Inter-row planting of legumes to improve the crude protein concentration in *Paspalum atratum* cv. Ubon pastures in north-east Thailand

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Abstract

Two field trials on an extremely acid, infertile upland soil were conducted in north-east Thailand to find legumes that, when planted in alternate 50 cm rows in *Paspalum atratum* cv. Ubon swards, would persist and improve the quality of the pasture. In Trial 1, the treatments were *P. atratum* sown alone or in alternate rows with *Lablab purpureus* cv. Rongai, *Vigna unguiculata* (KUC-7), *Canavalia ensiformis* (common Thailand type), *Aeschynomene americana* cv. Lee, *Macroptilium gracile* cv. Maldonado, *Stylosanthes guianensis* cv. Tha Phra (CIAT 184), *Centrosema pascuorum* cv. Cavalcade, *Calopogonium mucunoides* (common Thailand type) and *Pueraria phaseoloides* (common Thailand type).

In Trial 2 in the second year, the inter-rows between the existing rows of *P. atratum* were cultivated at the beginning of the wet season and the treatments were grass-only and grass inter-row planted with *S. guianensis* var. vulgaris × var. pauciflora (ATF 3308), *M. atropurpureum* cv. Aztec, *M. gracile* cv. Maldonado, *S. guianensis* cv. Tha Phra, *C. pascuorum* cv. Cavalcade, *C. pubescens* (common Thailand type), *S. hamata* cv. Verano, *C. mucunoides* (common Thailand type) and *P. phaseoloides* (common Thailand type).

The highest cumulative wet season dry matter (DM) yields in Trial 1 were produced by the grass-only swards, 12.2 t/ha DM, which was 35% higher than the average yields produced by the mixed grass-legume swards. Crude protein level of *P. atratum* was 4.5% in grass-only swards. Consequently, the total crude protein yields of the grass-only swards were up to 50% lower than the best grass-legume sward of *C. pascuorum* that produced 808 kg/ha crude protein from 4 cuts.

In Trial 2, highest yielding legumes in the first wet season were ATF 3308 stylo, *M. gracile*, Tha Phra stylo, Verano stylo and calopo. In the second wet season in Trial 2, all 3 *Stylosanthes* species produced significantly more DM than other legumes but there were no significant differences in cumulative dry matter production between grass-only and grass-legume swards. Crude protein yield of Tha Phra stylo swards was 80% greater than yields on the grass-only swards. Volunteer seedlings of Verano stylo emerged in the inter-rows in the other grass–legume swards where the twining legumes were either very sparse or had disappeared. *Stylosanthes* species appear suitable legume species to establish in Ubon paspalum pastures on infertile upland soils in north-east Thailand.

Introduction

The primary pasture production system in Thailand is to grow pure swards of cultivated grasses. The quality of these pastures is usually low as most farmers apply little if any fertiliser (Tudsri et al. 2001), and even where fertiliser has been applied, crude protein concentrations remain low, ranging from 4.4–8.6% on infertile soils (Hare et al. 1999a).

*Paspalum atratum* cv. Ubon grows well on waterlogged acid soils in Thailand (Hare et al. 1999a; 1999b) but it has low crude protein concentration, frequently falling below 7%. Introducing legumes into *P. atratum* pasture swards could be a cost-effective method for smallholder farmers to improve pasture quality.
Incorporation of a legume into a grass pasture not only provides a nitrogen source to promote grass growth but also leads to a more balanced diet for the animal. However, the management of tropical grass–legume mixtures to maintain a suitable composition is difficult with the faster-growing C₄ grasses usually dominating the slower-growing C₃ legumes (Humphreys 1981). Mixed grass–legume swards usually become grass-dominant within 1–2 years after establishment. The nature of the competition does vary from one field situation to another so that a particular species may be a strong competitor in one site but a weak competitor in another (Grime 1977). However, the general experience in Thailand and many other tropical countries is the failure of legumes to persist in mixed swards for more than 2 years (Hongyantarachai et al. 1989; Wongsawan and Watkin 1990; Ibrahim and Mannetje 1998; Hare et al. 1999b, 2003).

