COCOS, (1987), 5,28-31
Printed in Sri Lanka

Soybean-Coconut Intercropping

M. DE S. LIYANAGE and M. P. L. D. MARTIN
Coconut Research Institute, Lunuwila, Sri Lanka

INTRODUCTION

The income derived from coconut (*Cocos nucifera*) farming in tropical Asia cannot sustain an average small-farm family, especially if the crop is poorly managed. In pure stands, annual production is estimated at about 17 t/ha '(Nelliat et al. 1974), which is far less than the yields produced by crops such as sugarcane, *Saccharum officinarum*, (Blackman and Black 1959). Low coconut productivity is mainly attributed to the fact that the trees use only about 25% of the available soil mass (Kushwah et al. 1973) and that they intercept only about 44% of available solar radiation (Nair and Balakrishnan 1976).

Coconut is a major crop in Sri Lanka's intermediate rainfall zone. The soil and micro-climate under the canopy of young (5 to 6 years) and mature coconut (>45 years) is suitable for the intercropping of a range of annual food crops.

Grain legumes are becoming increasingly important in Sri Lanka. They are grown in coconut-based cropping systems either as an intercrop or as a catchcrop. Their importance is based not only on their use as a source of dietary protein and vegetable oil, but because of their ability to help maintain soil fertility. Soybean (*Glycine max*) is one of the six legumes grown in Sri Lanka. In recent years demand has increased, and considerable interest has developed in improving soybean production.

Coconut-soybean intercropping is a relatively new practice, and, until recently, little was known about its long-term potential. Average yields of local soybean cultivars are low compared with improved cultivars, but comparatively little has been done to introduce high yielding, high quality cultivars. Accordingly, an experiment was conducted to evaluate the agronomic performance of 15 soybean cultivars and to select those with potential for intercropping under coconut.

MATERIALS AND METHODS

The experiment was conducted under mature coconut (60 years) planted in 9 m squares at the Ratmalagara Research Station (intermediate rainfall zone; elevation 30 m) The soil was a sandy clay-loam with a pH of 5.3. Prior to the experiment, 2.2 kg of CRI'C' fertilizer mix was broadcast in a circle (1.65m) around the base of each coconut tree and incorporated into the soil.

The soybean crop was sown at the onset of the April–June rains, ca. May 20. The seeds of the 15 test cultivars were treated with Captan prior to slurry inoculation with a commercial inoculum (Nitragin S) at the rate of 75 g/kg seed. The pre-treated seed was sown in rows 60 cm apart in 6 × 2.4 m plots arranged in a randomized block design with four replications (total area = 900 m^2). A pre-emergence herbicide (Lasso) was sprayed in all plots. The seedlings were spaced 5 cm apart within the rows 10 days after sowing. NPK was applied at the rate of 20 kg N, 60 kg P_2O_5, and 40 kg K_2O/ha at planting. The crop received 456 mm of rainfall during the experimental period (supplemental irrigation was provided when necessary). Pests were controlled with chemical spray.

Reprinted from Soybean in Tropical and Subtropical Cropping System Proceeding, 57-60, 1985 by courtesy of the Editors.

Cultivar performance was evaluated on the basis of :

(a) Days to flowering—date on which approximately 50% of the plants in a plot had their first flower;

(b) Plant height—average height of ten randomly selected plants/plot at flowering;

(c) Nodule number and size—recorded three weeks after flowering on the basis of ten randomly selected plants from two border rows in each plot;

(d) Nodule size (expressed as dry weight);

(e) Days to maturity (95% ripening);

(f) Lodging—visual score of 1 to 5 (1 = all plants erect, 5 = all plants down);

(g) Plant density—estimated as the total number of plants/m2 harvested at maturity from two center rows :

(h) Pods per plant—determined from ten randomly selected plants/plot; and

(i) Yield dry weight/6 m2.

RESULTS

Growth and Development

Days to Flowering : The majority of cultivars produced their first flower in less than four weeks (Hardee, Bossier, and the two local checks commenced flowering in less than five weeks) (Table 1). Improved Pelican and Jupiter were the latest-flowering cultivars. A significant negative correlation between the number of days to the onset of flowering and plant height was observed ($r = -0.51^{**}$) (Table 3).

Plant Height at Flowering : Only Improved Pelican, Jupiter, Pb-1, and SK-2 were significantly taller than other cultivars (Table 1). Hampton, Hardee, Davis, Forrest, and Bragg reached a height of approximately 30 cm; Bonus was the shortest cultivar (24 cm). Plant height was positively correlated to seed yeild ($r = 0.64^{**}$) (Table 3).

Nodulation : Pb-1 and Hardee had the highest number of nodules/plant, 204 and 180, respectively (Table 1). The nodulation of other cultivars (Hampton, Bragg, Bossier, and Tracy) was moderately high; Bonus produced the least number of nodules (45). On a dry weight basis, however, Jupiter, Tracy, Bonus , and Clark 63 had the largest nodule size (0.58 to 1.55 g/plant). Improved Pelican, Hill, Hampton, Pb-1, and SJ-2 had smaller nodules (0.56 to 1.33 g/plant) Table 1.).

Days to Maturity : Hill had the shortest maturity period (80 days) and Jupiter the longest (134 days) (Table 1). All cultivars, except Bossier and Improved Pelican, reached maturity in 3 to 3.5 months.

Lodging : Although only taller cultivars were expected to lodge, i.e. Improved Pelican and Jupiter, both short and moderately tall cultivars proved susceptible (Bossier Bragg, Davis, Hill, Clark 63, and Williams).

