EFFECT OF PLANT DENSITY OF FABA BEAN INTERCROPPED ON WHEAT AND NITROGEN FERTILIZATION ON YIELD AND ITS COMPONENTS FOR BOTH CROPS

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ABSTRACT

Two experiment were carried out during the two growing seasons of 2010/2011 and 2011/2012 at Giza Agric. Res. St. to study the effect of plant density of faba bean intercropped on wheat and nitrogen fertilization on yield and its components for both crops. A split plots design with three replications was used. The main plots were devoted to nitrogen fertilizer levels (60, 75 and 90 kg N/fad. Whereas, the sub plots were allocated for pattern systems P_1,P_2,P_3 (100 wheat 12.5%, 25% and 37.5% faba bean respectively. The results indicated that increased population of faba bean from 12.5 % to 37.5 of solid led to reduction for all study characters number of spikes/m^2, grain/ spike, weight of grains spike and 1000 grain, grain and straw yield/ fad of wheat in the combined data. The reduction in grain and straw yield of wheat were estimated 5.84 and 6.47 for P_1, 10.09 and 8.82% for $P_2$13.33 and 13.53% for P_3 respectively. Intercropping 100% of wheat with faba bean (P_1) recorded the highest values of most yield components of faba bean, while the lowest values were observed by third density (P_3). Seed and straw yield were increased by increased plant density of faba bean (P_1 toP_3) but reduced as compared with solid yield.

This in seed and straw yieldfaba bean were 75.57 and 76.24 for (P_1) 61.48 and 66.70 for (P_2) 47.60 and 55.55 for (P_3) respectively.Grain and seed yield of wheat with faba bean were significantly affect by nitrogen fertilizer levels. The highest values of both crops (95.24 and 48.75) were observed when added 90 kg N/fad. While the lowest values (85.63 and 29.33) with 60 kg N/fad of solid crops. The highest of LER (1.53) MAI (4574.73) and MER (1.42) were observed (N_3×P_3) while the lowest was observed (N_1×P_1).

The values ofaggressivity (Ag) for faba bean was positive while wheat was negative it means that faba bean was dominated while wheat was dominated.

Key word: Intercropping, Wheat, Faba bean, Nitrogen Fertilizer.

INTRODUCTION

Intercropping a legume crop with a non-legume oneproved to be a successful system owing to the ability of legumes to fix considerable quantities of atmospheric nitrogen which beavailable to the associated non-legumes. The more efficient use of limiting resources in intercropping can occur because the component crops use the resourced either at different times, in different parts of the soil profile or canopy or in different forms legumes use atmospheric N_2 whereas non-legumes use available soil nitrogen. Agricultural intensification is considered to be one of the important ways of solving or decreasing the large gap between the production and consumption of food product.

El-Monufi (1984) stated that intercropping wheat with faba bean decreased straw and grain yields of wheat/faddan, as well as plant height, branches and pod number/plant, straw and seed yield/faddan of faba bean. On theother hand plant height and 100-grain weight of wheat, as well as 100-seed weight, harvest index and productivity score of field bean were lower than sole planting. Many investigators found that the land use efficiency was increased and yield advantage was produced by intercropping fababeanasalegume crop with non legume crops such as wheat **(Saleh *et al* 1986** and **Abd-El-Gawad 1988)** fodder beet (**El-Kassaby *et al*, 1985 and Abdel- Aal *et al* 1989**) and barley **Abo-Shetaia 1990**. reported that the yields of fababean and barley per faddanwere varied with1:1, 1: 2, 2:2 and 3:3 intercropping patterns. Pattern 3:3 produced the highest yield advantage for each crop which amounted to 60% more than the sole cropping.

Abdel-Shafie *et al* (1986) and Radwan (1993) showed that spike length, number of spikes/m^2, number grains/spike, grains weight/spike, weight of1000 grain of wheat were increased by intercropping with faba bean, while grain and straw yield/fad. werereduced compared with culture. **El-Naggar *et al* (1991)** showed that plant height, tiller numbers and 1000 grain weight of wheat were increased when intercropped with berseem.**Willey** and **Osiru (1972)**stated that yield of each component of both cropswill depend on both interspecific and intraspecific competition. Therefore, it is necessary to test a wide range of densities of each component in a wide range of combinations.(**Allen and Obura 1983**) interspecific facilitation occurs when one plant species enhances thegrowth of another plant species and has been observed mainly in legume/cereal systems such as soybean/corn and cowpea/corn.

Saleh *et al* (1986) found that intercropping legume with wheat in 2:2 intercropping system significantly increased plant height number of spikes/m^2 and grain yield/fad. of wheat than monoculture and the other two intercropping system (3:3 and 4:4). Monoculture in faba bean produced highest number of pods and seeds/plant as compared with the intercropping system. On the other hand, growing wheat and fababean in 2:2 intercropping system produced yield advantage and increased land usage by about 90 followed by 3:3 and 4:4 systems (about 80%). Wheat was the dominant intercrop component under the different systems.

