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Investigation of Ecological Relationship and Density Acceptance of Canola in Canola-field Bean Intercropping

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Abstract: In order to evaluate biologic effects of mixed culture of canola-field bean on farming system, in comparison with sole cropping, an experiment was carried out in 2004 at Ramin Agriculture and Natural Resources University, Iran. Experimental design was randomized complete blocks with three replicates. Different compositions of two crop, canola and field bean are treatments of the experiment, that including 20, 40 shrub m^{-2} for canola and 0, 20, 40 and 60 shrubs m^{-2} for field bean. Grain yield and components of crops, weed biomass and diversity, Land Equivalent Ratio (LER) and dominance index were evaluated. Results showed a significant difference between sole cropping and mixed culture in grain yield and components. In canola mixed field bean, yield of both crops was lower than monoculture. Highest yield of canola in monoculture was gained with 40 canola shrubs m^{-2} (2788 kg ha^{-1}) and lowest grain yield was gained with intercrop of 40 and 40 canola and field bean shrub m^{-2}, respectively. This trend, also be observed in field bean yield with increase of intercrop composition. It seems that cause of yields loss is competition between two crops and decrease of branches. Highest LER was found in mixed 20 and 60 canola and field bean shrub m^{-2}, respectively. And lowest LER was observed in mixed 40 and 20 canola and field bean shrub m^{-2}, respectively. Lowest dry matter (DM) of weeds within mixed stands was gained with 20 canola and 40 field bean shrub m^{-2}. Highest DM of weeds was related to monoculture of 20 canola shrub m^{-2}. Also, with increase density of field bean mixed stands, DM of weeds decreased, significantly. Also, diversity of weeds was decreased in mixed stands, in comparison with monoculture.

Key words: Bean, canola, intercropping, lend equivalent ratio, weed, yield

INTRODUCTION

Today, different agronomic systems are existing in the world. Management practices in these systems are effective on crop yield, resources use efficiency and population of weeds. Mixed culture is one of good methods in sustainable production of crop. Planting more than one crop caused better resources use, in comparison with mono-culture (Sobkowicz, 2006). In comparison with pure culture, intercropping systems has many advantages such as better use of resources for growth, weed, pest and disease control and increase in stability of yield in different environmental conditions (Nargis Akter *et al*., 2004). In addition, intercropping systems might be wisest selection in determining compatible plants, minimum competition and highest total yield. This could become possible by using suitable combination of different varieties (Saka *et al*., 2007). One of problems in designing and efficiency of mixed culture is due to lack of predicting interaction between species composition and environmental conditions (Fukais and Trenbath, 1993). Therefore, in mixed culture, the most important factors in selecting plants include their compatibility, having low competition and producing highest yield. Also, careful selection of companion crop, can result in nutrient balance, economic yield stability

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and sustainability of agricultural systems (Nargis Akter *et al*., 2004). In addition, better management and weed control and following bioenvironmental issues are other advantages of this culture method.

Due to high importance of oilseeds in nutrition, their production and processing situation was on concern from old time. But, problems in cultivation and production of these crops have been always a barrier in increase yield and obtaining sustainable yield. Therefore, due to important situation of mixed culture in removing some problems in agro-ecosystems and that researches in this field across the country, particularly in Khuzestan province was very limited, on the other hand, this study tries to compare and asses the mixed culture of canola and field bean (a plant that has suitable status in agricultural systems in the region due to its characteristics), in different densities of two crops with pure culture of canola.

MATERIALS AND METHODS

This experiment was carried out in the research farm of Ramin Agricultural and Natural Resources University, located 36 km northwest Ahwaz in 31 degree and 36 min geographic latitude, in 2004-2005. This region is in semi-arid parts with average annual rainfall rate of 269.9 mm. soil of experiment location has silt-clay-loam texture, with 0.84% organic matter. In this research, intercropping of canola (Hyola 401 cv.) and field bean (local) was investigated. Canola was planted in two 20 and 40 shrubs m^{-2} densities and field bean was planted in 0, 20, 40 and 60 shrubs m^{-2} densities. Experimental design was randomized complete blocks, with three replicate. Each plot include six furrow with 75 cm distance and four meter length, that one cultivation line of each one of two crops is located on those. Treatments was different combination of two crops (canola and field bean) (Table 1). It should be noted that treatment of pure culture are as control.

