THE PERFORMANCE OF SEVERAL LEGUME SPECIES ON MINE TAILINGS IN THE NASEBY FOREST

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ABSTRACT

Two adjacent experiments on mine tailings in the Naseby Forest were conducted between 1983 and 1989. One experiment evaluated Maku lotus (*Lotus pedunculatus* L.), Tana birdsfoot trefoil (*Lotus corniculatus* L.) and WL318 lucerne (*Medicago sativa* L.) with treatments of 0, 10, 20 and 40 kg/ha of P on an open site. The other experiment evaluated Maku lotus and Tana birdsfoot trefoil growth in the shelter of trees. Tree growth was also measured in both legume treatments and in the absence of legumes.

Establishment plant counts showed that only 4% of viable Maku lotus seed sown produced surviving plants in the open, compared with 12-13 % for all other cultivars. The establishment of Maku lotus and Tana birdsfoot trefoil was markedly improved in the shelter of the trees with plant numbers increasing five fold in Maku (23 % of viable seeds) and 2.5 fold in Tana (30 % of viable seeds).

Tana birdsfoot trefoil dry matter production was significantly higher than Maku lotus in both experiments. There was no significant dry matter production difference between WL318 lucerne and Tana birdsfoot trefoil.

During the first two seasons there was never any consistent species response to the phosphate treatments. These treatments were later discontinued and a maintenance rate applied.

Tree diameter at breast height (DBH) and tree height were measured from 1984-85 until 1988-89. The height increment of trees in the Tana birdsfoot trefoil pots was significantly better than the height increment in the nil legume plots. Maku lotus was not significantly different from the other treatments.

There was no significant difference between treatments for DBH increments. Soil organic carbon within the trees showed significantly higher levels in the Tana birdsfoot trefoil treatment than the Nil legume treatment.

Additional Keywords:* *Lotus, birdsfoot trefoil, lucerne, herbage production, tree height, tree diameter at breast height.

INTRODUCTION

Revegetation of any drastically disturbed land is an essential method for stabilizing soil and bringing land back into economic production. So, provided they can be satisfactorily established, and show sufficient long term persistence adapted legumes offer a relevant means of reclaiming these areas. Mine tailings represent one sixth of the 2,500 hectare Naseby Forest. Fire breaks in these areas give no economic return and require routine maintenance. Legumes such as Lucerne, Birdsfoot trefoil and *Lotus pedunculatus* L. have been shown to be able to build up significant amounts of nitrogen within the soil (Nordmeyer & Davis, 1976), so if successful legume stands can be established and maintained in association with trees, the expected improvement in the physico-chemical properties of these droughty, infertile, highly mineral "soils" should lead to improved tree growth rates.

MATERIALS AND METHODS

Several legume species and cultivars were established on two adjacent sites in Wet Gully Road, Naseby Forest, in spring of 1983 (Table 1, 2).

Plots in the open were partly levelled by raking and after broadcast sowing of seed (632 viable seeds per m^2 for all cultivars), were lightly rolled to improve seed/soil contact. At the time of sowing, open area plots were almost totally devoid of any plant cover. Seed was inoculated with the recommended strain of *Rhizobium* and oversown into 3 m by 4 m plots, with a 2 m gap between plots. Plots were later thinned again to reduce the amount of shading on the plots.

Table 1: Climate and soil characteristics from the Naseby Forest.

Soil		Climate (1923-1980)		
Type:	German stony sand	Average daily maximum (°C)		14.1
Date:	26/7/1983	Average daily minimum (°C)		2.0
pH	6.5	Daily mean (°C)		8.0
Olsen P	5.2	Rainfall mean (mm)		610.0
K	1.0	Rainfall (mm)	1984	580.0
Mg	50.0		1985	380.0
OC (%)	0.24		1986	750.0

Table 2: Experimental design of sites within the Naseby Forest.

