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Short Note

Economical viability of linseed based intercropping systems

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Abstract

Study was conducted at Palampur for three continuous rabi seasons to find out the economic viability of linseed based intercropping associations. Pooled data revealed that sowing of wheat with linseed either at 2:2, 6:4 or 4:4 row ratio resulted in significantly higher linseed equivalent yield as compared to sole linseed or wheat. Sowing of wheat with linseed in any of the row ratio (*i.e.* 2:2, 4:4 and 6:4) was statistically similar to sowing of linseed as pure crop in achieving significantly higher net returns and B:C ratio over rest of the treatments. Linseed with lentil in 6:4 row ratio and sowing of wheat as pure crop were also at par for net returns. Higher values of production and economic efficiencies were obtained with wheat: linseed intercropping either at 4:4 or 6:4 followed by sole linseed. Economic parameters like relative & additional profit and profit equivalent ratio were more in wheat: linseed at 4:4, 6:4 and 2:2 row ratios as compared to conventional practice of sowing sole crop of wheat with the amount equivalent to raise sole wheat by respective intercropping practices. The sole cropping of linseed was equally good as compared to sole wheat on same area.

Key words: Productivity, economics, intercropping, linseed, wheat, lentil.

There is urgent demand to increase total production and productivity of pulses and oilseed crops. The scope for increasing area under these crops is limited particularly in rabi season where these crops face a serious competition from high yielding cereals with significantly negative impact due to price and yield risk. Where the possibility of bringing more area under cultivation is limited, intercropping offers a possible solution to raise productivity through temporal intensification. Intercropping is the practice of cultivating two or more crops in the same field at the same time for increasing crop production/per unit area/time (Bajwa *et al.* 1992) by making more efficient use of the available growth resources. The selected crops must be of different rooting ability, canopy structure, height and nutrient requirements based on the complementary utilization of growth resources by the component crops. Inclusion of legumes in intercropping improves soil fertility through biological nitrogen fixation, helps in residual nutrient build up of the soil, increases soil conservation through greater ground cover than sole cropping and provides better lodging resistance for crops susceptible to lodging than when grown in monoculture. Intercrops often reduce pest incidence and improve quality of crop produce. Damage to the pest particularly diseases can also be minimized through intercropping (Wagh *et al.* 2011).

Intercropping provides insurance against crop failure or against unstable market prices for a given commodity, especially in areas subject to extreme weather conditions such as frost, drought and flood. Thus, it offers greater financial stability than sole cropping, which makes the system particularly suitable for labour-intensive small farms (Kurata 1986). Intercropping allows lower inputs through reduced fertilizer and pesticide requirements, thus minimizing environmental impacts of agriculture and helps the farmers in getting better returns by reducing the cost of cultivation.

There is a need to generate information regarding the appropriate proportion of the component crops for enhanced bioeconomic efficiency of different intercropping associations involving oilseed (linseed) with pulses (chickpea or lentil) and cereals (wheat). The present study was, therefore, designed to compare the biological efficiency and economics of different linseed based intercropping association under different geometrical patterns in irrigated environment.

The present study was carried out for three continuous rabi seasons of 2005-06 to 2007-08 at the experimental farm of CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur. The experiment was conducted in Randomized Block Design with 13 treatments comprising of three intercropping associations *viz.* wheat + linseed, linseed + gram and linseed + lentil each at 2:2, 4:4 and 6:4 row arrangements in replacement series and sole crop of wheat, linseed, lentil and gram in three replications (Table 1). The soil of the experiment site was silty clay loam in texture with pH 5.9 and medium available nitrogen, phosphorus and potassium. A seed rate of 100, 40, 45 and 25 kg/ha was used for sowing of wheat, linseed, gram and lentil as pure and intercrop as per area covered. Row to row distance of 25 cm was maintained for raising different crops. The each component crop was fertilized separately as per recommendations for individual crop on area basis. After maturity, the each component crop was harvested from the net plot area and the seed yield obtained was expressed in kg/ha. The yield of the component crops and other pure crops was expressed on linseed equivalent basis. In order to work out the most profitable treatment, the economics of each treatment was worked out on the basis of prevalent market prices of the inputs and output.

The yield of the crop was converted to rupees based on the prevailing market prices of seed to obtain treatment-wise gross return. Net return was obtained by subtracting the cost of cultivation from gross return for a particular treatment. B:C ratio was obtained by dividing net returns with the treatment-wise cost of cultivation. Production and economic efficiencies were calculated by dividing yield and net monitory return by total duration of crops, respectively, in a particular system. Area Equivalent Ratio (AER) was obtained by dividing cost of cultivation of conventional crop (wheat) over cost of cultivation of alternative cropping practice. Relative Profit (INR/ha) was equal to AER x net returns (INR/ha). Additional Profit was worked out by dividing relative profit of alternative cropping practice - net returns of conventional crop (wheat) raised. Profit Equivalent Ratio (PER) was obtained by dividing relative profit (INR/ha) with the net return of conventional crop raised.

