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Studies on Determining a Suitable Canola-Based Intercropping System

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Abstract

A field study to determine the feasibility of canola-based intercropping systems was carried out at Agronomic Research Area, University of Agriculture, Faisalabad during 1999-2000 and 2000-2001. The treatments were canola alone, canola + one row of wheat, canola + two rows of wheat, canola + one row of gram, canola + two rows of gram, canola + one row of lentil, canola + two rows of lentil, canola + one row of linseed and canola + two rows of linseed. All the intercrops significantly reduced the yield components, seed and oil yield of canola as compared to canola alone. Maximum reduction in seed yield of canola was observed when it was intercropped with two rows of wheat. Net field benefits were highest in the treatment canola + one row of wheat (Rs. 43125 ha^{-1}), which was 18.11% more than the canola alone.

Key words: Intercropping, canola, seed yield, net field benefits

Introduction

Intercropping is an advanced agro-technique and is considered to be an effective and potential mean of increasing crop production per unit area and time, particularly for farmers with small holdings. Generally farmers use marginal lands for oilseeds which lead to lower yields of oilseeds. Thus, Pakistan is deficient in edible oil and spends its foreign exchange resources on the import of edible oil. There is a need to develop the best intercropping system to increase the production of canola besides, increasing farm income. Kalra and Gangwar (1980) reported that intercropping helps in increasing farm income on sustained basis. While, Mandal *et al.* (1985) revealed that wheat in combination with mustard and chickpea reduced number of pods plant^{-1} and 1000-seed weight of mustard and chickpea. Singh and Pal (1994) reported that intercropping of wheat and mustard reduced the seed yield of both the crops than their pure stands. Whereas, Ayisi *et al.* (1997) concluded from their experiment on canola-soybean intercropping that seed oil content of canola increased compared with sole cropping. Likewise, Verma *et al.* (1997) reported that intercroppnig of wheat and Indian mustard gave maximum net returns.

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The present study was, therefore, undertaken to evaluate the feasibility of different canola-based intercropping systems under the agro-ecological conditions of Faisalabad.

Materials and Methods

A field study to examine the comparative productive efficiency and feasibility of different canola-based intercropping systems was carried out at the Agronomy Research Area, University of Agriculture, Faisalabad-Pakistan, during 1999-2000 and 2000-2001 on a sandy clay loam soil. The experiment was laid out in a randomized complete block design with three replications having a net plot size of 2.4 x 5.1 m. The experimental treatments were: canola alone, canola + one row of wheat, canola + two rows of wheat, canola + one row of gram, canola + two rows of gram, canola + one row of lentil, canola + two rows of lentil, canola + one row of linseed and canola + two rows of linseed. Canola variety "Hyola-401" was sown manually with a single row hand drill on 14th October 1999 and 2000 using a seed rate of 5 kg ha^{-1} in a paired rows pattern with 20 cm between the paired rows and 60 cm between the rows of different pairs. Wheat (cv. Inqlab-91), gram (cv. Bittal-98), lentil (cv. Masoor-93) an linseed (cv. Chandni) were intercropped between the strips on 23rd October 1999 and 2000 with a single row hand drill in one and two rows pattern. The plots consisting of monoculture of wheat, gram, lentil and linseed were also sown along the main experiment using standard agronomic recommendations. Canola in both sole and intercropping treatments was fertilized @ 90 kg N and 60 kg P_2O_5 ha^{-1}. All phosphorus and 1/2 nitrogen was side drilled using single row hand drill at the time of sowing of sole crop of canola and the remaining 1/2 nitrogen was top dressed with second irrigation at flower initiations stage. However, sole crops of wheat, gram, lentil and linseed were fertilized and irrigated according to the standard agronomic recommendations of these crops. Both sole and intercropped canola received three irrigations. Regardless of monoculture or intercropping all the component crops were kept free of weeds by manual hoeing. Both sole and intercrops were harvested manually at ground level using sickle and tied into separate bundles. These bundles were kept in the field for about a week for sun drying. The sun dried crops were threshed manually for separating seeds or grains.

Data of different growth and yield parameters were recorded by using standard procedures. The seed oil content was determined by NMR technique (Robertson and Morrison, 1979). Economic analysis of different treatments was conducted to see the net field benefits. Data collected were statistically analysed by using the computer statistical programme MSTAT-C (Freed and Eisensmith, 1986) and treatment means were compared by using DMR test at 5% probability level (Steel and Torrie, 1984).

Results and Discussion

Table-1 presents the data on yield and yield components of canola as affected by wheat, gram, lentil and linseed intercropping.

