Register of Australian Herbage Plant Cultivars

B. Legumes
1. Clover
(d) *Trifolium subterraneum* L. var. *subterraneum* (Katz. et Morley) Zohary and Heller (subterranean clover) cv. Denmark

Reg. No. B-1d-29

Registered 21 October 1991

Originator: National Subterranean Clover Improvement Programme

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Origin

Denmark was collected in Sardinia by C. M. Francis and D. J. Gillespie in June 1977, 11 km north of Fluminimaggiore (39.51ºN., 8.55ºE.). It was given the collector's code of CD 27 Sub Brachy A (Gorringe and Pullen 1983). The collection site consisted of a grey, gritty sand of pH 6.0, located at an altitude of 80 m and with mean annual rainfall of 750 mm. The site was well grazed at the time of collection and contained dense patches of *T. subterraneum*.

Denmark was selected in 1982 by J. S. Gladstones and W. J. Collins, as 1 of 97 late-midseason to late-maturing breeding lines for distribution to collaborators of the National Subterranean Clover Improvement Programme (Gladstones 1983) in Western Australia, New South Wales, Victoria and South Australia, for initial field evaluation. Evaluation of 93 of these lines commenced in Tasmania in 1983. Denmark showed promise from an early stage and was among the 5 best performing lines up to 1986 in each collaborating State. It entered final stage field evaluation trials in 1987 at 29 sites in Western Australia, Tasmania, New South Wales and Victoria. Selection and testing was conducted under the name CPI 89774F.

Field evaluation and final selection of Denmark were conducted by the following collaborators of the National Subterranean Clover Improvement Programme: D. A. Nicholas and P. G. H. Nichols (W.A. Department of Agriculture), J. A. Carpenter and P. M. Evans (Tas. Department of Primary Industry), B. S. Dear (NSW Agriculture), K. F. M. Reed and S. G. Clark (Department of Agriculture, Vic.) and P. E. Beale, M. J. Cochrane, G. J. Mitchell and I. D. Kaehne (S. A. Department of Agriculture). Screening for disease and insect resistance was conducted by D. J. Gillespie, M. J. Barbetti and J. D. Sandow (W.A. Department of Agriculture). Phytophthora root rot screening was conducted by P. A. Taylor and S. P. Flett (Department of Agriculture, Vic.). Virus screening was conducted by G. R. Johnstone (Tasmanian Department of Primary Industry). Isoflavone analyses were provided by W. R. Stern and B. H. Tan (University of Western Australia).

Denmark was submitted for registration by the collaborating organizations of the National Subterranean Clover Improvement Programme and recommended for registration by the Western Australian and Tasmanian Herbage Plant Liaison Committees. The W.A. Department of Agriculture will maintain breeders' seed. Provisional Plant Variety Rights have been granted (Anon. 1991).

Morphological description

Denmark has a leaf mark consisting of a thin, pale green, diamond-shaped crescent extending about midway to the margin, flanked by narrow, diffuse, silvery white arms. It is classified as $C_2A_{1–2}$ using the system of Collins *et al.* (1984). Expression of the arms is often weak in the seedling stage. Leaflets are moderately small, moderately broad and rounded, with only a slight indentation. They have no flush pattern and only occasional weak flecking. Stipule pigmentation under shaded conditions is weak to intermediate. Corollas are pink veined, sometimes with a pink flush before opening. Calyx pigmentation is absent. Stems, petioles and peduncles are all green and glabrous, while leaf upper surfaces have sparse hairs.

Seedlings of Denmark are moderately small and fine. Growth habit is prostrate in the early stages but less so after the commencement of flowering. Stems and peduncles are slender. Denmark averages 3.9 florets per inflorescence in undefoliated rows. Burrs are small and burr burial is fair. Burr production potential is high, with burr distribution being mainly distal. Seed colour is black. Approximately 140 000 seeds per kilogram.