Site	Replicates	Cultivars	Initial Fertiliser	Maintenance
Open	3	Maku lotus Tana birdsfoot trefoil WL318 lucerne	Basal S: 50kg S/ha as gypsum	25kg S/ha
			Basal Mo: 80g Mo/ha as sodium molybdate	40g Mo/ha
Trees	4	Maku lotus Tana birdsfoot trefoil	Basal B: 2 kg B/ha as borax	1 kg B/ha

P treatment

Phosphorus at: 0, 10, 20 and 40 kg P/ha as Ibex
(Treatments later discontinued and a standard maintenance rate applied.)

Plant counts (plant/m^2) were recorded to access plant establishment and early survival in both experiments. Plot cover (0 - 100 %) was visually recorded also on the experiments.

Herbage yield (kg DM/ha) was initially determined on the open site as three random hand cut 0.5 m^2 quadrats per plot and later changed to a sickle bar mower taking a 1 m x 4 m strip through each plot from the 1985-86 season until the end of the trial. Within the shelter of the trees herbage yield was determined by 3 - 6 random 0.5 m^2 quadrats from each plot depending upon the amount of plant growth present.

Soil samples (0 - 7.5 cm) were taken from each plot within the shelter of the trees after the final harvest of the 1988-89 season to record legume effect on soil characteristics.

RESULTS AND DISCUSSION

Plant establishment: When counts were made 4 months after sowing, only 4 % of the viable Maku lotus seed sown had produced surviving plants in the open, compared with 12 % for Tana birdsfoot trefoil and 13 % for WL318 lucerne (Table 3).

Maku lotus and Tana birdsfoot trefoil in the open land had failed to produce satisfactory stands by the end of the first season. Within the more favourable conditions in the shelter of the trees both the establishment and growth of lotus species was markedly improved, 23 % of viable seed for Maku lotus and 30 % of viable seed for Tana birdsfoot trefoil had produced surviving plants.

Plot cover: Plot cover recorded on the open site on 21 May 1984, reflected the poor establishment of both lotus species. Further recordings showed a marked increase in plot cover especially in the Tana birdsfoot trefoil in relation to WL318 lucerne (Table 3), this reflected the small size of the Tana birdsfoot trefoil and low early seedling vigour compared with lucerne (Seaney & Henson, 1970). Plot cover within the shelter of the trees was similar for both lotus species. Plot cover within the shelter of the trees was superior to the open site.

Table 3: Legume establishment and cover from two sites within Naseby Forest.

	Plants/m2 8/2/84	% Cover 21/5/84	% Cover 16/11/84	% Cover 25/11/84
Open				
Maku	27	23	24	52
Tana	74	28	65	80
WL318	80	61	74	78
SED	12.0	5.3	3.5	3.1
Significance	***	***	***	***
Trees				
Maku	143	71		
Tana	192	65		
Nil	0	0		
SED	23.4	6.4		
Significance	***	***		

Dry matter production: Low dry matter yields (kg DM/ha) of both lotus species in the establishment season (1983-84) was indicative of their low seedling vigour as well as patchy establishment. The WL318 lucerne growth was markedly superior to both lotus species during the establishment season (Table 4).

Due to severe drought stress during the 1984-85 season, yield from all plots was negligible after the second harvest on 5 February 1985. During this time on the open site Tana birdsfoot trefoil out yielded both other species. Yields of Maku lotus were nearly four times higher in the shelter of the trees than in the open, whereas under the favourable growth conditions in 1985-86, the response was slight. Similarly, the shelter of the trees did not enhance Tana birdsfoot trefoil growth in the 1985-86 season, whereas under drought conditions yields were 52 % higher on the tree site than in the open. Maku lotus recovered remarkably well after severe damage from drought stress during 1984-85 and compensated for initially poor establishment in the open with considerable vegetative (rhizome) spread to fill most gaps between plants.

As a mean for all seasons (1983-88), there was no significant dry matter production difference between Tana birdsfoot trefoil and WL318 lucerne, although both were significantly better than Maku lotus (Table 4). This same production pattern continued from the 1985-86 season through to the 1987-88 season. As a mean for all seasons (1983-88) dry matter production of Tana birdsfoot trefoil within the shelter of the Douglas Fir trees was significantly better than that of Maku lotus (Table 4).

