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Bio-economic Assessment of Different Wheat-canola Intercropping Systems

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ABSTRACT

Intercropping improves the agronomic output and economic efficiency of a cropping system through effective use of resources than the monoculture. Economic feasibility of different wheat-canola intercropping systems was evaluated by growing hybrid and synthetic canola genotypes as intercrop in wheat. Seven wheat and canola intercropping systems included in the study were 3 rows of wheat + 1 row of hybrid canola, 4 rows of wheat + 2 rows of hybrid canola, 3 rows of wheat + 1 row of synthetic canola, 4 rows of wheat + 2 rows of synthetic canola, wheat sole crop, hybrid canola sole crop and synthetic canola sole crop. Wheat and canola intercropping system with 4 rows of wheat + 2 rows of hybrid canola outperformed with maximum net income, benefit-cost ratio, land equivalent ratio and marginal rate of return compared with all sole and intercrops. However, minimum economic returns and benefit-cost ratios were recorded from sole synthetic canola and its intercrops. Regarding competitive functions, higher values of crowding coefficient and competitive ratio for wheat in all wheat and canola intercropping systems highlighted the dominant behavior of wheat on its companion intercrops. In crux, wheat and canola intercropping with 4 rows of wheat + 2 rows of hybrid canola was more productive and economically profitable than all other inter-and sole crops. © 2012 Friends Science Publishers

Key Words: Aggressivity; Economic efficiency; Intercropping; Competitive functions

INTRODUCTION

Multiple cropping or poly culture (growing of two or more than two crops on same piece of land in one year) as intercropping has been proved very productive in tropical and subtropical areas of the world. It is popular amongst the farmers as it offers yield advantage than sole cropping through yield stability and higher field benefits. Pakistan is a subtropical country with pre-dominantly irrigated agriculture and land resources with ample sunlight for plant growth. Therefore, options of raising two or more crops simultaneously on same piece of land are desired to improve the system productivity for small landholders in particular (Jabbar *et al.,* 2010; Lithourgidis *et al*., 2011). Intercropping improves the productivity than mono-cropping through effective use of water, nutrients and solar energy (Willey, 1990; Bhatti *et al.,* 2005; Lithourgidis *et al*., 2011).

Although, yield of component crops is decreased in intercropping systems than their pure stands but overall productivity of the system in terms of net income, benefit-cost ratio (BCR) and land equivalent ratio (LER) increased due to efficient use of resources (Verma *et al.,* 1997; Tahir *et al.,* 2003a, b; Banik *et al.,* 2006). However, as the requirement of components crops should be complementary, there are limited crop choices in designing the intercropping system.

Components crops in any intercropping system have different competitive behavior that can be better assessed in terms of relative crowding coefficient, aggressively, and competitive ratio (De Wit, 1960; McGilchrist, 1965; Willey *et al*., 1980). For instance, intercropping legumes with cereals, improve nitrogen supply (Giller & Wilson, 1991; Xiao *et al.,* 2004; Jabbar *et al.,* 2010). Likewise, some intercropping systems help in decreasing the pest pressure (Farooq *et al*., 2011; Lithourgidis *et al*., 2011).

Pakistan is facing a continual deficiency in edible oilseed production and currently is the third largest importer of edible oil at the expense of huge foreign exchange (Govt. of Pakistan, 2010). Therefore, efforts are needed to enhance production of oilseeds to save foreign exchange of the country. Canola (*Brassica napus* L.) is a high yielding oilseed crop with potential to minimize the gap amid national production and consumption of edible oil.

Moreover, canola oil is excellent for human consumption due to lower levels of erucic acid and toxic glucosinolates than conventional rapeseed oils (Przybylski *et al*., 2005). However, as its growing season overlaps with major food crop wheat (*Triticum aestivum* L.), its inclusion in the cropping scheme is very difficult. Therefore, intercropping of canola with wheat can provide a viable option to enhance oilseed production in the country.

It is hypothesized that if appropriately practiced, the intercropping of canola in wheat may increase net income and BCR of the system and help to overcome the shortage of oilseeds in the country. Therefore, this study was designed to evaluate the bio-economic aspects of hybrid and synthetic canola intercropping in wheat sown under different patterns.

