

Yield advantage of wheat (*Triticum aestivum*) and chickpea (*Cicer arietinum*) under different spatial arrangements in intercropping

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ABSTRACT

A 2-year experiment on 8 wheat (*Triticum aestivum* L. emend. Fiori & Paol.)–chickpea (*Cicer arietinum* L.)-based intercropping systems resulted in the highest yield advantage at 4 : 2 sowing ratio of wheat and chickpea. However, sole crops of wheat and chickpea resulted in the highest grain or seed yields. Wheat equivalence, gross return, net return (Rs/ha), net return (Rs/ha/day), net return/rupee invested, land-equivalent ratio, monetary advantage, relative net return, area-time equivalent ratio, relative value total were recorded highest at 4 : 2 sowing ratio of wheat and chickpea.

Intercropping provides profit-oriented and subsistence-oriented requirements from the same piece of land. A possible way of increasing productivity on farms with low crop yields per unit area, and limited resources could be through intercropping. Hence an experiment was conducted at Kalyani to study the yield of wheat (*Triticum aestivum* L. emend. Fiori & Paol.) and chickpea (*Cicer arietinum* L.) as influenced by intercropping and to analyse the intercropping advantages when raised at various proportions.

MATERIALS AND METHODS

The investigation was conducted from 1988–89 to 1989–90 at Kalyani (9.75 m above mean sea-level, 23°N latitude and 89°E longitude) on sandy-loam soil having 0.038% N, 15.97 kg available P/ha, 81.10

kg available kg/ha and pH 8.1. There were 8 treatment combinations in randomized block design having 3 replications. The treatments were : sole wheat (W), sole chickpea (CP), wheat + chickpea at 1 : 1 proportion, W + CP at 4 : 2 proportion, W + CP at 3 : 1 proportion, W + CP at 2 : 2 proportion, W + CP at 4 : 2, and W + CP at 6 : 2 proportion. The seeds of 'Sonalika' wheat and 'Mahamaya I' chickpea were sown in rows at 20 cm apart. The seed rates of 120 kg and 75 kg/ha were used for sole wheat and sole chickpea respectively. For intercrop situations 60 kg wheat/ha and 37.5 kg chickpea/ha were used for wheat + chickpea in 1 : 1 and 2 : 2 ratios, 80 kg wheat and 25 kg chickpea were used for W + CP in 2 : 1 and 4 : 2 ratios and 90 kg wheat and 18.8 kg chickpea/ha were used in W + CP in 3 : 1 and 6 : 2 ratios. The dates of sowing were: 3

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Table 1. Growth period of the crops in pure and mixed stands

Crop	Days to maturity	
	1988-89	1989-90
Sole wheat	115	115
Sole chickpea	132	131
Wheat with chickpea	115	117
Chickpea with wheat	120	117

December 1988 and 26 November 1989 in 2 years. A dose of 50 kg N, 17.5 kg P and 33.2 kg K/ha was applied to sole wheat, while to sole chickpea it was 20 kg N and 17.5 kg P/ha. In intercropped stand, the respective fertilizer dose was applied to the rows of component crops. Urea, single superphosphate and muriate of potash were the sources of N, P and K respectively. The gross plot size was 15 m². The growth period of different crops under pure and mixed stand is given in Table 1.

The land-equivalent ratio (LER), effective LER, monetary advantage, relative net return (RNR), area-time equivalent ratio (ATER) and relative value total (RVT) were calculated as per Willey and Osiru (1972), Mead and Willey (1980), Willey (1979), Jain and Rao (1980), Hiebsch (1980) and Schultz *et al.* (1982) respectively.

RESULTS AND DISCUSSION

The grain yield of sole wheat (3,163 kg/ha) was significantly higher than those of different row combinations of wheat + chickpea due to the difference in effective tillers/m². The yield of wheat was significantly higher among the intercrops when grown at 6 : 2 row ratio (wheat + chickpea) during 1989-90; however, during 1988-89 only an increasing trend was noted compared with 3 : 1 (Table 2).

