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Productivity of wheat (*Triticum aestivum*)-based intercropping systems under limited irrigation

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ABSTRACT

A field study was conducted during the winter seasons of 1987–88 and 1988–89 at Ranchi, to evaluate the suitability and benefits of intercropping of wheat (*Triticum aestivum* L. emend. Fiori & Paol.) with mustard [*Brassica juncea* (L.) Czernj. & Cosson], safflower (*Carthamus tinctorius* L.), linseed (*Linum usitatissimium* L.) and chickpea (*Cicer arietinum* L.) and lentil (*Lens culinaris* Medikus) under limited irrigation on a sandy-loam soil. Intercropping of wheat + lentil (4 : 2 row ratio) gave the maximum total grain yield, wheat-equivalent yield, energy output, protein yield, water-use efficiency, net return and net benefits. Wheat + mustard (8 : 2 row ratio) intercropping system was the next best one with higher wheat equivalent, energy output, net return and net benefits.

There is an urgent need to boost the production of grain legumes and oilseeds. However, under existing situation horizontal expansion of area by replacing wheat (*Triticum aestivum* L. emend. Fiori & Paol.), with grain legumes or oilseeds is not possible owing to high yield potential of dwarf wheat even under limited availability of irrigation and fertilizer. Under such conditions, intercropping of grain legumes and oilseeds with wheat can meet the national requirements of wheat, grain legumes and edible oilseeds. Therefore, an experiment was undertaken to evaluate the compatibility of different grain legumes and oilseeds with wheat under limited irrigation for overall efficiency in resource utilization and yield advantage.

MATERIALS AND METHODS

The field experiment was conducted in randomized block design replicated 4 times, with 6 cropping systems consisting of (*i*) sole wheat (*ii*) wheat + mustard [*Brassica juncea* (L.) Czernj. & Cosson] (8 : 2 row ratio), (*iii*) wheat + safflower (*Carthamus tinctorius* L.) (4 : 2 row ratio), (*iv*) wheat + linseed (*Linum usitatissimum* L.) (4 : 2 row ratio), (*v*) wheat + chickpea (*Cicer arietinum* L.) (4 : 2 row ratio) and (*vi*) wheat + lentil (*Lens culinaris* Medikus) (4 : 2 row ratio) at Ranchi during the winter seasons of 1987–88 and 1988–89. The soil was loam, having organic carbon 0.45%, available P 8.7 kg/ha, available K 128 kg/ha, with pH 5.8. The intercrop systems were in additive series. The varieties used were 'UP 262', 'Varuna', 'A 300', 'T 397', 'H 208' and 'BR 25' of wheat, mustard, safflower, linseed, chickpea and lentil respectively. Seed rate of 100, 10, 20, 20, 75 and 25 kg/ha was used for wheat, mustard, safflower, linseed, chickpea and lentil respectively. Wheat was sown on 18 November during both the years

Table 1. Effect of intercropping of oilseeds and grain legumes with wheat on grain yield, wheat equivalent, energy output, protein yield, N and P uptake, season water use and water-use efficiency (mean of 2 years)

Intercropping system	Grain yield (q/ha)			Wheat equivalent (q/ha)	Energy output (MJ/ha)			Protein yield (kg/ha)	N uptake (kg/ha)	P uptake (kg/ha)	Seasonal water use (mm)	WUE (kg grain/ ha/mm water use)
	Wheat	Inter-crop	System		Wheat	Inter-crop	System					
Wheat alone	16.88		16.88	16.88	24,811		24,811	184.80	41.10	8.20	257.31	6.56
Wheat + mustard	13.58	2.85	16.43	21.35	19,967	8,137	28,104	216.39	52.18	9.10	336.91	4.88
Wheat + safflower	12.89	2.05	14.94	15.22	18,937	5,128	24,065	178.81	47.67	7.28	330.61	4.52
Wheat + linseed	11.89	2.48	14.37	16.40	17,537	6,181	23,718	185.55	47.66	7.55	290.05	4.95
Wheat + chickpea	15.35	2.66	18.01	20.18	22,562	3,915	26,478	239.61	56.45	9.96	279.15	6.45
Wheat + lentil	15.66	4.62	20.28	24.06	22,566	6,785	29,802	279.24	67.34	11.14	282.35	7.18
CD (P = 0.05)	2.22			2.50	3,214		3,265	30.97	6.60	1.60	59.22	1.24

