Effect of Intercropping Wheat with Faba Bean on Wheat Productivity under Sandy Soil Conditions

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ABSTRACT

Two field experiments were carried out at the Experimental Station Farm of the Faculty of Agriculture, Damanhour University, El-Bostan Region, El-Behera Governorate, Egypt, during 2009/2010 and 2010/2011 winter growing seasons. This study aimed to invest?tigate the effect of four Egyptian wheat cultivars (Giza 168, Sakha 94, Gemmiza 9 and Sids 1), as well as six intercropping patterns of wheat with faba bean on wheat productivity under sandy soil conditions. The six intercropping patterns were: solid sowing of wheat at the three seeding rates, 300,350 and 400 grains m^{-2} and/or intercropped with Sakha1 faba bean cultivar by (1:1) alternate rows, 20 cm apart. A split-plot design with four replications was used in each experiment. The wheat cultivars occupied the main plots while, the intercropping patterns were arranged in the sub-plots. The most important obtained results can be summarized as follows:

Wheat cultivars were significantly different in most studied traits, except for plant height, biological yield ha^{-1}, straw yield ha^{-1} and harvest index (%) traits, in both seasons. Giza 168 cultivar surpassed the other three studied cultivars in grain yield ha^{-1} and its components in terms of spike length (cm), number of grains spike^{-1}, number of spikes m^{-2} and 1000-grain weight (g), in both studied seasons.

The solid plantings of wheat had the highest significant means of grain yield ha^{-1} and its studied components in terms of spike length (cm), number of spikelets spike^{-1}, number grains spike^{-1}, number of spikes m^{-2}, biological yield ha^{-1}, straw yield ha^{-1} and 1000- kernel weight (g), in both seasons, compared to intercropping treatments.

Planting wheat solely at the low seeding rate; i.e., 300 grains m^{-2} was significantly different compared with the sole wheat plantings, seeded with the higher rates; i.e., 350 plus 400 grains m^{-2} for most studied traits, in both seasons, except for spike length, biological yield (in the second season), number of grains spike^{-1}, number of spikes m^{-2}, straw yield ha^{-1}, harvest index (%) and 1000-grain weight (g), in both seasons. On the contrary, plant height character of solid wheat plants (in both seasons) was significantly decreased under the low seeding rate, 300 grains m^{-2}, compared to wheat solid planting, but, seeded wheat with the higher seeding rates; i.e., 350 plus 400 grains m^{-2}.

All studied traits were not significantly affected (in both seasons) by increasing seeding rates for solid wheat plantings from 350 to 400 grains m^{-2}, except for the number of grains spike^{-1} that was significantly decreased from 32.28 to 30.38, averaged in both seasons.

Intercropped wheat, with faba bean by planting wheat at a seed rate of 300 grains m^{-2} significantly increased both spike length, from 10.42 to 11.14 cm, and number of spikelets spike^{-1}, from 12.44 to 14.17, averaged in the two studied seasons, compared with intercropped wheat with faba bean, but, seeded wheat with the higher seeding rates; i.e., 350 plus 400 grains m^{-2}. Regarding the other studied traits, they were statistically similar in both seasons for both treatments.

Intercropped wheat with faba bean by seeded wheat with 400 grains m^{-2} insignificantly decreased all studied traits in both seasons, except for both plant height and harvest index, compared with intercropped wheat with faba bean by seeding wheat with 350 grains m^{-2}.

A significant interaction was detected between wheat cultivars and intercropping patterns (VxC$_1$) for the number of spikelets spike^{-1} and grain yield ha^{-1} in the first season.

Intercropping Sakha 1 faba bean cultivar at 166667 plants ha^{-1} with Giza 168 wheat cultivar seeded with the rate of 350 grains m^{-2} in (1:1) alternate rows, 20 cm apart, under El-Bostan Region conditions, could be advised to obtain a high productivity of wheat.

Key words: Wheat cultivars, intercropping patterns, solid plantings, seeding rates.

INTRODUCTION

Wheat is the main cereal crop in the world, as well as in Egypt. Wheat provides more than one-third of the daily calorie intake of consumers and 45% of their total daily protein consumption (Rowntree, 1993 and Abdel Ghaffar, 1994). The gap between the national needs and the local wheat production was estimated by about 4.73 million tons yearly, which represent about 36.38% of the national production (Darwish *et al.,* 2008). So, Egypt ranked the second among the world countries in importing wheat (Aboushal and Mahmoud, 2009). A great attention of several investigators has been directed to increase the productivity of wheat to minimize the gap between the Egyptian production and consumption, through increasing unit land area productivity and increasing planted area, particularly, using intercropping with other crops. Intercropping wheat with faba bean may be considered as one of the methods to increase the growing wheat area, horizontally, where,

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the Egyptian planted land is limited (El-Monufi, 1984; Ali *et al.*, 1986; Saleh *et al.*, 1986; Abd- El-Gawad *et al.*, 1988 and El-Metwally *et al.*, 2002).