The sole chickpea gave rise to the highest seed yield (1,300 kg/ha) in comparison with the other treatments. Among the 6 proportions, the highest seed yield was recorded when it was tried in alternate row arrangement (1 : 1) with wheat. This yield was statistically at par with paired-row sowing (2 : 2). In some of the ratios, the seed yield of chickpea was lowered due to smothering effect of wheat (the tall statured component).

When the actual yield of wheat under different proportions were compared with the expected yields, the yield obtained with 4 : 2 ratio was higher than any other intercropping systems as well as sole one. Here both temporal and spatial complementary relationships developed. Besides, chickpea being short-statured, offered less competition to wheat. This result confirms the findings of Mandal *et al.* (1986).

Wheat equivalence

It was apparent that sole chickpea during first year while wheat + chickpea intercropping at 4 : 2 ratio during second

Table 2. Yield of wheat and chickpea as influenced by the intercropping systems

Treatment	Yield (kg/ha)			
	Wheat (W)		Chickpea (CP)	
	1988-89	1989-90	1988-89	1989-90
Sole	3,086	3,239		
W + CP (1 : 1)	1,488	1,285	750	706
W + CP (2 : 1)	2,166	2,349	444	427
W + CP (3 : 1)	2,365	2,531	325	303
W + CP (2 : 2)	1,630	1,469	733	699
W + CP (4 : 2)	2,277	2,343	472	454
W + CP (6 : 2)	2,424	2,687	328	315
Sole chickpea			1,383	1,217
LSD (P = 0.05)	76	38	61	55

Table 3. Wheat equivalence, seed yield/ha/day and gross return as influenced by the intercropping systems

Treatment	Wheat equivalence (kg/ha)		Seed yield (kg/ha/day)		Gross return (Rs/ha)	
	1988-89	1989-90	1988-89	1989-90	1988-89	1989-90
Sole wheat	3,086	3,239	26.8	28.5	7,715	8,097
Wheat + chickpea (1 : 1)	3,513	3,262	18.6	17.0	8,783	8,153
Wheat + chickpea (2 : 1)	3,365	3,545	22.2	24.0	8,412	8,861
Wheat + chickpea (3 : 1)	3,344	3,379	23.3	23.7	8,359	8,447
Wheat + chickpea (2 : 2)	3,612	3,428	19.7	18.6	9,036	8,569
Wheat + chickpea (4 : 2)	3,551	3,614	23.4	24.2	8,879	9,034
Wheat + chickpea (6 : 2)	3,310	3,569	23.6	26.0	8,274	8,923
Sole chickpea	3,734	3,409	10.5	9.2	9,335	8,509
LSD (P = 0.05)	189	245	3.85	1.67	345	613

Table 4. Net return (Rs/ha), net return (Rs/ha/day) and net return/rupee invested as influenced by the intercropping systems

Treatment	Net return (Rs/ha)		Net return (Rs/ha/day)		Net return/ rupee invested	
	1988-89	1989-90	1988-89	1989-90	1988-89	1989-90
Sole wheat	3,690	4,072	32.08	35.41	0.91	1.10
Wheat (W) + chickpea (CP) (1 : 1)	4,383	3,754	38.10	31.28	0.99	0.85
Wheat (W) + chickpea (CP) (2 : 1)	4,062	4,511	35.32	37.59	0.93	1.03
Wheat (W) + chickpea (CP) (3 : 1)	4,229	4,318	36.77	35.98	0.92	1.04
Wheat (W) + chickpea (CP) (2 : 2)	4,480	4,013	38.95	33.45	0.98	0.88
Wheat (W) + chickpea (CP) (4 : 2)	4,649	4,805	40.42	40.04	1.09	1.13
Wheat (W) + chickpea (CP) (6 : 2)	3,984	4,633	34.64	38.61	0.92	1.08
Sole chickpea	4,865	4,039	36.85	30.60	1.08	0.90
LSD (P = 0.05)	210	612	3.79	5.07	NS	0.15

Cost of cultivation of sole wheat, Rs 4,025; W + CP (1 : 1), Rs 4,400; W + CP (2 : 1), Rs 4,350; W + CP (3 : 1), Rs 4,130; W + CP (2 : 2), Rs 4,556; W + CP (4 : 2), Rs 4,230; W + CP (6 : 2), Rs 4,290; and sole chickpea, Rs 4,470/ha

NS, Not significant

year gave rise to the highest values (Table 3). However, all the intercropping systems resulted in better performance with regard to wheat equivalence compared with the sole crop of wheat.

