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The potential of long bean and cucumber as intercrops with ginger on Malaysian peat

(Potensi kacang panjang dan timun sebagai tanaman selingan dengan halia di tanah gambut di Malaysia)

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Key words: intercropping, compatibility, ginger, cucumber, long bean, yield, LER, net returns

Abstrak

Kajian telah dijalankan dalam dua percubaan, dengan percubaan yang kedua dijalankan terus selepas percubaan pertama, untuk mengkaji kesesuaian timun dan kacang panjang sebagai tanaman selingan dengan halia di tanah gambut di Malaysia. Kombinasi ulangan 2^2 faktorial dengan tiga bandingan telah digunakan dalam reka bentuk blok lengkap terawak. Daripada keputusan percubaan pertama, kacang panjang dan timun didapati sesuai sebagai tanaman selingan dengan halia. Hasil halia boleh dipertingkatkan sekiranya ditanam sebulan lebih awal daripada tanaman-tanaman selingan. Halia mesti ditanam di luar barisan tanaman-tanaman selingan dan dikutip hasilnya 9 bulan selepas menanam. Pembajaan yang disyorkan pada halia, timun dan kacang panjang perlulah diberi pada tanaman-tanaman ini dalam sistem penanaman selingan. Dalam percubaan seterusnya, hasil halia meningkat lebih ketara berikutan dengan pengesyoran amalan pertanian yang telah dicadangkan dalam percubaan pertama. Halia juga memperoleh faedah daripada kesan timbal-balas perhubungan tanaman selingan. Pembajaan halia boleh dilakukan setiap 4 minggu atau setiap 8 minggu, sehingga minggu ke-28 dan ke-32 selepas menanam. Tanaman kacang panjang harus ditanam sebagai tanaman kedua. Daripada hasil, nisbah setara tanah dan pulangan bersih bagi sehektar, penanaman selingan yang paling baik ialah H–K–T iaitu halia ditanam sebagai tanaman pertama diikuti dengan kacang panjang dan timun.

Abstract

The studies involved two experiments, the second experiment being a follow-up to the first, to investigate the compatibility of cucumber and long bean as intercrops for ginger on Malaysian peat. A replicated 2^2 factorial trial with three controls was laid out in randomized complete block design. From the results of the first experiment, long bean and cucumber were found to be compatible as intercrops with ginger. Ginger yield can be improved further if planted 1 month earlier than the intercrops. Ginger must be planted outside the rows of the intercrops and harvested only at 9 months after planting. The recommended fertilizer levels must be applied for the individual crop of

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ginger, cucumber and long bean in the intercropping system. In the follow-up experiment, yield of ginger improved significantly following the agronomic recommendations suggested in the first experiment. Ginger further benefited from the complementary effects of intercrop association. Fertilizer application for ginger can be carried out at 4-weekly or 8-weekly intervals respectively up to 28 weeks and 32 weeks after planting of ginger. Long bean should be planted as the second rather than the third crop in the cropping sequence. From the yield, land equivalent ratio and the total net returns per hectare obtained, the best intercropping system was G–B–C where ginger was planted as the first crop followed by long bean and cucumber.

Introduction

There is a dire need to stimulate local food production as Malaysia imported food products worth M$3.3 billion in 1986 (Alwi 1987). One of the ways to increase food production is by intercropping. Intercropping of a short-season crop between a long-season annual or perennial is a common practice. This system increases productivity in the long-season crops that start slowly by getting a short-season crop off during the early growth stages (Beets 1977). Intercropping ensures a more efficient utilization of solar and soil resources. It has been reported that intercropping often produces higher yield than sole cropping (Andrews 1972; Willey 1979; Mead and Willey 1980). The yield advantage is substantial when the component crops are complementary. The incorporation of a legume can increase the yield of the associated non-legume and the soil N content (Andrews 1972; Willey 1979; Waghmare and Singh 1984). There is limited information on local vegetables based intercropping system. The study was carried out to determine the agronomic compatibility of long-season annual, ginger (*Zingiber officinale* Rsc.), intercropped with two short-season crops, long bean (*Vigna sesquipedalis* L.) and cucumber (*Cucumis sativus* L.) on oligotrophic peat.

Materials and methods

The first experiment was conducted from 16 August 1983 for 7 months and the second from 28 January 1985 for 9 months.