Tropical grass–legume mixtures have been successful where different management strategies led to the legume species competing successfully with the associated grass species (Hernandez et al. 1995; Ibrahim and Mannetje 1998; Tudsi et al. 2001, 2002). It is common practice to increase the legume seeding rate in order to increase the legume percentage in the first year (Jones et al. 1986), particularly on infertile soils (Humphreys 1987). Legumes are generally more compatible with erect bunch grasses than with stoloniferous grasses.

_P. atratum_ is an erect bunch grass which does not spread into vacant areas in pastures. These areas are often invaded by weeds (Kalmbacher et al. 1997), but could be better utilised by legumes. On seasonally wet-seasonally dry soils in Thailand, legumes failed to persist in _P. atratum_ swards (Hare et al. 1999a; 2003), but in these studies the grass seeding rate was higher than the legume rate. If the legume seeding rate was higher than the grass rate and sites were on slightly better drained soils, legumes might persist better (Hare et al. 2003), especially in the open spaces in _P. atratum_ pastures.

The objective of this research was to assess the persistence of a range of legumes planted in alternate rows with _P. atratum_ and their ability to improve the quality of _P. atratum_ swards in northeast Thailand on soils that are not waterlogged.

**Materials and methods**

The field experiments were conducted from 2000 to 2002 in Ubon Ratchathani province, north-east Thailand (15°N, 104°E) on the Ubon Ratchathani University farm in a 0.15 ha field. Rainfall at 1 km from the trial site (Figure 1), was above the medium-term average of 1593 mm/annum in all 3 years of the study. In the first establishment year (2000), it was 30% above the medium-term average, with over 400 mm/month in May, July and August. Rainfall in May, the first month of the wet season, in 2001 and 2002 and in June 2002, was more than 50% below the medium-term average but heavy thunderstorms in the second half of the wet season resulted in above average annual rainfall.

This upland site was on a sandy low humic gley soil (Roi-et soil series) (Mitsuchi et al. 1986). Soil samples to 10 cm, taken at sowing in May 2000, showed that the soil was acid (pH 4.7; water method), and low in organic matter (1%), N (0.05%), P (10.7 ppm; Bray II extraction method) and K (19.5 ppm) concentrations. Prior to cultivation, the site had been planted to ruzi grass, mixed with Verano stylo, for 6 years. It was ploughed in March and again in April 2000 and then rotary hoed to produce a fine seedbed before seed sowing in May 2000.

**Trial 1 — Simultaneous sowing of Ubon paspalum and forage legumes in alternate rows**

This trial was a randomised complete block design with 10 cultivar treatments and 4 replications. The treatments were Ubon paspalum sown alone or in alternate rows with lablab (_Lablab purpureus_ cv. Rongai), Lee American jointvetch (_Aeschynomene americana_ cv. Lee), llanos macro (_Macroptilium gracile_ cv. Maldonado), Tha Phra stylo (_Stylosanthes guianensis_ cv. Tha Phra) (CIAT 184), Cavalcade centurion (_Centrosema pascuorum_ cv. Cavalcade), cowpea (_Vigna unguiculata_), jackbean (_Canavalia ensiformis_ (common Thailand type), calopo (_Calopogonium mucunoides_ (common Thailand type) and puero (_Pueraria phaseoloides_ (common Thailand type) (Table 1).

In April 2000, thousand-seed weights and seed germination were determined for each species, in order to calculate seed sowing rates (Table 2). Lee American jointvetch, llanos macro, Tha Phra stylo, calopo and puero seeds were soaked in hot...
Inter-row planting of legumes with Paspalum atratum

Figure 1. Rainfall (mm) at Ubon Ratchathani University during the study and the medium-term mean (1992–2002).

Table 1. Botanical, cultivar and common names of species used in trials.