Agronomic characters

Denmark is of late-midseason maturity, with flowering commencing, on average, 3 days later than Karridale at Shenton Park, Western Australia, and 8 days later than Karridale at Wagga Wagga, New South Wales, and at Epping Forest, Tasmania. It has only a trace amount of formononetin (<0.05% of dry matter), while levels of genistein and biochanin A are 1.2 and 0.5% of dry matter, respectively. Denmark is relatively soft-seeded. In 3 laboratory tests, Denmark averaged 9.5% hard seed, after 4 months in an alternating 60º/15ºC temperature cabinet, compared to Karridale with 8.7%, Mt Barker and Woogenellup with 3.0% and Junee with 31.7%. Field data from several sites support these relative differences. The low level of hard-seededness is not seen as a significant disadvantage, as the zones to which it is suited are not regularly cropped. Denmark is compatible with commercial strains of *Rhizobium trifolii* (R. J. Roughley pers. comm.).

Denmark has good resistance to clover scorch, *Kabatiella caulivora* (Kirch.) Karak. In field screening trials conducted over 6 years, Denmark and Green Range had average ratings of 3.1, on an increasing damage scale of 0–10, compared to 4.6, 5.5, 7.0 and 1.1 for Karridale, Mt Barker, Woogenellup and

Esperance, respectively. Denmark has a high level of resistance to root rot caused by *Phytophthora clandestina* Taylor, Pascoe and Greenhalgh. Greenhouse tests, using an increasing damage scale of 0–1.0, gave a scaled rating for Denmark of 0.2, compared to 0.2, 0.7, 0.0 and 1.0 for Karridale, Mt Barker, Larisa and Woogenellup, respectively. Denmark also appears to have better resistance to root rot caused by *Pythium irregulare* Buisman than Karridale, Mt Barker and Woogenellup. On an increasing damage rating scale of 0–100, 5-week-old inoculated seedlings of Denmark had an average disease index rating of 48.5, compared to 62.5 for Karridale, 78.9 for Mt Barker and 70.2 for Woogenellup.

Denmark has greater resistance to leaf rust (*Uromyces trifolii-repentis* Liro), than Mt Barker and much greater resistance than Green Range and Karridale (Barbetti and Nichols 1991*a*). Denmark is also much superior to Karridale and Junee in its level of resistance to powdery mildew (*Erysiphe polygonii* D.C.), but is more susceptible than Mt Barker (Barbetti and Nichols 1991*b*). Denmark has some susceptibility to leafspot caused by *Cercospora zebrina* Pass. In a field trial, Denmark was found to be not significantly different from Karridale and Mt Barker in its susceptibility (Barbetti 1991). On the basis of field ratings from Holbrook, New South Wales, Denmark appears to have better resistance to common leafspot [*Pseudopeziza trifolii* (Fr.) Fuckell], than Karridale and Mt Barker.

Denmark is similar to Karridale and Mt Barker in its reaction to a range of viruses. Visual field ratings of symptom development in Hobart, Tasmania, indicate that Denmark develops slight symptoms to Beet Western Yellows virus, moderate symptoms to Alfalfa Mosaic, Cucumber Mosaic and Subterranean Clover Red Leaf viruses, strong symptoms to Bean Yellow Mosaic and Clover Yellow Vein viruses and extremely severe symptoms to Subterranean Clover Mottle Virus. It is also susceptible to Subterranean Clover Stunt Virus (P. Chu pers. comm.).

Denmark is similar to Karridale for susceptibility to redlegged earth mite (*Halotydeus destructor* Tucker) at the seedling stage. A phytotron study gave ratings on 2-week-old seedlings of 5.6 for Denmark, 5.4 for Karridale and Green Range, 4.2 for Mt Barker and 6.0 for Woogenellup (on an increasing damage scale of 0–10). However, spring field ratings from several trial sites indicate that Denmark suffers less visual damage from redlegged earth mite at the adult plant stage than other late-midseason cultivars. Denmark has a similar level of blue-green aphid (*Acyrthosiphon kondoi* Shinji) tolerance to Karridale. In a glasshouse trial on adult plants, blue-green aphid-infested plants of Denmark had a mean weight of 43% of uninfested controls, with Karridale, Clare, Daliak and Junee having 41, 61, 35 and 30%, respectively.

