A PRELIMINARY STUDY OF LUPINS ON PUMICE SOILS

N. J. Withers
Agronomy Department
Massey University

I. P. M. McQueen
Soil and Field Research Organ., Reserach Div.
Min. of Agriculture and Fisheries.
Rotorua

and

K. W. Clark
Plant Science Department
University of Manitoba
Winnipeg
Canada.

ABSTRACT

During the 1975/76 season three trials were conducted on pumice soils between Wairakei and Rotorua. Aspects studied were seed and forage yield of 3 lupin species, seeding rate, inoculation, seedling losses and the application of nitrogen and potassium fertiliser.

Mean forage yields at one site wre 2433 kg/ha D.M. at 77 days and 5825 kg/ha at 119 days. At another site, forage yield was 7533 kg/ha at 113 days. At two sites where seed yield was measured, **L. angustifolius** cv. Unicrop produced 2280 and 3392 kg/ha at 14% moisture content, **L. luteus** cv. Weiko III yielded 1620 and 1371 kg/ha and **L. albus** cv Ultra which was grown only at the second site yielded 1538 kg/ha.

There was no response to inoculation or to the application of nitrogen and potassium fertilisers.

INTRODUCTION

Yellow brown pumice soils occupy a large portion of the central North Island. Most of this area lies between 200 and 500 m above sea level, although some of the soils extend down to within 50 m in the coastal Bay of Plenty. Inland, the soils are of medium to low fertility, free draining and of coarser texture in the valleys than on the hills.

Climate plays a large part in their productivity. Cool winters and uncertain summer rainfall are further compounded by summer frosts in the areas towards Taupo.

Cropping is limited to those plants capable of withstanding out of season frosts and summer droughts together with somewhat variable soil moisture conditions. Low temperature tolerance, at least in the vegetative stage, of lupins suggests that they may have a role to play in the economy of the area.

Preliminary work in 1972 and 1973 showed that there were problems in achieving satisfactory establishment of lupins. In particular, sowings of Uniwhite lupins in July and August germinated and were then eaten off at ground level. It could not be determined whether the damage was caused by rodents, birds, insects or slugs. A trial in the coastal Bay of Plenty, under humid conditions, was severely affected by several leaf fungi of which the worst was thought to be **Pleiocheta setosa,** although **Stemplyllium, Pythium** and **Rhizoctonia** spp. were also present. It was also noted in this trial that plants on low fertility patches appeared to be performing at least as well as those on better parts of the trial area.

Generally, where plants survived, vegetative growth was good in all districts in which lupins were sown. No reliable estimates of seed yield were obtained but it was not thought to be high.

In 1975, replicated trials were laid down to identify more precisely some of the factors influencing performance.

EXPERIMENTAL

Three trials were laid down in late September:-

1. At Wairakei Research Station on Waipahihi sand, a trial with three species of lupin - **Lupinus albus** cv. Ultra, **L. angustifolius** cv. Unicrop, **L. Luteus** cv. Weiko III was laid down. Each species received treatments consisting of all combinations of nil and 30 kg/ha nitrogen (as nitrolime) and nil and 50 kg/ha potassium (as potassium chloride) applied as a surface dressing after sowing. Previously a basal dressing of 300 kg/ha of superphosphate and a trace element mix containing magnesium, boron, copper and molybdenum had been applied. Soil test levels were Ph 5.7, Ca 4, K 4, P 18, Mg 9, on the Ministry of Agriculture and Fisheries quick test. All seed was inoculated and 1.1 kg/ha of simazine was applied pre-emergence.

Design was a randomised block with 4 replications. Sowing was in 15 cm rows with a Stanhay precision drill. Forage cuts from 1 m x 0.75 m quadrats were taken on 13 January. Unicrop and some Weiko III plots were harvested for seed on 12 February. Ultra and the balance of Weiko III was harvested on 22 March. Quadrat size for seed harvest was 3 x 1.2 m.