<table>
<thead>
<tr>
<th>Species</th>
<th>Cultivar</th>
<th>Common names</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paspalum atratum</td>
<td>Ubon</td>
<td>atra paspalum, Ubon paspalum¹</td>
</tr>
<tr>
<td>Lablab purpureus</td>
<td>Rongai</td>
<td>lablab</td>
</tr>
<tr>
<td>Aeschynomene americana</td>
<td>Lee</td>
<td>American jointvetch</td>
</tr>
<tr>
<td>Macroptilium gracile</td>
<td>Maldonado</td>
<td>llanos macro</td>
</tr>
<tr>
<td>Stylosanthes guianensis</td>
<td>Tha Phra</td>
<td>Tha Phra stylo¹, CIAT 184, stylo 184</td>
</tr>
<tr>
<td>Centrosema pascuorum</td>
<td>Cavalcade</td>
<td>centurion</td>
</tr>
<tr>
<td>Centrosema pubescens</td>
<td>Common Thailand type</td>
<td>centro</td>
</tr>
<tr>
<td>Vigna unguiculata</td>
<td>KUC 7</td>
<td>cowpea</td>
</tr>
<tr>
<td>Canavalia ensiformis</td>
<td>Common Thailand type</td>
<td>cowpea</td>
</tr>
<tr>
<td>Calopogonium mucanooides</td>
<td>Cowpea jointvetch</td>
<td>jackbean</td>
</tr>
<tr>
<td>Pueraria phaseoloides</td>
<td>Common Thailand type</td>
<td>puerlo</td>
</tr>
<tr>
<td>Stylosanthes guianensis var. vulgaris x var. pauciflora</td>
<td>ATF-3308</td>
<td>stylo 3308</td>
</tr>
<tr>
<td>Macroptilium atropurpureum</td>
<td>Aztec</td>
<td>atro</td>
</tr>
<tr>
<td>Stylosanthes hamata</td>
<td>Verano</td>
<td>caribbean stylo, Verano stylo, hamata stylo¹</td>
</tr>
</tbody>
</table>

¹ Common name in Thailand.

Table 2. Thousand seed weight (TSW), germination %, seed treatment, rhizobium treatment and seed sowing rate of Ubon paspalum and of 9 forage legumes (Trial 1).

<table>
<thead>
<tr>
<th>Treatment</th>
<th>TSW (g)</th>
<th>Germination (%)</th>
<th>Seed treatment</th>
<th>Rhizobium treatment</th>
<th>Sowing rate (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ubon paspalum</td>
<td>2.9</td>
<td>70</td>
<td>None</td>
<td>None</td>
<td>12</td>
</tr>
<tr>
<td>Lablab</td>
<td>253.5</td>
<td>83</td>
<td>None</td>
<td>CB 756 cowpea Group J</td>
<td>250</td>
</tr>
<tr>
<td>Lee American jointvetch</td>
<td>3.4</td>
<td>65</td>
<td>Hot water 70°C, 3 min.</td>
<td>Cowpea jointvetch</td>
<td>20</td>
</tr>
<tr>
<td>Llanos macro</td>
<td>3.4</td>
<td>44</td>
<td>Hot water 70°C, 3 min.</td>
<td>None</td>
<td>20</td>
</tr>
<tr>
<td>Tha Phra stylo</td>
<td>2.9</td>
<td>98</td>
<td>Hot water 70°C, 5 min.</td>
<td>None</td>
<td>10</td>
</tr>
<tr>
<td>Cavalcade centurion</td>
<td>21.9</td>
<td>83</td>
<td>Sandpaper</td>
<td>CB 1923</td>
<td>50</td>
</tr>
<tr>
<td>Cowpea</td>
<td>203.8</td>
<td>90</td>
<td>None</td>
<td>Cowpea Group I</td>
<td>200</td>
</tr>
<tr>
<td>Jackbean</td>
<td>1348.7</td>
<td>92</td>
<td>None</td>
<td>Cowpea Group M</td>
<td>400</td>
</tr>
<tr>
<td>Calopo</td>
<td>11.5</td>
<td>38</td>
<td>Hot water 60°C, 3 min.</td>
<td>Cowpea Group M</td>
<td>40</td>
</tr>
<tr>
<td>Puero</td>
<td>12.2</td>
<td>46</td>
<td>Hot water 60°C, 3 min.</td>
<td>Cowpea Group M</td>
<td>40</td>
</tr>
</tbody>
</table>
water and Cavalcade centurion seeds were scarified with sandpaper prior to germination testing and sowing in May. Seeds of lablab, Lee American jointvetch, Cavalcade centurion, cowpea, calopo and puero were also inoculated with the appropriate rhizobium strains (Table 2).