MATERIALS AND METHODS

Plant material: Seed of wheat cultivar "Sehar-2006" was obtained from Cereals Section, Ayub Agriculture Research Institute, Faisalabad and seeds of hybrid canola "Hyola-401" and synthetic canola cultivar "Synthtic-1" were collected from ICI Seeds Pvt. Ltd., Pakistan. Weather data during the entire course of study are given in Table II.

Site description: This study was conducted at Experimental Farm of University College of Agriculture, Bahauddin Zakariya University, Multan, (71.43° E, 30.2° N & 122 meters asl), Pakistan during winter 2009-2010. Climate of the region is subtropical to semi-arid. The experimental land was quite uniform and soil analyses were conducted to ascertain soil fertility status before sowing (Table I).

Experimental details: Experiment was replicated thrice in a randomized complete block design (RCBD) with a net plot size of 5 m × 4.5 m. Seven wheat and canola intercropping systems including 3 rows of wheat + 1 row of hybrid canola, 4 rows of wheat + 2 rows of hybrid canola, 3 rows of wheat + 1 row of synthetic canola, 4 rows of wheat+2 rows of synthetic canola, wheat sole crop, hybrid canola sole crop and synthetic canola sole crop were evaluated in the study.

Crop husbandry: Before preparing seedbed, pre-soaking irrigation of 10 cm was applied. When soil reached to workable condition, the seedbed was prepared by cultivating the field twice with a tractor-mounted cultivator each followed by planking. Wheat and canola crops were sown on November 16, 2009 on well prepared seedbed with single row hand drill in 22.5 and 45 cm spaced rows, respectively using seed rate of 125 and 5 kg ha^{-1} for wheat and canola, respectively. Fertilizer was applied at 200 and 150 kg ha^{-1} nitrogen and phosphorus, respectively, using urea and triple super phosphate (TSP) as sources. Whole phosphorus and half of nitrogen were applied as basal dose, while remaining nitrogen was applied with first irrigation. Four irrigations i.e., at crown root stage, booting, anthesis and grain filling stages of wheat were applied to avoid the crop from the detrimental effects of water stress.

Table I: Pre-sowing physico-chemical analysis of soil

Determination	Unit	Value	Status
Physical Analysis			
Sand	%	67.7	
Silt	%	16.2	
Clay	%	16.1	
Textural class		Sandy loam	
Chemical Analysis			
pH		7.8	
EC	dS m^{-1}	1.27	
Organic matter	%	0.58	Low
Total nitrogen	%	0.04	Very low
Available phosphorus	ppm	10.0	Low
Available potassium	ppm	127	Medium
Total exchangeable salts	mS cm^{-1}	0.32	

Table II: Weather data during the study period

Month	Mean monthly Temperature (°C)	Mean monthly relative humidity (%)	Total rainfall (mm)
Nov-09	19.2	75.1	0.0
Dec-09	15.5	76.8	0.0
Jan-10	12.2	79.0	2.1
Feb-10	15.8	63.0	2.4
Mar.-10	23.5	62.0	45.1
Apr-10	30.4	34.0	6.5

Source: Agro-climatic Cell, Central Cotton Research Institute, Multan, Pakistan

In total, about 356 mm water (irrigation plus rainfall) was received by both wheat and canola during whole growing season excluding pre-soaking irrigation.

Observations: Mature crops of canola and wheat were harvested on March 29 and April 10, 2010, respectively. In wheat, total number of tillers was counted from a randomly selected unit area (m^{-2}) at three different locations leaving appropriate borders, and averaged. Ten randomly selected spikes (wheat) and silique (canola) were harvested and threshed manually to record number of seeds per spike and silique. Five random samples of thousand seeds were taken from each seed lot, weighed on an electrical weighing balance and averaged to record 1000-seed weight. At maturity, two central rows (for wheat) and one central row (for canola) were harvested throughout the plot length, sun-dried for three days, tied into bundles and weighed by using spring balance to record biological yield and are presented as t ha^{-1}. After that, it was manually threshed and weighed on an electric balance to calculate the seed yield. Seed yield was then adjusted to 10% moisture contents after determining seed moisture contents. Harvest index was recorded as ratio between grain yield to biological yield expressed and presented as percentage.