Number of pods plant^{-1}

During 1999-2000, all the associated cultures caused a significant reduction in number of pods plant^{-1} of canola compared with sole culture of canola. The significantly maximum number of pods plant^{-1} (374.44) was recorded in canola alone. On the contrary, the minimum number of pods plant^{-1} (292.10) was recorded in the treatment canola + two rows of wheat which differed significantly from rest of all the treatments. Maximum reduction in number of pods plant^{-1} of canola, where two rows of wheat were intercropped, could be due to severe competition of wheat plants with canola for different growth resources. The same trend was observed in 2000-2001. Reduction in number of pods plant^{-1} due to intercropping has also been reported by Mandal *et al.* (1985) in mustard crop.

Table 1: Impact of intercropping wheat, gram, lentil and linseed on yield and yield components of canola.

Treatments	No.of pods plant^{-1}		No. of seeds pod^{-1}		1000-seed weight (g)		Seed yield (kg ha^{-1})		Oil contents (%)		Oil yield (kg ha^{-1})	
	1999-2000	2000-2001	1999-2000	2000-2001	1999-2000	2000-2001	1999-2000	2000-2001	1999-2000	2000-2001	1999-2000	2000-2001
Canola alone	374.44^{a}	366.16^{a}	24.27^{a}	23.80	4.10^{a}	4.02^{a}	3361^{a}	3296^{a}	44.48^{a}	44.50^{a}	1495^{a}	14.67^{a}
Canola + one row of wheat	329.50^{cd}	322.08^{e}	22.04^{b}	21.61	3.75^{bcd}	3.69^{d}	2951^{bc}	2897^{bc}	43.03^{b}	43.06^{b}	1270^{b}	1247^{bc}
Canola + two rows of wheat	292.10^{e}	285.33^{f}	19.88^{c}	19.48	3.66^{d}	3.58^{e}	2691^{d}	2640^{c}	42.71^{c}	42.73^{c}	1149^{c}	1128^{c}
Canola + one row of gram	348.90^{bcd}	341.17^{bc}	22.64^{b}	22.23	3.89^{bc}	3.80^{bc}	3091^{bc}	3035^{ab}	41.75^{f}	41.77^{e}	1290^{b}	1268^{bc}
Canola + two rows of gram	353.20^{b}	345.30^{b}	23.20^{ab}	22.75	3.92^{b}	3.83^{b}	3177^{ab}	3114^{ab}	41.08^{h}	41.11^{g}	1305^{b}	1280^{b}
Canola + one row of lentil	343.20^{bcd}	335.47^{cd}	22.44^{b}	22.02	3.83^{bcd}	3.75^{c}	3063^{bc}	3003^{ab}	41.91^{ef}	41.95^{e}	1284^{b}	1260^{bc}
Canola + two rows of lentil	350.25^{bc}	343.25^{b}	22.86^{ab}	22.36	3.90^{bc}	3.82^{b}	3130^{abc}	3069^{ab}	41.38^{g}	41.41^{f}	1295^{b}	1271^{b}
Canola + one row of linseed	338.60^{bcd}	331,66^{d}	22.39^{b}	21.95	3.83^{bcd}	3.76^{c}	3022^{bc}	2963^{b}	42.21^{d}	42.25^{d}	1276^{b}	1252^{bc}
Canola + two rows of linseed	328.30^{d}	320.97^{e}	21.75^{b}	21.29	3.73^{cd}	3.67^{d}	2921^{c}	2867^{bc}	42.00^{e}	42.01^{de}	1227^{bc}	1205^{bc}
LSD	19.08	6.033	1.368	NS	0.1548	0.0574	223.6	284.5	0.1815	0.2448	99.50	125.6

Means followed by the same letter in a column do not differ significantly at $P \leq 0.05$; NS = Non significant

Table 2: Two year average gross income/expenditure, net field benefits (NFB) as affected by different canola-based intercropping systems

Treatments	Gross income	Gross expenditure	NFB	Increase or decrease over control (%)
	(Rs. ha^{-1})			
Canola alone	51504	14992	36512	-
Canola + one row of wheat	59314	16188	43126	18.11
Canola + two rows of wheat	57480	16650	40830	11.82
Canola + one row of gram	52431	15487	36944	1.18
Canola + two rows of gram	51758	15814	35944	-1.55
Canola + one row of lentil	51908	15403	36505	-0.01
Canola + two rows of lentil	52221	15670	36551	0.11
Canola + one row of linseed	53131	15425	37706	3.27
Canola + two rows of linseed	52226	15695	36531	0.05

Price/40 kg seed yield		Price/40 kg straw yield	
Canola	Rs. 600.00	Canola	Rs. 5.00
Wheat	Rs. 300.00	Wheat	Rs. 50.00
Gram	Rs.1090.00	Gram	Rs. 5.00
Lentil	Rs.1140.00	Lentil	Rs. 5.00
Linseed	Rs.900.00	Linseed	Rs. 5.00

Number of seeds pod^{-1}

Intercropping had significant effect on number of seeds pod^{-1} of canola during 1999-2000 but non-significant in 2000-2001. During 1999-2000 the maximum number of seeds pod^{-1} (24.27) were recorded in canola alone that was statistically at par with canola + two rows of gram and canola + two rows of lentil. On the contrary, the minimum number of seeds pod^{-1} of canola (19.88) were observed in canola + two rows of wheat which indicate competitive behaviour of wheat which finally resulted in decreased number of seeds pod^{-1} of canola. These results are in agreement with the findings of Singh and Yadav (1992) who reported that intercropping reduced the number of seeds pod^{-1} than pure stand in chickpea.

