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Energetics and productivity of lentil (*Lens culinaris*) + safflower (*Carthamus tinctorius*) intercropping at varying plant density

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ABSTRACT

A field experiment conducted during the post-rainy season (October–March) of 1991–92 and 1992–93 showed minimum reduction in seed yield of lentil (*Lens culinaris* Medikus) and safflower (*Carthamus tinctorius* L.) in replacement series as compared to additive one. Intercropping of 67% lentil + 33% safflower (2 : 1 row ratio), 75% lentil + 25% safflower (3 : 1 row ratio) produced higher lentil equivalent, energy output, energy productivity, land-equivalent ratio, monetary advantage, net return and benefit : cost ratio.

Safflower (*Carthamus tinctorius* L.) and lentil (*Lens culinaris* Medikus) perform better on residual soil moisture in post-rainy season because of deep root-system and relatively less water requirement than winter cereals under plateau region of Bihar. However, probability of crop failure is generally high owing to frequent occurrence of aberrant weather conditions which further depletes the receding soil moisture. Under such conditions intercropping can be not only profitable but more dependable than sole cropping. In intercrop system if one component crop fails, the other gives some yield and thus minimizes the risk of total crop failure and stabilizes the production to some extent. Hence an experiment was conducted to find out suitable plant density of lentil + safflower intercropping on residual soil moisture.

MATERIALS AND METHODS

The field experiment was conducted in randomized block design, replicated 4 times at the Birsa Agricultural University Farm, Ranchi, during the post-rainy seasons of 1991–92 and 1992–93. The treatment consisted 9 combinations of lentil + safflower intercropping along with their respective sole cropping (Table 1). The first 6 intercrop systems were in additive series, whereas remaining 3 in replacement series. The soil was silty loam, acidic in reaction (pH 5.8), low in available N (212 kg/ha) and medium in available P (10.8 kg/ha) and K (207 kg/ha). It was capable of storing 195 mm available soil water in the top 1 m soil layer. Cultivar used for lentil and safflower were 'BR 25' and 'A 300' respectively. Seed rate for sole cropping of both crops was 20 kg/ha with row-to-row spacing of 30 cm. Crops were sown on 15 November 1991 and 19 November 1992. Lentil alone and intercropped with safflower received 20 kg N/ha and 40 kg P_2O_5/ha, whereas sole safflower received 20 kg/ha each of N, P_2O_5

and K_2O. The crop received 60.7 and 96.8 mm rainfall in 7 and 9 rainy days during first and second year respectively. To evaluate the efficiency of intercropping systems pooled lentil equivalent, land-equivalent ratio, energy output, energy productivity, net return, benefit : cost ratio and monetary advantage were calculated as there was no seasonal variability.

RESULTS AND DISCUSSION

Grain yield

Grain yield of intercropped lentil and safflower reduced as compared with their sole cropping (Table 1). The extent of reduction was more in additive series than in replacement series and the magnitude of reduction in lentil and safflower was 34.2 and 55.6% under additive and 32.3 and 39.2% under replacement series respectively. Better performance of component crops under replacement series may be ascribed to relatively less competition for underground resources, particularly for water as the crops grew on receding soil moisture. In replacement series of intercropping increase in population of the crop resulted in higher yields which clearly indicate the compensatory relationship. However, in additive series increase in row ratio resulted in the improvement in productivity of lentil crop owing to relatively reduced intra-row competition. Consequently, superimposition of safflower resulted in poor productivity of the intercrop systems as a whole, except 100% lentil + 25% safflower (3 : 1 row ratio) where competition was minimum. Further intercropping of 67% lentil + 33% safflower (2 : 1 row ratio) and 75% lentil + 25% safflower (3 : 1 row ratio) and 100% lentil + 25% safflower (3 : 1 row ratio) gave significantly higher lentil equivalent 921.0, 918.0 and 917.9 kg/ha respectively than

Table 1. Grain yield, lentil equivalent and energetics of lentil + safflower intercropping with varying plant density (mean data of 2 years)

