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ESTABLISHMENT OF LEGUMES IN PASTURE OF SAVANNAH WOODLAND IN NORTH QUEENSLAND

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SUMMARY

Eight leguminous pasture species were sown, either by broadcasting or by drilling, with or without phosphate fertilizer into the native grass pasture of savannah woodland during a dry season.

Although responses to both drilling and fertilizing were recorded and these treatments might therefore be recommended, satisfactory stands were recorded and vigour was encouraging even in broadcast unfertilized plots.

The two annual species used, *Dolichos biflorus* and *Stylosanthes humilis,* were superior to all of the six perennial species used in stand and vigour in the season of establishment.

Practical applications, including the possibility of aerial seeding of legumes into native grassland during the dry season of the "dry tropics", and the importance of strategic burning and grazing in establishment, are discussed.

I. INTRODUCTION

A considerable portion of northern Australia experiences a dry season from April to December each year. The dry standing pasture of these "dry tropics" has been observed to be an adequate source of energy for growing cattle at Katherine, Northern Territory, during part of the dry season (Norman and Stewart 1964), but such cattle given a supplement containing 0·8 lb of digestible crude protein per day gained 1 lb weight per day, whereas similar cattle receiving no supplement lost weight.

Norman (1962) showed that only 50 lb of protein per acre can be expected from native grasses, commonly species of *Themeda* and *Sorghum,* which are inefficient in recovering fertilizer nitrogen and phosphorus and thus transferring these elements to the grazing animal. This contrasts with a protein yield of 125 lb/ac supplied by sown buffel grass (*Cenchrus ciliaris*) and 375 lb of protein per acre supplied by mixed buffel grass and Townsville lucerne (*Stylosanthes humilis*) pasture in studies by Norman (1960*b*). The yield of protein by the legume Townsville lucerne was of much greater magnitude than that of associated grasses. The performances of other legumes, too, in nurseries in North Queensland, have been good and the author has unpublished data indicating yields of protein in excess of 700 lb/ac from some of them.

Although there are many possibilities with respect to protein (or nitrogen) supply, one of the cheapest sources of protein must be pasture. Consequently this study was designed to determine whether or not legumes to provide protein can be established in predominantly grass pasture of savannah woodland.

The native pasture consists mainly of perennials but contains some annual grasses, some herbs, and both annual and perennial legumes. The perennial grasses appear to be the most important factor in the community and their behaviour is likely to be of major importance when seeding of new species is attempted. The grasses appear to draw upon reserves to respond fairly quickly to rains. Because of the competition they may be expected to offer to legume seedlings, it seems desirable that growth of perennial grasses should be checked.

Norman (1963) studied the time and frequency of burning of the native pastures at Katherine and concluded that, to retain good grass yields, burning should not be practised more often than once every 2 years, and that late in the dry season is the most satisfactory time to burn. It would appear from this study that, to weaken the native grass, frequent burning might be practised and this should take place early in the dry season. Grazing the subsequent "green pick" during the dry season might be expected to weaken the grass further.

In a study of factors influencing the establishment of Townsville lucerne, Norman (1960*a*) seeded the species into a cultivated, harrowed and raked seedbed on a number of planting dates. He concluded that establishment is not possible on stored moisture but is wholly dependent on subsequent rains. Weather conditions during the establishment period were found to be of primary importance, while the condition of the seedbed was thought to be of less consequence.

Graham (1963) reported that in central coastal Queensland some cultivation of native pasture was advantageous in establishing Townsville lucerne. Shaw (1961) reported that in the same region surface cultivation of native pasture with tandem discs resulted in a spread of Townsville lucerne and an increase in its density.

Graham (1963) found that in some circumstances good stands of Townsville lucerne could be established without the use of phosphate fertilizer, but yield response of established stands to superphosphate has been reported by Norman (1959) and others.

With these points in mind, seeding during the dry season, which might be more convenient from the property management aspect, was used in this study.

A number of leguminous species have performed well in nurseries at Parada Research Station in northern Queensland. Eight which may make a contribution in one respect or another as components of dryland pasture were selected for this study. This paper describes the establishment of these legumes in native pasture of savannah woodland by either broadcasting or drilling, with or without phosphate fertilizer, during the dry season.