1000-seed weight (g)

During 1999-2000, the significantly maximum 1000-seed weight (4.10g) was observed in the treatment where canola was grown alone. While minimum 1000-seed weight (3.66g) was obtained in canola + two rows of wheat which was, however, statistically at par with the treatment where one row of wheat, one row of lentil, one row of linseed and two rows of linseed were intercropped in canola. In 2000-2001 the significantly maximum 1000-seed weight (4.02g) was found in canola alone. By contrast the significantly minimum 1000-seed weight (3.58g) was noticed in canola + two rows of wheat. The significantly more 1000-seed weight in canola alone may be due to competition free environments and more feeding area available to base crop than rest of intercropping treatments. While the least 1000-seed weight in case of canola + two rows of wheat could be the result of intense competition. These findings are in line with those of Singh and Yadav (1992) who observed that 1000-seed weight was affected significantly by intercropping.

Seed yield (kg ha^{-1})

Data in Table-1 exhibits that during 1999-2000 the maximum seed yield of canola (3361 kg ha^{-1}) was recorded in canola alone that was however, statistically at par with canola + two rows of gram and canola + two rows of lentil treatments. On the contrary, the significantly minimum seed yield of canola (2691 kg ha^{-1}) was observed in canola + two rows of wheat treatment. During 2000-2001 the maximum seed yield of canola (3296 kg ha^{-1}) was observed in canola alone which was, however, statistically on a par with canola + one row of gram, canola + two rows of gram, canola + one row of lentil and canola + two rows of lentil treatments, while, the minimum seed yield of canola (2640 kg ha^{-1}) was obtained in canola + two rows of wheat which in turn, was found statistically at par with canola + one row of wheat and canola + two rows of linseed treatments. The higher seed yield of canola alone could be because of more number of pods plant^{-1}, seeds pod^{-1} and 1000-seed weight. There was comparatively less decrease in seed yield of canola when it was intercropped with legumes as compared to non-legumes. It could be due to less demand of legumes for similar resources. More reduction in canola seed yield by wheat and linseed might be due to more decrease in yield components of canola. These results are in line with those of Mandal *et al.* (1988) and Sing and Pal (1994).

Oil contents (%)

Oil contents (%) of canola were affected significantly in both the years by different canola-based intercropping systems. During the year 1999-2000 the significantly maximum seed oil contents (44.48%) were observed in canola alone. Whereas, canola intercropped with two rows of gram produced the minimum seed oil contents (41.08%). Similar trend was observed in 2000-2001. The higher percentage of seed oil contents in case of canola grown alone could be because of enjoying competition free environments. These findings are favoured by the results of Ayisi *et al.* (1997), but are in contradiction to the work of Singh and Gupta (1994) who revealed that intercropping did not affect seed oil contents.

Oil yield (kg ha^{-1})

The oil yield of canola was significantly affected by different canola-based intercropping systems. During 1999-2000, the significantly maximum oil yield of canola (1495 kg ha^{-1}) was recorded where canola was sown alone. The minimum seed yield of canola (1149 kg ha^{-1}) was observed in canola + two rows of wheat which, in turn, was statistically at par with canola + two rows of linseed. In 2000-2001 almost similar trend was observed. Significantly more oil yield of canola alone was due to higher seed yield and seed oil contents of canola. These results are similar to those of Ayisi *et al.* (1997).

Economic analysis

Feasibility, profitability as well as adoptability of a particular intercropping system is ultimately determined by the net monetary gain from it. Net field benefits (NFB) were calculated on the basis of 2-years (i.e. 1999-2000 and 2000-2001 average data). All intercropping systems except canola + two rows of gram (Rs. 35944 ha^{-1}) and canola + one row of lentil (Rs. 36505 ha^{-1}) (Table-2) gave higher net field benefits than that of the monocroping of canola. The maximum NFB was of canola + one row of wheat (Rs. 43126 ha^{-1}) against the minimum of Rs. 35944 ha^{-1} in canola + two rows of gram.

Conclusion

Canola + one row of wheat intercropping system appeared to be not only a productive practice but also highly profitable as compared to other intercropping systems and sole cropping of either component crops.

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