LEGUMES FOR WINTER GREENFEED PRODUCTION IN SOUTH ISLAND ARABLE CROPPING SYSTEMS

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ABSTRACT

To investigate the role of legumes as autumn-sown break crops in an intensive cropping system, four legumes (Woogenellup subterranean clover, Maris Bead tick beans, Partridge peas and Uniharvest lupins) plus a Tama ryegrass/Amuri oats control were sown at the beginning of March on a Lismore soil. The legumes were allowed to grow until either mid-August or mid-October when they were grazed off with sheep and either wheat (mid August) or barley (mid October) drilled into the stubble. By mid-August the ranking of the crops in terms of herbage production (kg DM/ha) was tick beans 4440, Partridge peas, 2830, the ryegrass/oats control 2750, lupins 1390 and subterranean clover 220. By mid October tick beans was still the most productive crop (6560 kg DM/ha) but the ranking of the other crops had changed (ryegrass/oats 3830, lupins 3560, subterranean clover 2510, peas 1890 kg DM/ha).

The final wheat grain yields on the plots previously in tick beans and peas were more than double those on the clover, lupin or control plots. Soil incubation results indicated a higher release of inorganic nitrogen from the plots previously in beans and peas than those previously in clover, lupins or the ryegrass/oats control. Bird damage prevented grain yield measurements on the barley. The herbage production of the tick beans and the benefits they conferred on the succeeding wheat crop indicate that beans could be a valuable component in intensive cropping systems.

INTRODUCTION

Irrigation permits many crops to be sown in the spring which previously had to be sown in the autumn/late winter to avoid the full impact of late spring and summer drought. This increases the opportunity for growing autumn-sown feed crops through the winter/early spring period between two spring-sown cash crops.

The crops currently used to fill the cool season gap between two spring-sown crops are cereal and ryegrass greenfeeds and some of the cruciferous crops. The yield of autumn-sown greenfeeds and brassicas generally falls between 2000 and 8000 kg DM/ha by the end of September in most eastern South Island regions (Stephen, 1973; Vartha and Rae, 1973; Rhodes, 1977; Stephen *et al.*, 1977; 1978). None of these crops are legumes and consequently they contribute nothing directly to soil nitrogen levels.

However, there are a number of legumes which, when sown in the autumn, have the ability to survive and grow through the cool season in many parts of the South Island. There is very little information on what level of herbage production could be expected from these legumes and even less on their influence on a subsequent crop relative to the currently used greenfeeds. Withers (1975) found that by mid October the herbage yield of Unicrop lupins sown in late April varied between 2500-4500 kg DM/ha. In this study at Palmerston North, fungal disease caused leaf-fall in the early spring in these autumn-sown lupins. Scott (1971) had harvested 1900 kg DM/ha from autumn sown Woogenellup subterranean clover by the end of July and a further 5000 kg DM/ha by mid November on a dry North Canterbury site. There appears to be no information available on the spring herbage yield of autumn-sown tick beans or peas.

The general pattern of herbage production from autumn-sown cool season crops is for rather slow growth rates through the winter followed by acceleration to much faster rates through the September/October period. While there are significant species differences in the expression of this effect (Crouchley and Bircham, 1971; Rhodes, 1977), the time of final harvest generally has a dominant influence on the total herbage production.

This paper reports the performance of four legumes and a ryegrass/cereal control all sown in the autumn and allowed to grow through to either August or October to simulate the situation preceding spring wheat (August) or late spring barley (October). The legumes and the control crop were assessed in terms of their herbage production through the cool season and their influence on soil nitrogen and the yield of the succeeding cereal crop.

MATERIALS AND METHODS

The four legumes (sweet lupins, field peas, tick beans and subterranean clover) and the ryegrass/cereal control were sown on March 8, 1979, into a cultivated seedbed on a Lismore stony silt loam. Details of the cultivars and sowing rates used are provided in Table 1. Experimental design was a split plot randomised block with the four legumes and the control crop comprising the subplots and the succeeding spring cereal (wheat or barley) the main plots. There were four replicates. The trial area had been growing an annual Tama greenfeed crop for the three previous years and was grazed intermittently. No cereals were grown on the area during this period.

TABLE 1: Crop cultivars, sowing rates and fertiliser application.

