PASTURE ESTABLISHMENT IN UPLAND RICE CROPS AT NA PHENG, CENTRAL LAOS

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ABSTRACT

Stylosanthes guyanensis (*stylo*) *was successfully established by broadcasting into first-year "slash and burn" rice crops. Grain yield of rice varieties of differing maturity was little affected by stylo growing at densities of 14-25 plants per sq.m., especially if stylo sowing was delayed. The growth and competitive relationships of rice and stylo in these ash sowings were largely independent of added nitrogen or phosphorus fertiliser.*

Melinis minutiflora *and* Panicum maximum *reduced yield of companion rice crops if sown without stylo.*

INTRODUCTION

Many farmers in Laos are unwilling to clear forest in order to sow pastures although large tracts of tropical uplands are cleared in order to grow cash crops. These systems are based either on continuous cropping practices, or on "slash and burn" system, in which forest is hand cut, burnt and crops sown in the ash, and after one to three years the land is allowed to revert to forest for three to twenty years (Nye and Greenland 1960). In both systems loss of soil fertility, erosion, poor watershed runoff characteristics and degradation of the vegetation resources may result. An alternative possibility is the incorporation of a legume based pasture in the cropping rotation.

One establishment technique which requires exploration is the sowing of pastures with a companion cash crop; this has the advantage of absorbing the cost of pasture establishment in the crop enterprise. Weed regeneration may be partly controlled by a pioneering pasture legume, better animal use of low quality crop residues becomes feasible, and soil protection and fertility accretion may result. The forage grown may be viewed as the basis for a long term pasture, as a short term addition to the dry season forage supply, or as an infection source from which the seed of a well adapted pasture legume may be carried to adjacent natural pastures.

In Laos upland areas contain more than a third of the population, most of whom are dependent upon a system of land use involving slashing and burning vegetation prior to sowing, termed swidden farming (Halpern 1964). A proportion of farmers also grow both "wet" rice in the lowlands and upland rice in the sloping foothills. Any program of forage improvement must take into account the net deficit in rice production, which precludes the use of existing paddy rice areas for pastures, and the lack of resources of machines, capital and sophisticated skills on which many programs of agricultural expansion are based.

A previous paper (Thomas and Humphreys 1970) referred to two successful demonstrations of the broadcasting of stylo (*Stylosanthes guyanensis*) and other pasture species in upland rice crops at the Lao-Australian Livestock Improvement Project, Na Pheng. This paper describes experimental work designed to elucidate the effects of companion sowings of stylo and grasses in rice crops produced by

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"slash and burn" techniques. The competitive situation was varied by the use of fertiliser, by growing rice varieties of differing maturity, and by delaying stylo sowing until the rice crop was well established. The basic objective was to achieve minimum reduction in rice yield compatible with successful pasture establishment and weed suppression.

EXPERIMENTAL METHODS

(i) *Objectives and design of the experiments*

Experiment 1 studied the effect of companion grass and legume mixtures on rice (*Oryza sativa*) grain yield. A factorial design was used with five replications of all treatment combinations as randomised blocks. Main plot (15m x 15m) treatments were: Stylo (*Stylosanthes guyanensis* cv. Endeavour) broadcast in a rice crop 34 days after rice sowing when rice was 60 cm high, or not sown. Sub-plot treatments were: Guinea (*Panicum maximum* cv. Coloniao) and molasses (*Melinis minutiflora*) grasses sown together in a rice crop 34 days after rice sowing or not sown.

Experiment 2 considered the effects of controlling the onset of competition by delaying the time of sowing stylo, and of varying the phosphate supply. A factorial design was used with eight absolute replications as randomised blocks. Plot size was 10 m x 10 m. The treatments were—

(a) Stylo sown 0, 31, or 60 days after sowing rice

(b) Triple superphosphate (20.7% P) applied at 0, 20, 40 and 80 kg phosphorus per ha at each stylo sowing date.

Experiment 3 studied the effects of undersown stylo on the grain yield of rice varieties of differing maturity type, grown under conditions of varying nitrogen and phosphorus supply. A factorial design was used with six absolute replications as randomised blocks. Main plot (10 m x 20 m) treatments applied at sowing were:

(a) Triple superphosphate applied at 0 and 40 kg phosphorus per ha

(b) Urea (46% N) applied at 0 and 40 kg nitrogen per ha.

Sub plot treatments were:

(c) Stylo sown 36 days after rice sowing or not sown

(d) Four upland rice varieties of varying maturity time.

