# PERFORMANCE OF PASTURE LEGUMES ON THREE CONTRASTING SOIL TYPES IN WESTERN VICTORIA

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## Abstract

The production and persistence of a range of legumes species was evaluated in western Victoria at three sites: Hamilton, an acid basaltic clay receiving 700 mm average annual rainfall (a.a.r.); Lake Bolac, a neutral clay (550 mm a.a.r.) and Chatsworth an alkaline, saline clay (525 mm a.a.r.). Balansa and Persian clovers performed well at all sites and their production was equal to, or better than, subterranean clover in all harvests over 3 years. Balansa out-produced the best subterranean clover in all winter cuts. cv. Astred (a stoloniferous red clover) performed well in all sites but, together with arrowleaf clover which did well only at Lake Bolac, had poor winter production. Lucerne did well in the neutral soils regardless of salinity; subterranean clover failed in the saline soil. The Persian clover spp *majus* regenerated well at two sites but disappeared from Hamilton in the third year. *Melilotus* spp. were clearly the most productive in the saline soil but failed at Hamilton.

*Key words: Pasture legumes, salinity, waterlogging, Trifolium, Melilotus, adaptation, regeneration.*

Single species of pasture legumes are sown over large areas of Australia. For instance, at least 20 million ha are sown to subterranean clover (*T. subterraneum*) in southern Australia. Some disadvantages of using the same species for most situations are lack of adaptation to some ecological niches, lack of diversity and a single growing cycle that may lead to feed shortages in summer, autumn or winter. Sowing a variety of legume species provides diversity, both of species and manage-ment systems, and complements commonly used species by requiring grazing when traditional legumes should be spelled and vice versa.

Balansa clover (*T. michelianum)* has been shown to be salt tolerant in glasshouse studies (4) and Persian and balansa clovers have persisted well under waterlogging and mild salinity in Western Australia, (1, 2). However, the area of adaptation of these two species in Australia may not be restricted to waterlogged, mildly saline soils.

Hard grazing which is required after senescence to produce regeneration in small seeded annuals can provide excellent quality feed in early summer (6). Later on, perennial legumes such as red clover (*T.* pratense) and lucerne (*M. sativa)* and late maturing annuals such as arrowleaf clover (*T. alexandrinum*) or *Melilotus alba* may produce summer feed after earlier maturing annuals have been utilised.

The aim of this work was to examine the adaptation, in terms of production and persistence, of a range of legumes on three different soil types in western Victoria in relation to the most common subterranean clovers used in the area, Leura and Trikkala.

## Materials and methods

Thirty five legumes were sown at Hamilton, Lake Bolac and Chatsworth on the following dates: May 23, 25 and 26, 1995, respectively. The 25 most representat-ive treatments of all species used are shown on Table 1. An additional subterranean clover control, Clare (*Trifol-ium subterraneum* var. *brachycalycinum),* was planted at the two high pH sites because of its adaptation to these conditions. The soil at Hamilton is a basaltic clay of low conductivity and a pH ($CaCl_2$) of 4.5, receiving an average annual rainfall (a.a.r.) of 700 mm. Lake Bolac is a fertile grey clay with low conductivity and a pH ($CaCl_2$) of 6.2. Its a.a.r. is 550 mm. Chatsworth receives 525 mm a.a.r., its soil conductivity in July was 1.33 dS/m (moderate salinity) with a pH ($CaCl_2$) of 7.4. Sowing rates were 10 kg/ha for all treatments. The seed was broadcast on cultivated ground with 300 kg/ha of 3:1 superphosphate:KCl fertiliser with Cu, Mo and Zn and then raked lightly. Plots size was 2 x 2 m at Hamilton and Lake Bolac and 2 x 1 m at Chatsworth with 1m buffer strips between plots.