Plant density	Row ratio	Grain yield (kg/ha)		Lentil equivalent (kg/ha)	Energy output (MJ/ha)		Energy productivity (g lentil equivalent/MJ)
		Lentil	Safflower		Gross	Net	
100% L + 25% S	(2 : 1)	377.8	487.7	662.2	17,995	13,934	163
100% L + 50% S	(2 : 1)	512.2	607.6	859.4	22,719	18,533	205
100% L + 25% S	(3 : 1)	560.8	625.0	917.9	23,867	19,828	227
100% L + 50% S	(3 : 1)	441.0	416.7	679.1	16,899	12,735	163
100% L + 25% S	(5 : 1)	642.4	428.3	887.1	20,249	15,986	221
100% L + 50% S	(5 : 1)	534.7	312.5	713.3	15,672	11,656	172
67% L + 33% S	(2 : 1)	504.3	729.2	921.0	25,643	21,638	230
75% L + 25% S	(3 : 1)	527.8	682.9	918.0	24,830	20,864	232
83% L + 17% S	(5 : 1)	548.6	555.5	866.1	21,953	18,027	220
Sole lentil		776.7		776.7	11,418	7,548	201
Sole safflower			1,079.6	616.9	26,991	22,820	148
CD (P = 0.05)				131.0	4,672	3,643	25

L, Lentil; S, safflower

Table 2. Land-equivalent ratio (LER), monetary advantage and economics of lentil + safflower intercropping with varying plant density (mean data of 2 years)

Plant density	Row ratio	LER	Monetary advantage (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	Benefit : cost ratio
100% L + 25% S	(2 : 1)	0.95	—242	4,525	1,845	1.68
100% L + 50% S	(2 : 1)	1.22	1,085	6,016	3,276	2.19
100% L + 25% S	(3 : 1)	1.30	1,483	6,425	3,787	2.43
100% L + 50% S	(3 : 1)	0.96	−198	4,754	2,056	1.76
100% L + 25% S	(5 : 1)	1.23	1,161	6,210	3,614	2.39
100% L + 50% S	(5 : 1)	0.98	—102	4,993	2,337	1.88
67% L + 33% S	(2 : 1)	1.33	1,600	6,447	3,847	2.48
75% L + 25% S	(3 : 1)	1.31	1,521	6,426	3,863	2.51
83% L + 17% S	(5 : 1)	1.22	1,093	6,063	3,537	2.400
Sole lentil		1.00		5,437	2,943	2.18
Sole safflower		1.00		4,319	1,709	1.65
CD (P = 0.05)		0.20			495	0.19

either of the sole crop. This confirms the findings of Wiley and Rao (1980).

Energetics

All the intercropping systems produced significantly higher energy than sole cropping of lentil, except 100% lentil + 50% safflower (5 : 1 row ratio). However, increase of 187, 176 and 163% in net energy output was noted with intercropping of 67% lentil + 33% safflower (2 : 1 row ratio), 75% lentil + 25% safflower (3 : 1 row ratio) and 100% lentil + 25% safflower (3 : 1 row ratio) respectively. Although energy production of these systems was similar that of sole safflower but had an edge as it provides balance domestic energy need through lentil, a grain legume, and safflower. In terms of energy productivity, 67% lentil + 33% safflower (2 : 1 row ratio) and 75% lentil + 25% safflower (3 : 1 row ratio) intercropping gave significantly higher productivity of 230 and 232 g lentil equivalent/MJ than sole lentil (201 g lentil/MJ) and safflower (148 g lentil equivalent/MJ) in our study.

Economics

Based on land-equivalent ratio (LER) 67% lentil + 33% safflower (2 : 1 row ratio), 75% lentil + 25% safflower (3 : 1 row ratio) and 100% lentil + 25% safflower (3 : 1 row ratio) intercropping systems were respectively 33, 31 and 30% more productive than sole cropping which consequently resulted inmonetary advantage of Rs 1,600, Rs 1,521 and Rs 1,483/ha (Table 2). Similarly, these systems gave remunerative net returns of Rs 3,847, Rs 3,863 and Rs 3,787/ha with benefit : cost ratios of 2.48, 2.51 and 2.43 respectively. This confirms the findings of Chetty (1983).

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