Crop	Cultivar	Crop sowing rate (kg/ha)	Fertiliser at sowing (kg/ha)
Sub. clover	Woogenellup(1)	15	375(2)
Tick beans	Maris Bead	300	375
Peas	Partridge	300	375
Lupins	Uniharvest	250	375
ryegrass/oats	Tama/Amuri	20/110	375
Wheat	Oroua	150	250(3)
Barley	Mata	150	250

(1) inoculated prior to sowing.
(2) reverted superphosphate.
(3) superphosphate plus 7 kg/ha phorate.

The four legumes on both the wheat and barley main plots were allowed to grow until they were grazed off completely with sheep just before the cereal was sown in either mid August (wheat) or mid October (barley). The ryegrass/cereal control plots received a further grazing in mid-winter (June 30). Plots were individually fenced (plotsize 10 x 5 m) and at each grazing sheep were allocated in proportion to the amount of herbage dry matter on the plots to be grazed. Herbage yield and post-grazing residue measurements were taken by cutting to ground level two 80 x 80 cm quadrats from each plot of the treatment being sampled.

Immediately following the spring grazing the stubbles were sprayed with a dessicant herbicide and the wheat or barley direct drilled into the crop residues.

Two irrigations were applied to the wheat and barley crops in December by the border method. This prevented soil moisture falling below 12% prior to the soft dough stage in the cereals.

Three months after sowing the wheat, soil samples were taken from all the subplots on the wheat main plots for nitrogen analyses. Total inorganic nitrogen was measured immediately after sampling, the samples were then incubated for 1 week at 25°C and a further inorganic nitrogen analysis performed using the technique described in Quin and Drewitt (1979).

The wheat was harvested with a small plot mini-header at 12% grain moisture on January 30, 1980. Unfortunately severe bird damage prevented measurement of grain yield on the later maturing barley crop.

RESULTS

By mid August the tick beans had produced 4440 kg DM/ha, a level of herbage production 57% higher than the second most productive legume, peas. Even though the grazing utilisation of the beans was slightly lower than the peas, the sheep still consumed 45% more herbage on the bean plots than the pea plots (Table 2). The total production of the ryegrass/oats mixture by mid August was not exceptional at 2750 kg DM/ha but, with two grazings, 100% utilisation was achieved which meant that the total amount consumed by the sheep on this treatment was very similar to the amount consumed by the sheep on the tick beans. The difference between the beans and the ryegrass/oats mixture was the timing of feed availability. In mid August 1040 kg DM/ha was available on the ryegrass/oats plots (after the June grazing) and 3080 kg DM/ha on the bean plots. In August the yield of the lupins was very mediocre and the subterranean clover yield was barely measureable.

TABLE 2: Herbage production and utilisation of sown species to mid August.

	Total yield kg/ha D.M.	Amount consumed by sheep (kg/ha DM)	% Utilisation
sub. clover	220dD	220cB	100
tick beans	4440aA	3080aA	69
peas	2830bB	2130bA	75
lupins	1390cC	870cB	63
ryegrass/oats	2750bB	2750abA	100
C.V.	22.7%	27.1%	

If the legumes were allowed to grow for a further two months to mid October substantial changes in the crops and their ranking occured. The total yield of the tick beans rose to 6560 kg DM/ha and although utilisation of the more mature crop fell to 59%, the beans still ranked among the best treatments in terms of the amount of material consumed by the sheep (Table 3). The main difference in the legumes between August and October was in the importance of the pea crop relative to lupins and clover. Disease and senescence in the pea crop actually caused a substantial reduction in total yield between August and October and the peas were so unpalatable by October that the sheep only consumed one-third of the herbage on the plots. However the yield of the clover and lupins did increase from the very low levels recorded in August and the high grazing utilisation achieved on these crops meant that the sheep consumed 2500-3000 kg DM/ha from these crops in October.

TABLE 3: Herbage production and utilisation of sown species to mid October.

	Total yield (kg/ha DM)	Amount consumed by sheep (kg/ha DM)	% Utilisation
sub. clover	2510cdBC	2510bA	100
tick beans	6560aA	3870aA	59
peas	1890dC	600cB	32
lupins	3560bcBC	2900abA	81
ryegrass/oats	3830bB	3320abA	87
C.V.	20.8%	29.3%	

When cereals were sown into the legume and control plot stubbles after the mid August grazing, colour differences quickly began to appear. The darkest green colour occurred on the plots where previously tick beans and peas had grown.

Wheat grain yield on the tick bean and pea plots was more than double that on the subterranean clover, lupin or control plots (Table 4). The higher grain yield was principally the result of higher head numbers per unit area and grain numbers per head. Thousand seed weight was much less important.

TABLE 4: Wheat grain yield and components.

