

EFFECT OF PRECEDING AND INTERCROPPING CROPS ON YIELD AND YIELD COMPONENTS OF WHEAT

M.A. Abou-Kerisha, R.A. Gadallah and M.M.A. Badr
Crop Intensification Research Department Field Crop Research Institute
Agricultural Research Center, Giza, Egypt

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ABSTRACT: *Two field experiments were conducted at Mallawi Agricultural Research Station in Minia governorate (Middle Egypt) in 2004 / 2005 and 2005 / 2006 grown seasons, to study the effect of three preceding crops (maize, maize sequence berseem and soybean) and intercropping two legumes crops (fahl berseem and faba bean) on yield and yield components of wheat. The experimental design was split plots with three replications.*

The data obtained showed that grain and straw yield of wheat grown after maize sequence berseem or soybean were higher than grown after maize. Intercropping wheat with faba bean or fahl berseem resulted in increased yield components of wheat. Grain yield of wheat grown with faba bean was higher than that grown with fahl berseem.

Wheat was a superior intercrop component where the relative yield produced was equal to that obtained from 90 to 94 % of solid. While the relative yield obtained of fahl berseem and faba bean was 16-19% for fahl berseem and 35 to 39 % for faba bean. The values of competitive ratio (CR) for wheat were greater than for common faba bean or fahl berseem indicating the dominance of wheat under these crops mixtures.

Similar trend to that of land equivalent ratio (LER) and competitive ratio (CR) was also observed for actual yield loss (AYL). The values of AYL for faba bean was positive in faba bean and wheat, which indicated a yield advantage for faba bean- wheat, while, AYL values for fahl berseem was negative in common fahl berseem wheat, which indicated a yield disadvantage for fahl berseem. AYL values for wheat was positive in the common fahl berseem wheat and faba bean, wheat. The highest gross return (7156.85 L.E) was obtained by intercropping wheat with faba bean grown after maize followed by intercropping wheat with faba bean grown after soybean.

Key words: *intercropping, clover, faba bean with wheat, preceding crops.*

INTRODUCTION

Wheat is one of the most important cereal crops in Egypt as well as in many countries around the world. Wheat production in Egypt does not meet the local consumption and it is not possible to add more increase to the area of wheat. The increasing of the yield per unit area is a necessity at the present time through several avenues, i.e. fertilization, irrigation, preceding crop, cropping system and others.

In Egypt farmers have small sized farms and this lead to planting wheat after maize in the same land every year. This system resulted in low grain yield and soil fertility as a result of planting cereal crops in the same area.

Legumes crops are used commonly in agriculture as a source of N for maintaining soil N levels.

Entz *et al* (2002), Glasener *et al* (2002) and Grant *et al* (2002) noted that cropping systems include legumes have the potential for contributing N to the following crops.

Kanwar *et al* (1990) found that the average yields of wheat grown without N fertilizer after legume crops (Pigeon peas, green gram, groundnut or soybean) were higher than those after non legume crops (pear millet, or sorghum). Abou-Kerisha (1998) showed that the increases in the mean values of growth and yield were greater when wheat was grown after maize followed by berseem (tri-cropping sequence) than grown after maize (di-cropping sequences). Grain and straw yields of wheat grown after maize followed by berseem was 25.3 and 19.6 % higher than after maize.

Cereal-legume intercropping offers potential benefits in low-input cropping systems, where nutrient inputs, in particular nitrogen (N) are limited. Abdel-Shafi *et al* (1986) showed that plant height ,number of grains / spike and 1000 grain weight of wheat were increased by intercropping with faba bean, while grain and straw yield / fad. were increased as compared with wheat monoculture. Radwan (1993) showed that plant height, spike length, number of grains / spike, weight of 1000 grain and straw yield fad of wheat were increased by intercropping with faba bean, while number of spikes / m² and grain yield / fad. were increased compared to wheat monoculture. El-Naggar *et al* (1991) showed that plant height, tiller numbers and 1000 grain weight of wheat were increased when it was intercropped with berseem. Kahurananga (1991) found that intercropping some clover species with wheat had no any significant effect on wheat grain yield. Abate *et al* (1992) also found that the presence of clover in wheat stands did not affect wheat grain yields significantly across locations and seasons. Mahrous *et al* (1998) found that intercropping lentil with wheat decreased grain or seed and straw yield, seed index for both crops, number of grains / spike for wheat and number of branches for lentil. Banik *et al* (2000) revealed that the actual yield loss (AYL) index can give more precise information than the other indices on the inter and intra-specific competition of the component crops and the behavior of each species involved in the intercropping systems. Khalif *et al* (2001) showed that lentil alone and wheat alone produced their maximum respective grain yields of 10.99 and 42.10 q / ha⁻¹ (quintal = 45 kg) compared to those recorded in various intercropping systems. However, in terms of monetary gain, the highest net income was obtained from intercropping one row of lentil with two rows of wheat. Liben *et al* (2001) indicated that intercropping of maize with faba bean is more advantageous than sole cropping of crops. The highest land equivalent ratio (LER) and economic