Agronomic operations including fertilization, irrigation and harvest were done based on technical recommendations of research centers in the region. In order to investigation of weed status, no control was made against the weed. Field bean was harvested at the end of April and canola at the beginning of May. Then, samples were taken to laboratory and were dried and following parameters were measured:

Grain Yield and Yield Components

To determine yield and yield components, after omitting the margins, in each plot, following parameters were measured:

- Grain yield, silique number, grain per silique and 1000 grain weight
- Biological yield of mixed culture and it components in area unit
- Weight of single shrub in mixture and pure culture

Table 1: Different composition in canola mixed field bean

Canola (shrub m^{-2})	Field bean (shrubs m^{-2})
20	0
20	20
20	40
20	60
40	0
40	20
40	40
40	60
0	20

Weed Measurements

Sampling of weeds, in order to evaluate of mixed culture effects on weed status, was done. Weeds were collected at the end of February in the floral stage and labeled. Then their dry weight was measured. In addition, species composition in different combination of mixed culture and pure culture was identified.

Evaluation Indexes of Mixed Culture

Agronomic index of the Land Equivalent Ratio (LER) that was calculated from formula 3 (Nargis Akter *et al*., 2004). LER for a canola-field bean intercrop is the sum of the partial LER values for canola (Lc) and field bean (Lf), in accordance with Vandermeer (1990).

$$Lc = \frac{Y\ \text{canola IC}}{Y\ \text{canola SC}} \quad (1)$$

$$Lf = \frac{Y\ \text{field bean IC}}{Y\ \text{field bean SC}} \quad (2)$$

$$LER = Lc + Lf \quad (3)$$

where, SC is solp crop and IC is intercrop.

Competition Index (dominance factor) which was calculated from formula 4.

$$CI = \frac{\text{BY of canola single shrub in sole crop}}{\text{BY of canola single shrub in intercrop}} - \frac{\text{BY of bean single shrub in sole crop}}{\text{BY of bean single shrub in intercrop}} \quad (4)$$

In analyzing data, SAS and MSTATC softwares and for drawing graphs. Excel software, were used.

RESULTS AND DISCUSSION

Canola Yield and Yield Components

Results showed significant difference between treatments in terms of No. of shrubs per unit area, weight of single shrubs, grain yield, 1000 grain weight, silique No., grain No. per silique and Biological Yield (Table 2).

Table 2: Analysis of variance by of canola yield and yield components mixed with field been

Source of variation	df	Shrub (m^{-2})	Weight of single shrub (g)	BY (kg ha^{-1})	Silique No.	Grain/Silique	1000 grain weight (g)	BY of Mixture
Replication	2	11.54	0.322	229.683	1564.9629	36.5185	0.16528	510553.58
Treatment	7	128.19*	45.023**	89422.570**	6524.4400**	327.8700**	4.92087	541563.31
Error	4	9.73	2.960	1572.954	845.7129	30.0393	0.75768	495546.05

*, **, Significant at 5 and 1% levels of probability, respectively

Table 3: Canola yield and yield components mixed with field bean

Canola	Bean	Shrub (m^{-2})	Weight of single shrub (g)	BY (kg ha^{-1})	GY (kg ha^{-1})	Silique No.	Grain/Silique	1000 grain weight (g)	BY of mixture
40	0	35.00a	18.07a	6277a	2788a	125.0a	25.2a	2.13b	633.0ab
40	20	20.66b	8.93cd	1790bc	217f	80.3ab	16.8b	3.32ab	710.8ab
40	40	17.33bc	8.46cd	1503cd	551e	62.1b	19.3ab	3.04ab	528.8b
40	60	16.00bc	6.13d	965d	752cd	60.0b	15.0b	3.38ab	561.0ab
20	0	17.33bc	13.00b	2260b	705d	120.1a	26.0a	2.94ab	602.5ab
20	20	14.00c	9.83c	1370cd	899b	78.6ab	22.0ab	3.07ab	615.8ab
20	40	17.33bc	7.66cd	1330cd	798c	68.0b	22.1ab	2.75ab	663.3ab
20	60	18.66bc	7.33cd	1373cd	702d	65.5b	21.0ab	3.72ab	929.5a

Similar letter(s) in each column shows non-significant difference

Number of canola shrubs m^{-2}, was affected seriously by field bean in mixed culture. Maximum No. of canola shrub was obtained with 40 shrubs m^{-2}, in sole crop (Table 3). With increase density of canola and field bean, BY of both crop single shrub decreased and mean comparison showed very decreasing trend in terms of weight of canola single shrub, in mixed culture.

