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Effect of Different sowing dates under Intercropping Patterns for Fahl Berseem and Wheat Crop Under the North Middle Nile Delta Region

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ABSTRACT

The present investigation was carried out in a clay soil at the experimental farm at Sakha Agricultural Research Station, Kafr El-Sheikh Governorate (31^0 07¯ N Latitude and 30^0 57¯ E longitude with an elevation of about 6 metres above mean sea level), Egypt in 2019/2020 and 2020/2021 seasons to study the effect of three sowing dates (15th, 25th November and 5th December) under three intercropping fahl berseem with wheat (100% grains of wheat with 10 or 17.5 or 25 % seeds of fahl berseem).On yield of weight and fahl berseem as well as total income of field area. A randomized completely block design in a split plot arrangement with three replications was used in both seasons the solid pattern of wheat recorded the highest values of grain yield /fed and its studied components in the two seasons of study. Sowing date 25th November). For the first intercropping pattern (100 % wheat with 10 % fahl berseem) gave the highest values of all studied traits the heights values of land equivalent ratio (LER)and total income (Egypt L.E) were attained by Sowing date 25th November under intercropping pattern of 100% wheat with 10 % fahl berseem. And these values were 1.19 and 1.21 as well as 10495 and 12248 in the first and second seasons, respectively. On the light of above-mentioned results, it could be recommended that sowing date 25th November under intercropping 10 % seeds of fahl berseem with grains of wheat as 100% is an appropriate intercropping pattern in the North of Middle Nile Delta of Egypt.

Keywords: Fahl berseem, wheat, intercropping pattern, sowing date.

1. Introduction

Wheat *(Triticum aestivum* L.) is considered as a strategic cereal crop and the main food for the Egyptians. More than 3 million faddans are cultivated annually with wheat crop. The average productivity is about 2.7 ton/fed (Wheat Research Department, Field Crops Research Institute, Agricultural Research Center, Egypt), where the recent high yielding wheat cultivars have been cultivated. In Egypt, the gap· between wheat consumption and production is continuously increased due to steady increases in the country population with limited cultivated area. Thus, increasing wheat productivity, either horizontal or vertical through scientific basis is a national target to fill this gap. Wheat yield is a function of some major variables; *i.e.* cultivars planting method, irrigation, soil fertility, fertilization climate, pests. etc. Intercropping is considered to be one of the most important factors for solving or reducing the large gap between the production and consumption of different crops such cereals crops.

Legume –Cereal mixture is an important sustainable technology compared with continuous cereal cropping. It can increase the stability of soil aggregates, increase available nitrogen and organic matter and decrease soil erosion (Jankauskas and Janksuskiens 2003). Leguminous forage crops with cereals and adding phosphorus fertilizer as permitted agro systems to develop soil and plant healthy (Cantero-Martineg *et al* .1995). Moreover, a fertilizer in dry land agro systems (Schwab *et al*., 1996). As far back to the literature the impotence of mixing berseem (Egyptian clover) with cereals which lead to

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decreasing the effect of heavy competitive pressure of berseem against other strategic winter crops such as wheat faba bean and also lowers the variability of annual return between mixtures and cereal monoculture to minimum was supported by (Norman (1973). Several investigators studied optimum rates of mixture components. Hussein and Abdel-Latif (1982) found that the optimum seeding rate of berseem was 30kg/fed. Mixed with 15kg/fed of barley, which produced higher green and dry matter yield. Gabra et .al (1984), noticed that in most cases, mixture yield of berseem barley association was nearly the same as high as the pure stand yield of berseem. Grasses in legume mixtures also contain a higher percentage of protein than grasses grown alone. in this concern, Nor EL-Din et.al (1984), reported that yield of berseem and barley mixtures were higher than yield of legume or grass in pure stand. EL-Hattab*et.al*. (1985), found that berseem – barley mixture was superior in green dry forage yields than mixtures- ryegrass, including wheat or oats. Seif and Sedhaom ,1988), found that fahl berseem – oats mixture was superior to mixtures with triticale or barley. Abou- Kerisha *et al*. (1996), indicated that sowing 75, 50 and 25% fahl berseem, on the other hand in most of characters of intercropping barley compared to pure barley. Mahrous *et al*. (1998) found that intercropping lentil with wheat decreased grain of seed and straw yield, seed index for both crops, number of groins /spike for wheat and number of branches for lentil. Banik *et al*. (2006) reported that chickpea yield was significantly reduced when it was intercropped with wheat. On the other hand, Thorsted *et al*. (2006) showed that intercropping of winter wheat and white clover decreased wheat grain yield by 10-25 % as compared with wheat sole cropping. Abou-kerisha *et al.* (2008) found that intercropping wheat with faba bean or fahl berseem resulted in increased yield components of wheat. The objective of this study is to investigate the effect of mixing fahl berseem (*Trifolium alexandrinum* L.) and wheat (*Triticum aestivum*) at different seeding rates of fahl berseem and fertilizer levels on yield and its components of each of wheat and fahl berseem.