II. MATERIALS AND METHODS

The experimental area was a low sand ridge on the Parada Research Station, near Mareeba (17°S. latitude). A stand of bloodwood (*Eucalyptus intermedia*) and box (*E. leptophleba*) trees shades a pasture of bunch spear grass (*Heteropogon contortus*) and kangaroo grass (*Themeda australis*), with such native legumes as *Glycine tomentosa, Rhynchosia minima* and species of *Indigofera.*

The trial area was burnt in August 1963 and it was then stocked until early January 1964, i.e. during the dry season and early part of the wet season. The trial plots consisted of strips 3 ft wide and 1 chain long through the trees. Plots were 6 ft apart.

The species sown and the seeding rates employed are shown in Table 1.

TABLE 1

SPECIES, WEIGHT AND NUMBER OF SEED PER ACRE SOWN

Species	Weight of Seeds Sown per Acre (lb)	No. of Seeds Sown per Acre ($\times 10^3$)
Cajanus cajan (common strain)	16	80
Calopogonium mucunoides (commercial)	4	100
Centrosema pubescens (commercial)	4	80
Dolichos biflorus (CPI 26260 cv. Leichhardt biflorus)	8	100
Glycine javanica (cv. Tinaroo glycine)	4	400
Phaseolus atropurpureus (siratro)	4	200
Stylosanthes gracilis (commercial)	4	800
Stylosanthes humilis (commercial)	4	700

Dolichos biflorus and *Stylosanthes humilis* are annuals at Parada while the others are perennials.

The fertilizer used contained 10% P_2O_5 and 24% CaO: a rate of 2 cwt/ac was applied. Uninoculated seed and fertilizer (or seed and sand in plots which were not fertilized) were mixed and placed in a fertilizer box before each run. When plots were being seeded, the mixture passed down flexible steel tubes to a position immediately behind six tines, 6 in. apart, carried on a tool-bar mounted below the fertilizer box. In seeding broadcast plots, the tines were carried clear of the ground. When drilling seed, the tines penetrated the soil surface about 1 in., though depth control was difficult with this primitive arrangement.

The seed of the eight species was sown on November 21, 1963, into native grassland in each of the following ways, with four replications giving a total of 128 plots:

1. Broadcast seed, no fertilizer.
2. Broadcast seed mixed with fertilizer.
3. Drilled seed without fertilizer.
4. Drilled seed mixed with fertilizer.

Preplanting rainfall in October-November totalled 0·48 in., which could not be regarded as effective under the hot, dry conditions obtaining at Parada in that period. There was no rain of any importance in late November and December. The wet season began on January 2 and ended on March 17, 1964, the monthly rainfall being 6·42, 7·36 and 10·86 in. respectively.

On March 25, observations were made with respect to stand and vigour of individual plants. Ratings of 0-10 for density (0 for no seedlings and 10 for high density) and 0-10 for vigour of individual plants (1 for very weak and 10 for good growth) were employed.

Means were compared by H.S.D. tests in the manner suggested by Snedecor (1956).

III. RESULTS

Table 2 summarizes the mean of ratings for density made on March 25, 1964, and Table 3 gives the mean ratings for vigour.

TABLE 2

RATINGS FOR DENSITY AT PARADA, MARCH 25, 1964

Species	Treatment				Mean
	No Fertilizer		Fertilizer		
	Broadcast	Drilled	Broadcast	Drilled	
1. *Cajanus cajan*	1·2	4·7	2·2	3·7	3·0
2. *Calopogonium mucunoides* ..	2·5	5·0	4·0	5·2	4·2
3. *Centrosema pubescens* ..	2·7	1·5	1·7	3·7	2·4
4. *Dolichos biflorus*	6·0	5·0	4·5	8·5	6·0
5. *Glycine javanica*	1·2	2·7	3·0	4·2	2·8
6. *Phaseolus atropurpureus* ..	3·7	4·5	3·7	4·5	4·1
7. *Stylosanthes gracilis*	3·5	6·0	2·7	5·0	4·3
8. *Stylosanthes humilis*	3·5	5·5	6·0	5·7	5·2
Mean	3·1	4·4	3·5	5·1	4·0

H.S.D. among species means: D = 1·85 (5% level)

TABLE 3

RATINGS FOR VIGOUR AT PARADA, MARCH 25, 1964

Species	Treatment				Mean
	No Fertilizer		Fertilizer		
	Broadcast	Drilled	Broadcast	Drilled	
1. *Cajanus cajan*	5·7	5·7	5·5	4·7	5·4
2. *Calopogonium mucunoides* ..	4·5	4·5	5·0	6·2	5·1
3. *Centrosema pubescens* ..	3·5	3·5	4·7	5·5	4·3
4. *Dolichos biflorus*	7·5	7·5	7·7	9·0	7·9
5. *Glycine javanica*	2·5	3·0	3·2	4·7	3·4
6. *Phaseolus atropurpureus* ..	4·5	5·7	3·7	6·2	5·1
7. *Stylosanthes gracilis*	3·7	5·2	4·2	5·5	4·7
8. *Stylosanthes humilis*	5·2	6·0	6·5	7·0	6·2
Mean	4·7	5·2	5·1	6·1	5·3