BY of canola single shrubs, from 18 in sole crop with 40 shrubs per m^2, decreased to 8 g. In mixed with field bean. This decreasing trend, especially was increased greatly in higher densities of field bean. It seems that BY decreasing is due to competition in mixed culture (Tsubo *et al*., 2003).

With increase of canola density, canola BY increased. Highest canola BY was observed in sole crop with 40 shrubs m^{-2} (with 627 kg DM ha^{-1}) and lowest BY was related to mixed culture of 40 canola shrubs and 60 field bean shrubs. In both density of canola, with increase in relative share of field bean population, canola BY decreased, especially with 40 canola shrubs m^{-2}. Cause of canola BY decrease in mixed culture, can be related to interaction of two crops and competition ability of legumes (Fairys, 1990). Some of other researchers reported no significant difference between mixed and sole crop (Raji, 2007).

Highest canola grain yield (GY) was obtained in sole crop with 40 canola shrubs m^{-2} by 2788 kg ha^{-1} and lowest GY was obtained in 40 canola and field bean shrubs m^{-2} in mixed culture by 551 kg ha^{-1}. Mean of GY in sole crop with 40 canola shrubs per m^2 was five times than mixed culture with the same density (Table 3).

These results agree with reports of Rouber *et al*. (2000) on decrease oat grain yield mixed with pea, in relation with sole crop and Sabkowicz (2006) on triticale mixed field bean. It also seems that increase in GY in mixed culture with 20 shrubs was due to decrease competition and interaction between two mixed crop and decrease in the No. of branches, that agree with results obtained by Finckh and Karpenstein-Machan (2002).

Mixed culture also decreased canola yield components. In this condition, No. of silique per plant decreased. Maximum No. of silique per plant was obtained from sole crop in both density of canola and minimum No. of silique was related to high densities in mixed culture. This agrees with reports of Sabkowicz (2006) and Fukais and Trenbath (1993). It seems that decrease in the No. of silique per plant with increase bean density, is related to fields bean shading on canola. In addition, the grain No. per silique decreased in different combinations of mixed culture. Lowest No. of grain per silique was observed in combination of 40 canola shrubs with 60 bean shrubs m^{-2}, by 15 grain per silique. Also, highest number of grain per silique was observed in sole cropping. One thousand grain weight of canola in sole crop was less than mixed culture.

Bean Yield and Yield Components

Results showed very significant difference between treatments in terms of shrub No. m^{-2}, single shrub weight, BY, GY, 100 grain weight, silique No. per shrub, grain No. per silique (Table 4).

It seems that the competition established with increase in density of both crops in mixed culture. The weight of single shrub of bean varied in different competition of mixed culture and showed decreasing trend in mixed culture, in comparison with sole crop. The highest weight of single shrub of bean was found in sole crop by 38.5 g and lowest was in mixed culture by 29.84 g (Table 5).

With regarding to results, it seems that intraspecific competition with canola and interspecific competition between bean shrubs particularly in high densities could be the reason of decrease in the biological yield of single shrub. This agrees with the report of Sabkovicz (2006) on intraspecific competition of triticale with bean. BY in bean sole crop, by 6718 kg ha^{-1}, showed increase in comparison with mixed culture. Some of researchers have also reported that yield of both species in mixed culture was lower than sole crop (Nargis Akter *et al*., 2004). The highest GY of field bean was

Table 4: Analysis of variance of bean yield and yield components mixed with canola

Source of variation	df	Shrub (m^{-2})	Weight of single shrub (g)	Silique No. of plant	Grain/Silique	BY (kg ha^{-1})	GY (kg ha^{-1})	1000 grain weight (g)
Replication	2	47.286	5.086	5.4351	0.69440	78408.101	354617992	47.71
Treatment	6	103.968**	169.189	15.7364**	7.11110**	243347.027**	3645.103**	9618.70**
Error	12	15.397	27.362	3.7268	0.36411	19516.350	3877.546	77.726