Ubon paspalum and the legumes were sown on May 3, 2000 in plots measuring 6 m × 5 m. Ubon paspalum was sown alone in 50 cm spaced rows in the first treatment, while the legume species and the grasses were sown in alternate rows 50 cm apart in the other treatments. The seed was lightly covered with soil and fertilised with 22 kg/ha N, 22 kg/ha P, 22 kg/ha K and 13 kg/ha S. The plots were hand-weeded 2 weeks after sowing.

Plant counts were made on three 1 m rows of legumes and Ubon paspalum in each plot, 4 weeks after sowing (Table 3). Harvests to estimate DM yield were taken from four 1 m rows of each legume and Ubon paspalum per plot, cut 10 cm from ground level on July 4, and then at approximately 6-week intervals on August 17, September 29 and November 13, 2000. On each occasion, samples were sorted into Ubon paspalum and legume species and weighed. Dry matter yields were calculated from 200 g subsamples of grass and legume which were dried at 70°C for 48 hours. Samples from the dried grass and legumes were analysed for total N (Kjehldal method) in order to calculate crude protein levels (%N × 6.25).

After each sampling, the plots were cut to 10 cm above ground level and fertilised with N, P, K and S at the same rates applied at sowing.

Trial 2 — Sowing forage legumes in rows between established rows of Ubon paspalum

This study used the same plots as in Trial 1, comprising 10 treatments replicated 4 times. The treatments were Ubon paspalum alone and Ubon paspalum inter-row planted with ATF 3308 stylo (S. guianensis var. vulgaris × var. pauciflora), Aztec atro (M. atropurpureum cv. Aztec), llanos macro, Tha Phra stylo, Cavalcade centurion, centro (Centrosema pubescens), Verano stylo (S. hamata cv. Verano), calopo and puero (Table 1).

On May 10, 2001, the grass in all plots was cut to ground level and the inter-rows between the 1 m spaced grass rows in the legume treatments cultivated into a fine seedbed by a small plough and harrows. On May 15, the legume seeds were sown in rows, 50 cm from the centre of the existing grass rows, in their respective plots. The seed was lightly covered with soil and all plots fertilised with 23 kg/ha N, 23 kg/ha P and 23 kg/ha K. Seeding rates were 10 kg/ha for the 3 stylo species, 20 kg/ha for Aztec atro, llanos macro and centro and 40 kg/ha for calopo and puero. All legume seeds were sandpaper-scarified but were not treated with rhizobium as rhizobium was not available.

On June 25, the grass was harvested at 10 cm above ground level from four 1 m rows in all plots and dry weight and crude protein determined as in Trial 1. Following this sampling, grass rows in all plots were cut to 10 cm above ground level and the whole plots fertilised at the same rates used at the time of legume sowing. No legumes were cut at this time. On August 14 and October 17, four 1 m rows of grass and legume were cut at 10 cm above ground level to estimate DM yield and the material was analysed for crude protein concentration as in Trial 1. After each sampling cut, remaining rows were cut and plots fertilised with the same rates of N, P and K as used previously.

Two dry season sampling cuts were taken from each plot on December 26, 2001 and April 26, 2002. On each occasion, only samples of grass were taken from four 1 m rows in each plot as the legumes present were below the 10 cm cutting height. At the April cut, the legume seedlings in the inter-rows were scored for percent ground cover in each plot. After each dry season cut, the same rates of N, P and K were applied again. Pastures were harvested during the wet season on June 17 (grass only), August 21 and October 22, 2002, to estimate DM yield and the material was analysed for crude protein concentration. Fertiliser (same rates as above) was applied only once in the 2002 wet season, on August 21.