H.S.D. among species means: D = 1·76 (5% level)

IV. DISCUSSION

It was possible in the 1963-64 season at Parada to establish legumes in native grassland by seeding in the dry season without removing the tree cover. Strategic preplanting burning and grazing are likely to have assisted in effecting establishment.

The results of this trial showed that both of the annual species, *Dolichos biflorus* and *Stylosanthes humilis,* were generally superior to the perennials in stand and vigour during the season of establishment. It is commonly observed that in the dry tropics perennial legumes are not as vigorous in their first season as in subsequent seasons, while annual species do not have this initial disadvantage. An initial advantage to any species could be of considerable importance in determining its subsequent performance. A dense stand of quality feed is likely to be located and grazed heavily by stock. Cattle are likely to balance their diet with adjacent energy-providing roughage, and in this way perennial grasses in the association are likely to be grazed during the dry season. In the process, the grass competition is likely to be minimized in the following season and uneaten legume seeds may be favoured by trampling into a rough seedbeed.

Of the two annual legumes, *Dolichos biflorus* recorded a better performance than did *Stylosanthes humilis* in this trial. Differences were to be expected, since the two have quite different growth habits and occur naturally in two quite different ecological niches. Townsville lucerne occurs in disturbed or heavily grazed areas where grass competition is low. *Dolichos biflorus,* on the other hand, occurs twining over perennial grasses in relatively undisturbed country. By broadcasting the seed over, or drilling the seed into, grassland, grass competition remained and thus Dolichos was favoured. With heavy grazing through the wet season, it

might be expected to perform in a less satisfactory manner. This difference in habit suggests a complementary role for the two species: one for continuous grazing and the other for deferring for the dry season.

It was found in this study that seed placement in the soil was superior to broadcasting in terms of resultant stand and vigour, though responses varied, depending on species. Overall, the rated increase in stand was 40%. Only modest responses to fertilizer were recorded in the experiment.

In these trials, little rain was recorded before the true wet season began and presumably there was little early germination. In other seasons, early storms might induce germination, and if following rains are not experienced for some time, a loss of seedlings may be expected. The author has unpublished data, however, which indicate that both of the annual species involved in this study (*Dolichos biflorus* and *Stylosanthes humilis*) have seedlings which can withstand considerable periods of drought.

Although some early germinating seedlings are lost in extended dry periods, the survivors have a considerable advantage over seedlings which appear after later falls of rain and it is these survivors which account for a considerable portion of the production during the season. It has been demonstrated also (author's unpublished data) that if legume seed to be established in grassland is not sown before the first rains of the season, native perennial grasses and other species have an immediate advantage and introduction of the new species later can be difficult.

Not only can some of the species involved survive dry periods through the drought resistance of seedlings, but others can escape such difficult times through hardseededness, common in leguminous species of the dry tropics. It is suggested that if, through natural selection, species have developed hardseededness, unscarified seed should be used when pastures are sown in regions of the dry tropics with unreliable rainfall expectation.

Some of the practical ramifications suggested by this work have been discussed previously but may be summarized in the following way: The establishment of legumes in savannah woodland can be achieved by either broadcasting or drilling seed into native grassland during the dry season. It is probable that burning and grazing will aid establishment, though these treatments were used rather than evaluated in this study. Drilling seed and fertilizer together is more satisfactory than broadcasting without fertilizer in obtaining establishment, but there is no evidence to suggest that aerial seeding (with or without fertilizing) should not be used when *Dolichos biflorus, Stylosanthes humilis and Phaseolus atropurpureus* are to be established in native pastures.

It is suggested that if aerial seeding (or other form of broadcasting) is used, attention could be paid to the possibility of using seed pelleted with superphosphate. This could increase the efficiency of the fertilizer usage and reduce the cost of establishment of improved pasture to such a level that widespread pasture improvement might be expected.

In addition to the above, the findings of this study suggest a number of breeding objectives, including hardseededness, seedling vigour and drought resistance, and modification of the growth habit of some species.

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