Melilotus alba: the preferred forage legume for autumn and spring-summer production on saline soils in SW Victoria.

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ABSTRACT

Accessions of *Melilotus alba* were tested at Worndoo and Glenthompson in SW Victoria in soils of neutral to alkaline pH. Electrical conductivity levels ranged between 1 and 5 dS/m. The second year regeneration of the best lines was 5000 plants/m^2 at Worndoo and 4600 plants/m^2 at Glenthompson, resulting in autumn and autumn-winter production of 1.7 t/ha and 2.2 t/ha respectively. At Worndoo this was 540% greater than Irrigation white clover and at Glenthompson around 20% greater than Nitro plus Persian clover. While spring production of *M. alba* lines was 160% greater than Palestine strawberry clover, the large improvements in production occurred in summer at both sites with 13.3 t/ha harvested at Worndoo and 12.1 t/ha at Glenthompson. This was 660% greater than Palestine strawberry clover. The results suggest that *M. alba* lines can produce the same quantity of forage than subterranean clover-ryegrass pastures growing in non saline soils in the district.

KEY WORDS

Melilotus alba, salinity, companion legumes, tall wheat grass.

INTRODUCTION

The area of land severely affected by salinity in Australia is estimated at 2.5 million ha, expands at about 2% each year and there is the potential for this to increase to 15 million ha. The area damaged by salinity to date represents 4.5% of cultivated land, and known costs include $130 million annually in lost agricultural production; $100 million annually in damage to infrastructure; and at least $40 million in loss of environmental assets (1). The area of winter waterlogged, moderately saline land is four times greater than that severely affected by salt. Tall wheat grass *Thinopyrum ponticum* (twg) and *Puccinellia* spp can grow in these areas but lack a suitable companion legume as Persian and balansa clovers fail at the highest levels of salinity. *Melilotus alba,* a legume native to temperate Europe and Asia (2), has performed well in SW Victoria in these conditions.

In Argentina and Spain, *Melilotus* spp are regarded as productive on saline land (3,4), they are also considered to improve degraded soil (5). The salt tolerance of *Melilotus* has been demonstrated in Spain, where populations that could germinate at high salt concentrations were identified (4). Serious problems with salinity are not confined to Australia, in the Mediterranean basin alone 150,000 km^2 are affected by salinity (6). This has important implications in the development of commercial legume cultivars with tolerance to salinity.

This paper aims to evaluate the production and persistence of *Melilotus alba* in saline soils in SW Victoria, both in monoculture and in mixtures with twg.

MATERIALS AND METHODS

Sowing in all experiments was carried out by hand by mixing the inoculated seed with fertiliser and sand before broadcasting onto the cultivated plots, followed by light raking. Commercial lucerne inoculant was used for *Melilotus* lines and the appropriate commercial strains for white, strawberry and annual clovers. Sowing rates were 20 kg/ha for *Melilotus*, and subterranean clover and 10 kg/ha for strawberry, white and other annual clovers. Fertilisers were applied at a rate of 250 kg/ha of superphosphate (9% P; 11% S), containing trace elements Mo, Cu and Zn (0.015, 0.5 and 0.5% respectively) and 150 kg/ha of muriate of potash (48% K). Plot size at Worndoo and Glenthompson sown in 1998 was 2 m x 1 m with 1m buffers. In

the experiment on raised beds sown at Glenthompson in 1999, the plots are 3 m long by 1.1 m wide. A drain separates each plot.

Regeneration in all experiments was measured by counting seedlings in five 10 cm x 10 cm quadrats per replicate four to five weeks after the opening rains. Dry matter production was determined by cutting one 0.2 m^2 quadrat placed at random in each replicate and drying the forage until constant weight in an oven. When sown species dry matter is shown, this is the result of multiplying the total dry matter by a visual rating ranging from 0 (no sown species) to 1 (100% sown species).