Results

Trial 1 — Simultaneous sowing of Ubon paspalum and forage legumes in alternate rows

Plant populations at 4 weeks after sowing, except for jackbean, were greater than 50 plants/m² (Table 3). There were no significant differences between Ubon paspalum plant densities in all plots strip-planted with legumes. Legume plant density varied significantly, with the large-seeded...
Inter-row planting of legumes with *Paspalum atratum*.

Jackbean having the lowest and the small-seeded Lee American jointvetch the highest plant density at 4 weeks after sowing. This was a reflection of the number of viable seeds planted, which varied widely from 270 seeds/ha for jackbean to 2900 and 3800 seeds/ha for Ubon paspalum and Lee American jointvetch, respectively.

The highest total first wet season dry matter yield was produced by the pure grass swards, 12.2 t/ha DM, which was 35% higher than the average yields produced by the mixed grass-legume swards (Figure 2). Yield of Ubon paspalum in pure grass swards was double that when grown in association with legumes.

Annual legumes, jackbean, cowpea and lablab, were dominant at the first cut, producing significantly more dry matter than the associated Ubon paspalum as well as all other legumes except Cavalcade centurion. However, these 3 annual legumes had died in all plots by the third cut. The other biennial and perennial legumes grew more slowly, with Cavalcade centurion and Lee American jointvetch producing the most legume DM at the second and third cuts, respectively. By the fourth cut, there were no significant differences in DM production between the surviving 6 legume species.

Total crude protein yields for the season were highest in the Cavalcade centurion, lablab, jackbean and puero swards (Figure 3). Cavalcade centurion swards produced 50% more crude protein than the pure grass swards and nearly twice

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**Table 3.** Plant populations (4 weeks after sowing) in Ubon paspalum and mixed grass–legume swards (Trial 1).

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Ubon paspalum</th>
<th>Legume population (plants/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ubon paspalum only</td>
<td>129 ab</td>
<td>—</td>
</tr>
<tr>
<td>Ubon paspalum — lablab</td>
<td>108 ab 120 bc</td>
<td>120 bc</td>
</tr>
<tr>
<td>Ubon paspalum — Lee American jointvetch</td>
<td>115 ab 166 a</td>
<td>166 a</td>
</tr>
<tr>
<td>Ubon paspalum — llanos macro</td>
<td>109 ab 107 bc</td>
<td>107 bc</td>
</tr>
<tr>
<td>Ubon paspalum — Tha Phra stylo</td>
<td>86 b 97 bcd</td>
<td>97 bcd</td>
</tr>
<tr>
<td>Ubon paspalum — Cavalcade centurion</td>
<td>96 ab 130 ab</td>
<td>130 ab</td>
</tr>
<tr>
<td>Ubon paspalum — cowpea</td>
<td>116 ab 79 cd</td>
<td>79 cd</td>
</tr>
<tr>
<td>Ubon paspalum — jackbean</td>
<td>97 ab 27 e</td>
<td>27 e</td>
</tr>
<tr>
<td>Ubon paspalum — calopo</td>
<td>114 ab 66 de</td>
<td>66 de</td>
</tr>
<tr>
<td>Ubon paspalum — puero</td>
<td>126 ab 104 bcd</td>
<td>104 bcd</td>
</tr>
</tbody>
</table>

*Within columns, means followed by a common letter are not significantly different at P = 0.05 by Duncan’s Multiple Range Test.*
the amount produced by the llanos macro and cowpea swards. Concentrations of crude protein in Ubon paspalum were low, averaging 5% (Figure 3), compared with an average of 14.3% in the legumes, with pueru producing the highest and cowpea the lowest levels.

**Trial 2 — Sowing forage legumes in rows between established rows of Ubon paspalum**

Total wet season DM yields exceeded 10 t/ha in the pure grass and llanos macro swards, which were significantly higher than DM yields produced by the centro and pueru swards (Figure 4). Total crude protein yields in the llanos macro swards were significantly higher than yields produced by the Cavalcade, centro, calopo and pueru swards (Figure 5). Crude protein concentrations in Ubon paspalum were very low at all cuts, averaging 4.7% (Figure 5), compared with 13.0–18.9% for the legumes.