There was no significant difference between Maku lotus and Tana birdsfoot trefoil during the establishment season (1983-84).

The production pattern of the following seasons was consistent with Tana birdsfoot trefoil production superior to that of Maku lotus, except during the 1987-88 season when there was no significant difference.

P treatments: There was no consistent response to P in the first two seasons, so P treatment were discontinued and a uniform maintenance rate applied to all plots. Results are not included.

Tree growth: Tree growth measurements began during the 1984-85 season. At the end of each season tree height and tree diameter at breast height were recorded from trees within each plot.

Tree height increments of Tana birdsfoot trefoil plots were significantly better than tree height increments in the nil legume plots (Table 5). There was no significant difference between Maku lotus and the other treatments for tree height increments. Although tree height increments were following the same trend as the Tana birdsfoot trefoil treatment.

There was no significant difference among treatments for tree DBH increments.

Both Tana birdsfoot trefoil and Maku lotus plots had significantly more soil potassium than the nil legume plots. Although the total soil nitrogen result was not significant between each treatment, it was approaching significance (Table 6).

Both soil organic carbon and potassium in the legume plots were significantly higher than in the nil legume plots. Results for legume plots compared with the nil legume plots for calcium and sodium also approached significance (Table 6).

Table 4: **Mean Dry Matter Production (kg DM/ha) from two sites within the Naseby Forest**

	1983-84	1984-85	1985-865	1986-87	1987-88	Mean
Open						
Maku	200	560	3,180	2,050	2,510	1,700
Tana	230	1,800	4,270	4,230	4,170	2,940
WL318	1,040	1,370	3,880	4,640	3,600	2,900
SED	144.6	195.0	186.6	278.8	358.7	155.6
Significance	***	***	***	***	***	***
Trees						
Maku	170	1,960	3,420	2,800	2,370	2,140
Tana	380	2,950	4,340	3,400	2,860	2,790
Nil	0	0	0	0	0	0
SED	130.9	272.2	94.6	141.1	173.3	119.1
Significance	NS	***	***	***	***	***

Table 6: **Soil test results from among the trees in the Naseby Forest.**

	pH	Ca	P	K	S	Mg	Na	OC	TN
Maku	6.4	7.5	7.5	3.0	0.75	43	2.5	0.60	0.028
Tana	6.5	8.3	7.8	3.3	1.25	51	1.5	0.68	0.030
Nil	6.5	8.3	7.0	1.5	1.25	47	1.5	0.50	0.013
SED	0.3	0.6	1.2	0.4	0.47	3	0.5	0.051	0.0068
Significance	NS	NS	NS	**	NS	NS	NS	*	NS
Legume	6.4	7.9	7.6	3.1	1.00	47	2.0	0.64	0.029
No legume	6.5	8.3	7.0	1.5	1.25	47	1.5	0.50	0.013
SED	0.1	0.1	0.3	0.4	0.14	2	0.2	0.032	0.0063
Significance	NS	NS	NS	*	NS	NS	NS	*	NS

Table 5: Tree height and diameter at breast height increments of the Douglas Fir trees on mine tailings in the Naseby Forest (1985-1989)

	Diameter (mm)	Height (M)
Maku	154.6	1.33
Tana	184.3	1.70
Nil	145.3	0.86
SED	21.0	40.26
Significance	NS	*

CONCLUSIONS

Tana birdsfoot trefoil can be successfully established and grown on mine tailings in the Naseby Forest and has a positive effect on tree growth and soil conditions. Tree growth was enhanced by the presence of legumes.

Tana birdsfoot trefoil dry matter production on the open site was superior to that of Maku lotus. This pattern was also repeated within the shelter of the Douglas Fir trees. There was no significant dry matter production differences between WL318 lucerne and Tana birdsfoot trefoil.

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