The data presented in Table 1 revealed that sowing of wheat with linseed either at 6:4 or 4:4 row ratio being at par with sole linseed had significantly higher linseed equivalent yield during 2005-06 and 2006-07. In the last year, sowing of linseed as pure crop being at par with sowing of wheat: linseed at 4:4 was proved to be the next best. Same trend was followed in pooled data, however, sowing of wheat as pure crop and wheat with linseed in 2:2 row ratio were also at par to these above mentioned intercropping associations for linseed equivalent yield. On pooled basis, sowing of wheat with linseed in 6:4 and 4:4 row arrangement gave 3.75 and 2.91% yield advantage over sowing of linseed as pure crop, while, it was 18.29 and 17.33 over sole wheat crop. Intercropping of linseed with wheat had not significantly affected grain and straw yield of wheat. This may be due to plasticity of wheat (Prakash *et al.* 1986). Nazir *et al.* (2006) and Singh *et al.* (1989) have also obtained yield advantage in wheat and linseed intercropping system.

The production efficiency was highest (61.3%) under wheat + linseed at 4:4 row ratio followed by wheat + linseed at 6:4 and 2:2 with 57.3 and 51.2% production efficiency, respectively. Among sole crops, linseed had maximum production efficiency (57.5%) followed by wheat (36.7%). While the other intercropping associations had low production efficiencies (Table 3).

Intercropping of wheat with linseed either in 4:4 or 6:4 row ratios being at par with each other have significantly higher net returns during first and third year of experimentation. Sowing of linseed as sole crop surpassed these two statistically alike treatments during the second year and was at par to these treatments during third year of experimentation. This was evident in the pooled data presented in Table 2 that the sowing of wheat with linseed at any of the row ratio (i.e. 2:2, 4:4 and 6:4) and linseed with lentil in 6:4 row ratio behaved statistically similar to sowing of wheat as pure crop for net returns. According to Hiremath *et al*. (1990), wheat + linseed intercropping in the ratio of 3:1 had highest net income/ha.

Significantly higher B:C ratio was recorded with sowing of linseed as pure crop during the second and third years. However, during first year, sowing of wheat with linseed either at 2:2 or 4:4 row proportions were proved to be significantly better over rest of the treatments, which were at par with sole linseed during third year and were the next best along with sowing of wheat with linseed at 6:4 row ratio during second year. Sowing of wheat with linseed in 6:4 row proportion was the other best combination during the first and third year. Pooled data presented in Table 1 revealed that sowing of linseed as pure crop being at par with sowing of wheat with linseed in any of the row ratios (*i.e.* 2:2, 4:4 and 6:4) had significantly higher B:C ratio over rest of the treatments. Billare *et al.* (1992) also proved wheat + linseed as economical viable intercropping system. Similarly, Pridham

Table 1. Linseed equivalent yield (kg/ha) as influenced by different treatments

Treatment	Linseed equivalent yield (kg/ha)			
	1st year	2nd year	3rd year	Pooled
Wheat+Linseed 2:2	977	883	985	948
Wheat+Linseed 4:4	1153	1014	1125	1097
Wheat+Linseed 6:4	1109	1027	1181	1106
Linseed+Gram 2:2	449	500	411	453
Linseed+Gram 4:4	495	612	669	592
Linseed+Gram 6:4	518	743	688	650
Linseed+Lentil 2:2	816	193	852	620
Linseed+Lentil 4:4	864	239	925	676
Linseed+Lentil 6:4	985	301	974	753
Sole Linseed	1084	1048	1065	1066
Sole Wheat	1005	834	967	935
Sole Gram	724	593	533	617
Sole Lentil	301	433	361	365
CD (P=0.05)	96	61	93	296

and Martin (2005) demonstrated the possibility for intercrops to perform comparably and even out yielding wheat monocultures and economically profitable and more sustainable alternatives.