Computation of competitive functions and land equivalent ratio (LER): Relative yield of wheat and canola was computed by converting the yields of intercrops into the yield of wheat and canola, respectively based on the market price of each. Total LER was calculated by the formula of Willey (1979) as:

Total LER = LER (wheat) + LER (canola);

Where LER (wheat) = Grain yield of intercropped wheat/Grain yield of sole wheat, LER (canola) = Grain yield of intercropped canola/Grain yield of sole canola.

Relative crowding coefficient (K) was computed according to De Wit (1960):

$$K_{ab} = (Y_{ab}/Y_{aa}–Y_{ab})–(Z_{ba}/Z_{ab})$$

Where K_{ab} is the relative crowding coefficient for the component crop "a", Y_{aa} is pure stand yield of crop "a", Y_{ab} intercrop yield of crop "a", Y_{bb} pure stand yield of crop "b", Y_{ba} intercrop yield of crop "b" and Z_{ab} and Z_{ba} are sown proportions of crop "a" and "b" in intercropping system.

Aggressivity value was calculated following McGilchrist (1965).

$$A_{ab} = (Y_{ab}/Y_{aa} + Z_{ab})–(Y_{ba}/Y_{bb} + Z_{ba})$$

Where A_{ab} is the aggressivity value for the component crop "a".

Competitive ratio was computed using the formula of Willey *et al.* (1980).

$$CR_a = (Y_{ab}/Y_{aa} \text{ x } Zab)/(Y_{ba}/Y_{bb} \text{ x } Z_{ba})$$

Where CR_a is competitive ratio for the component crop "a".

Statistical analysis: Data were analyzed using Fisher's analysis of variance technique and least significant difference (LSD) test at 5% probability was used to compare the differences among treatments' means (Steel *et al.,* 1997).

Economic and marginal analysis: Benefit-cost analysis was conducted to estimate the economic feasibility of different wheat-canola intercropping systems. The production costs of wheat and canola included the cost of field preparation, seed, sowing, irrigation, fertilizers, crop protection measures and harvesting. The gross income was estimated using the prevailing average market prices for both the grain and straw of the wheat and canola in Pakistan. Net income was calculated by subtracting total expenditure from the gross income while benefit-cost ratio (BCR) was computed by dividing the gross income with total expenditure. Marginal analysis was carried out on the basis of variable costs and prevailing market prices of wheat and canola following the procedure devised by CIMMYT (1988).

RESULTS

Number of fertile tillers, grains per spike, grain and biological yield of wheat varied significantly ($P \leq 0.05$) for wheat sown alone or in wheat-canola intercropping systems. However, 1000-grain weight and harvest index of wheat were similar for wheat alone or as intercrop (Table III). Higher number of tillers was noted in wheat as sole crop compared with wheat-canola intercropping systems (Table III). Maximum and minimum number of grains per spike were observed in wheat and canola intercropping with 3 rows of wheat + 1 row of synthetic canola and 3 rows of wheat + 1 row of hybrid canola, respectively (Table III). Wheat sole crop harvested higher grain and biological yield compared with all other intercropping systems; whereas intercropping system with 4 rows of wheat + 2 rows of synthetic canola observed less grain and biological yield of wheat (Table III).

Likewise, different wheat and canola intercropping systems had significant effect on plant population, number of seeds per silique, 1000-seed weight, seed yield, biological yield and harvest index of canola (Tables IV). Canola sole crop either hybrid or synthetic canola cultivars had higher plant population than wheat and canola intercropping systems (Table IV). Likewise, sole hybrid canola and intercropped with wheat with 4 rows of wheat + 2 rows of hybrid canola recorded higher number of seeds per pod, while synthetic canola intercropped with wheat in both patterns observed least number of seeds per pod (Table IV). Single row of hybrid and synthetic canola intercropped with three rows of wheat and hybrid canola sole crop had heavier seeds than rest of the treatments (Table IV). Nonetheless, hybrid canola sole crop performed better for seed and biological yield; whereas wheat and canola intercropping with 4 rows of wheat + 2 rows of synthetic canola harvested minimum grain and biological yield (Table IV). Hybrid canola sole crop observed higher harvest index, while smaller harvest index was noted in 3 rows of wheat + 1 row of synthetic canola intercropping system (Table IV).