Gross return

The highest gross return was achieved from the sole crop of chickpea and wheat + chickpea at 4 : 2 proportion during 1988-89 and 1989-90 respectively (Table 3). Higher

gross return was always achieved in intercropping systems of wheat + chickpea compared with sole wheat.

Net return

Similar to gross return, the highest net return/ha was obtained from sole chickpea and wheat + chickpea intercropping at 4 : 2 sowing ratio during 1988–89 and 1989–90 respectively. But there was no significant difference among the treatments during 1988–89 when net return/rupee invested was taken into consideration. During 1989–90 wheat + chickpea at 4 : 2 sowing ratio recorded the highest net return/rupee of investment (Table 4).

Land-equivalent ratio (LER)

The highest value of LER was recorded when the ratio of sowing wheat and chickpea was 4 : 2 during both the years. On an average, yield advantage up to 9% was achieved from this system as compared to monocultures. However, alternate row arrangement was not consistently advantageous over monocultures (Table 5).

The highest value of effective LER (mean of 2 years) revealed that 4 : 2 proportion of sowing wheat and chickpea were advantageous (Table 5).

Monetary advantage

The highest amount of monetary advan-

Table 5. Land-equivalent ratio (LER) and effective LER as influenced by the intercropping system

Treatment (wheat + chickpea)	LER		Effective LER			
	1988–89	1989–90	Wheat		Chickpea	
			1988–89	1989–90	1988–89	1989–90
1 : 1	1.024	0.977	1.046	0.98	1.025	0.97
2 : 1	1.022	1.076	1.023	1.07	1.021	1.07
3 : 1	1.028	1.030	1.027	1.03	1.028	1.03
2 : 2	1.058	1.028	1.057	1.01	1.058	1.01
4 : 2	1.079	1.096	1.080	1.07	1.075	1.08
6 : 2	1.022	1.089	1.024	1.09	1.028	1.08

Table 6. Monetary advantage (Rs), relative net return, area-time equivalent ratio and relative value total as influenced by intercropping systems

Treatment (wheat + chickpea)	Monetary advantage (Rs)		Relative net return		Area-time equivalent ratio		Relative value total	
	1988–89	1989–90	1988–89	1989–90	1988–89	1989–90	1988–89	1989–90
1 : 1	265.58		1.08	0.96	1.058	0.960	1.138	1.007
2 : 1	181.08	579.69	1.03	1.05	1.024	1.046	1.093	1.094
3 : 1	227.68	246.02	1.03	1.03	1.022	0.997	1.083	1.043
2 : 2	494.63	249.58	1.11	0.99	1.089	1.009	1.169	1.058
4 : 2	650.04	812.27	1.09	1.09	1.081	1.066	1.150	1.115
6 : 2	178.00	736.76	1.02	1.07	1.012	1.054	1.075	1.102

tage was achieved with wheat + chickpea intercropping at 4 : 2 sowing ratio during both the years of experimentation. However, all the intercropping systems sown at 1 : 1 row ratio in 1989-90, gave rise to monetary advantage. Monetary advantage was obtained because of LER having more than unity (Table 6).

Relative net return

Similar to monetary advantage, the value of RNR was always above 1 except at 1 : 1 and 2 : 2 sowing ratios during 1989-90. On an average wheat + chickpea intercropping system with 4 : 2 sowing ratio recorded the highest value (Table 6).

Area-time equivalent ratio

From the view point of ATER which took the duration of the crops into consideration, wheat + chickpea at 4 : 2 sowing ratio yielded the highest average value. By and large, all the intercropping systems of wheat + chickpea except at 1 : 1 and 3 : 1 sowing ratios in 1989-90 resulted in ATER value more than 1 (Table 6).

Relative value total (RVT)

The data on RVT indicated that all the intercropping systems became advantageous. However, when the mean of RVT values for both the years were considered,

wheat + chickpea intercropping at 4 : 2 sowing ratio was most advantageous (Table 6).

Thus it can be concluded that an intercropping of wheat + chickpea at 4 : 2 sowing is most advantageous.

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