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advantage with a net return was observed in the treatment which is a combination of planting pattern of 1 maize: 1 faba bean alternate rows. Banik *et al* (2006) reported that chickpea yield was significantly reduced when it was intercropped with wheat. Wheat facilitated an increase in nodule number and dry weight as well as root length of chickpea under intercropping over monocropping. These findings suggest that intercropping wheat and chickpea increase total productivity per unit area and improve land use efficiency. Fentliang *et al* (2006) showed that the grain yield of faba bean intercropped with maize was greater than that of faba bean monoculture due to increases of the stems per plant and the pods / stem of faba bean. Faba bean growth was suppressed in the wheat / faba bean intercropping system, and facilitated in the maize / faba bean intercropping system which disagrees with the traditional view that legumes are generally weak competitors compared with cereals in legume / cereal intercropping systems. Thorsted *et al* (2006 a) showed that intercropping of winter wheat and white clover decreased wheat grain yield by 10-25% as compared with wheat sole cropping. The yield reductions were likely caused by inter specific competition for light nutrients and water during vegetative growth and during grain filling period. Thorsted *et al* (2006 b) suggested that competition between wheat and white clover for nitrogen is reduced by nitrogen fixation of clover. Increase of availability of nitrogen to the intercropped wheat late in the growing season could increase grain protein content. Dhima *et al* (2007) showed that the values of aggressivity, competitive ratio (CR) and actual yield loss (AYL) were greater for barley and oat than for wheat and triticale, whereas the corresponding values for common vetch were lower in mixtures with barley and oat than in mixtures with wheat and triticale.

MATERIALS AND METHODS

Two field experiments were conducted at Mallawi Agricultural Research Station in Minia governorate (Middle Egypt) in 2004 / 2005 and 2005 / 2006 growing seasons, to study the effect of three preceding crops and intercropping wheat with berseem or faba bean on yield and yield components of wheat. The experimental design was split plots with three replications. The main plots were allocated to three preceding crops, i.e. maize, maize + berseem and soybean, while three intercropping treatment were assigned in the sub plots.

The treatments were as follow

I- The preceding crops

- a- Maize (A₁)
- b- Maize followed by berseem (A₂)
- c- Soybean (A₃)

II- Intercropping treatments:

1. Pure stand of wheat (Giza 168) was sown in rows (15 cm. apart) (b₁).
2. Pure stand of clover (fahl berseem) was sown in rows (15 cm .apart) (b₁).
3. Pure stand of faba bean (Giza 2) was sown in hills 20 cm apart on the two sides of ridges (60 cm. in width) and two plants per hill (b₁).
4. Single row of fahl berseem was sown by hand drilling between each two rows wheat (67% wheat + 33% fahl berseem of plot) in alternative system (b₂).
5. Single row faba bean was sown in hills (10 cm. apart) between each two rows wheat (67% wheat + 33% faba bean of plot) in alternative system (b₃).

The sub-plot area was $3.75 \times 6 = 22.5 \text{ m}^2$ ($\frac{1}{187}$ fad.) included 24 rows. Wheat grains were sown by hand drilling at a rate 40 kg/ fad. (9 gm / row). Seeds of faba bean were sown in rows 15 cm. and in hills at 20 cm. apart and thinned to one plants / hill at a rate 60 kg/ fad (13 gm / row). While seeds of fahl berseem were sown by hand drilling at rate 20 kg/ fad. (5 gm./row). Sowing and harvesting data of the crops, wheat and intercropped crops are recorded in Table (1).

Table (1): Sowing and harvesting dates of crops, wheat, fahl berseem and faba bean in 2004/5 and 2005/6 seasons.

Crops	First season 2004/ 5		Second season 2005 / 6	
	Sowing	Harvesting	Sowing	Harvesting
Wheat solid or intercropped	Nov. 22 nd Nov. 22 nd	May 25 th	Nov. 17 th Nov. 17 th	May 21 st
Fahl berseem solid or intercropping	Oct. 25 th Nov. 22 nd	May 15 th May 25 th	Oct. 20 th Nov. 17 th	May 10 th May 21 st
Faba bean solid or intercropping	Oct. 25 th Nov. 22 nd	April 15 th May 25 th	Oct. 20 th Nov. 17 th	May 11 st May 21 st

Normal cultural practices were done for crops under study, either in pure stand or intercropped as recommended. Calcium superphosphate (15kg P₂O₅/fad) was added during soil preparation. Potassium fertilizer was applied as potassium sulphate (48% K₂O) at the rate of 24 kg K₂O / fad. with the first dose of nitrogen to all crops either as sole or intercropping. Nitrogen fertilizer was applied to wheat as ammonium nitrate (33.5% N) at the rate of 70 kg N / fad and was added in three equal doses before each of first, second and third irrigations.

At full growth, ten plants of wheat, fahl berseem and faba bean were randomly taken from each sub plot to determine plant characters and yield components. Each, sub plot was harvested and seeds or grains were

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separated through sifting. Yield of all crops were determined on plot basis and converted to one faddan.

The following characters were studied.

1. **Wheat:** plant height (cm), spike length (cm), number of spike / m², weight of grains / spike(g), number of grains spike, weight of 100 grain(g), grain yield / fad.(ardab) and straw yield / fad. (heml) (ardab=150 kg and heml = 250 kg)
2. **Faba bean:** plant height, number of branches / plant , number of seeds / pod , weight 100 seed (g) seed yield / plant (g) and seed yield (ardab / fad.) (ardab = 155 kg)
3. **Berseem:** plant height, wt 1000 seed and seed yield / fad.(ardab = 157 kg).

