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DORYCNIUM SPECIES — TWO NEW LEGUMES WITH POTENTIAL FOR DRYLAND PASTURE REJUVENATION AND RESOURCE CONSERVATION IN NEW ZEALAND

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Abstract

Two *Dorycnium* species. *D. hirsutum* **and 0.** ***pentaphyllum*, have been under trial since the mid-1970s. They show most promise on North Island yellow-brown sands and the drier brown-grey/yellow-grey earth soils of the South island.**

Both species, *native* **to the Mediterranean** *region.* **are perennial with deep taproots. They are adapted best to drought-prone. free draining, weakly acid to alkaline soil types; heavy, wet soils are not tolerated. Severe winter frosting has little effect on** *Dorycnium.*

Major advantages of *Dorycnium* are the ability of plants to establish and grow in low fertility soils and the provision of an evergreen winter plant cover. Establishment has been successful both by oversowing and direct seeding on to diverse sites including depleted grassland and newly formed road batters.

More extensive farm trials are planned for *Dorycnium* because of its ability to provide stock and bee forage under cold, dry, low soil fertility conditions.

Keywords: *Dorycnium.* **leguminosae, pasture rejuvenation, soil conservation, semi-arid revegetation. nitrogen fixation. forage, browse, Hunter strip seeder**

INTRODUCTION

In the dry South Island hill country, within class 5e to 7e land categories, conservation is difficult on drought-prone soils affected by wind and frost and of low to moderate fertility. Many of these areas can provide for stock wintering and lambing, but in a semi-arid climate they produce little stock forage and provide an ideal habitat for rabbits.

Dorycnium is one of a number of plant species that have been under evaluation for soil conservation since 1970. Plant selection trials were originally laid down over a range of sites in both islands. Plants were intially established as seedlings, but oversowing and direct drilling have since been used. Also, several germplasm importations were made to ensure a range of genetic material was available for local evaluation.

The two *Dorycnium* species described are nitrogen fixing, leguminous plants which have shown considerable promise for revegetation in drought-prone and semi-arid areas of the South Island (Wills 1982) and in sandy North Island soils (AG. Foote, pers. comm.). Because they are virtually unknown agronomically, we still have much to learn about their establishment and management in New Zealand.

BOTANICAL DESCRIPTION AND ORIGINS

Two species of *Dorycnium* have been identified as having a good potential for dryland pasture rejuvenation and soil conservation; the erect *D. hirsutum* (L.) Ser. in DC. and the prostrate *D. pentaphyllum* Scop.

D. hirsutum is a hairy sub-shrub up to about 0.5 m tall and 1.0 m diameter. Branches are rather lax and may die back after pods have ripened or plants become over-mature. Flowers (5-10) are grouped in globular clusters and are white or pink with a dark keel. Flowering occurs in late spring/early summer; pods are 6-12 mm long and contain about 4 seeds and ripen January-February. Ripe pods dehisce, spreading seed up to 1-2 m from the parent plant. The main vegetative growth phase occurs in early spring with a secondary phase often in autumn and early winter.

D. pentaphyllum is a glabrous, prostrate, sub-shrub up to about 0.3 m tall and 1 .O m diameter. It is very similar to some Lotus species in its leaf morphology. The flowers (1530) are grouped in globular clusters and are white, although the calyx tube may be pink; they appear in late spring-early summer. Pods are small (2-4 mm long), contain one seed and ripen February-March. Although the pods are dehiscent, seed is propelled only a short distance. Vegetative growth is strongest in spring with some secondary growth in autumn.

Members of the genus *Dorycnium* are common in the Mediterranean region, from the Canary Islands to the Balkans, and central-southern Europe. They are usually found on light, infertile, sandy soils (Allen & Allen 1981). *D. hirsutum* has shown promise in California (Crampton 1946) and Australia (Brockwell and Neal-Smith 1966) both as a forage crop and as a deterrent to soil erosion. Successful cross-inoculation symbioses between Lotus rhizobia strains and *D. hirsutum* was also reported in the latter paper. There is no record of any current use in either country.

PLANT EVALUATION METHODS

1. Initial selection was based on annual, random, replicated plantings at a number of field sites during 1974-86. Each site was visited in spring and autumn, when plant vigour, survival, physical measurements, phenology, biology and mechanical damage were assessed. These have been supplemented with notes from other intermittent visits to sites and, where possible, meteorological records have also been correlated with the plant assessments. More regular and detailed measurements were completed on plants at the Earnscleugh Research Nursery.