Irrigation is considered one of the most important factors for increasing production (Shaaban, 2006). Water demand by wheat is variable according to different varieties, Kassab *et al.* (2019) reported that, for high yield of wheat crop water requirements are 2036.40 to 2147.91 m^3 fed^{-1} rely on climate and length of growing period. Moursi *et al*. (2019) indicated that, the highest value of seasonal applied water was recorded with pan evaporation (PE) method at 60% allowable soil moisture depletion (SMD) and the values were 2006.76 $m^3 fed^{-1}$ and 2011.8 $m^3 fed^{-1}$ in the two seasons, respectively. Meanwhile, the lowest values 1693.44 m3fed-1 and 1716.12$m^3 fed^{-1}$ were recorded with irrigation treatment 70% allowable SMD in the two seasons, respectively. Egypt has a population of around 100 million (with an increasing grown at a rate of 1.9% per year) mostly (around 97%) concentrated in the basin of the Nile river and the Nile Delta and a significant percentage (around 29%) of the total work force is the agricultural sector (El Baroudy *et al.,* 2020). Agriculture in Egypt faces many difficulties, such as scarcity of land and water resources, land fragmentation, and increasing demand for food, when need a sustainably expand agricultural production to meet escalating domestic demand for food and serve as a pathway out of poverty, particularly in rural areas. (Abdelaal, 2021)

2. Materials and Methods

An experiment was conducted at the Experimental Farm of Sakha Agricultural Research Station, A.R.C, Kafr EL-Sheikh Governorate, Egypt (at the North Middle Nile Delta region, 31^0 07^-N Latitude and 30^0 57^- E longitude with an elevation of about 6 metres above mean sea level), during 2019/ 2020 and 2020 /2021 winter growing seasons. The study aimed to investigate the effect of sowing dates under intercropping pattern of Egyptian clover Var. Fahl with wheat on both yield and yield components of wheat and fahl berseem. The experiments were laid out in a split plot with three replications. The main plots were devoted to the intercropping patterns (seed rates):

100% (60 kg/fed), +10% fahl (2kg/fed), 100% wheat (60kg/fed) +17.5% fahl (3.50kg/fed), 100% wheat(60kg/fed) +25%fahl (5kg/fed),100% wheat (60kg/fed) solid and 100%fahl(20kg/fed) solid. The subplots were assigned for three sowing date (15th, 25th November and 5th December). The area of the subplot was 12m^2(4m lengthy long and 3m width). Before planting, during soil preparation, all plots were Fertilized with a basal dose of super phosphate (15.5% p2Os) at the rate of 150Kg fed-^{1}. Nitrogen fertilizer levels were applied at the above-mentioned levels in two equal doses before the first and the second irrigation. Nitrogen fertilizer was urea (46%N). seed rate of pure stand was 20kg/fed for Egyptian clover Var. fahl and 60kg/fed for wheat crop. Wheat variety was Masr **3** from A.R.C., Fahl variety was Giza 1 from A.R.C. Wheat sowing by hand drilling in rows a part in 15 cm. with seeding rate of 50kg / fed. And berseem variety fahl broadcasting by hand. Wheat was harvested at maturity stage in May in the two seasons. Some meteorological data for the experimental site were recorded during the two growing seasons in Table (1). Some physical and chemical characteristics of the studied site were shown in Tables (2) and (3), of particle size distribution, soil bulk density, soil field capacity and permanent wilting point were determined according to Klute, (1986*)* in Table (2). The studied chemical characteristics, in Table (3): Soil reaction (pH) in (1:2.5 soil water suspension), total soluble salts (Ec_e) and soluble cations and anions were determined in soil paste extract by the standard methods as described.