Table 1. Production (kg/ha) and regeneration (pl/m$^2$) of 25 entries representative of all 11 pasture legume species sown at Lake Bolac.

| | | 1995 | | 1996 | | | 1997 | | |
|---|---|---|---|---|---|---|---|---|---|
| Species | Line/cultivar | Winter | Spring | Regen. | Winter | Spring | Regen. | Winter | Spring |
| | | | | | | | | | |
| *Melilotus alba* | PAM19 | 588 | 4240 | 150 | 2148 | 8743 | 100 | 1343 | 2018 |
| *M. alba* | PAM20 | 422 | 3994 | 217 | 1828 | 8555 | 200 | 1261 | 2005 |
| *M. indica* | MIS1 | 408 | 3270 | 700 | 1850 | 8195 | 733 | 1394 | 1990 |
| *M. indica* | R99 | 688 | 3708 | 50 | 1700 | 9535 | 67 | 1677 | 2478 |
| *M. indica* | ST2 | 562 | 5106 | 234 | 1853 | 7513 | 550 | 1514 | 2620 |
| *M. indica* | ST 1 | 562 | 4104 | 500 | 1828 | 7295 | 284 | 1451 | 1955 |
| *M. indica* | PAUM23 | 683 | 4954 | 117 | 1675 | 7423 | 417 | 1563 | 2283 |
| *T. subterraneum* | Leura | 463 | 3951 | 1967 | 2445 | 7840 | 7867 | 1921 | 2768 |
| *T. subterraneum* | Trikkala | 488 | 2353 | 1017 | 2130 | 7023 | 3567 | 1685 | 3108 |
| *T. brachycalycinum* | Clare | 402 | 4629 | 1134 | 3040 | 6928 | 3300 | 1476 | 1795 |
| *T. michelianum* | Paradana | 1741 | 5698 | 1767 | 3895 | 7955 | 18500 | 1908 | 3618 |
| *T. michelianum* | Bolta | 1407 | 6758 | 2450 | 3113 | 7350 | 23067 | 2650 | 4713 |
| *T. vesiculosum* | Tas663 | 808 | 6527 | 350 | 1420 | 11188 | 517 | 1557 | 2448 |
| T. *vesiculosum* | Zulu | 785 | 6910 | 550 | 1763 | 9965 | 2467 | 1924 | 2250 |
| *T. vesiculosum* | WA599 | 770 | 5674 | 1100 | 1393 | 8658 | 1817 | 1666 | 2073 |
| *T. pratense* | Astred | 368 | 4477 | 534 | 1393 | 11998 | 64 | 1000 | 2815 |
| *T. resupinatum* | Maral* | 1175 | 9976 | 833 | 2673 | 9010 | 3183 | 1101 | 2360 |
| *T. resupinatum* | Morbulk* | 2162 | 11209 | 900 | 2775 | 9845 | 4300 | 1334 | 2773 |
| *T. resupinatum* | Kyambro | 350 | 4779 | 2033 | 2303 | 10673 | 9733 | 2204 | 3380 |
| *T. resupinatum* | Nitro plus | 506 | 4494 | 1350 | 3433 | 7390 | 18800 | 2155 | 3265 |
| *T. resupinatum* | Prolific | 2306 | 6420 | 1100 | 3455 | 8203 | 8820 | 1628 | 2708 |
| *T. alexandrinum* | Bigbee | 1338 | 6941 | 717 | 3148 | 8395 | 1600 | 1177 | 2285 |
| *T. xerocephalum* | X14946 | 1124 | 5759 | 517 | 1898 | 7743 | 2833 | 1321 | 2463 |
| *Medicago sativa* | Southern special | 422 | 2436 | 267 | 1448 | 9108 | 17 | 1427 | 2738 |
| *M. sativa* | AWE1 | 505 | 3250 | 400 | 2318 | 10168 | 167 | 1498 | 3010 |
| | | | | | | | | | |
| lsd ($p=0.05$) | | 436 | 1329 | 645 | 910 | 1663 | 5317 | 530 | 893 |

* *Trifolium resupinatum* spp *majus*

Seedlings were counted in six 10 x 10 cm quadrats per replicate in the first year and from five 5 cm diameter soil cores at Chatsworth and eight 5 cm diameter cores at Hamilton and Lake Bolac in years two and three. Dry matter production was assessed by cutting one 0.25 m$^2$ quadrat per replicate and oven drying the samples at 100 $^{o}$C. The percentage of sown species was assessed visually in each plot. A single figure is given, one for winter and one for spring production, each year at Lake Bolac which is the sum of all harvests taken for that season. All experiments were grazed hard with sheep after each harvest and kept continuously grazed during summer and early autumn. In the second year at Hamilton, grazing continued during winter and early spring. Analyses of variance were performed on the data using Genstat 5.