2. Alternative seed line and time of sowing trials were established on Cluden and Galloway Stations in conjunction with extensive oversowing investigations. A number of 'alternative' plant species were established from seed in rotary drills in autumn and spring in 1983, 1984 and 1985 at the two sites. Each drilling consisted of 2 x 1.0 m long strips per plant accession; where seed was available several replicates or similar accessions were included at each site per time of sowing. Assessments included seedling emergence counts plus rankings for survival and growth at regular intervals to the present.

3. Hunter strip seeder trials were established on Bendigo Station in October 1984. The Hunter drill (courtesy NZAEI, Lincoln College) was used to sow single drill width strips (40 m long) of 'alternative' plant species. Legume seed was sown with sulphur superphosphate 200 at 250 kg/ha, grass seed with ammophos at 200 kg/ ha. Assessments included seedling emergence counts (point intercept, 10 x 1 .0 m^2 quads per plot, maximum 52 possible intercepts/quad) and regular, seasonal biomass cuts (5 x 1 .O m^2 cuts per drill strip). Cut plant material was dried to constant moisture content and then weighed. Selected sub-samples were analysed for foliar minerals by the Southland Co-operative Phosphate Co. Ltd.

RESULTS AND DISCUSSION

Initial selection

From the original ge.rmplasm importations, 2 selections each of *D. hirsutum* and *D. pentaphyllum* were identified as having most promise for New Zealand. For *D. hirsutum* there is an extremely hardy, hairy selection of moderate-low palatability (PN 1020) and a hardy, but less hairy, selection of moderate-good palatability (PN

1059). Both selections of *D. pentaphyllum* are hardy, are of good palatability and differ only in that one (PN 1066) is much more prostrate than the other (PN 1438).

South Island trials indicate that Dorycnium species are best adapated to light soil types, e.g. Waitaki (Otematata Station) and Conroy (Bendigo Station) brown-grey earth soils, and Wither Hill (Marlborough), Waimakariri (Dashwood Pass) and Glasnevin (Waipara) yellow-grey earth soils (J.S. Sheppard, pers. comm.). They will tolerate a pH range from 5.4 to 8.6 and, on Manorburn soils at Olrig Station, they are growing at high soluble salt concentrations. Dr J.M. Keoghan (pers. comm.) reports that they are also performing well in MAF trials on Omarama yellow-grey earth soils at Tara Hills.

In the North Island *D. hirsutum* has performed well in comparison with lucerne, sainfoin and sheep's burnet in trials at Bulls, Porangahau, Te Awanga and Wairoa, particularly on sandy, coastal soils. Some competition from ephemeral vegetation has been noted, *D. pentaphyllum* being worst affected. This is less of a problem in drier South Island soils except where strong growth flushes occur, especially after fertiliser applications, at the time seedlings are becoming established.

Direct seeding has recently been completed on newly formed road batters in the Clutha Gorge by hand spreading and also by hydroseeding both there and on the Remarkables Skifield road. While it is too early yet for significant growth from the hydroseeding, the handspread *Dorycnium* has established well in spite of the harsh site and rabbits. It is now forming good ground cover on a 45" + slope with very shallow soils.

Inoculation failure is not a major problem. Local observations support overseas findings that *Lotus (corniculatus) Rhizobium* strains are effective inoculants. At all trial sites, *D. hirsutum* and to a lesser degree *D. pentaphyllum* have spread some distance from parent plants and are nodulated and healthy. These plants are probably utilising rhizobia associated with the common annual legume *Trifolium arvense.* Both *Dorycnium* species have strongly developed taproots. In tight, stony Waitaki soils at Otematata, taproots of 2- to 3-year-old plants were still several mm thick at a depth of 0.45 m.

Seed counts and germination characteristics are: PN 1059 = 204,000 seeds per kg (standard deviation = 3190); PN 1066 = 393,000 seeds per kg (standard deviation = 4575).

In vitro germination tests indicate that scarification is beneficial, both species exceeding 80% germination after 28 days. Control levels at comparable times were 10-20% lower. Large quantities of seed are released in the field but population regeneration rates are low because of stock and insect predation and modest competitive ability.

The growth habit of both species, once established, supports other plants, especially grasses which appear to perform well within the *Dorycnium* sward. Wheatgrass (*Elytrigia* spp.), cocksfoot (*Dactylis glomerata*) and tall oat grass (*Arrhenatherum elatius*) all seem very compatible with this legume. When in flower, both species attract large numbers of honey and bumble bees.