Intercropping of hybrid canola in wheat was more economical because both intercropping systems of 3 rows of wheat +1 rows of hybrid canola and 4 rows of wheat + 2 rows of hybrid canola had higher relative yield of wheat and canola (Table V). Data also indicate yield advantage in all intercropping systems due to LER of more than one in all wheat and canola intercropping systems. Wheat and canola intercropping with 4 rows of wheat + 2 rows of hybrid canola and 4 rows of wheat + 2 rows of synthetic canola recorded higher and lower LER, respectively (Table V).

Wheat appeared highly dominant in all wheat and canola intercropping systems as it had higher values of relative crowding coefficient (K) than intercropped hybrid and synthetic canola cultivars. Overall, 4 rows of wheat + 2 rows of hybrid canola intercropping appeared better as both the crops had higher value of K (Table VI). Data regarding aggressivity (A) indicate that both component crops did not compete equally and positive sign of A values for wheat highlighted its dominant behavior over hybrid and synthetic canola (Table VI). Higher competitive ratio (CR) values indicate that wheat was more competitive than hybrid and synthetic canola in all intercropping systems.

Economic analysis indicated that all wheat and canola intercropping systems achieved higher net income and BCR compared with sole plantation of wheat and canola. Wheat and canola intercropping with 4 rows of wheat + 2 rows of hybrid canola proved better with higher net income (Rs. 48413) and BCR (1.78); whereas synthetic canola sown as sole crop seemed uneconomical (Table VII).

Table III: Effect of wheat-canola intercropping systems on yield and related traits of wheat

Treatments	Fertile tillers (m^{-2})	Number of grains per spike	1000-grain weight (g)	Grain yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
T_1	431.90 bc	64.00 b	43.30	2.70 b	9.47 bc	31.61
T_2	456.33 b	66.20 ab	45.26	2.94 b	9.62 b	33.67
T_3	423.67 c	68.40 a	43.83	2.68 b	9.60 b	30.88
T_4	403.33 c	65.73 ab	45.00	2.55 b	8.09 c	35.32
T_5	533.60 a	66.07 ab	43.12	3.76 a	11.33 a	33.20
LSD p ≤0.05	**31.21**	**3.0**	**NS**	**0.44**	**1.44**	**NS**

Where T_1 = 3 rows of wheat + 1 row of hybrid canola; T_2 = 4 rows of wheat + 2 rows of hybrid canola; T_3 = 3 rows of wheat + 1 row of synthetic canola; T_4 = 4 rows of wheat + 2 rows of synthetic canola; and T_5 = wheat sole crop
Means not sharing the same letters in the same column differ significantly from each other at 5% level of probability by LSD test

Table IV: Effect of wheat-canola intercropping systems on yield and related traits of canola

Treatments	Plant population (m^{-2})	Number of seeds per silique	1000-seed weight (g)	Seed yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
T_1	20.63 c	26.23 b	3.14 a	0.79 c	3.14 c	20.38 c
T_2	20.17 c	29.40 a	2.52 c	0.75 d	2.76 d	21.92 b
T_3	20.23 c	23.53 c	2.88 ab	0.53 e	2.31 e	18.78 e
T_4	24.50 b	24.63 c	2.74 bc	0.49 f	1.69 f	20.04 cd
T_6	25.47 a	29.79 a	2.94 ab	1.47 a	6.18 a	23.83 a
T_7	26.00 a	24.83 bc	2.74 bc	0.99 b	5.09 b	19.51 d
LSD p ≤0.05	**1.70**	**1.46**	**0.27**	**0.02**	**0.14**	**0.55**

Where T_1 = 3 rows of wheat + 1 row of hybrid canola; T_2 = 4 rows of wheat + 2 rows of hybrid canola; T_3 = 3 rows of wheat + 1 row of synthetic canola; T_4 = 4 rows of wheat + 2 rows of synthetic canola; T_6 = hybrid canola sole crop; and T_7 = synthetic canola sole crop
Means not sharing same letters in the same column differ significantly from each other at 5% level of probability by LSD test

Table V: Effect of wheat-canola intercropping systems on relative yield and land equivalent ratio of wheat and canola

Treatments	Relative yield (t ha^{-1})		Land equivalent ratio (LER)		
	Wheat	Canola	Wheat	Canola	Total
3 rows of wheat + 1 row of hybrid canola	4.28 a	2.14 a	0.72	0.54	1.26
4 rows of wheat + 2 rows of hybrid canola	4.44 a	2.22 a	0.78	0.51	1.29
3 rows of wheat + 1 row of synthetic canola	3.75 b	1.87 b	0.71	0.54	1.25
4 rows of wheat + 2 rows of synthetic canola	3.53 b	1.77 c	0.68	0.49	1.17