*, **, Significant at 5 and 1% levels of probability, respectively

Table 5: Bean yield and yield components mixed with canola

Canola	Bean	Shrub (m^{-2})	Weight of single shrub (g)	BY (kg ha^{-1})	GY (kg ha^{-1})	Silique No.	Grain/Silique	100 grain weight (g)
40	20	16.67b	37.37ab	3093b	1552bc	6.13a	3.4a	3093b
40	40	16.67a	23.67cd	2945b	1374c	7.50a	3.5a	2945b
40	60	26.00a	28.50	4780ab	2050abc	7.10a	3.3a	4780ab
20	20	17.67a	28.37bc	2923b	1429c	6.10a	3.3a	2923b
20	40	24.67a	31.4abc	4633ab	1804abc	5.70a	3.5a	4633ab
20	60	31.00a	31.13abc	6678a	2650a	7.30a	3.6a	6678a
0	20	15.33b	38.50a	6718a	2525a	7.30a	3.8a	6718a

Similar letter(s) in each column shows non-significant difference

Table 6: GY comparison of field bean single shrub in sole crop, with canola intercrop

Mixed culture treatments	GY of field bean (kg ha^{-1})
Field bean sole crop	2525
Field bean mixed with 20 canola shrub m^{-2}	1961
Field bean mixed with 40 canola shrub m^{-2}	1659

obtained with sole crop by 2525 kg ha^{-1}, that was higher than different densities mixed with canola. Other compositions of mixed culture in this experiment, had lower yield than bean sole crop. Especially, with increase of canola density in mixed culture, lowering of yield became more intensive (Table 6).

Comparison the BY of mixed culture showed that there was no significant difference between different compositions of mixed and sole cropping (Table 4). However, combination of 20 canola shrubs mixed with 40 bean shrubs m^{-2} had highest BY, by 9295 kg ha^{-1}. Cause of this might be due to bean characteristic and low portion of canola in this mixture composition. This agrees with results of Carr *et al*. (1992) on intercropping of sorghum-bean.

Land Equivalent Ratio

Land Equivalent Ratio (LER) had different percentage in seed yield in different mixture compositions. Minimum LER (69%) was obtained in 40 canola shrubs mixed with 20 bean shrubs m^{-2} and maximum LER (204%) was obtained in 20 canola shrubs mixed with 60 bean shrubs mixed with 60 bean shrubs m^{-2} (Table 7). LER in low density of canola (20 shrubs m^{-2}) was lower than 40 canola, in all compositions of mixed culture. It seems that in low densities of canola, with increase of No. of bean shrubs per unit area, GY of mixture increased and less land was needed to produce GY of sole cropping. Although, the GY of both crop was higher in sole cropping, but LER increased except in combinations of canola and bean with 40-20 and 40-40 densities. The pattern of yield decrease with increase in LER agrees with other mixed culture experiments (Nargis Akter *et al*., 2004; Sabkovicz, 2006). Studding LER of BY, showed that LER in low density of canola mixed with bean, had advantages in relation with sole cropping (Table 7).

Dominance Index

Results showed that in different mixtures, due to bean traits and inter-specific competition, Dominance index was less than 1 or negative. It shows better dominance of bean in mixture with canola (Table 7).

Table 7: LER and dominance in different mixtures of canola and field bean

Mixture composition		LER		
Canola	Field bean	BY	GY	Dominance
40	20	0.69	0.69	1.06
40	40	0.74	0.74	0.59
40	60	1.08	1.08	1.69
20	20	1.84	1.84	-0.3
20	40	1.99	1.99	0.47
20	60	2.04	2.04	0.46

Table 8: Weed species in sole crop and mixed intercropping

Composition	Weed species
Canola sole crop	Wild mustard, wild beet, sorrel and mallow
Field bean sole crop	Mallow, wild mustard and wild beet
Canola- field bean mixed intercrop	Mallow and wild beet

Table 9: Weed dry weight in different mixtures of canola and field bean

Mixture composition		
Canola	Field bean	Weed dry matter (g m^{-2})
40	0	47.01ab
40	20	13.4bc
40	40	10.24c
40	60	6.96c
20	0	64.45a
20	20	26.95bc
20	40	7.81c
20	60	5.64c

Similar letters shows non significant difference

Weed Biomass and Species

Results showed that mixed culture can be an effective implement for weed control that agree with results of some of researches (Deksen *et al*., 2002). Results of analysis of variance showed significant difference between different densities of both crops in mixed and sole cropping. Highest DM of weed was observed in canola sole cropping (Table 8, 9). This agrees with reports of Libman and Dyck Dik (1993) on decrease in weed biomass in mixed culture in relation with sole cropping. Results showed also that with increase bean density in mixture, weed biomass had decreasing trend. It seems that morphological traits of bean (such as high growth rate, early canopy closure and long term coverage of surface soil) and competition ability of this crop, had significant effect on decreasing weed biomass, particularly in early growth season (Siner *et al*., 2000).

