1000 seeds is 2.3 g.

Pasture type and use

Legume used to improve degraded land as a "green manure" plant, or as a productive pioneer species to revegetate saline alkaline soils, it represents an opportunity to obtain high levels of out-of-season production from land that is currently unproductive for grazing stock, mainly sheep and cattle. Also recognised as one of the most valuable plants for honey production and suitable for hay and silage.

Where it grows

Rainfall

Best suited to areas receiving greater than 400mm.

Soils

Grows best on deep, fertile, well drained, medium to heavy textured soils, but adapted to a wide range of calcareous, alkaline and saline soils. Grows naturally on a wide range of soil types and textures from clays to dune sand and river gravels. Optimum pH range (6.5 to 8.5) and does not tolerate highly acidic soils.
Responds well to high fertility, particularly P and K and will persist on moderate waterlogged and saline soils that are not subject to continuous flooding.

Temperature

Grows best in the temperature range 18-25^{o}C. Tolerates an annual mean temperature range of 5.7 -28.3^{o}C. Winter hardy and drought tolerant.

Establishment

Companion species

Grasses: Tall wheat grass, Puccinellia, Perennial ryegrass, Sorghum

Legumes: Strawberry clover, Balansa clover, Persian clover

Herbs: Chicory

Sowing/planting rates as single species

8-12 kg/ha

Sowing/planting rates in mixtures

3-5 kg/ha

Sowing time

Soil preparation should be similar to that for lucerne. Seed is usually drilled or broadcast directly after conventional seedbed cultivations. Can also be sown under a cereal cover crop or direct drilled into existing grass swards.
Sowing time for the annual varieties is autumn and more often spring for biennial varieties as they need a full growing season to prepare for the next season of production. Seed of Melilotus albus are "hard" and must be scarified before planting.

Inoculation

Requires seed inoculation by an effective strain of Rhizobium meliloti for successful establishment and performance.
Lucerne inoculant group type AL (strain RRI128) is very effective.

Fertiliser

Melilotus albus does not tolerate acid soils but grows well on neutral or alkaline soils. If soil pH is below 6.0, apply lime well in advance of seeding.
Adequate levels of phosphorus, potassium and sulphur should be available for good growth and high production. Properly inoculated and nodulated Melilotus albus will not require the addition of nitrogen.

Management

Maintenance fertliser

For optimum growth maintain adequate levels of nutrients, especially phosphorus, potassium, and sulphur.

Grazing/cutting

Grazing:
Annual cultivars are predominately used overseas as a "green manure" or soil conditioner although use as a forage in Texas and Argentina is increasing. The only Australian released cultivar "Jota" can be lightly grazed during autumn and rotationally more heavily grazed (1 week of grazing, followed by a 3-week spell) during the spring and summer. Defoliation must stop around December or the grazing pressure will have to be substantially reduced to allow adequate seed set and regeneration.

Overseas, biennial cultivars are lightly grazed in the spring when 25-30 cm high, but plants

should not be grazed heavily until late autumn. First year plants do not tolerate close grazing or mowing because regrowth occurs from the buds on the stem rather than on the crown. Pastures dominated by second year plants produce a large amount of forage and should be grazed when plants are 30-35cm high and maintained throughout the summer at a height of about 20-30cm to allow for rapid regrowth and prevent plants from becoming woody and unpalatable. Heavy stocking rates are also desirable to prevent forage from becoming coarse and of low quality.

Cutting:
The plant is very suitable for hay/silage. The hay or silage is palatable and nutritious but must be thoroughly cured. Partially cured hay can produce a hemorrhagic syndrome when ingested by cattle. The toxic substance, dicoumarol, which occurs only in mouldy hay, results from the conversion of non-toxic coumarin by fungi in moist plants. Ingestion by cattle of moderately large amounts of improperly cured hay or silage can result in death. Sheep and horses are reportedly less susceptible than cattle although dose response experiments with sheep determined levels >0.5% DM to be detrimental to their health. In addition to extra care required in the curing of hay and silage to prevent the formation of dicoumarol, the use of only purpose bred low coumarin cultivars is recommended.

Seed production

Has a high reproductive potential:
Each plant is capable of producing large quantities of seed (14,000 to 350,000 seeds per plant reported). Seeds may remain viable in the soil for more than 20 years.
Plants have high cross fertility and very little incidence of self fertility.
No ability to produce vegetatively when cut or grazed has been documented.
To maximise seed production and subsequent regeneration cutting or grazing should cease in December and resume in March.

Recruits from seed well. It has been reported that in the second year post establishment an average of 3,500 seedlings/m2 regenerated, though this declines rapidly in subsequent years. Fire stimulates germination of seed.

Ability to spread

Has a high potential for long-distance dispersal:

The fruits are shed in the summer autumn period and are dispersed by gravity, strong winds, and water. The seeds float, and thus rain wash and stream flow may be an important means of dispersal. Seeds are readily eaten by birds and animals. No information located on survival after digestion.

Weed potential

Has a moderate to high weed potential:

Melilotus albus is an early colonizer of disturbed sites and the species is naturalised in all Australian states, predominately along roadsides and drainage lines but also in riparian zones.

It is reported that it may be eliminated from an area within 2 to 3 years if the ground surface is covered by perennial species because seedlings cannot survive in a perennial sward or the conditions become more favourable for other species. However many researchers have detailed its persistence in many native and established grasslands although its abundance in these communities has been assumed to be due to periodic disturbance.

