Row arrangement in groundnut/ pigeonpea intercropping

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Received December 1987; revised June 1988

Field experiments were conducted to find the most productive and profitable row pattern in a groundnut/ pigeonpea combination under rainfed conditions. The treatments included two sole crops at their respective optimum population densities (333 000 plants ha^{-1} for sole groundnut and 60 000 plants ha^{-1} for sole pigeonpea) and five intercrop treatments involving groundnut/pigeonpea in 3:1, 4:1, 5:1, 6:1 and 8:1 ratios. The rows were sown 60 cm apart in sole pigeonpea and 30 cm in sole groundnut and all intercrop treatments. The intra-row spacing of both component crops in intercrop treatments was adjusted to maintain the population density equivalent to that of the sole crop optimum. Both 5:1 and 6:1 row arrangements were more productive in terms of yield advantage (LER of 1.49 for 5:1 and 1.48 for 6:1) and were also more profitable (5% monetary advantage for 5:1 and 3% monetary advantage for 6:1) than the 8:1 row arrangement (LER 1.41). Similar results were obtained in both years but the 6:1 row arrangement was more promising than the 5:1 row arrangement when the growing season was wet.

Keywords: Intercrop; Row arrangement; Groundnut; Pigeonpea

Intercropping is one means of increasing the income of a farming community under rainfed situations as it helps in better utilization of resources and ensures higher returns per unit area and time (Roy *et al.*, 1981). A groundnut/pigeonpea intercropping combination is specially important because it involves two crops of different growth patterns for extended use of resources; it is prevalent in the red soil areas of the southern States of India and is quite predominant in the semi-arid tracts of Andhra Pradesh. Traditionally, in this combination pigeonpea rows are wide-spaced, up to 5 m apart, with 14–16 groundnut rows between. This practice gives high yields of the groundnut cash crop but the overall advantage of intercropping may not be substantial because the pigeonpea is too sparsely distributed to make efficient use of resources during the later part of the season and produce an economic yield. Veeraswamy *et al.* (1974) reported that the arrangement of six rows of groundnut with one row of pigeonpea was more economical than 8:1. Recent studies at ICRISAT (1982) revealed that groundnut/ pigeonpea at 3:1 or 5:1 ratios were more advantageous than either of the sole crops.

This Paper describes studies carried out to suggest the most productive and profitable row pattern in a groundnut/pigeonpea combination under rainfed conditions in Hyderabad.

Materials and methods

The experiment was conducted for two years on rainfed medium deep Alfisols in the rainy seasons of 1983 and 1984, the pigeonpea crop extending into the post-rainy season, at the Agricultural College Farm, Rajendranagar, 15 km SW of Hyderabad, India (17° 19′ N, 79° 23′ E and 542 m altitude). The analysis of soil samples from the experimental plots indicated that available N, P_2O_5 and K_2O were 273.8, 25.96 and 305.67 kg ha^{-1}, respectively. The average annual rainfall at Rajendranagar is 560 mm, of which some 83% is received during the rainy season, mid June–the end of September. The 1983 rainy season was very wet (812 mm in the growing period from standard week 27 to standard week 4 in 49 rainy days); 1984 was rather dry (376 mm from standard week 27 to standard week 3 in 23 rainy days).

Treatments included two sole crops at their respective optimum population densities (333 000 plants ha^{-1} for sole groundnut and 60 000 plants ha^{-1} for sole pigeonpea) and five intercrop treatments involving groundnut/pigeonpea in 3:1, 4:1, 5:1, 6:1 and 8:1 ratios. The treatments were laid out in a randomised block design, replicated four times in 1983 and three times in 1984. The 3:1 ratio of

0041-3216/89/040309-04 $03.00

groundnut/pigeonpea was not included in the second year as it was realized from the first experiment that in this pattern the groundnut component was severely affected by the closely spaced pigeonpea. The rows were sown 60 cm apart in sole pigeonpea and 30 cm in sole and intercrop groundnut. The intra-row spacings of both component crops in the different intercrop treatments were adjusted to maintain the population equivalent to that of sole crop optimum.

The cultivars under test were Robout 33–1 (groundnut) and ICP L–6 (pigeonpea). A uniform basal application of 23:46:23 kg N, P_2O_5 and K_2O ha^{-1} was given to all treatments.

The sowings were made in the first week of July in both years after soaking rains. Pests of groundnut and pigeonpea were controlled by spraying endosulphon 35% EC at the rate of 1.5 ml l^{-1}. The groundnut and pigeonpea crops were harvested 114 and 196 days, respectively, after sowing in 1983; in 1984 they were harvested 124 and 185 days after sowing. One protective irrigation (5 cm) was given at 96 days after sowing in 1984 during a prolonged dry spell.

Photosynthetically active radiation (PAR) intercepted by crops in different treatments was measured by a 'T' meter (Williams and Austin, 1977). Readings were taken randomly at four locations $plot^{-1}$ at 15-day intervals till both crops were harvested and averaged for each treatment. The percentage of light intercepted was obtained by deducting the amount of PAR transmitted through the crop from 100. Gross returns were calculated at the market prices prevailing one month after harvest (Perrin *et al.*, 1979).