Competitive relationships and yield advantage:

- 1- Land equivalent ratio (LER) was calculated according to Willey (1979) using the following formula

$$LER = \frac{yab}{yaa} + \frac{yba}{ybb}$$

Where : yaa = pure stand yield of species a

ybb = pure stand yield of species b

yab = Mixture yield of a (when combined with b)

yba = Mixture yield of b (when combined with a)

- 2- Competitive ratio (CR) was calculated by following the formula as advocated by Willey and Rao (1980):

$$CR = CRa + CRb \quad CRa = \left\{ \left(\frac{LERa}{LERb} \right) \times \left(\frac{Zba}{Zab} \right) \right\},$$

Where: LERa and LERb represent relative yield of a and b intercrops, respectively. Since the CR values of the two crops will in fact be reciprocals of each other. CRa, CRb are the competitive ratio for intercrop wheat. Zab representing the sown proportion of intercrop a (wheat) in mixture with b (fahl berseem or faba bean) and Zba the sown proportion of intercrop b (fahl berseem or faba bean) in mixture with a (wheat).

- 3- Actual yield loss (AYL) (Banik, 1996) was calculated as:

$$AYL = AYL_a + AYL_b$$

$$= \left[\left\{ \frac{(Yab/Zab)}{(Yaa/Zaa)} \right\} - 1 \right] + \left[\left\{ \frac{(Yba/Zba)}{(Ybb/Zbb)} \right\} - 1 \right].$$

Where AYL_a and AYL_b are the partial yield loss of intercrop wheat and fahl berseem or faba bean, respectively. Yab representing the yield of intercrop a (wheat) in mixture with b (fahl berseem or faba bean), Yba the yield of intercrop b (fahl berseem or faba bean) in mixture with a (wheat).

4. Gross profit:

Gross profit was calculated in Egyptian pound (wheat 165 L.E / ardab, straw / heml 280 L.E, faba bean 300 L.E / ardab and fahl berseem 1099 L.E / ardab. All data were statistically analysed according to Snedecor and Cochran (1988) using MSTAT software Computer V₄ (1986). LSD test at 5% level was used to compare between treatments.

RESULTS AND DISCUSSION

I – Wheat

A– Effect of preceding summer crops on yield and yield components:

The data obtained on the effect of some preceding summer crops on yield and yield components of wheat are presented in table (2). The data showed significant differences in all studied characters due to preceding crops in the first, second and the combined analysis of the two seasons. The highest values were observed when wheat was grown after maize followed by berseem (A₂) followed by when wheat grown after soybean (A₃). While the lowest values were observed when wheat was grown after maize (A₁). The data of the combined analysis of the two seasons show that the increase in yield component of wheat grown after maize followed by berseem (A₂) and after soybean (A₃) amounted to 12.35 and 5.02% for plant height, 7.45 and 3.53% for spike length, 7.84 and 2.51% for number of spike/ m², 11.40 and 5.04% for number of grains/ spike, 8.67 and 4.66% for weight of 100 grain and 16.53 and 5.36% for weight of grains/ spike higher than that after maize (A₁), respectively.

The data of the combined analysis of the two seasons show that the increase in grain and straw yields / fad. of wheat grown after maize followed by berseem (A₂) and after soybean (A₃) accounted to 16.45 and 13.51% for grain yield / fad. and 5.79 and 5.45% for straw yield / fad. higher than that after maize (A₁) respectively. The increases of grain and straw yields / fad of wheat grown after berseem or soybean (legume crops) may be due to the increases of yield components compared to that grown after maize (cereal crops). These results were concordant with those obtained by Kanwar et al (1990) and Abou-Kerisha (1998).

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Table (2): Effect of some preceding crops on yield and yield components of wheat in the first and second seasons and their combined analysis.

Preceding crops	Plant height (cm)	Spike length (cm)	No. of spike /m ²	No. of grains /spike	Wt. of 100 grain (g)	Wt. of grains /spike (g)	Grain yield / fad (ardab)	Straw yield /fad (heml)
First season								
A ₁	75.00	9.12	338.97	41.13	4.58	2.06	17.77	6.78
A ₂	89.20	9.86	373.61	46.13	5.02	2.35	21.03	8.12
A ₃	82.70	9.39	362.35	43.00	4.98	2.24	18.63	7.55
LSD at 0.05	2.67	0.05	1.98	1.56	0.12	0.06	0.35	0.22
C.V.	2.48	2.95	0.42	2.85	1.84	2.01	1.40	2.27
Second season								
A ₁	74.00	8.33	335.38	44.87	5.33	2.66	20.80	7.86
A ₂	78.20	8.90	353.58	49.57	5.75	3.13	23.93	8.52
A ₃	76.70	8.72	347.07	48.10	5.37	2.98	23.87	8.23
LSD at 0.05	1.30	0.21	3.36	0.59	0.15	0.14	0.49	0.17
C.V.	1.30	1.86	0.74	0.95	2.08	3.59	1.62	1.54
Combined analysis of the two seasons								
A ₁	74.50	8.73	337.18	43.00	4.96	2.36	19.29	7.33
A ₂	83.70	9.38	363.60	47.90	5.39	2.75	22.48	8.32
A ₃	79.70	9.06	354.71	45.60	5.15	2.61	21.25	7.89
LSD at 0.05	1.23	0.15	1.62	0.69	0.08	0.06	0.25	0.12
C.V.	2.02	2.12	0.60	1.98	2.03	3.01	1.54	1.93

A₁ = Maize, A₂ = Maize / berseem and A₃ = Soybean

B – Effect of the intercropping:

Data presented in table (3) showed that yield and yield components of wheat were significantly affected by the intercropping of wheat with fahl berseem (b₂) and faba bean (b₃) compared to wheat sole cropping (b₁) in both seasons and their combined analysis. The data showed that all studied characters except number of spikes / m² and grain yield / fad were increased by using the two intercropping systems compared to monoculture. Meanwhile, the highest values of these characters were observed when wheat was intercropped with faba bean (b₃) and with fahl berseem (b₂) in a descending order in both seasons and their combined analysis. The data of the combined analysis of both seasons indicated that intercropping wheat with faba bean (b₃) and fahl berseem (b₂) caused an increase in yield and yield component of wheat amounted to 5.87 and 4.30% for plant height, 9.41

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and 6.16% for spike length, 8.49 and 4.36% for number of grains/ spike, 4.78 and 3.78 for weight of 100 grain, 14.23 and 8.37% for weight of grains/ spike and 48.55 and 30.06% for straw yield / fad. respectively as compared with wheat sole cropping (b_1). On the contrary, number of spike/ m^2 and grain yield / fad. were decreased by 26.82 and 8.73% when intercropped with fahl berseem and by 21.09 and 7.70% when wheat was intercropped with faba bean, respectively compared to wheat sole cropping (b_1). These decreasing in grain yield were due to decreases of number of spike/ m^2 under intercropping condition. Similar results are in agreement with those obtained by Abdel shafi *et al* (1986), Radwan (1993), EL-Naggar *et al* (1991) and Thorsted *et al* (2006 a).

Table (3): Effect of intercropping some crops on yield and yield components of wheat in the first and second seasons and their combined analysis.

Intercropping crops	Plant height (cm)	Spike length (cm)	No. of spike / m^2	No. of grains /spike	Wt. of 100 grain (g)	Wt. of grains /spike (g)	Grain yield / fad (ardab)	Straw yield / fad (ton)
First season								
b_1	79.00	8.82	427.08	40.90	4.66	2.05	20.07	6.10
b_2	83.60	9.64	312.27	43.57	4.91	2.21	18.63	7.54
b_3	84.30	9.91	335.58	45.80	5.00	2.39	18.73	8.81
LSD at 0.05	1.40	0.26	2.70	1.93	0.12	0.06	0.32	0.10
C.V.	0.33	2.67	0.73	4.32	2.35	2.47	1.61	1.33
Second season								
b_1	74.40	8.39	410.32	46.33	5.38	2.72	24.37	6.33
b_2	76.30	8.64	300.55	47.43	5.51	2.97	21.93	8.63
b_3	78.10	8.92	325.17	48.77	5.51	3.08	22.29	9.65
LSD at 0.05	1.98	0.39	3.88	1.83	0.11	0.16	0.36	0.17
C.V.	2.48	4.43	1.09	3.75	2.00	5.41	1.53	2.07
Combined analysis of the two seasons								
b_1	76.7	8.61	418.70	43.6	5.02	2.39	22.22	6.22
b_2	80.0	9.14	306.41	45.5	5.21	2.59	20.28	8.09
b_3	81.2	9.42	330.38	47.3	5.26	2.73	20.51	9.24
LSD at 0.05	1.14	0.23	2.24	1.26	0.08	0.08	0.23	0.10
C.V.	2.08	3.73	0.93	4.02	2.21	4.60	1.57	1.80

b_1 = wheat sole cropping, b_2 = wheat + fahl berseem and b_3 = wheat + faba bean

C– Effect of interaction preceding summer crops× intercropping systems on yield and yield components

Data tabulated in table (4) show the effect of the interaction of preceding summer crops and intercropping systems on yield and yield components of wheat. The data of combined analysis showed significant differences in the most studied characters; expect number of grains / spike and weight of 100 grain. The data of the combined analysis show that highest values of most wheat yield components were obtained by sowing wheat after maize followed by fahl berseem (A_2) and intercropped with faba bean (b_3). However the data of the combined analysis showed that wheat sole cropping (b_1) after maize followed by fahl berseem (A_2) as a preceding crops produced the highest values of number of spikes / m^2 and grain yield.

From these results it could be concluded that legume crops are important either as preceding or as intercropping crops which are considered as a source of N for maintaining soil N levels. Similar results are observed by Glasener *et al* (2002), Grant *et al* (2002) and Entz *et al* (2002).

II –Intercropped crops (fahl berseem and faba bean)

A – Effect of preceding summer crops:

Data in table (5) showed the effect of preceding summer crops on the yield and yield components of fahl berseem and faba bean in the first and second seasons and their combined analysis. The data showed that all studied characters of both crops were significantly affected by preceding crops except plant height of faba bean in the combined analysis. The data of the combined analysis indicated that the highest significant values of faba bean characters (plant height, number of branches / plant, number of seed / pod, weight of 100 seeds, seed yield / plant and seed yield / fad.) and fahl berseem characters (plant height, weight of 1000 seeds and seed yield / fad.) were obtained when faba bean or fahl berseem were grown after maize (A_1). Similar results were observed by Kanwar *et al* (1990) and Abou-Kerisha (1998).

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Table (4): Effect of the interaction between preceding and intercropping crops on yield and yield components of wheat in the first and second seasons and their combined analysis.