Mahrous *et al* (1998) found that intercropping lentil with wheat decreased grain or seed and straw yield, seed index for crops, number of grains/spike for wheat and number of branches for lentil. **Eid *et al* (1988)** found that intercropping wheat with faba bean 1:1 pattern gave the maximum values of LER and relative crowding coefficient (Rcc). **El-Mihi *et al* (1991)** found that competitive relationships of wheat-faba bean revealed that in mixture (2:2), land use efficiency was rather less than other intercropping systems mainly due to a higher aggressivity pressure.**Khaliq *et al* (2001)** found that in termsof monetary grain, the highest net income was obtained from intercropping one row of lentil with two rows of wheat.**Liben *et al* (2001)** reveledalso highest land equivalent ratio (LER) and yield advantage with highest anet return were observed when1 maize: 1 faba bean pattern was applied.

Nitrogen is the most important plant nutrient needed to obtain high yield. **El-Naggar and El-Habbak (1991)** reported that plant height, number of branches and pods/plant number of pods/ plant, 100 seeds weight, as well as

seed and straw yields significantly increased with increasing nitrogen rates.**Zahran *et al* (1997)** reported that plant height and tiller number of wheat were increased with increasing nitrogen level.**Mosalem *et al* 1997, Sorour *et al* 1998** and **Sobh *et al* 2000** reported a beneficial effect of nitrogen application on wheat. They reported that number of tillers and spikes/m^2, plant height, spike length, number of spikelets and grains/spike, grain and straw yields of wheat were increased with increasing nitrogen level.

El-Metwalley *et al* (2002) reported that the highest plant height, spike length, spikes/m^2, grain spike, 1000 grain weight, grain and straw yield of wheat was observed when intercropping 2:2 pattern was applied and highest plant height, pods/plant, 100 seed weight, seed yield plant, seed and straw yield of faba bean when intercropping 2:2 pattern.**Tosti and Guiducci (2010)** although the large inter-row spacing needed for the intercropping caused a decrease in wheat photosynthetically active radiation interception the grain yield was positively affected as the competitive effect of faba bean was limited to the initial stages of the cereal growing cycle and after faba bean incorporation into the soil, thewheat was able to recover even if legume was the dominant component of the intercrop.

Tayebeh *et al* (2011) showed that the different nitrogen rates have a significant effect on grain yield components (spikes number/m^2, seeds number spike and 1000 grain weight and grain yield of wheat).

This work was aimed to study effect of plant density of intercropped faba bean withwheat and nitrogen fertilizer levels on yield and yield components of both crops.

MATERIAL AND METHODS

Two experiments were carried out during the two growing seasons of 2010/2011 and 2011/2012 at Giza Agriculture Research Station to study the effect of plant density of faba bean intercropped on wheat and nitrogen fertilization on yield and its components for both crops. A split-plots design with three replications was used. The main plots were allocate for nitrogen fertilizer levels (60, 75 and 90 kg N/fad.) Whereas, the sub-plots were devoted to plant density of intercroppingfaba bean (cv Giza 716)with wheat (cvSides 1).

Intercropping planting:-

P_1– planting six rows of wheat on the middle of beds (120 cmwidth) spaced 15 cm between rows of wheat,and faba bean on both sides of the beds at a distance of 40 cm apart between hill and one plants/hill(100% wheat + 12.5% faba bean of pure stand)

P_2- planting six rows of wheat on the middle of beds (120 cm. width) spaced 15 cm between rows of wheat, and faba bean on both sides of the beds at a distance of 20cm apart between hill and one plants/hill(100% wheat + 25% faba bean of pure stand).

P_3 – planting six rows of wheat on the middle of beds (120 cm. width) spaced 15 cm between rows of wheat,and faba bean on both sides of thebeds at a distance of 15 cm apart between hill and one plants/hill(100% wheat + 37.5% faba bean of pure stand).

Solid planting (control):-

1. Faba bean was planted inridges 60cm width and20 cm apart between hilland two plants/ hill, 140.000plants/fad. (100% of pure stand).
2. Wheatwas plantedsix rows on beds (120 cm width) space 15 cm apart between rows(100% pure stand).

The soil was clay in texture with $p^H$of 7.2, 1.4% organic matter and having 21.44, 7.78 and 239.3 ppm available N, P and K, respectively.

Nitrogen in forms of ammonium nitrate (33.5 N %) at rates of 60, 75 and 90 kg N/fad. were added into three equal doses i.eat planting, before the first and second irrigation. Each experimental unit included five beds, each beds 120 cm width apart and 3.5m length, resulted in an area of 21m^2 (1/200 fad.). The preceding summer crop was maize (*zeamays* L.) in both seasons.

Calcium super phosphate (15.5% P_2O_5) at the rate of 150 kg/fad.andpotassiumsulphate (48% k_2o) at the rate of 50 kg/fad were applied during soil preparation.