Ginger planting materials were prepared in accordance with Leong (1981). Ginger (G) was planted simultaneously with either long bean (B) or cucumber (C). The intercropping treatments and the two fertilizer levels were laid out in a 2 x 2 combination and planted in the following sequence G+C–B and G+B–C. The treatment G+C–B meant simultaneous planting of G and C to be followed by B within a week after completion of C. Ginger being the long-season crop was harvested last, at 7 months after planting. The total nutrients applied for the two fertilizer levels 1 and 2 were N 290, P 78, K 330 and N 490, P 117, K 580 kg/ha respectively. Level 1 was the total nutrients applied to cucumber and long bean and level 2 the total for ginger, cucumber and long bean. The details of the fertilizer applications for individual crop are shown in *Table 1*. For ginger, the fertilizers were applied in equal amounts at 2, 4, 12 and 20 weeks after planting. For long bean and cucumber, the fertilizers were applied in equal amounts at 1, 3 and 5 weeks after planting. The fertilizers used were NPK Blue Special, Urea and Muriate of potash.

Three controls were tested in addition to the factorial combination namely:

- ginger as sole crop (G)
- cucumber followed by long bean without ginger (C–B)

Table 1. Fertilizer applications for the 7 treatments in both experiments

Treatment	Crop	Nutrients (kg/ha) applied for respective crop			Total nutrients (kg/ha) per treatment		
		N	P	K	N	P	K
G	G	200	39	250	200	39	250
C–B	C	200	39	180	290	78	330
	B	90	39	150			
B–C	B	90	39	150	290	78	330
	C	200	39	180			
G+C–B(1)*	C	200	39	180	290	78	330
	B	90	39	150			
G+C–B(2)*	G	200	39	250	490	117	580
	C	200	39	180			
	B	90	39	150			
G+B–C(1)*	B	90	39	150	290	78	330
	C	200	39	180			
G+B–C(2)*	G	200	39	250	490	117	580
	B	90	39	150			
	C	200	39	180			

*(1) = fertilizer level 1
(2) = fertilizer level 2

- long bean followed by cucumber without ginger (B–C)

The seven treatments were arranged in a randomized complete block design with four blocks. The planting distances (between x within) were 45 cm x 25 cm for ginger and 60 cm x 50 cm for long bean and cucumber. Bed size and the spatial arrangement of the crops are shown in *Figure 1*. The initial soil pH was 4.5 and was raised to 5.0 with the application of ground magnesium limestone (8 t/ha) applied at 1 month before planting. Trace elements were applied as a basal dressing 1 day before planting in accordance with Leong et al. (1985). Yield of the three crops were recorded.

For the second experiment, some changes were made to the planting schedule of the crops based on the experience and observation in the first experiment. Ginger was planted 1 month earlier on the same site after a fallow of 10 months. The planting sequence remained the same as G–C–B and G–B–C. These planting sequences were combined with two different times of ginger fertilizer applications 1 and 2 applied respectively at 4-weekly intervals from 8–28 weeks and 8-weekly intervals from 8–32 weeks after planting of ginger. The treatments were combined in a 2 x 2 factorial with the same three controls as in the first experiment. The seven treatments were laid out in a randomized complete block design in three blocks. Bed size remained the same as in the first experiment except that the interbed furrow was increased to 0.8 m *(Figure 1)*. The planting distance for ginger was changed to 80 cm x 25 cm with no changes for cucumber and long bean. The intercrop was planted within the rows of the main crop ginger *(Figure 1)*. All the treatments received the same total amount of nutrients at N 490, P 117, K 580 kg/ha *(Table 1)*. The fertilizers for cucumber and long bean were applied at 1, 3 and 5 weeks after planting. The soil pH was similarly raised to 5. Ginger from Bentong, Pahang and MARDI's long bean MKP_1 and cucumber MTi_2 were used as planting materials in the first experiment. In the second experiment long bean MKP_5 was used instead.