Nine *Melilotus* lines were sown at "Woorndoo" in SW Victoria on 17 April 1998, into a self mulching clay of pH 7 ($CaCl_2$) with an electrical conductivity ranging between 1-3 dS/m. The average annual rainfall is around 600 mm. The plants established well and were grazed with sheep in early spring 1998 and then allowed to set seed. The area was grazed after autumn production was determined in early winter 1999 and again after each dry matter assessment.

Two sites were sown at Glenthompson on 31 March 1998 and 22 April 1999. The soil is a grey clay with a pH of 8.4 ($CaCl_2$) and conductivity ranging between 3-5 dS/m. Conductivity was measured from soil cores taken over the whole experimental area in early autumn. Conductivity of the saturation extract was 42 dS/m. In addition to that, electrical conductivity was measured on 4 soil cores per plot in December 1999 in the experiment sown that same year in autumn. In 1999, the experiment was sown into the same soil on raised beds and left ungrazed until March 2000. *Melilotus* lines were sown with and without twg. Treatments for the two Glenthompson experiments are shown in Tables 2 and 3.

RESULTS

Worndoo

In the first spring at Worndoo, *Melilotus* lines averaged 3.9 t DM/ha, which was 18% more than the best control, Haifa white clover. In 1999, the average regeneration of *M. alba* lines was 3520 plants/m^2. This resulted in an autumn production of 1.5 t DM/ha, which was 4.6 times greater than the best control. After grazing with sheep in the second spring *Melilotus* lines averaged 1.8 t/ha which was 31% more than Palestine strawberry clover. By February 2000, they averaged 6.7 t/ha against 2 t/ha for Palestine. In autumn 2000, *Melilotus* lines averaged more than 400 seedlings/m^2 (Table 1).

Table 1. Production (t/ha) and regeneration (plants/m^2) of *Melilotus alba*, white (Haifa) and strawberry clover (Palestine) at Worndoo between 1998 and 2000.

Line/cv	DM spring 98	Regene-ration 99	Autumn DM 99	DM October 99	DM Feb 2000	Regenera-tion 2000
PAM 15	4.5	3130	1.4	1.5	3.9	270
Argy 1	4.3	3500	1.5	2.2	6.8	470
Argy 2	4.0	4660	1.6	1.6	5.6	800
EA1	4.0	4350	1.6	1.7	6.1	600
EA2	3.8	3470	1.5	1.8	4.0	310

Krajova	3.3	370	1.0	1.8	13.3	170
PAM15	3.6	5130	1.7	2.0	7.3	600
Haifa	3.3	-	0.2	1.3	1.9	10
Palestine	2.3	-	0.2	1.4	2.0	40
lsd (P=0.05)	1.19	3240	0.31	0.74	1.74	240

Glenthompson flat

At Glenthompson the first experiment was sown in 1998, it regenerated under grazing in 1999 and the best *M. alba* line produced 11.1 t/ha by February, which was 1.8 times more than Astred red clover (Table 2). Feed value was assessed in December 1999 showing 23% crude protein and a DM digestibility of 82%, on average, for all *M. alba* lines.

Table 2. Production of *Melilotus alba* lines (t/ha) compared with white clover (Irrigation), strawberry clover (Palestine) and red clover (Astred).

Line/cultivar	DM November 99	DM February 2000
Krajova	4.7	11.1
PAM 1	1.6	7.0
PChM14	2.8	6.0
PSM 21	3.5	5.3
Argy 1	3.0	5.2
EA2	2.8	5.1
Argy 2	3.8	4.6
PAM 15	4.3	3.6
EA1	1.8	3.0
Astred *	5.1	6.1

Irrigation	3.1	3.7
Palestine	3.8	3.6
lsd (P=0.05)	2.89	3.44

* Two out of three Astred replicates had comparatively low conductivity. Conductivity values varied 12-fold over the site.