The recorded dataon both compounds wereas follow:

I. Wheat:

At maturity, a sampleof 10 plants were chosen randomly from the pure stand andfrom intercropped plots of wheat to determine the following characters:

Plant height (cm), spike length (cm), number of spikes/m^2,flag leaf area (cm^2),number of grains/spike,weight of grains/spike (g),weight of 1000 grain (g),grain yield ardab(150 kg)/faddanand straw (ton) yield/fad.

The plants in three beds (12.6 m^2) of each experimental unit were harvested, collected together, labeled, thrashed and the grains were separated. The grain and straw yields were recorded in kg/m^2converted into grain yield in ardab/fad and straw yield/fad.

II. Faba bean:

At maturity, a sample of 10 plants were chosen at random from the pure stand or from intercropped plots of faba bean then the following characters were calculated.

Plant height (cm.), number of branches/plant, pods/plant and seeds/plant,seeds weight/plant (g) and 100-seed weight (g). Plants in three beds of each experimental unit were harvested, collected together, labeled, thrashed and the seeds were separated. The seed and straw yields were recorded in kg/m^2 then it converted to grain yield ardab (150 kg)/fad. and straw (ton) yield/fad.

III. Competitive relationships and yield advantages:

1. Land equivalent ratio (LER): as mentioned by**Willey (1979)**
2. Relative crowding coefficient (k): as mentioned by **De-Wit (1960)**
3. Aggressivity (A): determined according to **McGillchrist (1965)**
4. Competitive ratio (CR) by **Willey and Rao (1980).**

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

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

IV. Economic evaluation:

Monetary advantage index (MAI): Suggests that the economic assessment should be in terms of the value of land saved; this could probably be most assessed on the basis of the rentable value of this land. MAI was calculated according to the formula, suggested by **Willey (1979).**

$$\mathbf{MAI} = \frac{\text{Value of combined intercrops} \times \text{LER} - 1}{LER}$$

V. Monetary Equivalent Ratio (MER): MER was calculated according to the formula, suggested by **Adetiloye and Adekunle (1989).**

$$\mathbf{MER} = \frac{\mathbf{ra} + \mathbf{rb}}{\mathbf{Ra}}$$

Where as:

ra&rbmonetaryreturns from (a) and (b)

Ra. highest sole crop monetary return

ra = pa ×yarb = pb×yb

ya&yb yieldof a and b pa, pb prices of unit weight of crop a and b

VI. Gross return (LE/fad):

Gross return from each treatment was calculated in Egyptian pounds (LE) at market prices which were312 LE for ardab of wheat grains,585.5 LE for ardab of faba bean seeds,336 LE for of faba bean straw and 425 LE for of wheat straw for average of the two seasons.

Data for each experiment were then analyzed by **MISTATC (1980)** software for comparison of the mean values of the two seasons by LSD test at the 5% level. Response equations were calculated according to **Snedecor and Cochran (1988).**

RESULTS AND DISCUSSION

I- Wheat

a. Effect of nitrogen fertilizer levels on yield and itscomponent.

Data in Table (1) show that all characters of wheat were significantly increased by increasing nitrogen fertilizer levels in both seasons and their combine analysis. Theincrease plant height may be due to severe competition between plants either intra-competition between wheat plants or inter-competition between wheat and faba bean plants on light and nutrients

The highest values of characters (number of spikes, number of grains/spike, weight of grains, weight of 100 grain, grains and straw yields) except spike length, flag leaf areawere observed when added 90 kg N/fad. (N_3). The lowest values except spike length, flag leaf area were obtained by 60 kg N/fad. (N_1). Whereas the characters of wheat were decreased as compared with of solid (the combined analysis of the two seasons).Seed yield/fad.of wheat showed significantly progressive increase by increasing nitrogen fertilizer level from 60 to 90 kg N/fad under intercropping conditions.Grain yield/fad of wheat was less than wheat alone. The reduction in actual intercropping grain and straw yields under the three nitrogen levels by 14.37 and 14.71% at 60kg N/fad., 10.17 and 9.71% at 75kg N/fad., 4.76 and 4.41% at 90 kg N/fad. (the combined analysis of the two seasons), respectively. These results were similar to these obtained by **Sobh *et al* (2000) and Tayebeh *et al* (2011).**

Table (1): Effect of nitrogen fertilizer levels on yield and yield components of wheatintercropping with faba bean in the first, second seasons and their combined analysis of the two seasons.