An analysis of data presented in Table 3 revealed that a farmer cultivating sole wheat in one ha with cultivating cost of INR 12100 when switches to alternative wheat:linseed at row ratios of 4:4, 2:2 and 6:4 can cultivate 16, 30 and 7% more area with the same amount. This was inferred from AER values of 1.16, 1.30 and 1.07 under wheat + linseed, at 4:4, 2:2 and 6:4 row ratios, respectively. Consequently relative profit under these alternate practices was increased by INR 13375 to 11495 over INR 6611/ha that under sole wheat. The respective additional profit was also higher by INR 6764, 5863 and 4884/ha/annum, respectively, under wheat + linseed at 4:4, 2:2 and 6:4 row ratios. Their cultivation in 1.16, 1.30 and 1.07 ha gave 2.02, 1.89 and 1.74 times, respectively, higher profit than cultivation of sole wheat in one ha. Among sole crops, cultivation of linseed on 1.16 ha resulted in relative and additional profit of INR 12719 and 6108/ha, respectively with profit equivalent ratio of 1.92. The economic efficiency achieved with wheat: linseed at 6:4 was highest (5.88%) and closely followed by its 4:4 and 2:2 row proportions with efficiency of 5.84 and 5.04%, respectively. Among sole crops, linseed alone had economic efficiency of 5.61 followed by wheat alone (5.19%).

Thus among different intercropping association intercropping of linseed with wheat at 4:4, 2:2 and 6:4 is economical viable option which are comparable to sole linseed cropping as compared to sole wheat. The other intercropping associations along with cropping of other sole crops were not economical viable.

Table 2. Effect of treatments on economics

Treatments	Gross returns (Rs./ha)				Net returns (Rs./ha)				B:C (Rs./ha)			
	1st year	2nd year	3rd year	Pooled	1st year	2nd year	3rd year	Pooled	1st year	2nd year	3rd year	Pooled
Wheat+Linseed 2:2	19533	17667	19707	18969	9993	8427	10467	9629	1.05	0.91	1.13	1.03
Wheat+Linseed 4:4	23060	20273	22493	21942	12440	9953	12168	11520	1.17	0.96	1.18	1.10
Wheat+Linseed 6:4	22180	20533	23620	22111	10641	9294	12381	10772	0.92	0.83	1.10	0.95
Linseed+Gram 2:2	8980	9993	8220	9064	920	2233	460	1204	0.11	0.29	0.05	0.15
Linseed+Gram 4:4	9900	12233	13373	11835	-333	2813	3953	2144	-0.03	0.30	0.42	0.23
Linseed+Gram 6:4	10373	14876	13760	13003	-126	4676	3560	2703	-0.01	0.46	0.35	0.27
Linseed+Lentil 2:2	16333	3867	17033	12411	6333	-5813	7333	2618	0.63	-0.60	0.76	0.26
Linseed+Lentil 4:4	17280	4786	18500	13522	6180	-6013	7700	2622	0.56	-0.56	0.72	0.24
Linseed+Lentil 6:4	19700	24686	19480	21289	8100	5280	8180	7187	0.70	0.27	0.73	0.57
Sole Linseed	21680	20967	21307	21318	8234	12070	12471	10925	0.61	1.36	1.41	1.13
Sole Wheat	20100	16680	19353	18711	7800	4680	7353	6611	0.63	0.39	0.61	0.54
Sole Gram	11813	11860	10660	11444	2733	3080	1867	2560	0.30	0.35	0.21	0.29
Sole Lentil	6020	8660	7380	7353	-3127	-235	-1682	-1681	-0.34	-0.03	-0.19	-0.19
CD (P=0.05)	1925	NS	1877	5465	3139	1231	1853	5249	0.20	0.32	0.29	0.55

Table 3. Economic indices as influenced by different intercropping treatments (On basis of pooled data of three years)

Treatments	Cost of cultivation (Rs./ha)	Production efficiency (kg/ha/day)	Economic efficiency (Rs./ha/day)	AER	Relative profit (Rs./ha)	Additional profit (Rs./ha)	Profit equivalent ratio
Wheat+Linseed 2:2	9340	51.22	5.04	1.30	12474	5863	1.89
Wheat+Linseed 4:4	10422	61.28	5.84	1.16	13375	6764	2.02
Wheat+Linseed 6:4	11339	57.30	5.88	1.07	11495	4884	1.74
Linseed+Gram 2:2	7860	6.34	2.38	1.54	1853	-4758	0.28
Linseed+Gram 4:4	9691	11.28	3.12	1.25	2677	-3934	0.40
Linseed+Gram 6:4	10300	14.23	3.42	1.17	3175	-3436	0.48
Linseed+Lentil 2:2	9793	14.15	3.35	1.24	3235	-3376	0.49
Linseed+Lentil 4:4	10900	14.17	3.65	1.11	2911	-3700	0.44
Linseed+Lentil 6:4	14102	38.85	4.07	0.86	6167	444	0.93
Sole Linseed	10393	57.50	5.61	1.16	12719	6108	1.92
Sole Wheat	12100	36.73	[illegible]	1.00	6611	0	1.00
Sole Gram	8884	13.47	3.25	1.36	3487	-3124	0.53
Sole Lentil	9034	9.61	2.09	1.34	-2252	-8863	-0.34
CD (P=0.05)	-	-	-	-	-	-	-

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