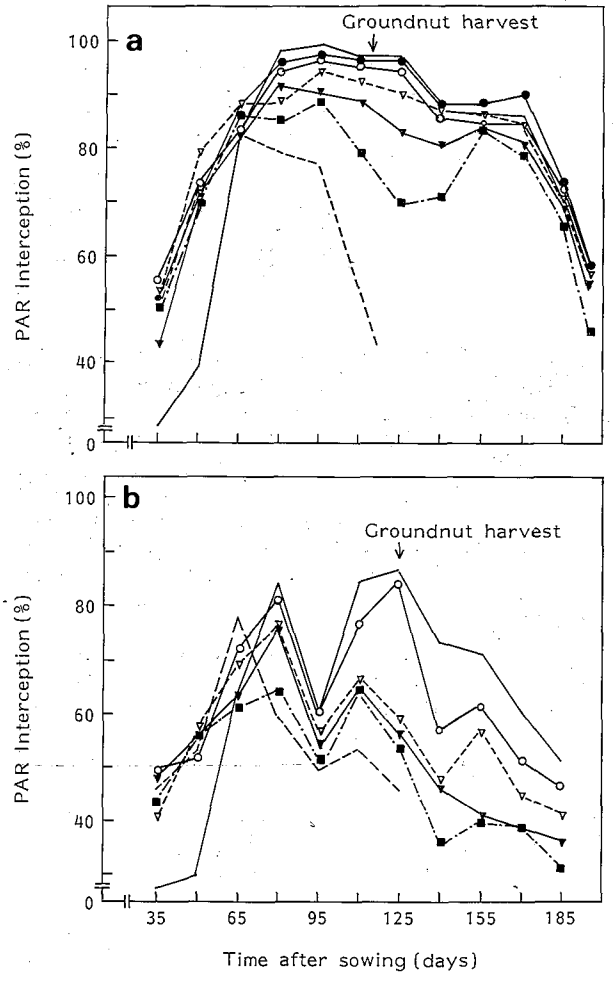

Figure 1 Interception of photosynthetically active radiation by groundnut and pigeonpea intercrop at Hyderabad, in (a) 1983 and (b) 1984. – – –, Sole groundnut; ——, Sole pigeonpea; ●—●—●, Groundnut/pigeonpea (3:1); ○—○—○, Groundnut/pigeonpea (4:1); △---△---△, Groundnut/pigeonpea (5:1), ▲—▲—▲, Groundnut/pigeonpea (6:1); ■—·—■, Groundnut/pigeonpea (8:1)

Results and discussion

In the intercrop it was not possible to measure the amount of light intercepted by each crop, thus the curves in Figure 1 show the total interception by both crops. The intercrop treatments in both years intercepted light as in sole groundnut up to 65 days; afterwards they followed the pattern of sole pigeonpea till final harvest, which suggests that the intercrop treatments were more efficient in utilizing solar radiation over a longer period of time. Similar observations have been made by others (ICRISAT, 1982). Light interception decreased as the space between two pigeonpea rows widened, so that the 8:1 row arrangement experienced less light interception throughout the crop growth period.

The 1983 results indicated that competition for light started in intercropped groundnut from 65 days onwards, which was the most critical stage for pod formation in the crop. This might be due to almost continuous rains (49 rainy days) during the crop growth period, resulting in vigorous pigeonpea growth (8288 kg ha^{-1} of dry matter in 1983 but only 3160 kg ha^{-1} in 1984) which competed with groundnut for light.

Groundnut pod yield

The base crop groundnut yields were significantly influened by various treatments (Table 1). In both years, sole groundnut produced significantly higher pod yield than the intercrop treatments, among which the 8:1 row arrangement produced more yield (1025 kg ha^{-1}) compared with 3:1 (558 kg ha^{-1}) and 4:1 (591 kg ha^{-1}) row arrangements (in 1983 only).

Pigeonpea grain yield

In 1983 the grain yields of pigeonpea did not differ significantly between treatments (Table 1). The best grain yield (1840 kg ha^{-1}) was produced in sole pigeonpea and the lowest (1492 kg ha^{-1}) in the 8:1 row arrangement. In 1984, the sole pigeonpea yield was significantly higher than all intercrop pigeonpea yields, but no differences were found between the different row arrangement treatments. The grain yields in the intercrop treatments ranged 15–28% less than in sole pigeonpea.