Nitrogen fertilizer	Plant height (cm)	Spike length (cm)	No.of spikes/ m^2	Flag Leaf area	No.of grains/ spike	Wt. of grains/ spike(g)	Wt. of 1000 grain(g)	grain yield /faddan	Straw yield (fad)
First season									
N_1 (60 kg)	84.45	8.13	372.8	19.21	49.17	2.35	43.40	19.53	2.85
N_2 (75 kg)	92.61	8.18	385.3	19.10	51.51	2.92	44.69	20.50	3.02
N_3 (90 kg)	93.75	8.03	401.3	18.89	52.47	3.33	45.81	21.87	3.21
L.S.D 5%	1.95	0.03	1.34	0.14	0.19	0.39	0.02	0.12	0.03
Pure	97.50	8.27	422.00	19.20	53.57	2.70	50.50	23.00	3.20
Second season									
N_1 (60 kg)	89.78	8.19	396.0	19.16	50.70	2.85	44.51	20.03	2.95
N_2 (75 kg)	95.23	8.25	409.4	19.04	51.87	3.15	45.60	21.00	3.12
N_3 (90 kg)	97.57	8.11	424.3	18.78	52.84	3.50	47.59	22.13	3.28
L.S.D 5%	2.19	NS	1.31	NS	0.03	0.44	0.2	0.22	0.03
Pure	101.13	8.35	428.21	19.25	51.40	2.64	50.18	23.20	3.60
Combined analysis of the two seasons									
N_1 (60 kg)	87.11	8.16	384.4	19.19	49.93	2.60	43.96	19.78	2.90
N_2 (75 kg)	93.92	8.21	397.4	19.07	51.69	3.03	45.15	20.75	3.07
N_3 (90 kg)	95.66	8.07	412.8	18.84	52.66	3.42	46.70	22.00	3.25
L.S.D 5%	1.22	0.09	1.39	0.08	0.08	0.24	0.01	0.08	0.19
Pure	99.3	8.31	425.11	19.23	52.49	2.67	50.34	23.10	3.40

b. Effect of plant density faba bean on yield components of wheat

The results in Table (2) reveal that all characters under studies of wheat were significantly affected by plant density in the two seasons and their combined analysis. Increasing plant density of intercropped faba bean with wheat from 12.5% (P_1), at 37.5% (P_3) increased wheat plant height, spike length and flag leaf area. These results may be to increasing plant population of faba bean increased inter-competition between wheat and faba bean plants for light and nutrients.

Most of yield attributes of wheat such as number of spikes/m^2, number of grains/spike and weight of 1000 grain were significantly affected by plant density (Table 2). Intercropping faba bean with wheat at first density (P_1) recorded the highest values of most characters (number of spikes/m^2, grains/spike, weight of grain/spike and 1000 grain) while the lowest values was recorded by third plant density (P_3) except plant height, spike length and flag leaf area.

Wheat grain yield/fad was significantly affected by plant density in both seasons Table (2). Grain yield of wheat was increased by decreasingplant density of faba

bean.Intercropping the first plant density of faba bean(12.5%)with wheat recorded the highest values of wheat grain and straw yields followed by (25%) and (37.5%) of its pure stand. The productivity of grain yield/fad was 94.16, 89.91 and 86.67% of pure stand,respectively. Similar results were obtained by **Willey and Osiru (1972), Sorour *et al* (1998), Sobh *et al* (2000) and Tayebeh *et al* (2011).**

Table (2): Effect of plant density faba beanon yield and yield components of wheatin the first, second seasons and their combined analysis of the two seasons.

Plant density	Plant height (cm)	Spike length (cm)	No.of spikes/ m^2	Flag leaf area cm^2	No.of grains/ spike	Wt. of grains/ spike (g)	Wt. of 1000 grain (g)	grain yield /faddan	Straw yield (fad)
First season									
P_1(12.5%)	85.54	8.05	404.80	18.95	52.17	3.49	46.05	21.57	3.13
P_2 (25 %)	90.22	8.13	383.3	18.96	50.99	2.68	44.71	20.57	3.06
P_3 (37.5%)	95.05	8.17	371.3	19.20	49.99	2.33	43.15	19.77	2.88
L.S.D 5%	1.21	0.02	2.41	0.06	0.16	0.23	0.02	1.10	0.02
pure	97.50	8.27	422.00	19.20	53.57	2.70	50.50	23.00	3.20
Second season									
P_1(12.5%)	90.05	8.13	423.2	18.99	52.92	3.92	46.82	21.93	3.22
P_2 (25 %)	93.36	8.18	408.9	19.12	51.56	3.03	45.73	20.97	3.10
P_3 (37.5%)	99.17	8.23	397.7	19.16	50.93	2.66	45.14	20.27	3.00
L.S.D 5%	1.20	NS	1.37	NS	0.02	0.30	0.03	0.12	0.02
pure	101.13	8.35	428.21	19.25	51.40	2.64	50.18	23.20	3.60
Combined analysis of the two seasons									
P_1(12.5%)	87.78	8.09	414.0	18.97	52.54	3.70	46.44	21.75	3.18
P_2 (25 %)	91.79	8.15	396.1	19.04	51.27	2.86	45.22	20.77	3.10
P_3 (37.5%)	97.11	8.20	384.5	19.18	50.46	2.50	44.15	20.02	2.94
L.S.D 5%	0.81	0.01	1.31	0.04	0.08	0.17	0.02	0.08	0.01
pure	99.3	8.31	425.11	19.23	52.49	2.67	50.34	23.10	3.40

c. Effect of the interaction between intercropping patterns faba bean with wheat and nitrogen fertilizer levels on wheat yield characters