(ii) *Site description and management*

The upland site selected comprised 2.5 ha of predominantly primary moist monsoon dipterocarp forest on the western border of the Lao-Australian Livestock Improvement Project at Na Pheng, Central Laos, 52 km N.N.E. of Vientiane. Some features of the location are described by Thomas and Humphreys (1970). The soil was a low fertility (Reeve and Hubble 1967) grey sandy loam overlying laterite at 1.5 m; the land sloped 6% to the south-west. The area was hand cut ("slashed") during March and April, 1969 and burnt on May 12, 1969. Large logs were gathered and refired, and unburnt branches and log fragments were removed. Termite mounds up to 1.5 m high and tree stumps were interspersed in the area; surplus plots were included to provide discards for the larger termite mounds and ash heaps.

Rice was sown in experiments 1, 2 and 3 between May 29 and June 4, 1969, in 3 cm deep holes punched with a pointed stick on a 30 x 30 cm grid; 10 seeds were placed in each hole before covering. There was no other cultivation treatment applied. A local mid-season upland glutinous variety, Khao Non Deng (136 days sowing to maturity) was sown in all experiments. Three varieties obtained from the Station Agricole at Thangone were also sown in experiment 3. Stylo seed was

inoculated with CB756 rhizobium peat culture and broadcast at 2 kg per ha in experiment 1, and 4 kg per ha in experiment 3. In experiment 2 stylo was initially sown at 2 kg per ha in the day 0 sowing treatments, but a further 4 kg per ha was sown 11 days later; the remaining sowings were made at 6 kg per ha. Each grass was broadcast at 3 kg per ha in experiment 1.

Granulated B.H.C. at the rate of 2 kg a.i. per ha was applied to all plots on three occasions to control stem borer, termites and leaf eating insects. Continual hand weeding was undertaken.

(iii) *Measurements*

Rice panicles were harvested at maturity, air dried, hand threshed, winnowed, and again air dried before recording weight of paddy. Sampling area was 6 x 6 m per sub-plot in experiment 1, 9 x 9 m per plot in experiment 2, and 4.5 x 4.5 m in experiment 3. Grain yield data of Khao Non Deng in experiment 3 is unavailable. Pasture material was cut at ground level at the same time as rice maturity, separated botanically, air dried, and then oven dried at 60°C for 24 hours to determine dry matter weight. These observations were based on five 50 x 50 cm quadrats per sub-plot in experiment 1, five 1 x 1 m quadrats per plot in experiment 2, and 4.5 x 4.5 m single quadrats in experiment 3. Stylo density was also recorded at harvest.

RESULTS

(i) *Seasonal conditions*

The first heavy rain of the monsoon season occurred on May 6, 1969, and 214 mm were recorded on 15 wet days until sowing commenced on May 29. Heavy and continual rains followed sowing, causing some loss of soil, seed and fertilizer. Moisture stress was not evident in the 122 day period to the harvest of the early rice variety; 1525 mm were recorded on 72 wet days. 56 mm fell on 4 wet days at the beginning of the next 16 day period until the mid season variety harvest. In the final period of 21 days until the late season variety harvest slight moisture stress was evident, and 86 mm was recorded on 6 wet days.

(ii) *Experiment 1—effects of grasses and stylo*

Rice grain yield (Table 1) was 1030 kg per ha. Sowing molasses and guinea grasses with the rice crop significantly decreased rice yield by 19%. Somewhat unexpectedly, stylo had a significantly beneficial effect of 20% on rice yield; rice yield was unaffected if stylo and grasses were sown together.

Companion grass decreased stylo growth (Table 1), and stylo density decreased from 23 to 16 plants per sq m in the plus and minus grass plots respectively.

(iii) *Experiment 2—stylo sowing time and phosphorus supply*

The time of sowing stylo did not significantly affect companion rice straw yield (Table 2), but grain yield was decreased by 15% if stylo and rice were sown on the same day. Sowing stylo 31 or 60 days after rice gave the same yield of grain.

Delaying stylo sowing time substantially decreased stylo growth and plant density, and poor stylo swards developed in the 60 day delayed sowing treatment.

The level of phosphate fertilizer applied to these ash sowings did not significantly affect rice growth, grain production or stylo growth. Fertilizer application caused a significant reduction in stylo density in the 60 day sowing treatment.