Preceding crops	Intercropping	Plant height (cm)	Spike length (g)	No. of spike /m ²	No. of grains /spike	Wt. of 100 grain (g)	Wt. of grains / spike (g)	Grain yield / fad (ardab)	Straw yield /fad (ton)
First season									
A ₁	b ₁	73.30	8.73	410.25	37.70	4.40	1.77	18.40	5.87
	b ₂	75.00	9.27	305.75	42.00	4.67	2.13	17.60	6.27
	b ₃	76.70	9.37	300.90	43.70	4.67	2.27	17.30	8.20
A ₂	b ₁	81.70	8.97	440.20	44.70	4.83	2.25	22.00	6.37
	b ₂	93.00	10.27	320.15	46.00	5.10	2.22	20.30	8.53
	b ₃	93.00	10.33	360.50	47.70	5.13	2.59	20.80	9.47
A ₃	b ₁	82.00	8.77	430.80	40.30	4.77	2.13	19.80	6.07
	b ₂	82.70	9.37	315.75	42.70	4.97	2.27	18.00	7.83
	b ₃	83.30	10.03	340.50	46.00	5.20	2.31	18.10	8.77
LSD at 0.05		2.43	0.85	4.67	NS	NS	0.10	NS	0.18
C.V.		0.33	2.67	0.73	4.32	2.35	2.47	1.61	1.33
Second season									
A ₁	b ₁	73.30	8.23	400.20	43.00	5.23	2.40	22.030	6.00
	b ₂	73.70	8.30	310.25	45.30	5.43	2.67	20.30	8.33
	b ₃	75.00	8.47	295.70	46.30	5.33	2.90	20.07	9.27
A ₂	b ₁	75.30	8.47	420.05	48.70	5.67	3.00	25.40	6.67
	b ₂	79.00	9.10	300.60	49.30	5.77	3.17	22.70	8.83
	b ₃	80.30	9.13	340.10	50.70	5.80	3.23	23.70	10.07
A ₃	b ₁	74.70	8.47	410.70	47.30	5.23	2.77	25.70	6.33
	b ₂	76.30	8.53	305.35	47.70	5.33	3.07	22.80	8.73
	b ₃	79.00	9.17	325.15	49.30	5.40	3.10	23.10	9.63
LSD at 0.05		NS	NS	6.72	NS	NS	NS	0.62	NS
C.V.		2.48	4.43	1.09	3.75	2.00	5.41	1.53	2.07
Combined analysis of the two seasons									
A ₁	b ₁	73.30	8.48	405.23	40.40	4.82	2.09	20.22	5.94
	b ₂	74.40	8.79	308.00	43.70	5.05	2.40	18.95	7.30
	b ₃	75.90	8.92	298.30	45.00	5.00	2.59	18.69	8.74
A ₂	b ₁	78.50	8.72	430.13	46.70	5.25	2.63	23.70	6.52
	b ₂	86.00	9.69	310.38	47.70	5.44	2.88	21.50	8.68
	b ₃	86.70	9.73	350.30	49.20	5.47	2.73	22.25	9.77
A ₃	b ₁	78.40	8.62	420.75	43.80	5.00	2.45	22.75	6.20
	b ₂	79.50	8.95	310.55	45.20	5.15	2.67	20.40	8.28
	b ₃	81.20	9.60	332.83	47.70	5.30	2.71	20.60	9.20
LSD at 0.05		1.97	0.40	3.88	NS	NS	0.14	0.39	0.17
C.V.		2.08	3.73	0.93	4.02	2.21	4.60	1.57	1.80

A₁ = Maize, A₂ = Maize / berseem and A₃ = Soybean

b₁ = wheat sole cropping, b₂ = wheat + fahl berseem and b₃ = wheat + faba bean

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Table (5): Effect of preceding crops on yield and yield component of faba bean and fahl berseem in the first and second seasons and their combined analysis.

Preceding crops	Faba bean						Fahl berseem		
	Plant height (cm)	No. of branches/plant	No. of seed /pod	Wt. of 100 seed (g)	Seed yield / plant (g)	Seed yield /fad (ardab)	Plant height (cm)	Wt. of 1000 seed (g)	Seed yield /fad (ardab)
First season									
A ₁	121.00	3.40	3.60	52.00	39.00	5.50	95.90	3.64	1.46
A ₂	118.00	3.40	3.05	45.00	36.50	4.95	91.70	3.59	1.23
A ₃	119.00	3.10	3.05	52.00	35.50	5.30	91.80	3.28	1.37
LSD at 0.05	2.22	0.14	0.23	1.13	1.04	0.18	2.44	0.18	0.07
C.V.	1.16	3.71	4.38	1.42	1.77	2.41	1.63	7.23	3.31
Second season									
A ₁	120.00	3.50	3.30	58.00	41.00	5.70	104.50	3.60	1.52
A ₂	117.50	3.15	2.87	51.00	38.50	4.70	101.50	3.54	1.16
A ₃	119.00	3.20	2.92	57.00	36.50	4.95	102.00	3.35	1.43
LSD at 0.05	1.31	0.12	0.15	0.66	0.66	0.22	1.13	0.16	0.16
C.V.	0.69	2.55	3.13	0.75	1.07	3.09	0.69	2.86	7.30
Combined analysis of the two seasons									
A ₁	120.50	3.45	3.45	55.00	40.00	5.60	100.20	3.62	1.49
A ₂	118.25	3.28	2.96	48.00	37.00	4.83	96.60	3.57	1.19
A ₃	118.50	3.15	2.99	54.50	36.00	5.13	96.95	3.32	1.40
LSD at 0.05	NS	0.10	0.15	0.54	0.51	0.68	112.00	0.09	0.07
C.V.	0.95	3.19	5.05	1.10	1.44	2.86	1.21	3.00	5.75

A₁ = Maize, A₂ = Maize / berseem and A₃ = Soybean

B- Effect of intercropping faba bean and fahl berseem with wheat on the intercropped crops.