Seeding rate of wheat crop, in a mixture with faba bean, may be adjusted below its full rate. If the full rates of both crops were planted, neither would yield well because of overcrowding. Reducing the seeding rate of wheat may a chance wheat to yield well within the mixture. Accordingly, selecting the optimum wheat seeding rate, the suitable wheat cultivar and the intercropping pattern with faba bean which, produces high yields of both crops, under sandy soil conditions, was the aim of the present study.

MATERIALS AND METHODS

Two field experiments were carried out, during the two successive winter growing seasons of 2009/2010 and 2010/2011, at the Experimental Farm of the Faculty of Agriculture, Damanhour University, El-Bostan Region, El- Behera Governorate, Egypt, to study the performance of four Egyptian cultivars of wheat (Giza 168, Sakha 94, Gemmiza 9 and Sids 1) as well as six intercropping wheat with faba bean patterns, on wheat productivity under sandy soil conditions. The six intercropping patterns were as follows:

1-Sowing wheat as a sole crop at the rate of 300 grains m^{-2} (W_lF_0).

2-Sowing wheat as a sole crop at the rate of 350 grains m^{-2} (W_mF_0).

3-Sowing wheat as a sole crop at the rate of 400 grains m^{-2} (W_hF_0).

4-Intercropped wheat with faba bean at the rate of 300 grains of wheat m^{-2} (W_lF_1).

5-Intercropped wheat with faba bean at the rate of 350 grains of wheat m^{-2} (W_mF_1).

6-Intercropped wheat with faba bean at the rate of 400 grains of wheat m^{-2} (W_hF_1).

Soil samples, taken from the experimental site were mechanically analyzed (Piper, 1950) and are presented in Table (1).

A split–plot experimental design, with four replicates, was used in both seasons. The cultivars were randomly assigned to the main plots, while, the intercropping patterns were allocated in the sub–plots. The area of the sub–plot was 7.0 m^2 (3.5 m long and 2.0 m wide), including ten rows, 20 cm apart, where wheat seeds were hand drilled, while, faba bean was hand-planted in hills, in both seasons. Faba bean, Sakha 1 cultivar, was intercropped with wheat in (1:1) alternative rows. The plant population of faba bean was about 166667 plants ha^{-1}. and was maintained through thinning seedlings to one plant $hill^{-1}$, spaced at 30 and 15 cm for solid and intercropping treatments, respectively. Both crops were sown on 5th Nov. in both seasons. Phosphorus fertilizer was broadcast during soil preparation in the form of calcium super phosphate (15.5 P_2O_5%) at the rate of 75.0 kg P_2O_5 ha^{-1}. Potassium sulphate (48% K_2O) was side-dressed at the rate of 60.0 kg K_2O ha^{-1} before the first irrigation. Ammonium sulphate (20.5% N), at the rate of 240 kg N ha^{-1}, was added in three splits; namely, (1/5) broadcasted after sowing before irrigation and (4/5) was side-dressed at two equal doses before first and second irrigations. All other cultural practices were applied as recommended for wheat fields in El-Bostan Region.

Plants were harvested at 155 days from sowing, in both seasons, then ten random guarded wheat plants were taken from each sub-plot to calculate the following characters:

1- Plant height(cm): measured from ground surface up to the tip of stem spike. 2- Spike length (cm). 3- Number of spikelets $spike^{-1}$. 4- Number of grains $spike^{-1}$.

Also, a guarded length of one meter from the inner six rows of each sub-plot was harvested to determine the following traits:

5- Number of spikes m^{-2}: number of fertile tillers m^{-2} was calculated by counting all spikes per square meter.

6-Biological yield ha^{-1}: was recorded for the harvested area and converted to tons ha^{-1}.

7-Grain yield ha^{-1}: was recorded for the harvested area after threshing and, then, converted to tons ha^{-1}.

8-Straw yield ha^{-1}: the straw yield of the previous samples was estimated in kg m^{-2}= [Biological yield (kg m^{-2}) – grain yield (kg m^{-2})],then, it was converted to tons ha^{-1}.

9-1000-grain weight (g): recorded as the average of two random samples, each with 1000 clean grains.

10- Harvest index (H.I %): calculated as follows:

H.I (%) = (Grain yield/Biological yield) x 100.

Five orthogonal comparisons were done for intercropping patterns; i.e., C_1: Solid vs. intercropping wheat plantings; C_2: Low rate of solid wheat plantings vs. both the medium and high rates of solid wheat plantings { W_lF_0 vs. (W_mF_0+ W_hF_0)}; C_3: The medium rate of solid wheat plantings vs. the high rate of solid wheat plantings (W_mF_0 vs. W_hF_0); C_4: The low rate of intercropped wheat and faba bean plantings vs. both the medium and high rates of intercropped wheat and faba bean plantings {W_lF_1 vs. (W_mF_1+ W_hF_1)} and C_5: The medium rate of intercropped wheat and faba bean plantings vs. the high rate of intercropped wheat and

Table 1. Soil mechanical analysis of the experimental sites in 2009/2010 and 2010/2011 growing seasons

