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EFFECTS OF INTERCROPPING ON YIELD AND RETURNS IN CORN AND SORGHUM

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SUMMARY

The yield and gross returns (Rs/ha) were studied over two years in three experiments on intercropping in corn and sorghum. Paired-row planting recorded 8 to 12% and 44% higher yield in corn and sorghum respectively over conventional equidistant planting at the same plant populations. Additional gross returns due to intercropping ranged from 24 to 76% in corn (1975–76 winter) and 4 to 56% in corn and 15 to 75% in sorghum (1976 rainy season) compared to pure crops. Intercropping was beneficial, particularly in the limited cropping periods of this semi-arid tropical zone.

The need to increase food production is one of the major world problems where pnysical area under cultivation cannot be increased. There is scope to increase productivity by relay, multiple or sequence cropping and intercropping in order to produce more per unit area and time, and to stabilize overall production. The main object in intercropping is to produce an additional crop without much effect on the base crop yield, or to obtain higher total economic returns even though there is some marginal sacrifice of the base crop. This is especially important in the semi-arid tropics, where the growing season is short and soil moisture the main constraint. The advantage of paired-row planting was reported by Anand Reddy *et al.* (1978), in an observation trial (1975 rainy season) with sorghum where an additional yield of 4 q/ha was obtained by altering the planting pattern. Singh (1976) has also reported the superiority of paired rows under acute drought conditions as well as during good rainfall years. Based on these results, three experiments were conducted during 1975–76 to assess the profitability of introducing an intercrop between the main crop pairs and to determine a suitable intercrop for corn and sorghum at the same level of population as that of a sole base crop.

MATERIALS AND METHODS

The experiments were conducted during the winter (irrigated) and rainy (rainfed) seasons of 1975–76 and 1976 respectively on sandy loam soils at College Farm, Rajendranagar, in a typical semi-arid climate. The experiments were laid out in a randomized block design. The following eight treatments were replicated thrice in net plots of 7.2 m^2, with corn (DHM-101, duration 135 days) as the base crop in 1975–76 winter:

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1. Normal planting in ridges and furrows 60 cm apart and 30 cm between plants,
2. Paired rows, 45 cm apart, planted in deep furrows (rafter method); with 75 cm between two pairs and 30 cm between plants,
3. Paired row + 2 rows of wheat (UP 215) between pairs of corn,
4. As for 3 but with safflower (C 438),
5. As for 3 but with groundnut (Spanish Improved),
6. As for 3 but with sarson (Japan Sarson),
7. As for 3 but with soyabean (EC 11780), and
8. As for 3 but with sesamum (T-12).

In the 1976 rainy season ten treatments were tested with corn and sorghum as base crops, replicated four times in 7.2 and 8.1 m^2 plots for corn and sorghum respectively.

Corn (DHM-101)	*Sorghum (CS 3541)*
1. Normal planting in ridges and furrows 60 cm apart, 30 cm between plants,	Normal planting in ridges and furrows 45 cm apart, 15 cm between plants,
2. Paired row planting in deep furrows (rafter method), 45 cm between planted rows, 75 cm between two pairs, and 30 cm between plants,	Paired row planting in deep furrows (rafter method), 30 cm between planted rows, 60 cm between two pairs, and 15 cm between plants,
3. As for 2 with 2 rows of greengram (PS-16) between pairs of corn,	Paired rows as for 2 with 2 rows of greengram,
4. As for 2 with blackgram (L 35-1)	As for 2 with blackgram,
5. As for 2 with groundnut (Spanish Improved),	As for 2 with groundnut,
6. As for 2 with soyabean (EC 11780),	As for 2 with soyabean,
7. As for 2 with cowpea (C 152),	As for 2 with cowpea,
8. As for 2 with sunflower (Morden 1267),	As for 2 with sunflower,
9. As for 2 with finger millet (Kalyani), and	As for 2 with finger millet, and
10. As for 2 with foxtail millet (Arjuna).	As for 2 with foxtail millet.