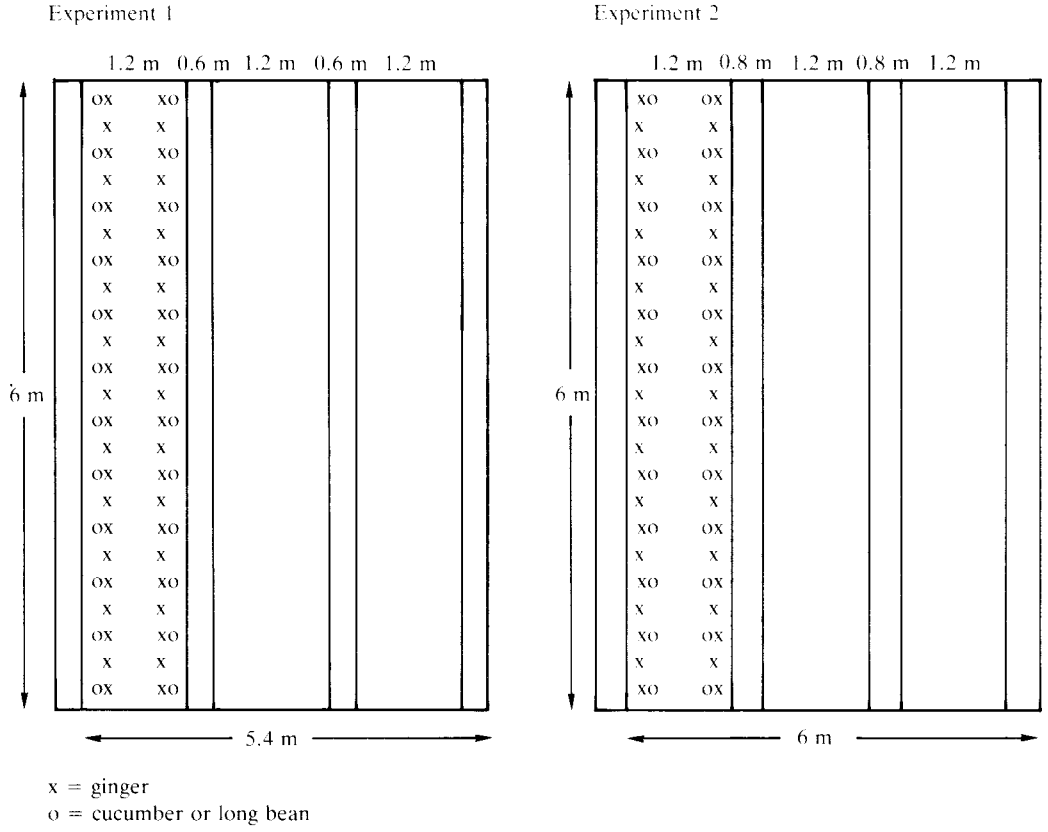

Figure 1. The spatial arrangement of the crops on beds in individual plot in both experiments

Results and discussion

Yield

Ginger In the first experiment *(Table 2)*, ginger yield was significantly reduced in all the intercropping treatments compared to the monocropping as control. The low yield obtained was attributed mainly to the relatively slow establishment of the ginger rhizome when planted simultaneously with the intercrops and excessive shading by the intercrops when ginger was planted inside the rows of the intercrops *(Figure 1)*. The above can be overcome by planting the ginger 1 month earlier and outside the rows of the intercrops. It was also noted that the rhizome harvested at 7 months after planting were small but have the potential for further growth. Chew et al.'s (1968) recommendation of 7 months after planting as the optimum time to harvest ginger as a monocrop was, therefore, not applicable when ginger was intercropped. It was proposed that in future trials, ginger should be harvested at 9 months after planting for full realization of its potential.

The cropping sequence of the intercrops had no effect on the yield of ginger as no significant differences were detected *(Table 3)*. Treatments with fertilizer level 2 recorded a significantly higher yield than level 1. The results indicated that fertilizer application for ginger was essential in the intercropping system. Any residual effects of the applied fertilizers to the intercrops coupled with nitrogen fixed by long bean were insufficient to support a good crop of ginger.