Characteristics	Seasons	
	2009/2010	2010/2011
Sand (%)	77.37	74.25
Silt (%)	4.66	5.11
Clay (%)	17.97	20.64
Texture class	Sandy	

faba bean plantings (W_mF_1 vs. W_hF_1). On the other hand, the other five orthogonal comparisons were done for the interactions; i.e., V×(C_1, C_2, C_3, C_4 and C_5). The obtained data were statistically analyzed, according to (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

A-Wheat cultivars performance:

Data of the grain yield ha^{-1} and its components of the four wheat cultivars; i.e., Giza 168, Sakha94, Gemmiza 9 and Sids 1, in 2009/2010 and 2010/2011 seasons, are presented in Tables (2 and 3). Data indicated that the four wheat cultivars were significantly different in the grain yield ha^{-1} and its studied components in both seasons, except for the plant height, biological yield ha^{-1}, straw yield ha^{-1} and harvest index traits, where these traits were insignificantly affected by the studied wheat varieties in both studied seasons (Table 2). In this concern, many studies reported insignificant differences among wheat cultivars, regarding plant height (Shalaby *et al.,* 1992; El-Genbeehy, 1994; Hassan, 2003 and Shalaby *et al.,* 2009), biological yield and harvest index (El-Eryani, 1995 and Shalaby *et al.,* 2009)and straw yield (El-Genbeehy, 1994). On the other hand, the data disagreed with those stated by other studies, which reported significant wheat cultivars differences, regarding plant height (Tabl *et al*., 2005); straw yield, biological yield and harvest index (Saleh, 2000; Moussa,2001;Ali *et al.,* 2004; Tabl *et al.,*2005 and Badran ,2009. The difference between the present results and these ones may be due to the fact that they tested foreign along with Egyptian genotypes that differed in their genetic make up and their interaction with the environmental conditions prevailing during their growth.

Data presented in Table(3) showed that Giza 168 cultivar surpassed the other varieties in grain yield ha^{-1} and its components, in terms of spike length (cm), number of grains $spike^{-1}$, number of spikes m^{-2} and 1000-grain weight in both studied seasons. The differences in grain yield and its components among the evaluated four wheat varieties might be attributed to their genetic variations. Significant varietal differences in the literature, regarding these traits were reported (Abdel-Hameed, 2002; Saleh, 2003; Ali *et al.,* 2004; Abdel-Hameed, 2005 and Badran, 2009). Moreover, the other cultivars gave different mean values for the studied traits in both seasons.

B- Intercropping patterns effect:

The analysis of variance for the effect of intercropping patterns on grain yield and its studied components, in 2009/2010 and 2010/2011 seasons are presented in Table(2). The results showed either significant or highly significant effects for the six studied intercropping patterns on all studied traits, in both seasons, except for the harvest index character, in the second season, where the differences did not reach the level of significance.

Concerning the first comparison, C_1; i.e., solid wheat plantings vs intercropping wheat with faba bean plantings, data in Table (2) indicated that almost highly significant differences were detected in both seasons between both treatments for all studied traits, except for harvest index character(in the second season). The solid wheat plantings had the highest means of grain yield ha^{-1} and its studied components, in terms of spike length (cm), number of spikelets $spike^{-1}$, number of grains $spike^{-1}$, number of spike m^{-2}; biological yield ha^{-1}; straw yield ha^{-1} and 1000- kernel weight (g), in both seasons, compared to intercropping treatments (Table 3). These results might be attributed to the higher density of plants in intercropping plantings, in which lower light interception, water and nutrients were found than solid culture. The present results were in agreement with those stated by Ali *et al.* (1986) El-Naggar *et al*. (1991) Radwan (1993) and Thorsted *et al.* (2006). On the contrary, the intercropped wheat plants were significantly superior for plant height (in both seasons) and H.I (in the first season), compared with the solid wheat plantings (Table 3). The increase in plant height for intercropping treatments might be attributed to the shading and competition among wheat and faba bean plants effects in dense population for light, which caused an increase in some growth substances, such as auxins and, consequently, more plant elongation produced compared with solid wheat culture. Similar findings were reported by Abd El-Gawad *et al.* (1986), Radwan (1993) and Abou-Kerisha *et al.*(2008).

Table 2. Mean squares for the analysis of variance of wheat grain yield (tons ha^{-1}) and its components, as affected by wheat cultivars (V) and intercropping patterns (I) with faba bean in 2009/2010 and 2010/2011 winter growing seasons