In the dry season (November–April), DM production of Ubon paspalum averaged 2200 kg/ha, with no significant differences between grass–legume and pure grass plots. Legumes were very small and prostrate at the first dry season cut (December) and as they were below the 10 cm cutting height, no legume dry matter data were collected. In April, many legume seedlings were emerging in the plots, so their presence was scored visually in each treatment. ATF 3308 stylo, Tha Phra stylo and Verano stylo were dense along the inter-rows in all their respective plots; llanos macro, Cavalcade, centro and calopo had 20–30% ground cover in their respective plots; pueru covered only 5% in its plots and no Aztec atro seedlings were observed. However, in all twining legume plots, high numbers of small volunteer Verano stylo seedlings were emerging.

In the third wet season, there were no significant differences in cumulative dry matter production between pure grass and grass–legume swards (Figure 6). Volunteer Verano stylo plants were the dominant legume in all twining legume swards and a small amount of volunteer calopo also grew in the Verano stylo swards (Figure 6). Aztec atro and pueru disappeared after the second wet season cut. Tha Phra stylo swards produced over 80% more crude protein yield than the pure grass swards (Figure 7).

**Discussion**

This research has shown that, with management, adapted legumes can successfully establish and grow in Ubon paspalum swards. While Ubon paspalum is not an aggressive, competitive grass, the companion legumes that are introduced must seed freely and be adapted to cutting in order to survive the long dry season. Whenever legumes grow in close proximity with grasses, they must have mechanisms which allow them to survive both the physical and biotic environment (Grime 1977). The best adapted legumes were the stylo species, Tha Phra, Verano and ATF 3308, which all showed good persistence and production on upland sandy soils. By having many low growing points, good drought tolerance and free-seeding habits, they persisted and regenerated in the second year after sowing. These were the only legumes that regenerated well from fallen seed in third-year Ubon paspalum swards. Stylo species flower and produce large amounts of seed under dry conditions in north-east Thailand (Hare and Phaikaew 1999) and a proportion of this seed starts germinating very quickly at the onset of the first rains at the beginning of the wet season.

In the second wet season of Trial 2, volunteer Verano stylo seedlings emerged in all plots where the twining legumes had either died or were very sparse. The trial site was in a former ruzi grass and Verano stylo pasture and the seedlings of volunteer Verano stylo must have come from buried seed. Verano stylo is ubiquitous along roadsides throughout north-east Thailand and it persists year after year due to its ability to set large amounts of seed with over 90% hardseededness (Mott et al. 1981). Under field conditions, this seed softens slowly with approximately 35% of Verano seed softened in one year (McKeon and Mott 1982). Even though after 3 years much of the hardseededness would have been broken, only 10% germination is sufficient to establish a new sward (McKeon and Mott 1982). Tha Phra stylo is also very persistent on upland sandy soils but, with the reported occurrence of anthracnose in CIAT 184 stylo (Tha Phra stylo) in several situations in south-east Asia (Chakraborty et al. 2001), seed production of the anthracnose-resistant hybrid species, ATF 3308 stylo (Grof et al. 2001), is currently being undertaken by Ubon Ratchathani University. In small trials at the university, dry matter production of ATF 3308
Inter-row planting of legumes with Paspalum atratum

**Figure 3.** Total wet season crude protein yields of Ubon paspalum and grass + legumes planted in alternate rows in the first year (Trial 1). Crude protein concentrations of the components are shown in the columns. Columns carrying different letters are significantly different at P = 0.05 by Duncan’s Multiple Range Test.

![Crude protein yields graph](image)

**Figure 4.** Total wet season dry matter yields of Ubon paspalum and grass + legumes, with the legumes planted between grass rows in second-year grass swards (Trial 2). Columns carrying different letters are significantly different at P = 0.05 by Duncan’s Multiple Range Test.