## Results and discussion

Establishment of most entries was satisfactory. Subterranean clover established poorly at Chatsworth possibly due to the saline conditions. Establishment of cvv. Nitro plus and Kyambro was poor due to low quality seed. These two Persian clovers improved in spring and regenerated well in 1996 and 1997.

At the first dry matter assessment at Lake Bolac (3/9/95) the Persian clovers Prolific and Morbulk, produced more than all other entries (Table 1). Morbulk is a newly registered *majus* type maturing ten days earlier than cv. Maral. A group comprised of the two balansa cultivars, berseem, Maral Persian clover and x14946 (*T. xerocephalum*) all produced above 1 t/ha in this first winter. Interestingly, the arrowleaf clovers had almost double the production of the subterranean clovers. With the same sowing rate, the larger subterranean clover seedlings did not seem to compensate for their lower numbers in the first three months after emergence.

Table 2. Production (kg/ha) and regeneration (plants/m$^2$) at Hamilton and Chatsworth between 1995 and 1997 for 25 pasture legumes.

| | Hamilton | | | | | Chatsworth | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1995 | 1996 | | 1997 | | 1995 | 1996 | | 1997 | |
| Line | Spring | Regen. | Spring | Regen | Winter | Spring | Regen | Spring | Regen | Spring |
| | | | | | | | | | | |
| PAM19 | 972 | 0 | 0 | 0 | 0 | 3771 | 250 | 185 | 270 | 1621 |
| PAM20 | 660 | 0 | 0 | 0 | 0 | 5233 | 400 | 130 | 262 | 1888 |
| MIS1 | 610 | 0 | 0 | 0 | 0 | 6460 | 6400 | 2775 | 1135 | 3569 |
| R99 | 572 | 0 | 0 | 0 | 0 | 3464 | 1600 | 1762 | 429 | 1682 |
| ST2 | 642 | 0 | 0 | 0 | 0 | 7990 | 5625 | 529 | 2024 | 757 |
| ST1 | 711 | 99 | 1250 | 50 | 25 | 8350 | 11350 | 2048 | 1826 | 2496 |
| Paum 23 | 731 | 314 | 1320 | 100 | 25 | 7353 | 975 | 562 | 1421 | 1500 |
| Leura | 3641 | 1337 | 3650 | 6733 | 1833 | 243 | 100 | 628 | 64 | 389 |
| Trikkala | 2618 | 957 | 3663 | 1283 | 1088 | 603 | 100 | 276 | 63 | 282 |
| Clare | - | - | - | - | - | 420 | 250 | 334 | 95 | 416 |
| Paradana | 4736 | 1320 | 6788 | 15167 | 3496 | 4115 | 3377 | 1705 | 317 | 931 |
| Bolta | 6833 | 825 | 6888 | 14883 | 3559 | 3985 | 4325 | 2807 | 611 | 1492 |
| Tas663 | 4936 | 132 | 2388 | 50 | 161 | 1405 | 375 | 40 | 79 | 648 |
| Zulu | 4720 | 380 | 3588 | 484 | 384 | 2155 | 100 | 84 | 317 | 875 |
| WA599 | 3780 | 330 | 3613 | 134 | 328 | 1570 | 250 | 85 | 325 | 922 |
| Astred | 4360 | 181 | 3675 | 167 | 315 | 1305 | 875 | 1823 | 151 | 2174 |
| Maral | 4312 | 149 | 3700 | 0 | 0 | 2415 | 2150 | 1878 | 254 | 1020 |
| Morbulk | 5088 | 182 | 3113 | 167 | 203 | 2718 | 1675 | 1882 | 238 | 1317 |
| Kyambro | 3956 | 825 | 5463 | 8950 | 2290 | 988 | 3350 | 1305 | 1119 | 3111 |
| Nitroplus | 3241 | 776 | 5064 | 3150 | 2360 | 1058 | 1225 | 910 | 206 | 727 |
| Prolific | 3715 | 611 | 3588 | 2183 | 2417 | 4468 | 1100 | 2399 | 389 | 2590 |
| Bigbee | 5158 | 231 | 2675 | 33 | 127 | 2593 | 975 | 1488 | 87 | 1924 |
| X14946 | 2559 | 116 | 1963 | 150 | 199 | 2398 | 1125 | 102 | 32 | 166 |
| Southern special | 770 | 0 | 0 | 0 | 0 | 445 | 400 | 1111 | 111 | 1901 |
| AWE1 | 933 | 0 | 0 | 0 | 0 | 1060 | 375 | 1711 | 87 | 2378 |
| | | | | | | | | | | |
| lsd (p=0.05) | 783 | 573 | 1437 | 2106 | 610 | 1235 | 2071 | 1327 | 510 | 1036 |