SOV	DF	Traits									
		Plant height (cm)		Spike length (cm)		No. of spikelets $spike^{-1}$		No. of grains $spike^{-1}$		No. of spikes m^{-2}	
		2009/2010	2010/2011	2009/2010	2010/2011	2009/2010	2010/2011	2009/2010	2010/2011	2009/2010	2010/2011
Replications	3	137.36	263.63	10.24**	23.08**	221.31**	167.03**	18.74**	23.93*	2324.69	7541.97*
Wheat varieties (V)	3	678.00	886.00	32.32**	21.98**	54.00**	21.81*	42.49**	21.87*	108486.11**	9740.17*
Error "a"	9	206.88	363.42	1.45	2.57	6.49	3.74	2.33	4.78	13157.62	1915.68
Intercropping pattern	5	552.00**	960.00**	13.37**	11.20**	101.20**	25.85**	21.78**	63.79**	10707.50*	13467.50*
+ C_1	1	2090.67**	3650.67**	55.06**	44.06**	384.00**	90.48**	77.04*	207.09**	40837.50**	54340.17**
+ C_2	1	400.17*	620.17**	3.23*	3.11	37.50**	13.80**	10.67	27.09	337.50	4320.17
+ C_3	1	180.50	264.5	2.00	1.62	12.50	3.13	18.00*	42.78*	4512.50	3960.50
+ C_4	1	48.17	204.17	5.56**	5.42*	54.00**	15.36**	2.67	37.50	5400.00	204.17
+ C_5	1	40.50	60.50	1.02	1.81	18.00	6.48	0.50	4.50	2450.00	4512.50
V x I	15	17.07	17.60	0.27	0.09	4.67	0.54	1.42	4.24	331.94	1210.17
V C_1	3	58.67	66.67	0.98	0.19	12.64*	1.21	2.38	1.76	915.28	1684.61
V C_2	3	12.17	9.50	0.12	0.06	7.08	0.21	0.89	9.87	181.94	1069.06
V C_3	3	13.83	8.50	0.07	0.03	1.83	0.15	2.00	0.45	312.50	713.83
V C_4	3	0.17	1.50	0.16	0.07	1.11	0.68	1.33	8.61	66.67	1637.50
V C_5	3	0.50	1.83	0.03	0.10	0.67	0.44	0.50	0.50	183.33	945.84
Error "b"	60	60.17	6٩.11	059	0.81	4.51	1.77	3.70	10.63	4100.06	4487.71

+C_1: Solid vs. intercropping wheat plantings.
+C_2: Low rate of solid wheat plantings (W_lF_0)vs. both medium and high rates of solid wheat plantings(W_mF_0+ W_hF_0).
+ C_3: Medium rate of solid wheat plantings (W_mF_0) vs. high rate of solid wheat plantings (W_hF_0).
+ C_4: Low rate of intercropped wheat and faba bean plantings (W_lF_1) vs. both medium and high rates of intercropped wheat and faba bean plantings (W_mF_1+ W_hF
+ C_5: Medium rate of intercropped wheat and faba bean plantings (W_mF_1) vs. high rate of intercropped wheat and faba bean plantings (W_hF_1) .
* and ** : Significant at 0.05 and 0.01 levels of probability, respectively.

Table 2. (Cont).

SOV	DF	Traits									
		Biological yield (tons ha^{-1})		Straw yield (tons ha^{-1})		Grain yield (tons ha^{-1})		H.I (%)		1000- grain weight (g)	
		2009/2010	2010/2011	2009/2010	2010/2011	2009/201(	2010/2011	2009/2010	2010/2011	2009/2010	2010/2011
Replications	3	32.09**	24.64**	15.12*	9.38	3.20**	3.98*	18.14	42.78	٢.٩٨	0.33
Wheat varieties (V)	3	1.45	4.47	1.19	0.43	1.38**	2.67*	133.58	102.52	8.50*	7.26**
Error "a"	9	3.00	3.50	2.78	3.01	0.28	0.62	41.10	94.67	1.57	0.76
Intercropping patter	5	57.69*	81.28**	28.79**	42.77**	5.16**	6.56**	58.05	92.04	6.41**	5.05**
+ C_1	1	274.59**	375.92**	138.67**	204.55**	22.99**	25.89**	208.21*	338.03	22.30**	19.42**
+ C_2	1	11.11*	20.98	3.02	5.13	2.56**	5.36**	29.15	91.49	3.08	2.16
+ C_3	1	0.24	0.25	0.28	0.33	0.01	0.01	2.11	5.56	1.13	0.72
+ C_4	1	0.27	4.59	0.72	0.99	0.11	1.32	38.71	17.92	4.58	1.82
+ C_5	1	2.23	4.66	1.28	2.84	0.13	0.22	12.08	7.18	0.90	1.13
V x I	15	1.95	3.74	0.71	1.75	0.37	0.40	1.91	14.65	0.54	0.08
V C_1	3	2.00	4.64	0.42	2.12	0.84*	0.55	6.08	14.86	0.87	0.10
V C_2	3	1.77	0.90	0.93	0.71	0.17	0.01	2.06	9.64	0.04	0.02
V C_3	3	3.75	7.50	1.52	3.49	0.51	0.76	0.61	25.79	0.03	0.05
V C_4	3	0.83	2.36	0.14	1.01	0.12	0.28	0.41	13.99	1.70	0.09
V C_5	3	1.41	3.30	0.54	1.42	0.21	0.40	0.39	8.99	0.07	0.15
Error "b"	60	2.42	6.01	1.89	5.42	0.29	0.48	38.73	101.88	1.34	1.48

+C_1: Solid vs. intercropping wheat plantings.