Combined analysis of the two seasons presented in Table (3) show that decreasing plant density faba bean and increasing nitrogen fertilizer levels led to increasing number of spikes/m^2, number of grains/spike, weight of grains/spike, weight of 1000 grain yield and straw yields/ fad. The highest values wereobserved by (N_3×P_1), i.e., nitrogen fertilizer level (90 kg N/fad) with 12.5% plant density of faba bean (P_1).While the lowest values of these characters wereobserved by (N_1×P_3), i.e.,nitrogen fertilizer level (60 kg N/fad)(N_1) with plant density (P_3).Similar result were obtained **El-Naggarand El-Habbak (1991).**

II. Faba bean

a. Effect of nitrogen fertilizer levels on yield and its component of faba bean.

Data in Table (4) show that all studied characters were significantly affected by nitrogen fertilizer levels. Intercropped faba bean with wheat at 90 kg N/fad. (N_3) gave the highest value of plant height followed by 75 kg N/fad.

(N_2) and the lowest value was 60 kg N/fad (N_1) in both seasons and the combined analysis. These results may be due to increase the nitrogen fertilizer caused increase inter competition between faba bean and wheat plants for light.

Table (3): Effect of the interaction between nitrogen fertilizer levelsand plant density faba bean intercropped with wheat characters of the combined analysis of the two seasons.

Nitrogen fertilizer levels	Plant density	Plant height (cm)	Spike length (cm)	No.of spikes/m^2	Flag leaf area cm^2	No.of grains/ spike	Wt. of grains / spike (g)	Wt. of 1000 grain (g)	grain yield /faddan	Straw yield (fad)
N_1 (60 kg)	P_1(12.5%)	82.44	8.10	400.67	19.09	50.80	3.07	45.25	20.75	3.05
	P_2 (25 %)	86.19	8.16	380.00	19.20	50.05	2.50	44.08	19.78	2.93
	P_3(37.5%)	92.69	8.21	372.50	19.27	48.95	2.24	42.54	18.85	2.73
N_2 (75 kg)	P_1(12.5%)	89.47	8.16	413.83	19.04	52.80	3.81	46.43	21.75	3.15
	P_2 (25 %)	93.82	8.22	396.67	19.06	51.47	2.81	44.96	20.55	3.10
	P_3(37.5%)	98.46	8.26	381.67	19.16	50.80	2.49	44.05	19.95	2.95
N_3 (90 kg)	P_1(12.5%)	91.44	8.02	427.50	18.78	54.03	4.23	47.63	22.75	3.33
	P_2 (25 %)	95.36	8.08	411.67	18.86	52.30	3.26	46.62	22.00	3.27
	P_3(37.5%)	100.18	8.12	399.33	18.87	51.63	2.76	45.85	21.25	3.15
LSD 5%		NS	NS	2.27	NS	0.13	0.28	0.03	0.12	0.02
pure		99.3	8.31	425.11	19.23	52.49	2.67	50.34	23.10	3.40

Table (4): Effect of nitrogen fertilizer levels on yield and yield components of faba bean intercropped with wheat in the first, second seasons and their combined analysis of the two seasons.

Nitrogen fertilizer	Plant height (cm)	No.of branches /plant	No.of pods /plant	No.of seeds /plant	Wt.of seeds/plant (g)	Wt.of 100seeds (g)	Seeds yield /faddan	Straw yield (fad)
First season								
N_1 (60 kg)	120.0	2.61	14.06	41.93	22.52	66.86	2.71	0.641
N_2 (75 kg)	127.7	2.98	14.90	46.98	23.70	64.94	3.32	0.967
N_3 (90 kg)	134.7	3.04	16.43	49.00	24.89	63.72	4.57	0.248
L.S.D 5%	1.90	0.06	0.36	0.54	0.23	0.07	0.03	0.03
pure	133.50	3.10	21.35	54.00	27.63	70.25	9.75	2.94
Second season								
N_1 (60 kg)	122.9	2.90	17.39	49.39	24.53	66.51	2.90	0.660
N_2 (75 kg)	130.4	3.08	18.79	50.83	25.47	64.79	3.83	1.042
N_3 (90 kg)	137.8	3.17	20.48	51.86	26.28	63.62	4.77	1.324
L.S.D 5%	0.6	0.04	0.29	0.29	0.22	0.04	0.08	0.02
pure	131.0	3.18	20.90	52.84	27.22	69.70	9.40	2.85
Combined analysis of the two seasons								
N_1 (60 kg)	121.4	2.76	15.73	45.66	23.52	66.69	2.81	0.650
N_2 (75 kg)	129.1	3.03	16.85	48.91	24.58	64.87	3.57	1.004
N_3 (90 kg)	136.2	3.10	18.46	50.43	25.59	63.67	4.67	1.286
L.S.D 5%	1.47	0.03	0.08	0.25	0.13	0.03	0.03	0.02
pure	132.3	3.14	21.13	53.42	27.43	69.98	9.58	2.9