Data presented in table (6) showed that most studied characters of fahl berseem, i-e, plant height, weight of 1000 seeds and seed yield / fad of solid fahl berseem were higher than those grown with wheat. Faba bean plant height of solid were shorter than those grown with wheat while, weight of 100 seeds, seed yield /plant and seed yield / fad of solid faba bean were higher in most traits than those grown with wheat in the first, the second seasons and the combined analysis of both seasons. Seed yield / fad of faba bean and fahl berseem intercropped with wheat amounted to 37.35 and 17.24 % of their sole cropping, respectively in the combined analysis of the two seasons. It is clear that competitive of wheat with fahl berseem was impact higher than that with faba bean. Similar results are observed by El-Naggar *et al* (1991), Radwan (1993) and Mahrous *et al* (1998).

Table (6): Effect of intercropping crops on yield and yield component of faba bean and fahl berseem in the first and second seasons and their combined analysis.

Faba bean							Fahl berseem			
Intercropping crops	Plant height (cm)	No. of branches/plant	No. of seed / pod	Wt. of 100 seed (g)	Seed yield / plant (g)	Seed yield / fad (ardab)	Intercropping crops	Plant height (cm)	Wt. of 1000 seed (g)	Seed yield fad / (ardab)
First season										
b ₁	115.7	3.32	3.19	50.00	37.33	7.40	b ₁	101.4	3.60	2.30
b ₃	123.0	3.28	3.28	49.30	36.67	3.10	b ₂	84.8	3.40	0.40
LSD at 0.05	2.21	NS	NS	NS	NS	0.24	LSD at 0.05	2.65	0.17	0.11
C.V.	1.61	2.54	5.36	4.27	3.68	4.04	C.V.	2.47	5.11	7.03
Second season										
b ₁	114.0	3.26	3.04	55.70	39.00	7.70	b ₁	111.0	3.56	2.33
b ₃	123.7	3.31	3.02	55.00	38.33	2.53	b ₂	94.3	3.43	0.40
LSD at 0.05	2.15	NS	NS	NS	NS	0.23	LSD at 0.05	1.76	0.10	0.11
C.V.	1.57	3.73	2.33	1.95	4.60	3.91	C.V.	1.49	2.55	6.92
Combined analysis of the two seasons										
b ₁	114.8	3.29	3.12	52.83	38.17	7.55	b ₁	106.3	3.58	2.32
b ₃	123.3	3.30	3.15	52.17	37.17	2.82	b ₂	89.6	3.42	0.40
LSD at 0.05	1.37	NS	NS	NS	NS	0.15	LSD at 0.05	1.42	0.10	0.07
C.V.	1.59	3.19	4.17	3.20	4.27	4.00	C.V.	1.99	3.61	6.98

b₁ = faba bean or fahl berseem sole cropping,

b₂ = wheat+ fahl berseem and

b₃ = wheat + faba bean

C. Interaction effect of preceding crops and intercropping on yield and yield components.

Data presented in table (7) showed that intercropping faba bean with wheat led to increase plant height, number of branches / plant and number of seed / pod of faba bean plant compared to faba bean sole cropping, although the effect was insignificant of the combined analysis of the two seasons. With regard to weight of 100 seed and seed yield / plant, the differences were significant but the trend in some cases was not regular. Seed yield / fad of faba bean sole cropping was significantly higher than that obtained by different intercropping treatments. Plant height of fahl berseem sole cropping was significantly higher than those recorded for the intercropped plants. Differences in weight of 1000 seed between sole planting and intercropping treatments were insignificant under the same respective interaction treatments. Seed yield / fad of fahl berseem sole cropping was ever higher than those obtained when it was intercropped. Furthermore, statistical analysis showed significant interaction effect in the second

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season and the combined analysis of the two seasons. Similar results were observed by Abdel-Shafi *et al* (1986), Radwan, (1993) and Mahrous *et al* (1998).

Table (7): Effect of the interaction between preceding and intercropping crops on yield and yield component of faba bean and fahl berseem in the first and second seasons and their combined analysis.