+C_2: Low rate of solid wheat plantings (W_lF_0)vs. both medium and high rates of solid wheat plantings(W_mF_0+ W_hF_0).

+ C_3: Medium rate of solid wheat plantings (W_mF_0) vs. high rate of solid wheat plantings (W_hF_0).

+ C_4: Low rate of intercropped wheat and faba bean plantings (W_lF_1) vs. both medium and high rates of intercropped wheat and faba bean plantings (W_mF_1+ W_hF_1)

+ C_5: Medium rate of intercropped wheat and faba bean plantings (W_mF_1) vs. high rate of intercropped wheat and faba bean plantings (W_hF_1) .

* and ** : Significant at 0.05 and 0.01 levels of probability, respectively.

Table 3. Means of wheat grain yield (tons ha^{-1}) and its components, as affected by different cultivars and (wheat/ faba bean) intercropping patterns in 2009/2010 and2010/2011 winter seasons

Trait	Season	Wheat cultivars (A)				Comparisons among intercropping patterns (B)										Mean
		Giza 168	Sakha 94	Gemmiza 9	Sids 1	C_1:Solid vs. intercropping wheat plantings		C_2 : W_lF_0 vs. (W_mF_0+ W_hF_0)}.		C_3 :W_mF_0 vs. W_hF_0		C_4 : W_lF_1 vs. (W_mF_1+ W_hF_1)		C_5 :W_mF_1 vs. W_hF_1		
						Solid plantings	Inter cropping	W_lF_0	(W_mF_0+ W_hF_0)	W_mF_0	W_hF_0	W_lF_1	(W_mF_1+ W_hF_1)	W_mF_1	W_hF_1	
Plant height (cm)	2009/2010	94.00[1]a	91.00a	86.00a	82.00a	83.58b	92.92a	79.50b	85.63a	83.25a	88.00a	91.50a	93.63a	92.50a	94.75a	88.25
	2010/2011	100.00a	96.00a	91.00a	86.00a	87.08b	99.42a	82.00b	89.63a	86.75a	92.50a	96.50a	100.88a	99.50a	102.25a	93.25
Spike length (cm)	2009/2010	12.90a	10.30d	11.30b	10.60c	12.03a	10.52b	12.40a	11.85b	12.10a	11.60a	11.00a	10.28b	10.46a	10.10a	11.28
	2010/2011	12.80a	10.60d	11.50b	11.00c	12.15a	10.80b	12.51a	11.97a	12.20a	11.75a	11.27a	10.56b	10.80a	10.32a	11.48
No. of spikelets $spike^{-1}$	2009/2010	16.00a	14.00b	16.00a	13.00c	16.75a	12.75b	18.00a	16.13b	16.75a	15.50a	14.25a	12.00b	12.75a	11.25a	14.75
	2010/2011	14.98a	14.00b	15.00a	13.00c	15.22a	13.28b	15.98a	14.84b	15.15a	14.53a	14.08a	12.88b	13.33a	12.43a	14.25
No. of grains $spike^{-1}$	2009/2010	31.75a	29.00c	30.83b	29.17c	31.08a	29.29b	31.75a	30.75a	31.50a	30.00b	29.63a	29.13a	29.25a	29.00a	30.19
	2010/2011	31.83a	31.50a	30.88b	29.67c	32.44a	29.50b	33.50a	31.91a	33.06a	30.75b	30.75a	28.88a	29.25a	28.50a	30.97

W_mF_0= Low rate of solid wheat plantings.
W_mF_0 = Medium rate of solid wheat plantings
W_hF_0 = High rate of solid wheat plantings.
W_lF_1 = Low rate of intercropped wheat and faba bean plantings.
W_mF_1= Medium rate of intercropped wheat and faba bean plantings.
W_hF_1 = High rate of intercropped wheat and faba bean plantings.
(1) Means followed by the same letter, within each row for each comparison, are not significantly different at 0.05 level.

Table 3. (Cont.)