Denmark has consistently produced more herbage and persisted better, than current late-midseason cultivars in the high rainfall regions of Western Australia, Tasmania and New South Wales. Its autumn seedling densities in regenerating swards have been higher than all other late-midseason cultivars in Western Australia and Tasmania and have been at least as great as those of Karridale at most sites in New South Wales.

An outstanding feature of Denmark is its ability to maintain a higher clover proportion than other late-midseason cultivars throughout the growing season. Total winter herbage production from swards of Denmark has consistently been similar to that of Karridale and much greater than that of Mt Barker, Woogenellup and Larisa, while in Western Australia, yields of clover have been higher than Karridale. Total spring herbage production of Denmark swards has been at least as high as those of Karridale at most sites in Western Australia, Tasmania and New South Wales, and in Western Australia, yields of clover have been greater. In Tasmania, total seasonal herbage production of Denmark, over all trials, has averaged 18% higher than that of Karridale. In the presence of clover scorch disease, the production advantage of Denmark is even greater, due to its superior clover scorch resistance. This was evidenced at Manjimup, Western Australia, in both 1988 and 1989, when spring clover herbage production of Denmark averaged 12% higher than Karridale and 48% higher than Mt Barker, which both showed moderate symptoms of clover scorch, and 379% higher than Woogenellup, which exhibited severe symptoms.

Denmark has consistently produced and maintained higher seed populations than all other late-midseason cultivars in Western Australia and Tasmania. In New South Wales, seed yields of Denmark have been high in areas receiving more than 650 mm annual rainfall and it has persisted satisfactorily at sites with a mean annual rainfall of only 510 mm. Field observations also suggest that Denmark is more tolerant of heavy grazing than other late-midseason cultivars.

Denmark will be recommended in Western Australia throughout the existing Karridale zone and the old Mt Barker zone, where growing season length is at least 7.5 months. In Tasmania, its good all-season performance befits Denmark to all subterranean clover areas, where it will be recommended as a replacement for the currently recommended mixtures of Karridale with either Enfield or Trikkala. It has also performed well on heavy soils, where Trikkala and Larisa are currently recommended. In New South Wales, Denmark is suited to southern areas receiving at least 650 mm annual rainfall and 700 mm in central zones. It will be recommended in preference to Karridale where clover scorch is likely to occur.

Acknowledgments

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References

Anon. (1991). Denmark subclover. *Australian Plant Varieties Rights Journal* **4**(4), 18–19.

Barbetti, M. J. (1991). Response of subterranean clover varieties to cercospora disease under controlled environment and in the field. *Australian Journal of Experimental Agriculture* **31**, 333–6.

Barbetti, M. J., and Nichols, P. G. H. (1991*a*). Susceptibility of subterranean clover varieties to rust under controlled environment and field conditions. *Australian Journal of Experimental Agriculture* **31**, 77–80.

Barbetti, M. J., and Nichols, P. G. H. (1991*b*). Susceptibility of subterranean clover varieties to powdery mildew under controlled environment and field conditions. *Australian Journal of Experimental Agriculture* **31**, 81–4.

Collins, W. J., Francis, C. M., and Quinlivan, B. J. (1984). Registered cultivars of subterranean clover—their origin, identification and potential use in Western Australia. Bull. No. 4083. Western Australia Department of Agriculture. pp. 28.

Gladstones, J. S. (1983). Proposed structure of the National Subterranean Clover Improvement Programme. Western Australian Department of Agriculture Bulletin. pp. 42.

Gorringe, R. J., and Pullen, R. (1983). Australian Plant Introduction Review **15**(2): A-42. (CSIRO Division of Plant Industry: Canberra.)