The duration of the base crops was 130 days, but the intercrops were of shorter duration (90-100 days) except that the duration of groundnut was the same as for the base crops.

The fertilizer schedule adopted was as follows:

	N	:	P	:	K
Corn, sorghum, wheat	120	:	60	:	30
Sunflower	80	:	40	:	20
Fingermillet	60	:	30	:	30
Safflower, sarson, sesame	50	:	25	:	25
Foxtail millet	40	:	20	:	20
Groundnut, soyabean, greengram, blackgram, cowpea	15	:	30	:	30

All the P and K was applied as a basal dose to all the crops. Nitrogen was applied half as basal and half as top dressing a month after sowing to all crops except foxtail millet and legumes, to which all the nitrogen was applied as a basal dose. The plots with intercrops received more fertilizer than those that were sole cropped.

The rainy season spread from June to October, with precipitation during the crop growth and pre-sowing period of 403 mm and 165 mm respectively. Uniform populations were maintained in all base crop treatments by thinning, and row spacings for intercrops were as recommended when they are sole cropped. The net plot area was taken for computing yields per hectare of both base and intercrops and gross returns (Rs/ha) were calculated on prevailing market prices.

RESULTS

Data pertaining to yields of base and intercrops and gross returns are presented in Tables 1 and 2. During the 1975-76 winter yield differences were significant among treatments, with paired-rows producing the highest yield of corn (45.3 q/ha) compared with 41.9 q/ha for normal planting (Table 1). The base crop

Table 1. *Grain yields of base crop and intercrops, and gross returns from intercropping in 1975-76*

Treatments	Grain yield (q/ha)		Gross returns (Rs/ha)
	Corn	Intercrop	
Normal planting	41.9	–	3354
Paired row planting	45.3	–	3627
Paired row + wheat	42.7	10.7	4644
Paired row + safflower	39.5	6.9	4410
Paired row + groundnut	34.7	9.3	4174
Paired row + sarson	40.9	8.7	5894
Paired row + soyabean	31.3	1.6	2829
Paired row + sesame	32.6	*Nil	2606
SE ±	4.3	–	1093
CD (P = 0.05)	9.3	–	–

* Sesame crop failed

Table 2. *Grain yield of base crops and intercrops, and gross returns from intercropping in 1976*

Treatments	Grain yield (q/ha)		Gross returns (Rs/ha)	Grain yield (q/ha)		Gross returns (Rs/ha)
	Corn	Intercrop		Sorghum	Intercrop	
Normal planting	30.1	–	2409	30.9	–	3085
Paired row planting	33.9	–	2711	44.4	–	4442
Paired row + greengram	29.8	0.90	2497	45.0	0.93	4625
Paired row + blackgram	29.7	0.57	2493	45.7	0.74	4737
Paired row + groundnut	29.4	9.37	3758	40.4	9.07	5402
Paired row + soyabean	30.9	0.57	2588	39.5	0.59	4067
Paired row + cowpea	29.5	1.11	2505	45.7	0.85	4681
Paired row + sunflower	25.7	3.38	2831	28.1	3.24	3554
Paired row + finger millet	24.4	6.65	2542	32.1	6.78	3812
Paired row + foxtail millet	25.1	6.94	2601	33.9	5.47	3859
SE ±	2.5	–	197	2.9	–	318
CD (P = 0.05)	5.2	–	404	5.9	–	653

yield in association with intercrops ranged from 42.7 to 31.3 q/ha. The significant reduction in base crop yield when intercropped was due to the effects of groundnut, soyabean and sesame compared with yields from paired-row sole crops. Gross monetary returns showed that the loss in corn yield was only well compensated where groundnut was the intercrop. The maximum gross returns of Rs 5894/ha was with sarson and minimum of Rs 2829/ha with soyabean as intercrop, apart from the sesame (which did not produce any yield).