Combined performance of both crops

The combined yields of the two crops are presented in Table 2 as land equivalent ratio (LER) *i.e.*, the proportional land area that would be required as sole crops to produce the yields achieved in intercropping. In both years all intercrop treatments gave yield advantage over sole crops. In 1983, the 6:1 row arrangement gave 37% (LER 1.37) yield advan-

Table 1 Pod yield of groundnut and grain yield of pigeonpea as affected by intercrop and row spacing at Hyderabad

Treatments	Pod yield of groundnut (kg ha^{-1})			Grain yield of pigeonpea (kg ha^{-1})		
	1983	1984	Mean	1983	1984	Mean
Sole groundnut	2093	1346	1720	–	–	–
Sole pigeonpea	–	–	–	1840	838	1339
Groundnut/pigeonpea (3:1)	558	–	558	1619	–	1619
Groundnut/pigeonpea (4:1)	591	897	774	1655	711	1183
Groundnut/pigeonpea (5:1)	933	1089	1011	1612	699	1156
Groundnut/pigeonpea (6:1)	896	1019	958	1638	687	1163
Groundnut/pigeonpea (8:1)	1025	1025	1025	1492	603	1048
S.E. ±	132.7	74.6	110.3	83.7	41.4	88.6
LSD (P = 0.05)	399.9	228.1	318.5	NS	122.1	255.9
CV (%)	26.1	12.6	3.2	10.2	11.8	22.6

NS, Not significant

Table 2 Land equivalent ratios (LER) of pod/grain yields and gross monetary returns of groundnut pigeonpea intercropping at Hyderabad, 1983 and 1984

Treatments	Land equivalent ratio (LER)									Gross monetary returns (Rs. ha^{-1})		
	1983			1984			Mean LER					
	G'nut	P'pea	Total	G'nut	P'pea	Total	G'nut	P'pea	Total	1983	1984	Mean
Sole groundnut	1.00	–	1.00	1.00	–	1.00	1.00	–	1.00	8733	5918	7326
Sole pigeonpea	–	1.00	1.00	–	1.00	1.00	–	1.00	1.00	9146	3124	6135
G'nut/p'pea (3:1)	0.26	0.89	1.15	–	–	–	0.26	0.89	1.15	10 497	–	10 497
G'nut/p'pea (4:1)	0.29	0.91	1.20	0.67	0.85	1.52	0.48	0.88	1.36	10 843	6650	8747
G'nut/p'pea (5:1)	0.44	0.88	1.32	0.81	0.84	1.65	0.63	0.86	1.49	11 966	7446	9706
G'nut/p'pea (6:1)	0.47	0.90	1.37	0.76	0.82	1.58	0.62	0.86	1.48	11 968	7103	9536
G'nut/p'pea (8:1)	0.51	0.82	1.33	0.76	0.72	1.48	0.64	0.77	1.41	11 754	6830	9292
S.E. ±	0.04	0.05	0.07	0.06	0.04	0.07	0.04	0.03	0.05	606.2	328.9	418.4
LSD (P = 0.05)	0.13	NS	0.20	0.17	0.13	0.21	0.13	0.08	0.15	1800.9	964.7	1208.3
CV (%)	17.1	9.9	11.2	13.1	10.2	9.3	21.1	9.5	10.6	11.3	9.1	12.6

NS, Not significant

tage over sole crops, with groundnut and pigeonpea producing 47 and 90% of their respective sole crop yields. Widening the pigeonpea rows from 2.1 to 2.7 m improved the groundnut yield by 4%, but at the same time the pigeonpea yield was reduced by 8% (Table 1). This improvement in groundnut pod yield may result from less competition for light between pigeonpea and groundnut plants, whereas the pigeonpea grain yield reduction can be attributed to intra-row competition for available resources and competition from groundnut. Reducing the row distance from 2.1 to 1.8 m lowered the groundnut and pigeonpea yields by 3 and 2%, respectively.

In 1984, the 5:1 row arrangement gave a greater yield advantage (LER 1.65, 81 groundnut and 84% pigeonpea) than the other intercrop treatments, followed by the 6:1 row arrangement with a LER of 1.58 (76 groundnut and 82% pigeonpea).

The two years' data indicate that intercropping was more beneficial in 1984 than in 1983, suggesting that utilization of resources under moisture constraint conditions would be better with intercropping than with sole cropping.

The mean LER values for both years show that the 5:1 row arrangement (LER 1.49) and the 6:1 row arrangement (LER 1.48) were more advantageous than either the 8:1 row arrangement (LER 1.41) or any of the sole crops.

In both years the intercrop treatments having high yield advantage (LER) also gave high monetary returns. In 1983, the 6:1 (Rs. 11 968 ha^{-1}) and the 5:1 (Rs. 11 966 ha^{-1}) row arrangements, on average, gave 37 and 31% additional monetary return over sole groundnut and sole pigeonpea, respectively. Although the 5:1 row arrangement gave a lower LER value (1.32), it gave additional returns of Rs. 212 ha^{-1} compared with the 8:1 row arrangement (LER 1.33), possibly due to a higher pigeonpea contribution which had a better market price (Rs. 465 100 kg^{-1} grain) than groundnut (Rs. 400 100 kg^{-1} pods).

In 1984, the 5:1 (Rs. 7446 ha^{-1}) and 6:1 (Rs. 7103 ha^{-1}) row arrangements gave 9 and 4% monetary advantage, respectively, over the traditional 8:1 row arrangement (Rs. 6830 ha^{-1}), with 26 and 20% monetary advantage over sole cropping of groundnut. The combined performance of the two years show that the 5:1 and 6:1 row arrangements gave 5 and 3% greater monetary returns, respectively, than the 8:1 row arrangement.

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