Glenthompson beds

In the 1999 sown experiment, by early February, the best line had produced 12.1 t/ha in a binary mixture with twg. The conductivity in early summer on that treatment was 1.2 dS/m. The best pure *Melilotus* treatment produced 10.1 t/ha on a conductivity of 1.8 dS/m, and the lowest producing line with no grass yielded 8.3 t/ha on a conductivity of 1.9 dS/m. In autumn 2000, the *M. alba* in mixture with twg averaged 1300 plants/m^2 and the ones in monoculture 3000 plants/m^2 (Table 3).

Table 3. Production (t/ha), establishment and regeneration (plants/m^2), and electrical conductivity (dS/m) on raised beds at Glenthompson. Treatments with twg as a companion followed by the letter g, those grown in monocultures are followed by ng. Controls are Bolta balansa clover, Kyambro and Nitro plus Persian clovers and Leura subterranean clover.

Line/cv	Establ-ish-ment	Total DM Nov 99	Sown spp DM Nov 99	Cond dS/m Dec 99	Total DM Feb 00	Regen. May 00	Sown spp DM Aug 00
Dom g	600	3.1	1.1	1.4	11.2	840	0.9
Dom ng	580	2.3	1.6	1.6	9.6	3260	2.2
Ea1 g	650	3.2	1.3	1.2	12.1	1810	0.8
Ea1 ng	620	2.1	1.0	1.9	6.2	2100	1.1
Ea2 g	910	2.6	0.9	1.5	10.5	1830	1.2
Ea2 ng	720	2.5	2.1	1.8	10.1	4650	2.2
Pab g	600	3.0	0.8	1.2	9.5	790	0.6
Pab ng	570	2.0	1.2	1.9	8.3	2250	1.8
Pam15 g	750	2.8	0.7	1.9	9.5	1270	0.2

Pam15ng	730	2.3	1.3	1.8	9.1	2510	1.9
Bolta	290	1.2	0.1	1.2	*	960	0.2
Kyambro	360	1.3	0.2	1.7	*	1810	0.7
Nitro	410	1.7	0.4	1.2	*	2850	1.9
Leura	260	1.3	0	1.4	*	40	0
lsd (P=0.05)	222	0.59	0.69	n.s.	3.62	1840	0.9

* annuals dead since December 99, not sampled.

All treatments emerged and were counted four weeks after sowing. From that point onwards, those species not well adapted to the conditions either disappeared or performed poorly. Total dry matter includes the companion grass when sown and some salt tolerant volunteers which dominated the failed plots. *Melilotus* lines in monoculture produced the most in winter. These treatments also showed the highest total production with more than 2.5 t/ha of dry matter produced between late April and the end of August.

DISCUSSION

These results suggest that production need not be reduced on waterlogged/salt affected areas, but rather that the large amount of available water in these soils is an opportunity for obtaining high yields of quality forage later in the growing season. A large quantity of dry matter was produced between December and February at both sites, suggesting that *Melilotus alba* has the potential production that would help fill the summer-autumn feed gap. On an annual basis these pastures are producing similar amounts to those pastures in the district on non-saline soils. Even though around half of the growth was produced out of season, the good regeneration of *M. alba* in the second year resulted in excellent autumn-winter production on these soils. Third year regeneration at Worndoo was poor compared to the previous year, probably due to flooding soon after germination. Analyses conducted on *M. alba* lines from Glenthompson in December 1999 showed in vitro digestibility levels above 80% and crude protein levels above 20%. It is assumed that animals should perform extremely well on this quantity and quality of pasture. To test this hypothesis, an animal production experiment will be established at the Glenthompson site. An evaluation of possible anti-nutritional factors of these plants and their effects on sheep will be carried out during this experiment. Electrical conductivity values appeared to vary at Glenthompson; those measured on the individual plots being lower than those measured before sowing. This could be due to the fact that salinity levels increase towards the end of the summer.

The *M. alba* lines tested here were all annuals except the biennial Krajova. This cultivar did not appear to regenerate well in either of the sites in the third season. *M. officinalis* is another biennial species of *Melilotus* which has been used successfully as a pasture plant in other countries and worth testing in our saline sites.

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