Trait	Season	Wheat cultivars (A)				Comparisons among intercropping patterns (B)										Mean
		Giza 168	Sakha 94	Gemmiza 9	Sids 1	C_1:Solid vs. intercropping wheat plantings		C_2 : W_lF_0 vs. (W_mF_0+ W_hF_0).		C_3 :W_mF_0 vs. W_hF_0		C_4 : W_lF_1 vs. (W_mF_1+ W_hF_1)		C_5:W_mF_1 vs. W_hF_1		
						Solid plantings	Intercropping	W_lF_0	(W_mF_0+ W_hF_0)	W_mF_0	W_hF_0	W_lF_1	(W_mF_1+ W_hF_1)	W_mF_1	W_hF_1	
No. of spikes m^{-2}	2009/2010	415.00a	369.17b	387.50b	370.83b	406.25a	365.00b	402.50a	408.13a	420.00a	396.25a	380.00a	357.50a	366.25a	348.75a	385.63
	2010/2011	405.83a	362.50d	394.33b	370.83c	407.17a	359.58b	393.75a	413.88a	425.00a	402.75a	362.50a	358.13a	370.00a	346.25a	303.38
Biological yield (tons ha^{-1})	2009/2010	9.12a	8.78a	9.38a	9.07a	10.78a	7.40b	10.10b	11.12a	11.21a	11.03a	7.50a	7.34a	7.61a	7.08a	9.09
	2010/2011	10.34a	9.89a	10.13a	9.34a	11.91a	7.95b	10.97a	12.37a	12.46a	12.29a	7.51a	8.17a	8.55a	7.79a	9.93
Straw yield (tons ha^{-1})	2009/2010	5.57a	5.66a	5.95a	6.02a	7.00a	4.60b	6.65a	7.18a	7.27a	7.09a	4.77a	4.51a	4.71a	4.31a	5.80
	2010/2011	6.52a	6.58a	6.59a	6.31a	7.96a	5.04b	7.50a	8.20a	8.3a	8.09a	4.84a	5.15a	5.44a	4.85a	6.50
Grain yield (tons ha^{-1})	2009/2010	3.55a	3.12c	3.43b	3.05c	3.78 a	2.80 b	3.45 b	3.94 a	3.93 a	3.95a	2.73a	2.83a	2.90a	2.77a	3.29
	2010/2011	3.82a	3.31c	3.53b	3.03d	3.94a	2.90b	3.47b	4.18a	4.17a	4.19a	2.67a	3.02a	3.11a	2.94a	3.42
H.I (%)	2009/2010	40.06a	35.84a	37.22a	34.56a	35.45b	38.39a	34.35b	36.00a	35.74a	36.23a	36.50b	39.03a	38.41a	39.64a	36.92
	2010/2011	37.55a	36.14a	36.91a	32.90a	34.00a	37.75a	32.05a	34.97a	35.39a	34.56a	36.89a	38.18a	37.71a	38.66a	35.87
1000-grain weight (g)	2009/2010	42.50a	41.23c	41.90b	41.30c	42.21a	41.25b	42.57a	42.04a	42.22a	41.85a	41.69a	41.03a	41.20a	40.86a	41.73
	2010/2011	42.10a	41.00c	41.50b	40.90c	41.83a	40.93b	42.13a	41.68a	41.83a	41.51a	41.20a	40.79a	40.98a	40.60a	41.38

W_mF_0= Low rate of solid wheat plantings.
W_mF_0 = Medium rate of solid wheat plantings
W_hF_0 = High rate of solid wheat plantings.
W_lF_1 = Low rate of intercropped wheat and faba bean plantings.
W_mF_1= Medium rate of intercropped wheat and faba bean plantings.
W_hF_1 = High rate of intercropped wheat and faba bean plantings.
(1) Means followed by the same letter, within each row for each comparison, are not significantly different at 0.05 level.

Respecting the second comparison, C_2; i.e., low density of solid wheat plantings (W_lF_0) vs. both the medium and high densities of solid wheat plantings (W_mF_0+ W_hF_0),data in Table (2) revealed that some studied traits were insignificantly affected by increasing seeding rates of wheat plantings more than 300 grains m^{-2} ;i.e., number of grains spike^{-1}, number of spikes m^{-2}, straw yield ha^{-1}, H.I(%) and 1000-grain weight (in both seasons), spike length and biological yield ha^{-1} traits (in the second season). Meanwhile, increasing seeding rate of wheat more than 300 grains m^{-2} significantly affected some traits; namely, plant height, grain yield ha^{-1} and number of spikelets spike^{-1} (in both seasons), biological yield ha^{-1} and spike length (in the first season). Furthermore, both spike length (in the first season) and number of spikelets spike^{-1} traits (in both seasons) were significantly decreased with increasing seeding rate for wheat plantings more than300 grains m^{-2} (Table 3). These results could be attributed to decreasing of competition among wheat plants under the studied low rate (300 grains m^{-2}) for water, nutrients and light, compared with the higher seeding rates of (350 and 400 grains m^{-2}).

Regarding the third comparison, C_3; viz., the medium density of solid wheat plantings vs. the high density of solid wheat plantings (W_mF_0 vs. W_hF_0), data in Table(2) indicated that significant differences between both treatments for the number of grains spike^{-1} (in both seasons). Increasing seeding rate from 350 to 400 grains m^{-2} significantly decreased the number of grains spike^{-1} from 32.3 to 32.0 as averages in both seasons (Table 3). These results might be due to the favorable utilization of available environmental resources for plants under the medium density of solid wheat plantings, compared with the high one. In this concern, Ghanem and El-Khawaga(1991) and Mohamed (1997)found that increasing seeding rates led to decreasing the number of spikelets spike^{-1}, while, Mosalem (1993) found that the number of spikelets spike^{-1} was not significantly affected by increasing seeding rates.