Alternative **seed line and time of sowing trials**

Germination of three accessions of *Dorycnium* at Cluden and Galloway was generally lower than that for *Lotus, Trifolium, Medicago* and *Sanguisorba* accessions for each of the times of sowing (trials at Dashwood Pass, Marlborough have also shown similar results (J.S. Sheppard pers. comm.). At the Galloway site (700 m asl) spring sowing was marginally better, but autumn sowing was slightly better at Cluden (500 m).

Performance of Dorycnium in these sowings as at 2/88 was:

Galloway autumn sowings - surviving well in all but the 1985 sowing. Performance

moderate, surpassed by that of birdsfoot trefoil, Pawera and alsike clovers.
Galloway spring sowings - surviving well in all sowings. Performance second-ranked to birdsfoot trefoil, Pawera and alsike clovers.
Cluden autumn sowings - good survival in all but the 1985 sowing, otherwise top-ranked for performance together with birdsfoot trefoil,
Cluden spring sowings - again good survival in all sowings except for *D. pentaphyllum* (1985). Top-ranked for performance together with birdsfoot trefoil and burnet in 1983/84 sowings, second ranked in 1985 sowings.

Observations indicate that *D. pentaphyllum* is more sensitive to site and competition and more palatable. Therefore its establishment in the field could be difficult unless it is managed carefully. Few problems were noted in establishment of *D.* hirsutum from seed but maturation period for the seedlings is longer than that for most other legumes investigated; thus extended establishment periods should be allowed.

Hunter trials

Availability of seed meant that only two *D.* hirsutum accessions could be included.

Initial establishment of *Dorycnium* hirsutum (1059) was similar to that for Lotus and better than that for *Medicago,* with seedlings having good, vigorous performance by mid-January 1985 (Table 1). While over-wintering had affected performance at mid-August, plants were still green and largely unaffected by frost.

Although initial establishment was slow, from the third season on the biomass production from 1059 increased to levels similar to those of Lotus and *Medicago* (Fig. 1). Owing to extremely dry conditions in early 1988, no cuts have been made since trimming in January 1988.

Foliar mineral analyses (Table 2) indicate high K in Sanquisorba, high Ca in *Medicago,* high Fe in 1059 and *Medicago* (in the field) and high Al in 1059, Lotus and *Medicago* (in the field).

Table 1: Hunter Strip Seeder trial, Bendigo (established 16 October 1984)

	mea" number of intercepts per m^2 at 1, 2, 3 and 10 months after sowing									
Plant spp/variety	1 month	2 months	3 months	Vigour (0-5)	Height (cm)	Spread (cm)	10 months	Vigour (0-5)	Height (cm)	Spread (cm)
Dorycnium *hirsutum* 1059	10	11	14	3.2	7	4	8	2.6	4	3
Dorycnium hirsutum 1020	3	4	4	2.5	3	2	2	1.5	2	1
Lotus *corniculatus* 'Tretana'	10	9	22	2.8	8	3			Dormant	
Lotus *corniculatus* 'Cascade'	14	11	5	2.8	4	1	-		Dormant	
Lotus tenuis Commercial	14	14	10	2.8	4	2	11	2.8	8	16
Medicago sativa WL 3 18	7	13	10	2.8	6	3			Dormant	
Sanguisorba minor 2303	15	16	11	3.0	6	4	21	2.2	4	6
Lupinus polyphyllus Russell	5	8	8	3.5	15	8	-		Dormant	
Melilotus officinalis 'Yukon'	11	23	28	3.8	12	8	-		Dormant	

Table 2: Mineral analysis of foliar samples, taken May 1986

Plant spp./variety	Location	Major elements as % of dry matter N	P	K	S	Ca	Mg	Na	Si	Cl	Trace elements as ppm Fe	Mn	Z"	Cu	Al
D. hirsutum 1059	Nursery	3.7	0.20	1.30	0.22	1.79	0.63	0.09	0.15	0.1s	463	84	25	11.9	200
D. hirsutum 1059	Bendigo	2.1	0.11	0.94	0.10	1.24	0.37	0.16	1.11	0.44	1291	180	22	13.8	2346
D. pentaphyllum *1066*	*Nursery*	4.2	0.29	1.94	0.33	1.21	0.38	0.05	0.26	1.08	669	96	24	15.1	610
L. tenuis Comm.	Bendigo	2.4	0.09	0.93	0.1 1	0.87	0.34	0.48	0.57	0.82	588	71	12	11.2	1537
M. sativa WL318	Bendigo	3.5	0.12	1.15	0.18	2.11	0.39	0.13	0.83	0.24	1048	58	18	14.1	1657
S. minor	Nursery	2.6	0.23	1.78	0.23	1.18	0.26	0.05	0.25	0.74	577	136	33	16.3	481
s minor	Bendigo	1.4	0.38	2.68	0.32	0.54	0.25	0.44	0.67	1.83	609	85	23	13.8	956