Naturalised wild ecotypes, high in coumarin with a strong "vanilla" type smell are a serious contaminant in certified grain crops, especially canola. Tainting of dairy and other animal products has also been reported. Due to the highly out-crossing nature of the species there is a high risk that coumarin levels, within specifically bred low coumarin commercial varieties, will increase overtime as a result of a concentration effect due to out-crossing with high coumarin wild ecotypes.

Intolerant of shade.

Major pests

As this is a new species to Australian agriculture there is limited data on major insect pests. Internationally the Sweetclover weevil (*Sitona cylindricollis*) is the most damaging insect affecting *Melilotus albus* where severe infestations have resulted in complete failure of established stands. Other pests include the root-borer (*Walshia miscecolorella*), blister beetles (*Epicautua* spp.) and the sweet clover aphid (*Therioaphis riehmi*).

Major diseases

Internationally Melilotus albus is affected by a number of fungal diseases. The major diseases include:

- Clover rot (Sclerotinia trifoliorum)
- Spring black stem (Ascochyta meliloti)
- Summer black stem (Cerospora davissii)
- Stem canker (Ascochyta caulicola)
- Root rot (Phytophthora cactorum)
- Sweetclover rust (Uromyces striatus)

Viral diseases reported to attack the plant include

- Cucumber Mosaic Virus
- Steinklee Virus
- Ringspot
- Sweet Clover Necrotic Mosaic Virus
- Sweet Clover Latent Virus

Herbicide susceptibility

Easily eradicated with glyphospate or phenoxy herbicides such as 2,4-D or dicamba.

Animal production

Feeding value

Melilotus albus is a high quality legume providing a well-balanced complement of nutrients during vegetative growth stages, and when cut and cured properly, makes a nutritious and palatable hay.
During the vegetative growth, digestibility is typically in the range of 75-80% DM with greater than 25% crude protein. Nutritive values decline as plants enter reproduction and maturity.
On a dry matter basis, Melilotus albus hay is simular to lucerne hay in metabolizable energy and most digestible nutrients, but is slightly higher in digestible crude protein. Crude protein content of hay often exceeds 15% DM.

Palatability

Vegetative growth is highly palatable but palatability declines as plants enter the reproductive stage, attributed to a bitter taste as a result of an increase in the concentration of coumarins.

Production potential

Production potential is high provided growing conditions are adequate.
For biennial species hay yields of 2.2 to 3.5 t/ha have been reported during the first year and 2.2 to 9.4 t/ha in the second year.
Dry matter production for annual species growing on saline soils (1 and 5 dS/m) are reported at between 1.7 to 2.2 t/ha during autumn winter and up to 13.3 t/ha over summer. Average production was around 10t/ha.
As 70% of total growth occurs between October and April there is potential for Melilotus albus to fill the summer autumn feed gap. Research has shown that sheep grazing at a rate of 25 DSE/ha gained 6-7 kg/head during this period.
Besides its use for hay or pasture, it is also used in as a soil improvement crop. Because of its symbiotic relationship with Rhizobium bacteria, pure stands may add up 120 kg/ha of nitrogen to the soil. The nitrogen fixation rate is reported superior to other legumes and is beneficial in crop rotations and the species is used as a model genetic organism for nitrogen fixation studies.

Livestock disorders/toxicity

Bloat has been reported to occur in livestock but occurs less frequently than animals pastured on lucerne or Trifolium species.
Hay or silage made from Melilotus albus plants that contain coumarin, can become toxic to animals (sweet clover bleeding disease), especially cattle, if the hay is spoiled by moisture and decay. The fungal conversion of coumarin to dicoumarol, which acts as an antagonist to vitamin K, produces an anti-coagulant and can cause haemorrhaging, ultimately causing death in severe cases. This risk is minimised through the development and use of low coumarin cultivars.

Cultivars

Group	Cultivar	Seed source/Information

Annual cultivars	Jota	Plants Breeders Rights Database
	Adela	Research Institute for Fodder Crops, Ltd.
	Emerald	Texas Agricultural Experiment Station
Biennial cultivars	El Domador	INTA Argentina
	Krajova	Research Institute for Fodder Crops, Ltd.
	Cumino	Canadian Journal of Plant Science 38:507-508
	Denta	Crop Sci. 4:666-667.
	Polara	Canadian Journal of Plant Science 51:249-251.
	Artic	University of Saskatchewan, Canada

Further information

Evans PM, Kearney GA (2003) Melilotus albus (Medik.) is productive and regenerates well on saline soils of neutral to alkaline reaction in the high rainfall zone of southwestern Victoria. Aust J Exp Agric 43:379-355.

Evans PM and Thompson AN (2006) "Jota" annual sweet clover (Melilotus albus Medik.): a new salt tolerant legume for the high rainfall zone of southern Australia. Proceedings of the 13th Australian Agronomy Conference, Perth. Australian Society of Agronomy Perth 10-14 Sept, 2006.

Evans PM, Trigg P, Kearney GA and Byron AH (2004). Effect of cutting regime on the agronomic performance of 2 contrasting lines of Melilotus albus (Medic). Australian Journal of Experimental Agriculture. Volume 44: 1177-1183.

"Sweetclovers" UC SARPE Online Cover Crop database http://www.sarep.ucdavis.edu/cgi-bin/ccrop.EXE/show_crop_41

Acknowledgements

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Author and date

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