With respect to the fourth comparison (C_4); namely, the low density of intercropped wheat with faba bean plantings vs. both the medium and high densities of intercropped wheat with faba bean plantings { W_lF_1 vs. (W_mF_1+ W_hF_1)}, the results revealed significant differences for spike length and number of spikelets spike^{-1} traits in both seasons (Table 2). Intercropped wheat with faba bean, by planting wheat at seeding rate of 300 grains m^{-2} significantly increased both spike length (from 10.42 to 11.14 cm) and number of spikelets spike^{-1} (from 12.44 to 14.17), averaged in the two studied seasons, compared with intercropped wheat with faba bean by wheat planting with the higher seeding rates; i.e., 350 and 400 grains m^{-2} Table (3). It is clear that the seeding rates of wheat and faba bean, in the mixture, were adjusted below their full rate. If full rate of each crop was planted, neither would yield well because of intensive over crowding. By reducing the seeding rate of each crop, there would be have a chance to yield well within the mixture.

Concerning the fifth comparison, C_5; namely, the medium density of intercropped wheat with faba bean plantings (350 grains m^{-2}) vs. the high density of intercropped wheat with faba bean plantings (400 grains m^{-2}); i.e., W_mF_1 vs. W_hF_1, it is clear that intercropped wheat with faba bean by seeding wheat at 400 grains m^{-2} insignificantly decreased all studied traits (in both seasons), except for both plant height and harvest index traits, compared with intercropped wheat with faba bean by seeding wheat at 350 grains m^{-2} (Table3). Since harvest index is the grain yield/biological yield ratio, it is logically to say that, if both nominator and denominator increase and/or decrease together, the ratio, then, will be slightly changed.

It seems evident that the optimum planting seeding rates for wheat, in pure stand and intercropping with faba bean, under the studied conditions, were 400 and 350 grains m^{-2}, respectively. This finding might be due to the lower intraspeceific competition for the edaphic and above ground environmental resources, especially light. This, in turn, resulted in an increase in grain yield components and, finally, in producing more grain yield ha^{-1}.

C- (Varietiesx intercropping patterns)interaction effects:

Table (2) shows that the effect of interaction between the studied four wheat cultivars and the six intercropping patterns was statistically insignificant for all studied traits, in both seasons, except for both number of spikelets spike^{-1} and grain yield ha^{-1}, in the first season. These results indicated that all studied traits, except for the two latter traits, showed similar response to the six intercropping patterns with the four wheat cultivars. On the other hand, the significant interaction (VxC $_1$) recorded for the number of spikelets spike^{-1} and grain yield ha^{-1}, in the first season, indicated that both studied factors; i.e., wheat cultivars and intercropping patterns, were not independent in their effect on these traits. The highest means for the number of spikelets spike^{-1} and grain yield ha^{-1} were obtained by solid sowing of wheat cultivar Giza 168, while, the lowest mean for grain yield ha^{-1} was recorded with Sakha 94 wheat cultivar when interplanted with faba bean. Regarding the number of spikelets spike^{-1}, both

Table 4. Means number of spikelets/ spike and grain yield ha^{-1} for wheat plant, as affected by the wheatvarieties and intercropping patterns (VxC_1) in2009/2010season

Trait	Intercropping patterns(I)	Wheat varieties (V)			
		Giza 168	Sakha 94	Gemmiza 9	Sids 1
Number of spikelets $spike^{-1}$	Solid plantings of wheat	18.67	16.00	18.33	14.00
	Intercropping	13.33	12.00	13.67	12.00
	$L.S.D_{(0.05)}$ for the two levels of (I) under the same wheat cultivar	2.13			
Grain yield tons ha^{-1}	Solid plantings of wheat	2.12	1.86	1.90	1.68
	Intercropping	1.43	1.26	1.53	1.38
	$L.S.D_{(0.05)}$ for the two levels of (I) under the same wheat cultivar	0.55			

Sakha 94 and Sids 1 wheat cultivars gave the lowest means when interplanted with faba bean (Table 4).

CONCLUSION

Intercropping Sakha 1 faba bean cultivar at 166667 plants ha^{-1} with Giza 168 wheat cultivar seeded with the rate of 350 grains m^{-2} in (1:1) alternate rows, 20 cm apart, under El-Bostan Region conditions, could be advised to obtain a high productivity of wheat.

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ا لمخص العر

تأث ميل القمح مع الفول البلدي على إنتاجية صول القمح الاراضى الرملية

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أجريت ربتان حقليتان با زرعة البحثية لكلية الزراعة جامعـه دمنهور- نطقه البستان- افظه البحـ ة -ج.م.ع- خلال مو ي شتاء ٢٠١٠/٢٠٠٩ و٢٠١١/٢٠١٠ بدف دراسة تأث ميـل صو القمح والفول البلدي على إنتاجية صول القمـح ـت ظروف الاراضى الرملية. أستخدم هذه الدراسة أربعه أصناف من القمح ا صري وهى: جيزة ١٦٨وسخا ٩٤و يزة ٩ وسـدس ١ حيث زراعه كلا منها بثلاثة معـدلات مـن التقـاوي (٣٠٠ و٣٥٠ و٤٠٠حبه/م٢)زراعه منفردة وكذا ميلا مع الفول البلدي (صنف سخا ١) سطور متبادلة(١:١) على مسافات ٢٠سم بـ السطور. وقد نفذت هذه الدراسة بتصميم القطع ا نـشقة مـرة واحدة أربع مكررات، حيث خصصت القطع الرئيسية لأصناف القمح الأربع، حـ خصصت القطع الفرعية لـنظم التحميـل. و كن تلخيص أهم نتائج هذه الدراسة على النحو الاتى:-