		Faba bean						Fahl berseem		
Preceding	Intercropping	Plant height (cm)	No. of branches plant	No. of seed / pod	Wt. of 100 seed (g)	Seed yield / plant (g)	Seed yield / fad (ardab)	Plant height (cm)	Wt. of 1000 seed (g)	Seed yield / fad (ardab)
crops										
First season										
A ₁	Solid	117	3.39	3.55	51.0	42.0	7.7	105.7	3.67	2.50
	inter	125	3.41	3.65	53.0	36.0	3.3	86.0	3.60	0.41
A ₂	Solid	113	3.38	3.00	48.0	35.0	7.1	95.3	3.70	2.10
	inter	123	3.42	3.10	42.0	36.0	2.8	88.0	3.47	0.35
A ₃	Solid	117	3.20	3.02	51.0	35.0	7.4	103.3	3.43	2.30
	inter	121	3.00	3.08	53.0	36.0	3.2	80.3	3.13	0.43
LSD at 0.05		NS	NS	NS	4.24	2.83	NS	4.59	NS	NS
C.V.		1.61	2.54	5.36	4.27	3.68	4.04	2.47	5.11	7.03
Second season										
A ₁	Solid	115	3.49	3.25	57.0	44.0	8.6	113.0	3.60	2.60
	inter	125	3.51	3.35	59.0	38.0	2.8	96.0	3.60	0.43
A ₂	Solid	113	3.10	2.80	54.0	37.0	7.2	108.0	3.57	2.00
	inter	122	3.20	2.93	48.0	40.0	2.2	95.0	3.50	0.31
A ₃	Solid	114	3.18	3.07	56.0	36.0	7.3	112.0	3.50	2.40
	inter	124	3.22	2.77	58.0	37.0	2.6	92.0	3.20	0.45
LSD at 0.05		NS	NS	0.14	2.16	3.56	0.40	3.05	NS	0.19
C.V.		1.57	3.73	2.33	1.95	4.60	3.91	1.49	2.55	6.92
Combined analysis of the two seasons										
A ₁	Solid	116	3.45	3.40	54.0	43.0	8.15	109.4	3.64	2.55
	inter	125	3.45	3.50	56.0	37.0	3.05	91.0	3.60	0.42
A ₂	Solid	113	3.25	2.90	51.0	36.0	7.15	101.7	3.64	2.05
	inter	122.5	3.30	3.02	45.0	39.0	2.5	91.5	3.49	0.33
A ₃	Solid	115.5	3.20	3.05	53.5	35.5	7.35	107.7	3.47	2.35
	inter	122.5	3.10	2.93	55.5	36.5	2.9	86.2	3.17	0.44
LSD at 0.05		NS	NS	NS	2.12	2.02	0.26	2.46	NS	0.12
C.V.		1.59	3.19	4.17	3.20	4.27	4.00	1.99	3.61	6.98

III – Competitive relationships and yield advantages

A - Land equivalent ratio (LER):

Data in table (8) indicated clearly that LER showed considerable yield advantage resulting from intercropping wheat with fahl berseem or faba bean in the combined analysis of the two seasons. The values of land equivalent ratio (LER) for intercropping treatments were greater than one. It could be concluded that the actual productivity was higher than the expected productivity when wheat was intercropped with fahl berseem or faba bean. In this respect, wheat was superior in the intercrop system where the relative yield produced was 90 to 94% of the solid. However fahl berseem or faba bean was inferior companion crop where the relative yield obtained was only 16-19% for fahl berseem and 37 to 39% for faba bean of the sole cropping of both crops. The highest LER value (1.30) was observed when wheat was intercropped with faba bean and after soybean as preceding crop. The lowest LER value (1.07) was obtained when wheat was intercropped with fahl berseem and after preceding crop of maize followed by fahl berseem. This result was similar to those of by Abdel-Shafi *et al* (1986), Radwan, (1993) and Liben *et al* (2001).

B. Competitive ratio (CR)

Data presented in table (8) revealed that wheat had competitive ratio higher than that fahl berseem and faba bean when they were intercropped together. From these results it can be noticed that wheat was dominant crop when it was intercropped with either fahl berseem or faba bean. These results are agreed with those obtained by Thorsted *et al* (2006 a) and Dhima *et al* (2007).

C- Actual yield loss (AYL):

Similar trend to that of LER and CR was also observed for AYL (Table 8). In particular, AYL for faba bean was positive values in the faba bean- wheat association, which indicates a yield advantage for faba bean, probably because of the positive effect of wheat on faba bean when grown in association while AYL values of fahl berseem was negative when intercropped with wheat which indicates a yield disadvantage occurred when fahl berseem was intercropped with wheat. AYL for wheat was positive values in the fahl berseem - wheat and faba bean – wheat associations. AYL values of wheat were less than AYL values of fahl berseem–wheat intercrop, which resulted in total negative AYL. Quantification of yield loss or gain due to association with other species or the variation of the plant population could not be obtained through partial LER since partial AYL shows the yield loss or gain by its sign and as well as its value. Thus there was AYL values of faba bean ranged from 0.050 to 0.185 indicating an increase in yield from 5.0 to 18.50 % faba bean–wheat intercrop when they grown after maize followed

Table (8): Effect of preceding and intercropping crops on competitive relationships and gross profit in the combined analysis of the two seasons.

Preceding crops	Intercropping crops	Land equivalent ratio				Competitive ratio			Actual yield loss				Gross Profit L.E
		LER wheat	LER Faba bean	LER Fahl berseem	LER	CR wheat	CR faba bean	CR Fahl berseem	AYL wheat	AYL faba bean	AYL Fahl berseem	Total	
A ₁	b ₁	1.00	---	---	1.00								4999.50
	b ₂	----	1.00	----	1.00								2445.00
	b ₃	----	----	1.00	1.00								2802.45
	b ₄	0.94	----	0.16	1.10	2.938	---	0.340	+0.405	----	-0.506	-0.101	5632.33
	b ₅	0.92	0.37	----	1.29	1.243	0.804	----	+0.386	+0.124	----	+0.510	6446.05
A ₂	b ₁	1.00	---	----	1.00								5736.10
	b ₂	----	1.00	----	1.00								2145.00
	b ₃	----	----	1.00	1.00								2552.95
	b ₄	0.91	----	0.16	1.07	2.844	----	0.352	+0.360	----	-0.517	-0.157	6340.57
	b ₅	0.94	0.35	----	1.29	1.343	0.745	----	+0.408	+0.050	----	+0.458	7156.85
A ₃	b ₁	1.00	---	----	1.00								5489.75
	b ₂	----	1.00	----	1.00								2205.00
	b ₃	----	----	1.00	1.00								2582.65
	b ₄	0.90	----	0.19	1.09	2.368	----	0.422	+0.344	----	-0.438	-0.094	6167.96
	b ₅	0.91	0.39	----	1.30	1.167	0.857	----	+0.358	+0.185	----	+0.543	6845.00