The Persian clover spp. *majus* produced significantly more in the first spring, the next best group had the balansas, Prolific, Big Bee, the arrowleaf clovers and *T. xerocephalum.*The latter set seed, but did not regenerate well at any site. The stoloniferous red clover Astred and the lucernes did not match the production of annuals in the first spring.

The Persians, balansas, WA599 arrowleaf and the subterranean clovers regenerated well in 1996 (Table 1).? Leura produced more seedlings than Trikkala and Clare despite the 1995 season receiving 573 mm. Its winter production was slightly higher than earlier flowering Trikkala, showing once more that, in subterranean clover, maturity has no effect on winter production. Paradana, Nitro and Prolific produced well over 3 t/ha of dry matter, suggesting these small seeded annuals can often produce more winter forage than subterranean clover following adequate regeneration. In spring, two very poor winter producers, Astred and Tas663 exceeded 11 t/ha. AWE1 lucerne and Kyambro Persian clover, however, produced well after reasonable winter production.

In 1997, Bolta, Nitro and Paradana showed massive regeneration. Not surprisingly Bolta also had the highest winter production. Even though Bolta is later maturing, its average advantage over Paradana in Spring at Lake Bolac was only 0.5 t/ha. Kyambro and Nitro plus continued to perform well in the dry 1997 Spring.

Large differences in adaptation between Hamilton and Chatsworth were observed. At Chatsworth all Melilotus and lucernes performed well but they failed at Hamilton (Table 2). At Hamilton, berseem clover performed well only in the first season while the Persian clovers spp. *majus* produce as much as Leura in the second spring, but regenerated poorly in the third season. Across all seasons Paradana and Bolta performed best, in terms of winter and spring production, and regeneration. They were followed by Kyambro, Nitro and Prolific and then Leura subterranean clover which, in turn, performed better than Trikkala. Two accessions of *Biserrula pelecinus* failed at Hamilton.

In the first spring at Chatsworth, the highest producers were *Melilotus*, especially the line ST1. Both *Melilotus alba* lines continued to grow after December, 1995, but were not assessed for production and the experimental area was grazed in mid-February 1996, so this late flowering species was not allowed to set seed to its full potential. In 1996, the best regeneration was observed in *Melilotus*. Balansa and the Persian clovers had adequate plant numbers and the subterranean clovers failed. The experiment was grazed in late September, 1996, the balansas did not recover but the Persian clovers did. The poor regeneration of balansa clover in 1997 is attributed to this spring grazing. By 1997, *Melilotus*, Astred, some Persian clovers and the lucernes, especially AWE1 from Argentina, were performing well. The success of lucerne in this saline site at Chatsworth may be attributed to the absence of winter waterlogging during the experimental period.

These results confirm reports that *Melilotus* spp. tolerate salinity (3, 5) and that Persian and balansa clovers not only tolerate waterlogging and mild salinity (1, 2) but can also adapt to a wide range of climatic and edaphic situations. Their production at the three sites studied here was never lower than the best subterranean clover for the area and in many harvests significantly better, especially the balansa clovers in winter.

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