2. At Oruanui (10 km N.W. of Wairakei) on Tihoi sand, two varieties, **L. angustifolius** cv. Unicrop and **L. luteus** cv. Weiko III were sown in a split plot randomised block design with four replications.

Varieties were main plots, while sub-plots sown at 100 and 200 kg seed/ha were further split into plus and minus inoculant. The seed was sown on September 23 using a Stanhay precision seeder in 15 cm rows. Prior to sowing, a basal fertiliser dressing was applied containing 300 kg/ha 50% potassic superphosphate and trace elements as in trial 1.

Plant counts were taken on October 16 (2.5 - 7.5 cm stage) and November 12, 1975 (18 - 22 cm stage) from random one meter lengths of each of five inside rows of each sub-plot.

In each sub-plot 2.4 m^2 was harvested for DM yield determination on December 9 1975 and similar quadrats on January 20 1976.

Cattle broke into the trial area in March, before the pods were ripe, and no seed yields were obtained.

3. At Tikitere, 18 km NE of Rotorua, on Kaharoa sand another trial using the same varieties as in trial 2 as main plots was sown on September 26 1975. Sub-plots were four forms of seedling protection, viz

4.2 m^2 cages to exclude birds
Metaldehyde at 7 kg a.i./ha
Parathion at 1.5 a.i./ha
No protection.

The trial area was surrounded by rabbit-proof netting. All seed was inoculated and was sown in 30 cm rows. Basal fertiliser was applied as in trial 2, and simazine at 1 kg a.i./ha applied pre-emergence for weed control.

The design was again a split plot, randomised block with four replicates.

Plant counts were taken on October 24 (5-6 cm stage) and November 27 1975 (28 - 35 cm stage) in a similar manner to trial 2. Two 5 m rows from each sub-plot were harvested for seed on March 18, 1976. At this stage Weiko III was still flowering on some lateral branches.

RESULTS

Mechanical problems caused some variation in seeding rates from the desired levels in all three trials. This was most marked in trial 1. (Table 1). In trial 2 the low seeding rate of Weiko III appeared to be the only treatment affected (see Table 2).

TABLE 1: Plant population, yields dry matter and seed, by varieties

Trial	Cultivar	Plants /m2	Forage yield (kg DM/ha) (13.1.76)	Seed (kg/ha) at 14% MC
1	Unicrop	95	7180 a	3392 aA
	Weiko III	43	8012 a	1371 cB
	Ultra	55.2	7408 a	1538 bB
			(9.12.75) (20.1.76)	
2*	Unicrop	92.7 aA	3320 aA 5890 bA	–
	Weiko III	99.3 aA	2650 bA 7010 aA	–
3*	Unicrop	41.3 aA	–	2280 aA
	Weiko III	54.9 aA	–	1620 bB

* 200 kg/ha seeding rate only

TABLE 2: Effects of seeding rate (Trial 2)

Cultivar	Seeding Rate	Plants /m^2 (16.10.75)	(12.11.75)	Forage Yield (kg DM/ha) (9.12.75)	(20.1.76)
Unicrop	100	62.7 bB	58.0 bB	2760 bB	5750 aA
	200	92.7 aA	92.7 aA	3320 aA	5890 aA
Weiko III	100	24.7 bB	23.3 bB	1000 bB	4710 bB
	200	104.7 aA	99.3 aA	2650 aA	7010 aA

Duncan's lettering applies in vertical columns within varieties

Trial 1 was affected by root rot fungi, mainly in Weiko III and this contributed to the reduction in plant numbers of this variety. The other two trials were notably free of disease.

Table 2 shows that despite differences in plant populations, all cultivars produced similar forage yields. The relative yields of Unicrop and Weiko III in December in trial 2 probably reflect the slower maturing character of Weiko III.