Means not sharing the same letters in the same column differ significantly from each other at 5% level of probability by LSD test

Table VI: Effect of wheat-canola intercropping systems on relative crowding coefficient, aggressivity and competitive ratios of wheat and canola

Treatments	Kw	Kc	Aw	Ac	CRw	CRc
3 rows of wheat + 1 row of hybrid canola	1.87	-0.34	1.18	-1.18	2.01	0.50
4 rows of wheat + 2 rows of hybrid canola	2.56	0.13	0.27	-0.27	1.37	0.73
3 rows of wheat + 1 row of synthetic canola	1.81	-0.33	1.21	-1.21	1.98	0.50
4 rows of wheat + 2 rows of synthetic canola	1.12	-0.03	0.19	-0.19	1.39	0.72

Kw and Kc, Aw and Ac, and CRw and CRc are relative crowding coefficients of wheat and canola, aggressivity values of wheat and canola and competitive ratios of wheat and canola, respectively

Marginal analysis also revealed that 4 rows of wheat + 2 rows of hybrid canola was the best treatment with highest (2079%) marginal rate of return while other combinations were dominated either due to higher variable costs or lower net benefits (Table VIII).

DISCUSSION

Wheat-canola intercropping had significant effect on grain and relative yields of wheat and canola (Tables III-V). Sole crops of wheat and hybrid canola had higher wheat and canola yield, respectively; whereas 4 rows of wheat and 2 rows of hybrid canola intercropping provided higher relative yields for both wheat and canola (Tables III-V).

High grain yield of sole wheat crop was primarily due to higher number of tillers as pure stand of wheat was not different with respect to grains per spike and grain size from intercropping systems except that 3 rows of wheat + 1 row of canola that recorded lesser number of seeds per spike (Table III). Tillering capacity is a genetic character for a number of cereal crops and is influenced by intercropping due to inter-plant competition between the intercrops for essential components of plant growth such as soil, water, nutrients, and erratic emergence as well due to allelopathic effects of both crops on each other (Farooq *et al.,* 2011). Higher number of fertile tillers in sole wheat crop was the result of more wheat crop rows in this treatment. The difference in biological yield of wheat under different

Table VII: Effect of wheat-canola intercropping systems on net economic returns and benefit-cost ratio

Treatments	Total expenses	Gross income (Rs. ha^{-1})	Net income	Benefit Cost Ratio (BCR)
3 rows wheat + 1 row hybrid canola	61662	106365	44703	1.72
4 rows wheat + 2 rows hybrid canola	61662	110075	48413	1.78
3 rows wheat + 1 row synthetic canola	58162	94631	36469	1.62
4 rows wheat + 2 rows synthetic canola	58162	86439	28277	1.48
Wheat sole crop	60662	89283	28621	1.47
Hybrid canola sole crop	61662	80960	19298	1.31
Synthetic canola sole crop	56962	64599	7637	1.13

Table VIII: Marginal analysis of different wheat-canola intercropping systems

Treatment	Variable cost (Rs. ha^{-1})	Net benefits	Change in variable cost	Change in net benefits	Marginal rate of return (%)
Synthetic canola sole crop	-	64599	-	-	
3 rows wheat + 1 row synthetic canola	1200	94631	1200	24684	2057
4 rows wheat + 2 rows synthetic canola	1200	86439	-	-	D
Wheat sole crop	3700	89283	2500	2844	114
4 rows wheat + 2 rows hybrid canola	4700	110075	1000	20792	2079
3 rows wheat + 1 row hybrid canola	4700	106365	-	-	D
Hybrid canola sole crop	4700	80960	-	-	D

intercropping systems might be due to variable competitive behavior and plant population (tillers) due to the presence of more number of rows in sole wheat crop. Likewise, higher seed yield of sole hybrid and synthetic canola was directly due to higher plant population compared with intercropped canola; while better genetic makeup due to heterosis enabled hybrid canola cultivar to perform better compared with synthetic canola (Table IV). The total biomass per unit area reflects the overall growth behavior of a crop. Szumigalski and Acker (2005) reported that seed yield is reduced due to competition between the intercrops. Decrease in biological yield of canola as a result of two or three rows of wheat is presumably due to increased competition of both crops for growth resources (Szumigalski & Acker, 2005). Moreover, higher number of rows in sole canola crop for both hybrid and synthetic cultivars and free environment due to lack of inter-specific competition might be the reasons of their higher biological yield compared with their intercropping treatments (Tahir *et al.,* 2003b; Imran *et al.,* 2011).