![Dry matter yields graph](image)
stylo was equal to that of Tha Phra stylo and seed production was superior.

Other twining legumes were productive in the first season but most failed to re-establish adequately in the second season to be of any medium-term benefit. Except for Cavalcade, the contribution of the annual legumes, lablab, jackbean and cowpea, to sward productivity and quality was short-lived and, by the third harvest in the wet season, they had died out. Their demise was most likely a function of their annual growth and the repeated cutting of their elevated growing points. Cavalcade persisted longer because its lower growing points were protected from cutting and it also is more of a trailing legume and can root from trailing stems (Clements 1992).

Lee American jointvetch behaves as an annual rather than a short-lived perennial in north-east Thailand because of the long dry season. It behaved like Calvacade, regrowing after each wet season cut because, under repeated cutting, it changes its more erect habit to branch close to the ground (Bishop 1992), thereby protecting many growing points from defoliation.

Perennial twining legumes, with their elevated growing points, are vulnerable to heavy grazing or regular cutting. In these trials, the performance of twining legumes varied, with all competing strongly in Trial 1 but many performing weakly in Trial 2. In Trial 1, llanos macro, calopo and puro persisted throughout the first wet season and, at the final wet season harvest in October, there were no significant differences between their yields and those of the remaining legumes. Above average rainfall, which created moist soil conditions under which all 3 legumes thrive (Skerman et al. 1988; Cameron 1992; Halim 1992; Hare et al. 1999a), may have contributed to their competitive performance in this trial. In Trial 2, llanos macro and calopo were both vigorous at the first legume harvest but, at the end of the wet season, only calopo showed good persistence. This may be due to the growth habit of calopo, which, under cutting or grazing, will

Figure 5. Total wet season crude protein yields of Ubon paspalum and grass + legumes, with the legumes planted between grass rows in second-year grass swards (Trial 2). Crude protein concentrations for the components are shown in the columns. Columns carrying different letters are significantly different at P = 0.05 by Duncan’s Multiple Range Test.
grow along the ground and then root at the nodes under moist conditions. Llanos macro does not have this habit of rooting from trailing stems.

In Trial 2 in the second wet season after oversowing into grass swards, the twining legumes produced negligible amounts of dry matter. After the final harvest in October, only 16 mm of rain fell from November to February, the main flowering period of these legumes. We have observed that, unless some dry season rain falls or irrigation is applied, these legumes either fail to flower or produce shrivelled pods and seed. During a long dry season, these perennial twining legumes act as annuals and, without fallen seed, they die out.

The trials were managed to endeavour to favour the legumes. High legume seeding rates were used, the inter-rows were cultivated before oversowing in second-year grass swards, only the grass rows were cut at the beginning of the second and third growing seasons and the amount of fertiliser applied to third-year swards was reduced in order to reduce the competitiveness of Ubon paspalum. Any species, which did not perform well under these conditions, would not perform well under commercial conditions.

High legume seeding rates and the selective cutting of only grass during the legume establishment phase will assist the survival and production of legumes. Smallholder farmers apply very little fertiliser and, when fertiliser in these trials was reduced, legume production increased. Reducing the amount of fertiliser is a good management strategy for smallholder farmers. Even though dry matter production of Ubon paspalum is reduced, the associated increase in legume proportion in the sward raises the overall crude protein concentration and total protein on offer in grass–legume swards. This should result in improved animal performance.

Figure 6. Total wet season dry matter yields of third-year Ubon paspalum and second-year legume swards, planted in alternate rows (Trial 2). Columns carrying different letters are significantly different at P = 0.05 by Duncan’s Multiple Range Test.

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While stylo species were seen as suitable for planting in Ubon paspalum swards, other new legume species that seed freely and are tolerant of close cutting and grazing are still needed. Further evaluation of an extended range of legumes is needed to identify new legume species for grazed pasture mixtures.

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References


HARE, M.D., THUMMASAENG, K., SURIYAJANTRATONG, W., WONGPICHET, K., SAENGKHAM, M., TATSAPONG, P.,
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