Differences in forage yields were highly significant between seeding rates in December but by January the gap had closed in both varieties, although the very poor establishment of the low seeding rate Weiko III continued to depress yields.

For seed production, Unicrop was the superior cultivar in these trials.

There was no significant difference among fertiliser treatments within species in trial 1 nor were there any significant responses to inoculation and seedling protection in trials 2 and 3.

DISCUSSION

As a forage crop it appears probable that Weiko III will be slightly higher yielding than Unicrop in spite of its slow early growth. Harvesting in December, when Unicrop was in full flower and Weiko III in bud, produced low yields of forage. No regrowth occurred following this early cut. At the early pod stage in mid-January, yields had improved considerably while DM content was still only 12%. Mean daily DM increment to this stage was 59 kg DM/ha/day for Weiko III lupins sown at 200 kg/ha as compared with 43 kg DM/ha/day for established pasture over the same period, as recorded on Oruanui Sand at Wairakei Research Station (Baars, et al 1975). The difference in yield would probably not repay the cost of cultivation and sowing upins as a special forage crop. As a catch crop following winter swedes the return would be much greater.

Seed yields among cultivars in trial 1 were confounded by large population differences and it is possible that differences in seed yield would not have been so great had populations been similar. Withers (1975) has shown that plant population is an important factor in lupin seed production. Seed weight per plant between Weiko III and Unicrop were similar (Table 3) although Weiko III produced more pods per plant. Both yield components are similar to that found in other trials (Withers unpublished data) but for Ultra they were lower.

TABLE 3: Seed weight and pod numbers per plant from Trial 1.

Cultivar	Weight seed/plant g	No. of pods/plants	
Unicrop	3.5	3.7	2.2
Weiko III	3.2	7.4	1
Ultra	2.4	4.0	0.2

In trial 1, tertiary flowering in Unicrop and secondary flowering in Weiko III and Ultra did not develop as would be expected under the good moisture conditions prevailing (see Table 4). This was attributed to frosts which occurred during December and which reached -3.5 and -4.5 degrees on 15 and 27 December. This would have severely limited yield as there was adequate moisture during January and February for development of more pods. In trial 2 Weiko III did not develop many pods, nor did the farmer's surrounding crop of L. albus c.v. Neuland. This effect could also have been caused by frost.

TABLE 4: Summer rainfall and frosts at Wairakei Research Station.

Month	Rainfall (mm)		Number of Frosts
	1975/6	Mean*	
November	80	88	5
December	80	136	8
January	162	100	1
February	160	103	3

*Gerlach 1974

There was no response to inoculation at the site of trial 2. The rhizobia used to induce nodulation on Lupinus spp. is related to that found on the roots of species such as **Lotus, Cytisus and Ulex** (Greenwood pers. comm.), all of which are common on pumice soils, and it is possible that there were adequate rhizobia already present for natural inoculation.

Protecting seedlings from predators had no effect in trial 3. However, the whole trial area was protected from rabbits which may have been the main culprits in previous trials. Alternatively the late sowing of the trial may have avoided the period of maximum seedling damage.

From estimated costs and returns in Table 5 it can be seen that the 2t/ha yield obtained in most plots is not economical but as yield approaches the 3t/ha level obtained by Unicrop in trial 1 the crop becomes profitable and is approximately equivalent to the gross margins from 12 ewes/ha or 3400 kg/ha of barley. Costs could be significantly reduced by direct drilling the crop after a winter forage crop thereby eliminating the cultivation costs. Lupins have been shown to be suitable for direct drilling (Withers **et al.** 1974).

TABLE 5: Estimated costs and returns per hectare for lupin seed

Costs		Returns			
Cultivation	45		Yield t/ha		
Seed	50			2	3	4
Sowing	18		90	180	270	360
Fertiliser	15	Price/t	100	200	300	400
Weed Control	25	$	110	220	330	440
Harvesting	50		120	240	360	480
Cartage	54		130	260	390	520
	$257					

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