Land equivalent ratio (LER) is a measure of how much land would be required to achieve intercrop yields when sown as sole crops. The values of LER higher than 1, equal to 1 or less than 1 indicate over-yielding, same or below-yielding capacity, respectively of the intercropping systems compared with their sole crops. LER higher than 1 in all intercropping systems indicate over-yielding potential of all intercropping systems compared with pure stands of wheat, hybrid and synthetic canola (Table V). Nonetheless, higher LER exhibited by 4 rows of wheat + 2 rows of hybrid canola intercropping indicates its superiority over other cropping systems (Table V) that might be due to the efficient utilization of natural (light, land) and added (fertilizer, water) resources (Tahir *et al.,* 2003b; Imran *et al.,* 2011).

Dominance of crops in intercropping systems is described on the basis of crowding co-efficient (K) value and the crop with high value of "K" is dominant over the crop having low value of "K". Therefore, in all wheat and canola intercropping systems wheat dominated canola. Competitive behavior of component crops in an intercropping system is determined by its aggressivity (A) value. An A value of zero indicates that component crops are equally competitive. For any other situation, both crops will have the same numerical value, but the sign of the dominant species will be positive and that of dominated negative. Positive sign of "A" in all intercropping systems indicated dominant behavior of wheat over hybrid and synthetic canola; and highly dominant when one row of hybrid and synthetic canola was intercropped in 3 rows of wheat (Table VI). Likewise, competitive ratio (CR) is used as an important tool to know the degree of competition between the component crops and higher value of CR indicate the higher competitive ability of a crop. High CR value of wheat in all intercropping systems highlights its superior competition ability to utilize the resources compared with canola (Table VI). Nonetheless, higher CR value of 2 rows of hybrid and synthetic canola intercropped in 4 rows of wheat indicate its better competition with wheat compared with one row of hybrid and synthetic canola intercropped in 3 rows of wheat (Table VI; Tahir *et al.,* 2003b; Imran *et al.,* 2011).

Overall success and adoptability of any treatment or technique depends on its economic feasibility. According to economic and marginal analysis, wheat and canola intercropping with 4 rows of wheat + 2 rows of hybrid canola outperformed with higher net income, benefit-cost ratio (BCR) and marginal rate of return compared with all other intercropping systems and sole crops of wheat and canola (Tables VII & VIII). Although the individual yield of canola and wheat was lower in this intercropping system than their sole crops, however higher relative yield of both crops in aforementioned cropping system compensated it; and in consequence outperformed with higher net income and BCR along with higher marginal rate of return (Jabbar *et al.,* 2010). Lower grain yield but higher total grain yield equivalent of rice in different rice based intercropping systems with maize, sesbania, mungbean, ricebean, cowpea and pigeonpea has been reported (Jabbar *et al.,* 2010). Higher economic returns from intercropping compared with sole crops have been exhibited for intercropping systems including wheat and lentil, canola and wheat, mustard and garlic, mustard and onion and sunflower and mungbean (Ali & Akram, 1992; Tahir *et al.,* 2003a; Sarker *et al.,* 2007; Imran *et al.,* 2011).

In conclusion, wheat and canola intercropping systems reduced the yield of both crops compared with their respective sole planted crops, but overall productivity with higher values of relative yield, LER and net income was recorded in intercropping compared with sole planting of wheat and canola. Regarding the competitive functions, wheat was proved as dominant crop over canola in all intercropping systems. Nonetheless, economic and marginal analysis clearly highlighted the superiority of wheat and canola intercropping with 4 rows of wheat + 2 rows of hybrid canola with higher net benefits, BCR and marginal rate of return. Therefore, wheat-canola intercropping with 4 rows of wheat + 2 rows of hybrid canola should be opted to enhance field benefits and domestic oilseed production.

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