All characters of faba bean (number of branches/plant, number of pods, seed/plant, weight of seed/plant and 100 seeds) were increased by increasing of nitrogen fertilizer levels from 60 to 90 kg N/fad. The intercropping pattern resulted in decreased all characters except plant height. When faba bean intercropped with wheat at 60, 75 and 90kg N/fad.the increased in actual seed yield of faba bean were 27.33, 37.27 and 48.75% of the combined analysis of the two seasons, respectively. These results were coincided with **El-Naggar and El- Habbak (1991).**

Straw yield/fad of faba bean was significantly increased by increasing nitrogen fertilizer in intercropped wheat (the combined analysis of the two seasons). This increases in actual straw yield of faba bean/fad were 22.41, 34.62 and 44.34% withnitrogen fertilizer levels N_1 to N_3 as compared with faba bean sole, respectively.

b. Effect of plant densityof faba beanunder intercropped with wheat on yield and its component of faba bean.

Data presented in Table (5) showed that all characters under study of faba bean were significantly affected by different plant density on the two seasons and the combined analysis. Plant height of faba bean recorded the highest value (P_3) when faba bean was intercropped in (100% wheat+37.5% faba bean) and followed by (P_2) second density (100 wheat +25% faba bean) and lowest value was showed with (P_1) first density (100% wheat +12.5% faba bean). Increased population of faba bean from 12.5% to 37.5% decreased all characters of faba bean yield components, i.e., number of branches, pods/plant, number of seed/plant, weight of seed yield/plant, 100 seed weight in the both seasons except seed and straw yields/fad as shown in Table (5). Plant density increased intra competition between wheat and faba bean plants on light, water and nutrient. These results were coincided with **El-Monufi (1984)**.

The increased in seed and straw yields/ fad. at plant density of P_1, P_2 andP_3 were 24.42, 38.52 and 52.40 and 23.76, 33.21 and 44.45 of the combined analysis of the two seasons compared to faba bean sole cropping, respectively. Similar results were obtained by **Salah *etal* (1986).**

Table (5): Effect of plant density on yield and yield components of faba bean in the first, second seasons and their combined analysis of the two seasons.

Plant density	Plant height (cm)	No.of branches /plant	No.of pods /plant	No.of seeds /plant	Wt.of seeds/plant (g)	Wt.of 100seeds (g)	Seeds yield /faddan	Straw yield (fad)
First season								
P_1(12.5%)	123.4	3.45	16.29	47.49	25.08	64.49	2.23	0.680
P_2 (25 %)	127.7	2.73	15.05	45.86	23.69	65.32	3.50	0.945
P_3(37.5%)	131.2	2.36	14.08	44.57	22.53	65.72	4.87	1.231
L.S.D 5%	1.35	0.10	0.82	0.92	0.31	0.03	0.10	0.03
Pure	133.5	3.10	21.35	54.00	27.63	70.25	9.75	2.94
Second season								
P_1(12.5%)	126.4	3.23	20.27	52.50	26.50	64.41	2.44	0.679
P_2 (25 %)	130.4	3.07	18.89	50.67	25.28	65.12	3.88	0.982
P_3(37.5%)	134.2	2.85	18.01	48.91	24.49	65.40	5.17	1.347
L.S.D 5%	1.35	0.09	0.50	0.56	0.24	0.02	0.09	0.02
Pure	131.0	3.18	20.9	52.84	27.22	69.7	9.40	2.85
Combined analysis of the two seasons								

P_1(12.5%)	124.9	3.34	18.28	49.99	25.79	64.45	2.34	0.679
P_2 (25 %)	129.1	2.90	16.97	48.26	24.49	65.22	3.69	0.963
P_3(37.5%)	132.7	2.61	16.04	46.74	23.51	65.56	5.02	1.289
L.S.D 5%	2.10	0.09	0.13	0.51	0.19	0.02	0.07	0.02
Pure	132.3	3.14	21.13	53.42	27.43	69.98	9.58	2.9

c. Effect of the interaction between intercropping patterns faba bean with wheat and nitrogen fertilizer levels.

Plant height number of branches/plant, weight of seeds/plant and weight of 100 seeds as well as seed and straw yields/fad were significantly affected by the interaction between intercropping plant density × nitrogen fertilizer levels as shown in Table (6). The highest values of plant height, weight of seeds/plant, number of seeds and wheat of seeds/plant were observed with 100% wheat + 12.5% faba bean and added 90kg N/fad. (N_3×P_1) while number of branches/plant, weight of 100 seeds, seeds and strawyields/fad.were recorded with interaction (N_3×P_3) whereas its lowest values plant height, number of branches/plant, seed and straw yields/fad. were observed (N_1×P_1). This result may be due to the decrease in plant density of faba bean intercropped with wheat from 37.5% to 12.5% decreased inter and intra competition between plants for light, water and nutrients from the same nutritional faba bean area.