Table 2. Least significant difference (LSD) test on the yield of the 3 crops in both experiments

Experiment 1 (t/ha)				Experiment 2 (t/ha)			
Treatment	Ginger	Cucumber	Long bean	Treatment	Ginger	Cucumber	Long bean
G	12.58	–	–	G	14.89	–	–
G+C−B(1)	4.12	31.82	19.59	G−C−B(1)	16.01	17.53	16.04
G+C−B(2)	6.78	34.12	20.45	G−C−B(2)	15.76	21.59	17.07
C−B	–	32.43	19.53	C−B	–	18.04	16.82
G+B−C(1)	3.72	24.54	23.52	G−B−C(1)	15.96	17.89	23.80
G+B−C(2)	6.40	28.72	26.59	G−B−C(2)	17.72	16.19	23.11
B−C	–	30.95	24.50	B−C	–	16.76	21.23
LSD (5%)	2.54	n.s.	3.22		n.s.	n.s.	2.45
SE$\bar{d}$	1.65	4.15	2.14		3.36	3.52	1.35
C.V. (%)	24.6	13.6	9.6		20.7	19.5	6.8

n.s. = not significant

Table 3. Effect of different cropping sequences and fertilizer levels on the yield of the 3 crops in both experiments

Experiment 1 (t/ha)				Experiment 2 (t/ha)			
Treatment	Ginger	Cucumber	Long bean	Treatment	Ginger	Cucumber	Long bean
Factor 1 Crop Sequence							
G+C−B	5.45	32.96	20.03	G−C−B	15.90	19.58	16.56
	n.s.	**	**		n.s.	n.s.	**
G+B−C	5.05	26.61	25.05	G−B−C	16.85	17.04	23.46
Factor 2 Fertilizer							
Level 1	3.91	28.17	21.56	Time 1	15.98	17.70	19.92
	**	n.s.	n.s.		n.s.	n.s.	n.s.
Level 2	6.59	31.43	23.52	Time 2	16.75	18.89	20.08
SE $\bar{x}$	0.582	1.45	0.767		1.37	1.43	0.55
C.V.(%)	24.6	13.6	9.6		20.7	19.5	6.8

n.s. = not significant
**significant at 1% level

In the subsequent experiment, no significant yield differences were detected between the intercropped ginger and the control *(Table 2)*. The improved yield of the intercropped ginger was attributed mainly to the implementation of the cultural practices suggested in the first experiment. Earlier planting of ginger had enable it to establish earlier and compete more effectively with the fast growing intercrops. The reduction of shade intensity by planting outside the rows of the intercrops also contributed to the improved compatibility and yield. Harvesting of ginger from 7 months to 9 months, after a longer growth period, could have further contributed to the improved yield of the intercropped ginger. The association with the intercrops had also benefited the intercropped ginger, illustrated by the improved yield compared to the monocrop, through crop complementation.

No yield differences were detected for the different cropping sequences and the time of fertilizer application for ginger *(Table 3)*. Therefore, long bean and cucumber can be compatibly intercropped with ginger in no particular cropping sequence. Time of fertilizer application for ginger had no effect on the yield of

ginger. The fertilizer can be applied at intervals of either 4 weeks or 8 weeks up to 28 weeks and 32 weeks respectively after the planting of ginger.

Cucumber In the first experiment *(Table 2)*, no significant yield differences were detected among the intercropped treatments and the controls. However, from the factorial analysis, cucumber yielded significantly higher when planted before rather than after long bean in the cropping sequence *(Table 3)*. This was probably because of the seasonal variation and the better initial nutritional status of the soil especially micronutrients which tended to be depleted by the third crop. No significant yield differences were detected between the two levels of fertilizer applied. The addition of ginger fertilizer did not further increase the cucumber yield. This indicated that the fertilizer level currently recommended for cucumber was sufficient in the intercropping system.

In the second experiment, no significant differences were detected among the treatments and the control *(Table 2)*. Similarly, no significant differences were detected in the factorial analysis of the different cropping sequence and time of fertilizer application *(Table 3)*. Intercropping with ginger did not affect the cucumber yield. The results confirmed the compatibility of cucumber as an intercrop with ginger and it can be planted either as the second or third crop in the cropping sequence. Time of fertilizer application for ginger had no effect on the cucumber yield. The lower yield of cucumber in the second experiment was attributed mainly to the higher incidence of downy mildew disease and nematode infection.