(iv) *Experiment 3—Rice variety and nitrogen and phosphorus supply*

Sowing stylo 36 days after rice planting did not significantly affect grain yield of any rice variety, and this finding was independent of fertilizer level (Table 3). In

TABLE 1

Experiment 1—Yield of pasture species and rice grain as affected by oversowing

Treatment	Yield (kg per ha) Stylo	Molasses grass	Guinea grass	Rice grain
Stylo sown	440	—	—	1200
Grasses sown	—	1210	130	800
Stylo and grasses sown	210	1000	120	990
No pasture sown	—	—	—	1030
Significance	$P < 0.01$	N.S.	N.S.	$P < 0.05$

TABLE 2

Experiment 2—Effect of delaying stylo sowing time on rice and stylo production

	Stylo sowing time : days after sowing rice 0	31	60	Significance
Rice grain (kg/ha)	1130[a]	1310[b]	1340[b]	$P < 0.01$
Rice straw (kg/ha)	7510	8010	7910	N.S.
Stylo yield (kg/ha)	1640	220	30	
	(2.13)[a]	(1.23)[b]	(0.50)[c]	$P < 0.01$
Stylo density (plants/sq. m)	24.5	15.0	6.5	
	(1.36)[a]	(1.16)[b]	(0.82)[c]	$P < 0.01$

Figures followed by differing lower letters differ at the 5% level of probability.

Transformed (log (x + 1)) values appear in brackets.

TABLE 3

Experiment 3—Effect of nitrogen and phosphorus fertilisers and stylo on rice varieties

	Khao Nammack VT-7	Khao Yngong VT-16	Khao Dock Sone VT-11
Days from sowing to:			
Panicle exsertion	91	111	123
Maturity	122	138	159
Yield of grain (kg/ha):			
Without fertiliser	1370[b]	1390	1080[ab]
With phosphorus	1350[b]	1410	1090[ab]
With nitrogen	1660[a]	1310	1210[a]
With phosphorus and nitrogen	1590[a]	1400	910[b]
Significance:	$P < 0.05$	N.S.	$P < 0.05$
Without stylo	1550	1390	1040
With stylo	1430	1370	1100
Significance:	N.S.	N.S.	N.S.

Figures followed by differing letters differ at the 5% significance level.

these ash sowings, the local rice varieties were generally insensitive to fertilizer; a 20% increase from 40 kg N per ha was recorded for the early variety, and combined nitrogen and phosphorus may have caused a yield depression for the late variety.

Stylo growth was independent of fertilizer level. Yield of stylo was 60, 170 and 310 kg per ha when harvested at the maturation of the early, mid and late season varieties respectively. Stylo density was independent of variety and averaged 14 plants per sq m.

The experimental areas were ungrazed until November, 1970. At this time a dense stylo dominant pasture about 1.7 m high was evident; molasses grass was prominent where sown in experiment 1. Yield was estimated to be in excess of 12,000 kg dry matter per ha. Woody regrowth constituted a problem, but herbaceous weeds had been suppressed.

DISCUSSION

These results confirm that productive stylo based pastures may be very simply established in the upland cropping areas of central Laos. The absence of stylo response to added phosphate on this sandstone derived soil is interesting, in view of the known responsiveness of this species (Blunt and Humphreys 1970, Bruce 1972), and of responses obtained in the same year on an adjacent site cleared three years previously (Shelton and Humphreys, unpublished). However, Reeve and Hubble (1967) recorded that "available" phosphorus on a nearby site increased after firing from 12 to 24 p.p.m. in the 0-3 cm layer, and from 6 to 10 p.p.m. in the 13-16 cm layer, and the effects of ash accretion in this first year may have been substantial. The excellent growth of stylo observed in the following year suggests that other nutrient shortages were unlikely to have provided a major limitation to phosphorus response. The small response of these tall leafy tropical rice varieties to improved nutrition is a common finding and the grain yields recorded (1000-1400 kg per ha) were in excess of average values for both "wet" rice and upland rice in Laos (Halpern 1964).

Competition between stylo and rice was not acute when stylo was sown 31 days after rice but, stylo sown 60 days after rice was severely suppressed by rice. Subsequent work at the University of Khon Kaen (Shelton and Humphreys, unpublished) has found that a sowing delay of 10 days and a low seeding rate are adequate to minimise effects of stylo on rice grain production. Although some moisture shortage may have affected the yield of the late rice variety, the presence of stylo did not appear to accentuate stress. The small beneficial effect of stylo on rice yield in experiment 1 was unexpected, but some cases of nitrogen transfer from a legume to an ungrazed companion species are reported in the review by Charles (1958).

This technique of pasture establishment merits larger scale testing, and should be successful in environments similar to Na Pheng if attention is paid to the control of woody regrowth.

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