Yield Components and Seed Quality

Plant Density : Plant density did not differ significantly between cultivars at harvest, ranging from 32 to 33 plants/m (Table 2).

Table 1. *Agronomic charateristics of soybean test cultivars.*

Cultivar	*Days to Flowering*	*Plant Height at Flowering (cm)*	*Nodules/Plant 3 Weeks after Flowering (no)*	*Nodule Dry Weight/Plant 3 Weeks After Flowering (g)*	*Days to Maturity*	*Lodging*
Jupiter ...	39	54	65	0.91	134	1.25
Hampton 266 A ...	27	30	125	0.79	98	1.00
Hardee ...	33	30	180	1.47	106	1.00
Improved Pelican ...	51	63	87	0.56	133	2.25
Bossier ...	36	31	127	1.20	113	1.25
Bragg ...	27	30	131	1.03	106	1.25
Davis ...	26	28	93	0.75	103	1.25
Tracy ...	27	27	112	1.55	89	1.00
Forrest ...	27	32	86	0.77	89	1.00
Hill ...	29	27	82	0.57	80	2.00
Clark 63 ...	27	38	85	0.90	86	2.00
Bonus ...	27	24	45	0.58	98	1.00
Williams ...	25	28	91	0.71	96	1.25
Pb—1 ...	35	48	204	1.33	93	2.25
SJ—2 ...	35	49	86	0.57	105	1.75
LSD (0.05) ...	12	10	51	0.61	7	0.67

Table 2. *Soybean seed yield and quality.*

Variety	*Plant Density (no/m)*	*Pods/Plant (no)*	*100-Seed Weight (g)*	*Seed Yield (t/ha)*
Jupiter ...	33	17	23	0.4 (1.5)z
Hampton 266 A ...	33	17	21	1.4 (1.5)
Hardee ...	32	23	16	1.5 (2.2)
Improved Pelican ...	32	26	14	1.1 (1.5)
Bossier ...	33	17	17	0.8 (2.0)
Bragg ...	33	18	20	1.2 (1.7)
Davis ...	33	17	18	1.4 (2.2)
Tracy ...	32	12	20	1.0 (1.2)
Forrest ...	33	18	16	1.4 (1.6)
Hill ...	33	13	16	0.9 (1.6)
Clark 63 ...	32	15	16	1.0 (1.6)
Bonus ...	32	8	21	0.8 (1.4)
Williams ...	33	8	22	1.0 (1.7)
Pb—1 ...	33	27	13	1.4 (1.8)
SJ—2 ...	33	32	12	0.9 (1.6)
LSD (0.05) ...	—	8.0	8.81	0.53

z Monocropped yield

Table 3. *Correlation co-efficients (r) between growth and yield.*

Characteristic		*Plant Height (cm)*	*Pods/Plant*	*Seed Yiel (t/ha)*	*100-Seed Weight (g)*
Days to flowering	...	-0.51***	-0.17	-0.20	-0.01
Plant height (cm)	...	—	0.65***	0.64***	0.26
Pods/Plant	...	—	—	0.55***	-0.52**
Seed yield (kg/ha)	...	—	—	—	0.10

, * — P < 0.01, < 0.001, respectively.

Pods Per Plant : Local cultivars Pb-1 and SJ-2 had significantly more pods/plant ($P<0.01$), with a mean of 29 pods/plant (Table 2). Hampton, Hardee, Forrest, Davis, Bragg, Bossier, Improved Pelican, and Jupiter produced a more moderate number of pods (mean 20/plant, range 17 to 27), while Bonus and Williams produced the lowest numbers (mean 8/plant). Pod number was significantly correlated to seed yield ($r = 0.55^{**}$) (Table 3).

Seed Yield : Hardee, Hampton, Davis, and Forrest produced significantly greater seed yields ($P<0.01$) than other test cultivars (mean 1.45 t/ha). Jupiter had the lowest yield (0.4 t/ha) (Table 2).

When yield was computed on a daily basis, Hampton, Hardee, Davis, Forrest and Pb-1 produced similar yield responses, ranging from 14 to 16 kg/day/ha. When the yields obtained under coconut were compared with those grown in monoculture (Table 2), Hampton was shown to have suffered the lowest yield reduction (2.9%), followed by Forrest (9.6%) and Pb-1 (25.9%). In contrast, the yields of Hardee, Davis, Bragg, and Improved Pelican were reduced by 28 to 33% when compared with monocultured crops.

Among the 15 cultivars tested, Hampton, Hardee, Davis, Forrest and Pb-1 were found to be the most acceptable cultivars for intercropping under coconut in Sri Lanka's intermediate zone.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the assistance of INTSOY, the University of Illinois, the Sri Lankan Department of Agriculture, Kingsley Silva and the field staff at Ratmalagara Research Station, and Mr. D. T. Mathes of the Biometry Unit, Coconut Research Institute.

LITERATURE CITED

Blackman, G. E. and J. N. Black. 1959. Physiological and Ecological Studies in the analysis of plant environment. The role of light factor in limiting growth. Ann. Bot. 23 (89): 131–145.

Kushwah, B. L., E. V. Nelliat, V. T. Markose, and A. F. Sunny. 1973. Rooting pattern of coconut. Indian J. Agron., 18 : 71–84.

Nair, P. K. R. and T. K. Balakrishnan. 1976. Pattern of light utilisation by canopies in coconut/cocoa crop combination. Indian J. Agric. Sci. 46 : 453–462.

Nelliat, E. V., K. V. A., Bavappa, and P. K. R., Nair. 1974. Multi-storeyed cropping—a new dimension in multiple cropping for coconut plantations. World Crops 26(6): 262–266.