Long bean In the first experiment *(Table 2)*, no significant yield differences were detected in the various intercropping treatments and the controls. In the factorial analysis, long bean yielded significantly higher when planted before rather than after cucumber in the cropping sequence *(Table 3)*. This showed that long bean can be compatibly intercropped with ginger with no detrimental effect on the yield of long bean. The explanation given for cucumber cropping sequence can be similarly explained for the better performance of long bean as a second rather than third crop in the cropping sequence. No significant yield differences were detected between the two levels of fertilizer applied. The additional ginger fertilizer in level 2 did not contribute significantly to the long bean yield. The fertilizer level currently recommended for long bean was sufficient in the intercropping system.

In the subsequent experiment, similar results as in the first experiment were recorded *(Table 2* and *Table 3)*. The consistent results obtained reconfirmed the compatibility of long bean as an intercrop with ginger grown as a second crop in the cropping sequence. The best cropping system was G–B–C, that is ginger followed by long bean then cucumber, irrespective of the time of fertilizer application for ginger.

Land equivalent ratio (LER)

According to Mead and Willey (1980), intercropping or growing of two or more crops together on the same area can often produce higher yields than sole crops. LER is one form of assessment of the yield advantage of intercropping. LER is defined by Mead and Willey (1980) as:-

$$LER = LA + LB = \frac{YA}{SA} + \frac{YB}{SB}$$

where LA and LB are the LERs for the individual crop; YA and YB are the individual crop yields in intercropping; and SA and SB are their yields as sole crops.

All the intercropping treatments recorded a total LER greater than the controls of G (monocrop), C–B

(cucumber followed by long bean without ginger) and B–C (long bean followed by cucumber without ginger) *(Table 4)*. The LER obtained in the second experiment were greater than those obtained in the first. This indicated a further improvement in the intercropping system attributed mainly to an increase in ginger yield. The intercropping system increased productivity of the land and further illustrated the yield advantage of intercropping over monocropping.

Estimated total net returns per hectare

Costs of production per hectare for ginger ($6 916), long bean ($4 615) and cucumber ($5 434) were obtained respectively from Leong (1981), Mah (1981) and Hamidah (1981). These figures were used as the standard costs of production since data collection on the cost of production was difficult based on small experimental plots. The estimated total net returns based on the above costs of production and the average ex-farm prices obtained from the Federal Agriculture Marketing Authority (FAMA) for the duration of harvest of each crop is shown in *Table 5*. The average ex-farm prices for the first and second experiment for ginger, cucumber and long bean were 85 and 82 cents/kg, 38 and 55 cents/kg, and 87 and 87 cents/kg respectively.

The results showed the economic advantage of intercropping over monocropping of ginger in terms of total net returns in both experiments. The total net returns improved further in the second experiment after following the necessary changes in the cultural practices for ginger. The best cropping system was G–B–C irrespective of the time of fertilizer application for ginger. This system recorded five times more income than the sole crop of ginger. This indicated that the intercropping system G–B–C is economically feasible.

Table 4. Total LER and its components for ginger (LG), cucumber (LC) and long bean (LB) for the 7 treatments in both experiments

Experiment 1					Experiment 2				
Treatment	LG	LC	LB	Total LER	Treatment	LG	LC	LB	Total LER
G	1.00	–	–	1.00	G	1.00	–	–	1.00
G+C–B(1)	0.33	0.98	1.00	2.31	G–C–B(1)	1.07	0.97	0.95	2.99
G+C–B(2)	0.54	1.05	1.05	2.64	G–C–B(2)	1.06	1.20	1.01	3.27
C–B	–	1.00	1.00	2.00	C–B	–	1.00	1.00	2.00
G+B–C(1)	0.30	0.79	0.96	2.05	G–B–C(1)	1.07	1.07	1.12	3.26
G+B–C(2)	0.51	0.93	1.08	2.52	G–B–C(2)	1.19	0.96	1.09	3.24
B–C	–	1.00	1.00	2.00	B–C	–	1.00	1.00	2.00

Table 5. Estimated total net returns per hectare for the 7 treatments in both experiments

Experiment 1		Experiment 2	
Treatment	Total net returns ($'000)	Treatment	Total net returns ($'000)
G	3.77	G	5.29
G+C–B(1)	15.64	G–C–B(1)	19.74
G+C–B(2)	19.52	G–C–B(2)	22.66
C–B	19.22	C–B	14.48
G+B–C(1)	15.93	G–B–C(1)	26.64
G+B–C(2)	22.49	G–B–C(2)	26.55
B–C	22.99	B–C	17.62

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