Results of this experiment showed effect of type of farming system on weed density and species composition. This agrees with Shetty and Rao (1981).

In mixed culture of canola and bean, weed dry weight and diversity was significantly decreased (Table 9). It seems that difference between crops in response, change and renovation in farming options and crop and weed traits as well as time of emergence, were cause of changes in weed density and their dominance within crops. In other hand, change in crop density and spatial array have prevented invrease in population of a particular species, that agrees with reports of Deksen *et al*. (2002).

CONCLUSION

The existence of interaction between components of one culture pattern and farming systems, such as presence of different crops, plough systems, application of different herbicides and management of plant residues, makes difficult the estimation of equality of reactions of different weed populations or control strategy in a farming system. In fact, using diversity of crops will be as a tool

to disrupt of balance and stability of weed communities, increase ability of competition of crop, maintenance the quality of resources and environment. Using mixed culture in the condition of experiment region with common farm crops, can be effective in establishing stability in the agricultural ecosystems in terms of biological, economical and environmental dimensions.

REFERENCES

Carr, P.M., B.G. Schatz, J.C. Gardner and S.F. Zwinger, 1992. Intercropping sorghum and pintobean in a cool semiarid region. Agron. J., 84: 810-812.

Deksen, D., A. Anderson, R.E. Blackshaw and B. Maxwell, 2002. Weed dynamics and management strategies for cropping systems in the northern great plains. Agron. J., 94: 174-185.

Fairys, N.A., 1990. Effects of nitrogen fertilizer, cutting frequency and companion legume on herbage production and quality of four grasses. Can. J. Plant Sci., 71: 717-725.

Finckh, M.R. and M. Karpenstein-Machan, 2002. Intercropping for Pest Management. In: Encyclopedia of Pest Management. Pimentel, D. (Ed.). Taylor and Francis Press, ISBN: 978-0-8247-0632-6.

Fukais, B. and R. Trenbath, 1993. Processes determining intercrop productivity and yields of component crops. Field Crop Res., 34: 247-271.

Libman, M. and E. Dyck., 1993. Crop rotation and intercropping strategies for weed management. Ecol. Applied, 3: 92-122.

Nargis Akter, M.D., A. Alim, M. Mahbubui Islam, Z. Naher, M. Rahman and A.S.M. Iqbal Hossein, 2004. Evaluation of mixed and intercropping of lentil and wheat. J. Agron., 3: 48-51.

Piper, J.K., 1993. Neighborhood effects on growth, seed yield and weed biomass for three perennial grains in polyculture. J. Sustain. Agric., 4: 11-31.

Raji, J.A., 2007. Intercropping soybean and maize in a derived savanna ecology. Afr. J. Biotechnol., 6: 1885-1887.

Rouber, R., K. Scmidtke, H. Kimpel-Freund, 2000. Competition and yield advantage in mixtures of pea (*Pisum sativum* L.) and oats (*Avena sativa* L.). J. Agron. Crop Sci., 185: 33-47.

Saka, J.O., O.N. Adeniyan, S.R. Akande and M.O. Balogun, 2007. An economic evaluation of intercropping African yam bean, kenaf and maize in the rain forest zone of Nigeria. Middle East J. Sci. Res., 2: 1-8.

Shetty, S.V.R. and A.N. Rao, 1981. Weed management studies in sorghum/pigeon pea and pearl millet/groundnut Intercrop systems observation. Proceeding International Workshop Intercropping, ICRISAT, 1981, Hyderabad, India, 238-238.

Siner, J., W. Cox and E. Shields, 2000. Cropping system effects on weed emergence and densities in corn. Agron. J., 92: 754-760.

Sobkowicz, P., 2006. Competition between triticale and field beans in additive intercrops. Plant Soil Environ., 52: 47-56.

Tsubo, M., E. Mukhala, H. Ogindo and S. Walker, 2003. Productivity of maize-bean intercropping in a semiarid region of South Africa. Water SA., 29: 381-388.

Vandermeer, J.H., Intercropping, C.R. Carrol, J.H. Vandermeer and P.M. Rosset, 1990. Agroecology (Biological Resource Management). 1st Edn. McGraw Hill, New York, ISBN-10: 007052923X, pp: 481-516.