تباينت أصناف القمح معنويا فيما بينها وذلك عظم الـصفات الـ دراستها باستثناء صفات: ارتفاع النبات(سم) وا ـصول البيولوجي/هكتار و صول القش/هكتار ومعامـل ا ـصاد (%) وذلك كلا مو ي الدراسة. وقد تفوق الصنف "جيـزة ١٦٨" على باقي الأصناف ت الدراسة صفة صول ا بوب/هكتـار وكذا الصفات ا صولية: طول السنبلة(سم) وعدد ا بوب/سـنبله وعدد السنابل/ م٢ ووزن الألف حبة (جم) كلا مو ي الدراسة.

أعطت الزراعة ا نفردة للقمح اعلـي ا توسـطات ـصول ا بوب/هكتار ومكونات ا صول: طول السنبلة (سـم) وعـدد السنيبلات/سنبلة وعدد ا بوب/سنبلة وعدد السنابل/ م٢ وا صول البيولوجي/هكتار و صول القش/هكتار ووزن الألف حبه(جـم) مقارنه بزراعته ميلا على الفول البلدي. وعلى العكس من ذلـك فقد أدى ميل الفول البلدي مع القمح إ زيادة معنوية ارتفاع نباتات القمح(ا و) وكذا معامل ا صاد (ا وسم ألأول)، حـ تصل الفروق إ مستوى ا عنوية بـ ا عاملت وذلـك بالنسبة لصفه معامل ا صاد ا وسم الثا .

كانت الفروق الاحصائيه معنوية بـ زراعة القمح منفردا باستخدام الكثافة ا نخفضة(٣٠٠ حبه/م٢) مقارنة بزراعتة منفردا جمـوع الكثافة (٣٥٠ و٤٠٠ حبه/م٢) وذلك عظم الـصفات الـ دراستها و كلا مو ي الدراسة باستثناء صفات طـول الـسنبلة وا صول البيولوجي (ا وسم الأول) وكذا عدد ا بوب/سـنبله وعدد السنابل/ م٢ و صول القش/هكتار ومعامـل ا ـصاد(%) ووزن الألف حبة (جم) وذلك كلا مو ي الدراسة.

تتأثر يع الصفات الـ دراستها معنويا عند زيادة معـدل التقاوي للقمح ا رع منفردا من٣٥٠ إ ٤٠٠ حبه/ م٢ كـلا مو ي الدراسة باستثناء صفه عدد ا بوب /سنبله والـ تناقـصت معنويا من ٣٢,٢٨ إ ٣٠,٣٨ (كمتوسط لكلا مو ي الدراسة)

أدت زراعه القمح عدل ٣٠٠ حبه/م٢ ميلا مـع الفـول البلدي إ زيادة معنوية صفه طول الـسنبلة مـن ١٠,٤٢ إ ١١,١٤ سم وصفه عدد السنيبلات/سنبله من ١٢,٤٤ا ١٤,١٧ كمتوسط لكلا مو ي الدراسة، وذلك عنـد مقارنتـه بالزراعـة ميلا مع الفول البلدي. ولكن جموع الكثافة الأعلـى مـن معدل التقاوي (٣٥٠ و٤٠٠ حبه/م٢) حـ تتـأثر بـاقي الصفات ا دروسة بذلك.

أدت زراعه القمح عدل٤٠٠ حبه/م٢ ميلا مع الفول البلدي إ حدوث نقص غ معنوي يع الصفات الـ دراسـتها كلا مو ي الدراسة باستثناء صفات: ارتفاع النبات ومعامل ا صاد وذلك مقارنه بزراعته ميلا مع الفول البلدي ولكن عدل ٣٥٠ حبه/م٢.

كان التفاعل بـ أصناف القمح ونظم التحميل معنويـا فقـط بالنسبة لصف عدد السنيبلات/سنبله و صول ا بوب/هكتـار(ا وسم الأول).

وعموما فانه للحصول على أفضل إنتاجيه من القمـح حـال ميله مع الفول البلدي(صنف سخا ١) وا رع بكثافـة نباتيـه (حوا ١٦٦٦٦٧نبات/هكتار) بنظام السطور ا تبادلة (١:١) على مسافات ٢٠سم بـ السطور ت ظروف الاراضى الرملية نطقه البستان حافظه البحـ ة، و ضوء نتائج هذه الدراسة فانه ينصح باستخدام صنف القمح "جيزة ١٦٨" مع زراعته عـدل ٣٥٠ حبه/م^{2}.