Table (6): Effect of the interaction between nitrogen fertilizer levels and plant density faba bean on faba bean characters of the combined analysis of the two seasons.

Nitrogen fertilizer levels	Plant density	Plant height (cm)	No.of branches /plant	No.of pods /plant	No.of seeds /plant	Wt. of seeds /plant (g)	Wt. of 100 seeds (g)	Seeds yield /faddan	Straw yield (fad)
N_1 (60 kg)	**P_1(12.5%)**	116.3	2.57	18.03	47.45	24.65	65.63	1.81	0.435
	P_2 (25 %)	121.5	2.78	16.72	45.68	23.60	67.05	2.63	0.700
	P_3(37.5%)	126.5	2.93	15.79	43.85	22.52	67.69	3.98	0.816
N_2 (75 kg)	**P_1(12.5%)**	125.5	2.60	18.33	50.37	25.79	64.38	2.25	0.798
	P_2 (25 %)	130.2	2.93	17.07	48.91	24.49	64.90	3.84	0.915
	P_3(37.5%)	131.5	3.56	16.08	47.44	23.77	65.32	4.63	1.30
N_3 (90 kg)	**P_1(12.5%)**	153.0	2.65	18.48	52.16	26.95	63.34	2.95	0.833
	P_2 (25 %)	135.5	2.99	17.07	50.19	25.37	63.70	4.60	1.275
	P_3(37.5%)	140.2	3.67	16.27	48.93	24.43	63.97	6.45	1.75
LSD 5%		2.096	0.14	NS	NS	0.43	0.04	0.11	0.3
Pure		132.3	3.14	21.13	53.42	27.43	69.98	9.58	2.9

Competitive relationships and yield advantage of intercropping:

1. Land Equivalent Ratio (LER):

Results in Table (7) clearly show that LER exceeded one at all intercropping treatments in the two seasons. Best result was obtained by nitrogen fertilizer level 90 kg N/fad (N_3) with third plant density (P_3) which achieved 53% over for land usage of the combined analysis in the two seasons, respectively as compared with the sole cropping. The highest value Ry_w (0.98) was observed in (N_3×P_1) while the lowest one (0.82) was observed by (N_1×P_3). The highest value of Ry_f (0.67) was observed by (N_3×P_3) while the lowest value (0.19) by (N_1×P_1).

2. Relative Crowding Coefficient (Rcc):

Data in Table (7) indicate that intercropping wheat withfaba bean achieved yield advantage in all intercropping patterns of the combined analysis in the two seasons. The best result of Rcc was achieved bynitrogen fertilizer level 90 kg N/fad (N_3) with plant density (P_1) was (29.67).The lowest Rccvalue (2.12)was showed by ($N_1 \times P_1$).

3. Aggressivity(Agg):

Results in Table (7) show that faba bean was the dominant crop and wheat was the dominated crop on all intercropping patterns of the combined analysis in the two seasons. Agg values were increased with the increasing nitrogen fertilizer levels. The present results clearly indicatedthat faba bean has higher competitive abilities having fast growth characters,and stronger than wheat.

4. Competitive Ratio (CR):

Data presented in Table (7) reveale that faba bean had higher competitive ratio than wheat when they were intercropped together. The highest value of CR for faba bean was observed by($N_3 \times P_1$) i.e., 90 kg N/fad (N_3)with(P_1). The lowest value of CR for faba bean was observed by ($N_1 \times P_2$)and highest value for wheat was observed by ($N_3 \times P_3$)of the combined analysis in the two seasons, respectively.

5. Monetary advantage index (MAI):

The values of monetary advantage index (MAI) were positive when intercropping wheat with faba bean under cropping system and different N levels. The results revealed that the values of MAI were increased under increasing nitrogen fertilizer levels up to (N_3) and increase plantdensity of faba bean. The highest MAI(4574.73) was observed by ($N_3 \times P_3$). The lowest value (741.15) was observed by($N_1 \times P_1$)of the combined analysis in the two seasons.

6. Monetary Equivalent Ratio (MER):

Monetary equivalent ratio defined as the sum of the ratios of intercrop monetary returns to the highest sole crop monetary return from the entire land area occupied by all intercrops per unit time. MER used to evaluate economic superiority of intercropping systems. Results in Table (7) show that the highest MER (1.42) was observed by($N_3 \times P_3$). The lowest MER (1.04) was observed by($N_1 \times P_1$)of the combined analysis of the two seasons.

Table (7): Competitive relationships, yield advantage and economic evaluation intercropping wheat with faba bean of the combined analysis of the two seasons.