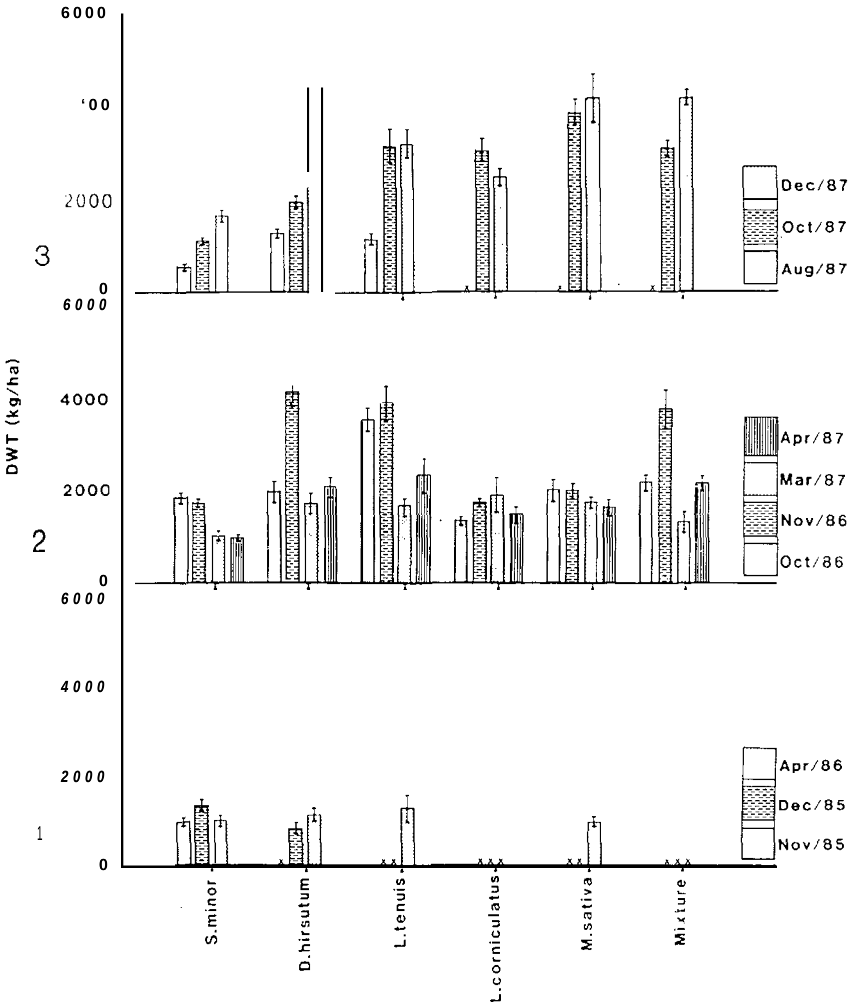

Figure 1: Hunter Strip Seeder trial (1984) — total biomass cuts over3 growing seasons at specified months, for *D hirsutum* 1059 and several other herbaceous species.

Dorycnium *hirsutum* (1059) continues to provide comprehensive, year-round vegetative ground cover at Bendigo. In contrast to lucerne (with bare interplant areas and winter dormancy), a varied mix of native and introduced plants co-exists within the sward. Regular trimming (biomass cuts) appears to have benefited Dorycnium, preventing it from become overmature. This is also true of plants on the Wither Hills, Marlborough. Reseeding is, however, recommended at intervals to assist population regeneration.

CONCLUSIONS

A number of applications for Dorycnium appear possible in New Zealand, both in grasslands and for erosion control/rehabilitation (Wills 1986; Sheppard & Douglas 1986). This legume should be well suited to the dry, sunny, rabbit prone country of Central Otago, especially in the Carrick, Earnscleugh and Manorburn area. Once established, it could provide an ideal setting for regeneration and introduction of other grasses and herbs to restore productivity and prevent erosion.

Current research is further refining selections, establishment requirements and management. Seed is presently being bulked up and a Plant Variety Right evaluation is underway at the Earnscleugh Research Nursery. As more extensive farm trials become feasible, the ability of Dorycnium to produce good ground cover in low fertility sois under cold, dry conditions, and to provide both stock and been forage, may be fully exploited, possibly under even wider climatic and edaphic conditions.

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