A₁ = Maize, A₂ = Maize / berseem and A₃ = Soybeanb₁ = Solid wheat, b₂ = solid faba bean, b₃ = solid fahl berseem, b₄ = wheat + fahl berseem andb₅ = wheat + faba bean.

by fahl berseem (A_2), followed by soybean (A_3) as compared to their sole cropping. In contrast, in the fahl berseem- wheat association, the AYL values of fahl berseem ranged from 0.438 to 0.517, indicating yield loss of 43.8 to 51.7% of fahl berseem – wheat association when grown after soybean (A_3) followed by after maize sequence fahl berseem (A_2) as compared with its sole crop yield, which occurred when grown in association with wheat. Similar results were observed by Banik *et al* (2000) and Dhima *et al* (2007).

D. Gross returns

Data presented in table (8) showed that intercropping fahl berseem or faba bean with wheat had favorable gross returns / fad, where the highest gross return (7156.85 L.E) was obtained by intercropping wheat with faba bean (b_5) after the preceding crop of maize followed by berseem (A_2). The gross returns of intercropping wheat with faba bean (b_5) which grown after soybean (A_3) had the second rank (6845.00 L.E). The lowest value (5632.33 L.E) was observed by intercropping wheat with fahl berseem (b_4) grown after the preceding crop of maize (A_1). Similar result was observed by Dhima *et al* (2007).

From these results can be concluded that the best treatment was obtained by intercropping wheat with faba bean after the preceding crop in maize sequence berseem which gave the highest economic returns in this study.

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تأثير المحاصيل السابقة والتحميل على محصول القمح و مكوناته

محمد أبو العيون أبو كريشة، رأفت عايد جاد الله، مصطفى محمود عبد النبي بدر
قسم التكايف المحصولي - معهد بحوث المحاصيل الحقلية - مركز البحوث الزراعية - الجيزة - مصر

الملخص العربي

أجريت تجربة حقلية في محطة بحوث ملوى في محافظة المنيا (مصر الوسطى) في عامي ٢٠٠٤ / ٢٠٠٥ وتم تكرارها في عام ٢٠٠٥ / ٢٠٠٦ وذلك لدراسة تأثير ثلاث محاصيل تسبق القمح (ذرة ، ذرة يعقبها برسيم ، فول صويا) وكذلك تأثير تحميل القمح مع محصولين بقوليين هما (البرسيم الفحل والفول البلدي) وذلك على محصول القمح ومكوناته وعلى الكفاءة الإنتاجية لوحدة المساحة والعائد النقدي . وقد تم استخدام تصميم القطع المنشقة فسي ثلاث مكررات لتنفيذ هذه التجربة ويمكن إيجاز أهم النتائج المتحصل عليها كما يلي :

(١) أوضحت النتائج أن محصول القمح من الحبوب والقش المنزرع بعد ذرة يعقبها برسيم أو بعد فول صويا كانت أعلى من ذلك الذي زرع بعد الذرة الشامية (٢) أدى تحميل الفول البلدي أو برسيم الفحل إلى زيادة في مكونات محصول القمح . وكان محصول القمح النامي مع الفول البلدي أعلى من زراعة القمح مع البرسيم الفحل .

(٣) أثبتت النتائج أن محصول القمح كان محصولاً جيداً للتحميل حيث أعطى محصولاً يقدر بـ ٩٠ ، ٩٤ % من المحصول المنفرد . وعلى الجانب الآخر فإن المحصول النسبي للبرسيم الفحل كان يقدر من ١٦ - ١٩ % من المحصول المنفرد ، و ٣٥ - ٣٩ % من المحصول المنفرد للفول البلدي . (٤) أوضحت النتائج أن القيمة النسبية التنافسية للقمح كانت أعلى من كلا من الفول البلدي أو البرسيم الفحل مما يدل على سيادة القمح بالتحميل مع هذين المحصولين .

(٥) أظهرت النتائج أن التأثير على الخسارة الحقيقية للمحصول كان موازياً لتأثير معدل استغلال الأرض LER والنسبة التنافسية CR بتأثير معاملات التجربة وبينما كانت قيمة الفقد الحقيقي للمحصول موجباً في حالة تحميل القمح مع الفول البلدي والتي يظهر ميزة

محصولية نجد أن هذه القيمة في حالة البرسيم الفحل كانت سالبة في حالة تحميل البرسيم الفحل مع القمح والتي أظهرت عدم تواجد أى ميزة محصولية للبرسيم الفحل وأن قيم الفقد في المحصول بالنسبة للقمح كانت موجبة في حالة تحميل البرسيم الفحل مع القمح أو تحميل القمح مع الفول البلدى (٦) أظهرت النتائج أنه تم التحصل على أعلى عائد نقدى (٧١٥٦,٨٥ جنيها) عندما تم تحميل القمح مع الفول البلدى بعد الذرة وتلاه المعاملة التي تم فيها تحميل القمح مع الفول البلدى بعد فول الصويا .