Nitrogen fertilizer levels	Plant density	LER Ry_w	LER Ry_f	LER	Kw	KF	Rcc	Agw	AgF	CRw	CRF	MAI	MER
N_1 (60 kg)	P_1(12.5%)	0.90	+ 0.19	= 1.09	1.24	1.71	2.12	-0.55	+0.55	0.13	1.39	741.15	1.04
	P_2 (25 %)	0.85	+ 0.27	= 1.12	1.47	2.44	3.59	-0.83	+0.83	0.21	1.08	983.82	1.06
	P_3(37.5%)	0.82	+ 0.42	= 1.24	1.64	1.92	3.15	-0.42	+0.42	0.30	1.13	1673.4	1.11
N_2 (75 kg)	P_1(12.5%)	0.94	+ 0.23	= 1.17	2.26	2.25	5.09	-0.89	+0.89	0.13	1.69	1410.89	1.12
	P_2 (25 %)	0.89	+ 0.40	= 1.29	2.01	2.68	5.39	-0.89	+0.89	0.22	1.60	2312.10	1.19
	P_3(37.5%)	0.86	+ 0.48	= 1.34	2.34	2.53	5.92	-0.61	+0.61	0.32	1.30	2696.10	1.23
N_3(90 kg)	P_1(12.5%)	0.98	+ 0.31	= 1.29	9.1	3.26	29.67	-1.46	+0.46	0.14	2.27	2294.90	1.18
	P_2 (25 %)	0.95	+ 0.48	= 1.43	5.0	3.69	18.45	-1.21	+1.21	0.24	1.92	3650.33	1.31
	P_3(37.5%)	0.92	+ 0.67	= 1.53	4.25	5.56	23.63	-1.29	+1.29	0.34	1.81	4574.73	1.42

W and f denoted wheat and faba bean, respectively.

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تأثير الكثافة النباتية للفول البلدى المحمل علي القمح والتسميد الأزوتى على كمية المحصول ومكوناته لكلا المحصولين

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أقيمت تجربتان حقليتان خلال موسمى الزراعة ٢٠١٠ / ٢٠١١ و٢٠١١ / ٢٠١٢ بمحطة البحوث الزراعية بالجيزة لدراسة تأثير الكثافة النباتية للفول البلدى المحمل على القمح والتسميد الأزوتى على كمية المحصول ومكوناته لكلا المحصولين، واستخدم تصميم قطع منشقة فى ثلاث مكررات حيث وضع فى القطع الرئيسية ثلاث مستويات تسميد (٦٠، ٧٥، ٩٠ كجم نتروجين/ فدان) ووضع فى القطع المنشقة ثلاث كثافات للفول البلدى (١٢.٥، ٢٥، ٣٧.٥% من الزراعة المنفردة).

أوضحت النتائج ان زيادة كثافة الفول البلدى من ١٢.٥ إلى ٣٧.٥ % أدت إلى نقص فى الصفات المدروسة للقمح هى عدد سنابل/م^2 وعدد حبوب فى السنبلة ووزن ١٠٠٠ حبة ومحصول الحبوب والقش للفدان من خلال تحليل التجميعى، فقد كانت قيم انخفاض محصولى الحبوب والقش للقمح هى ٥.٨٤و٦.٤٧% مع (P_1) ، ١٠.٠٩و ٨.٨٢ % مع (P_2) ، ١٣.٣٣و١٣.٥٣% مع (P_3) على التوالى.

وكان تحميل ١٠٠% قمح مع فول بلدى (P_1) سجل أعلى قيم مكونات المحصول من الفول البلدى بينما أقل قيم كانت مع الكثافة الثالثة (P_3)٠ ومحصول الحبوب والقش كانت تزداد مع زيادة كثافة الفول البلدى من (P_1) إلى (P_3)وذلك بالمقارنة بالمحصول المنفرد وقدر الانخفاض من محصول البذور والقش بنحو٧٥.٥٧% و٧٦.٢٤% مع (P_1) و٦١.٤٨ و٦٦.٧٠% مع (P_2) و٤٧.٦٠ و٥٥.٥٥% مع (P_3) على التوالى.

وكان محصولى الحبوب والبذور لكلا من القمح والفول البلدى قد تأثر معنوياً بمستويات التسميد الأزوتى حيث كانت أعلى القيم لكلا منهما ٩٥.٢٤ و ٤٨.٧٥% مع أضافة ٩٠كجم نتروجين/ للفدان٠ بينما أقل القيم كانت ٨٥.٦٣ و ٢٩.٣٣% مع ٦٠ كجم نتروجين / للفدان من المحصول المنفرد فى التحليل التجمعى.

وسجل أعلى قيم لمعدل استغلال الأرض LER (١.٥٣) ومعدل العائد النقدى MAI (٤٥٧٤.٧٣) ومعدل المكافئ النقدى MER (١.٤٢) مع نظام (N_3×P_3) بينما سجل أقل القيم مع (N_1×P_1) وكانت قيم العدوانية (Ag) للفول البلدى هو السائد بقيم موجبة بينما القمح هو المسود بقيم سالبة.