WUE, Water-use efficiency

in rows 23 cm apart, whereas safflower, linseed, chickpea and lentil 30 cm apart and mustard at 45 cm. Wheat alone and with intercrops received 60 kg N and 12 kg P/ha, and only 2 irrigations (1 each at crown-root-initiation and boot stages of wheat crop) apart from 116 mm rainfall during first year and 85 mm during second year. The distribution of rainfall was more favourable for crop growth during the first year. The mean daily air temperature varied from 13.9 to 26.9°C in first year and 12.9 to 25.2°C in second year. To evaluate the productivity of intercropping systems wheat-equivalent yield, energy output, protein yield, net return and benefit : cost ratio were calculated.

RESULTS AND DISCUSSION

Grain yield

Intercropping of wheat and lentil generated a bonus yield, that of wheat and chickpea gave an additional yield without any significant reduction in wheat yield (Table 1). The yield advantage was because of complementary relationship between wheat and grain legumes when grown in association (Mandal *et al.*, 1986). However on the basis of wheat-equivalent, wheat obtained for mustard not only compensated the yield loss of wheat but also showed significant improvement in the productivity of wheat + mustard intercropping system, owing to high market value of the mustard.

Energy output

Intercropping of wheat with grain legumes did not affect the energy productivity of wheat (Table 1). Among the intercropping systems, wheat + lentil and wheat + mustard gave 20 and 30% respectively more energy output than wheat alone. Significant improvement in energy productivity under wheat + lentil was because of more total grain production and that under wheat + mustard intercrop system was owing to much higher energy density within a unit mass of mustard compared to wheat and grain legumes.

Protein yield and N and P uptake

Intercropping system of wheat with grain legumes also gave 40 and 34% more protein yield than wheat alone and wheat + oilseeds (Table 2). Intercropping systems removed significantly more N than that of wheat alone owing to differential rooting pattern of component crops as well as high root density per unit soil volume, which exploited different soil layers resulting more efficient utilization of N from soil when grown together (Trenbath, 1974). Wheat + grain legumes absorbed 32% more P than that of wheat + oilseeds, owing to higher requirement of P by legume component. Wheat + lentil removed the maximum P.

Water use

Seasonal consumptive water use of wheat + mustard or safflower system was

Table 2. Effect of intercropping oilseeds and grain legumes with wheat, on net return and benefit: cost ratio (mean of 2 years)

Intercropping system	Cost of cultivation (Rs/ha)	Net return (Rs/ha)	Benefit : cost ratio
Wheat alone	2,402	1,856	0.77
Wheat + mustard	2,477	2,796	1.12
Wheat + safflower	2,326	1,345	0.55
Wheat + linseed	2,446	1,586	0.65
Wheat + chickpea	2,649	2,346	0.88
Wheat + linseed	2,472	3,499	1.42
CD (P = 0.05)		559.5	0.22

significantly more than that of wheat alone (257.3 mm), owing to higher transpiration demand of mustard and longer duration of safflower. Wheat + grain legumes or linseed could not show marked variation compared with wheat alone. In terms of water-use efficiency, intercropping of wheat + grain legumes enhanced the productivity of water compared with wheat + oilseeds. Intercrop system of wheat + lentil gave the maximum water-use efficiency of 7.18 kg grain/ha/mm water use.

Production economics

Wheat + lentil gave the highest net return and net benefit (Table 2), followed by wheat + mustard with 51 and 45% respectively more than that of wheat alone.

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