Previous crop	Grain yeild kg/ha	Head No. per m²	Grains per head	1000 seed weight (g)
sub. clover	1230bB	377bB	9.0bB	36.5cA
tick beans	3670aA	471abAB	20.0aA	38.9aA
peas	3890aA	580aA	17.8aAB	38.4abA
lupins	1530bB	412bAB	10.3bB	37.0bcA
ryegrass/oats	1620bB	405bAB	10.4bB	38.8aA
C.V.	15.7%	19.0%	15.4%	2.8%

Grain nitrogen percentage tended to be a little lower on the plots previously in tick beans and peas but the total grain nitrogen yield was substantially higher on these treatments than the others (Table 5) due to the much higher grain yield (Table 4).

Incubation of soil samples taken from beneath the wheat crop three months after sowing showed that there tended to be a greater release of inorganic nitrogen from the soil on the plots previously in beans and peas than those previously in subterranean clover or lupins, although the differences were not significant (Table 5). The lowest release of nitrogen during incubation was from the plots previously in the ryegrass/oats control.

TABLE 5: Wheat grain nitrogen levels and soil incubation results.

Previous crop	GrainN %	Grain N Yield (kg/ha)	Increase in inorganic N following soil incubation (ppm)
sub. clover	1.84abA	23bB	3.0abA
tick beans	1.75bA	64aA	3.8abA
peas	1.75bA	68aA	4.3aA
lupins	1.86aA	29bB	3.4abA
ryegrass/oats	1.82abA	30bB	2.3bA
C.V.	2.9%	14.7%	26.6%

TABLE 6: Temperature and frost data for winter 1979 relative to 17 year average.

		April	May	June	July	August
Mean	1979	11.1	7.6	6.7	6.7	5.6
Temp°C	17 yr av	11.2	7.9	5.4	4.9	6.2
Mean	1979	5.4	3.3	1.3	2.1	1.5
Min.°C	17 yr av	5.9	2.9	0.4	-0.1	1.2
Lowest	1979	-1.5	-2.8	-1.9	-3.2	-2.4
Min.°C	17 yr av	-0.4	-3.2	-4.6	-5.1	-4.2
No days	1979	6	12	22	19	18
ground frost	17 yr av	6.4	13.8	20.9	22.8	19.3

DISCUSSION

These results indicate there is potential to grow as much, if not more, herbage over the winter months in Canterbury from an autumn-sown legume as from the conventional autumn-sown ryegrass or cereal greenfeed. Moreover the legume can confer a substantial advantage on the grain yield of the following cereal crop. The legumes that proved particularly interesting in this study were tick beans and, to a lesser extent, Partridge peas.

The total herbage yield of the tick beans was very high and was only affected by the rather mediocre utilisation of the crop achieved under grazing. In practice this utilisation could probably be considerably improved by strip-grazing, a common practice in similar tall, stalky crops such as choumoellier. Observations of sheep behaviour on plot guard areas in this study indicated that the growth stage of the tick beans markedly affected their acceptability to the animal. The sheep refused to each the beans until they started flowering after which crop acceptability improved. (N.B. Flowering on the plots began late July/early August so that crop acceptability proved no problem at the first grazing in mid August.)

It was quite evident from the results that peas sown as early as the beginning of March deteriorate rapidly after August and peas are therefore not a good crop to precede a late spring-sown cereal.

The herbage production of the lupins and subterranean clover up to mid August was very low although it did improve if left ungrazed to mid October. Bitter blue lupins sown late January/early February had produced 3-4 tonnes herbage DM/ha by May under irrigation in Canterbury (G.B. Henderson, pers. comm.) and it appears that their role under intensive cropping in Canterbury may be a quick feed crop preceeding an autumn-sown cereal crop for grain.

The climatic data presented in Table 6 indicates that in 1979, June and July were somewhat milder than average. Therefore, at this stage, the suitability of the peas and tick beans for an average Canterbury winter is a little uncertain. Observations indicate the frost hardiness of tick beans is closely related to sowing date. These points are currently under study.

It should be noted that the previous history of the site on which this study was conducted had produced a rather infertile nitrogen depleted soil. This has probably accentuated the effect of the legumes on the succeeding grain crop and such dramatic effects may not occur to the same extent on a more fertile soil. However it remains valid to seek a catch crop which will produce a large quantity of herbage over the cool season and at the same time make a substantial contribution to soil nitrogen, for as cropping intensity rises, soil nitrogen increasingly becomes a constraint to crop yield.

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