During the 1976 rainy season (Table 2) base crop yields were significantly different among treatments, with the highest in paired-planted corn (33.9 q/ha) and sorghum (44.4 q/ha) compared to normal planting (30.1 and 30.9 q/ha respectively), and bigger differences in sorghum (13.6 q/ha) than corn (3.8 q/ha). When intercropped, the base crop yields ranged from 30.9 to 24.4 q/ha and 45.7 to 28.1 q/ha in corn and sorghum trials respectively, whilst the intercrop yields ranged from 0.6 to 9.4 q/ha and 0.6 to 9.1 q/ha in corn and sorghum respectively. Cereal-cereal (corn + foxtail millet or finger millet) and sunflower intercrops affected the corn yield significantly compared to paired-row sole crop, but there was no significant reduction in corn yield when the intercrop was a legume. The situation in sorghum was similar, but sunflower intercrop had most effect on the base crop.

The gross returns (Rs/ha) were heaviest with a base crop + groundnut and lowest from normal planting in both base crops, with paired rows ranking 3rd and 5th in corn and sorghum respectively. Intercropping with other legumes, sunflower, finger millet and foxtail millet produced similar gross returns to the sole crop in paired planting, but there was 3.5–8.0% increase above normal planting in corn, whereas intercropping with other legumes (except soyabean) in sorghum produced similar returns to the sole crop in paired planting. Intercropping with foxtail millet, finger millet and sunflower resulted in 13, 14 and 20% reductions compared to sole crop in paired row planting. When gross

returns were compared with normally planted sole crops all the intercrops resulted in extra income, ranging from 4 to 75%. The most striking result was that paired planting itself resulted in nearly 44% higher yields in sorghum than normal planting, though not in corn (8-12%). Sorghum thus appeared to be more suitable for intercropping than corn, though this differential behaviour of crops needs further study.

DISCUSSION

Modifying the planting pattern by using paired rows increased the yields of base crops by 8.2 and 12.2% in corn in the winter and rainy seasons respectively, whereas the increase in yield of sorghum was 44%, suggesting that paired-row planting was preferable to conventional equidistant planting. Advantages of paired rows have also been reported by Anand Reddy *et al.*; Singh; and Pal and Ram 1971. Growing intercrops between the pairs of base crops was found to be feasible, with significantly increased returns in both seasons and crops. Gross returns increased by 75.8, 38.5, 31.5 and 24.5% with sarson, wheat, safflower and groundnut as intercrops respectively in a base crop of corn during winter (Table 1), but soyabean and sesame reduced gross returns by 15.7 and 22.3% respectively. Intercropping soyabean in corn reduced the gross returns, due to low yields of both crops, and sesame failed to make any growth as an intercrop. Singh *et al.* (1973) have also reported similar results.

The yield levels of legumes other than groundnut were low, which may have been due to using genotypes of low yield potential, with reduced plant populations and shorter durations. These legumes might also have competed with the base crop for light and water at earlier stages due to their profuse vegetative growth, unlike the longer duration groundnut. Moreover, the short-statured groundnut may have offered least competition compared to other legumes.

The increase in gross returns was highest with a groundnut intercrop where either corn (56%) or sorghum (75%) was the base crop (Table 2). Even cereals as intercrops increased gross returns by 6-8% in corn and 24-25% in sorghum, whereas sunflower recorded an increase of 18 and 15% with corn and sorghum as base crops respectively. Other legumes increased gross returns by 3.5-7.5% in corn and 32-54% in sorghum compared to normal planting.

It is clear that sarson was a profitable intercrop in corn (winter), as is commonly practiced in northern parts of India, but it is not popular in Andhra Pradesh, where it needs further testing before final recommendation. From the results of both seasons and crops it is clear that an intercrop of groundnut can increase farm returns, with only a marginal decrease in base crop yields, a practice which needs to be popularized in AP.

The following inferences can be drawn from these results and discussion: (1) Paired row planting in deep furrows (rafter method) has advantages over conventional equidistant planting at the same level of plant population of base crop; (2) It is feasible to introduce an intercrop between pairs of rows, but

choice of the intercrop is an important factor for higher returns, and (3) Intercropping in a paired-row system helps to increase the economic returns per unit area and time, besides making better use of available resources in semi-arid tropics.

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