Table 1: Means of some agro meteorological data for kafr El –Sheikh Area during the two growing seasons.

Month	Mean T (C0)	Mean RH (%)	U2 m.sec-1	Pan Evap. mm/month	Rain, mm/month
		2019/2020 season.			
Nov. 2019	26.5	65.25	0.37	2.31	0.00
Dec. 2019	17.4	72.9	0.39	2.66	10.3
Jan. 2020	15.1	74.7	0.35	2.09	68.0
Feb. 2020	7.05	70.7	0.59	1.83	14.3
Mar. 2020	19.1	67.5	0.93	5.12	64.6
April. 2020	22.45	62.55	1.14	6.08	0.00
		2020 /2021 season.			
Nov. 2020	21.25	100.15	0.52	2.28	12.35
Dec. 2020	20.0	76.5	0.52	2.49	4.69
Jan. 2021	17.25	73.1	0.45	2.57	17.5
Feb. 2021	17.0	71.7	0.67	3.56	0.00
Mar. 2021	19.22	67.07	0.98	4.80	5.4
April. 2021	20.47	62.19	1.14	6.42	0.00

Where: T= Air temperature, RH= Relative humidity and U_2 = wind speed, at 2 m height, $m.sec^{-1}$
Source: Agro-climatological Station at Sakha Agricultural Research Station.

Table 2: The mean values of some physical characteristics of the studied site before cultivation.

Soil depth (cm)	Particle size distribution			Texture Classes	F.C %	P.W.P %	AW %	Bd Mg/m^3
	Sand %	Silt %	Clay %					
0 – 15	17.2	21.6	61.2	Clay	47.8	26.0	21.8	1.15
15 – 30	18.2	22.8	59.0	Clay	42.7	23.2	19.5	1.18
30 – 45	18.9	23.8	57.3	Clay	40.5	22.0	18.5	1.23
45 – 60	19.7	24.2	56.1	Clay	37.7	20.5	17.2	1.29
Mean	18.5	23.1	58.4	Clay	42.2	22.9	19.3	1.21

Where: F.C % = Soil field capacity, P.W.P % = Permanent wilting point, AW % = Available water and Bd Mg/m^3 = Soil bulk density.

Table 3: The mean values of some chemical characteristics of the studied site before cultivation.

Soil depth, Cm	Ec ds/m	pH 1: 2.5 soil water suspension	Soluble ions meq/l							
			Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{-}	HCO_3^{--}	Cl^{-}	SO_4^{--}
0-15	4.38	8.11	10.7	7.9	17.3	8.1	0.00	5.9	16.2	21.9
15-30	4.64	8.07	13.2	7.1	16.8	9.5	0.00	5.7	16.0	24.9
30-45	4.76	8.03	15.3	6.8	16.3	9.3	0.00	5.6	15.8	26.3
45-60	5.45	8.00	17.5	5.3	14.2	7.8	0.00	5.2	15.5	33.9
Mean	4.81	----	14.2	6.8	16.2	8.7	0.00	5.6	15.9	26.8

Note: SO_4^{--} was determined by the difference between soluble cations and anions.

2.1. Studied characters: -

I. Wheat characters:

- Plant height (cm) was measured in cm from the soil surface to the top of the main spike, excluding owns.
- Spike length (cm). ten main spikes were randomly selected and measured; their average was calculated to express spike length in cm.
- Number of spikes /m^2 was calculated by counting all spikes per square metre.
- 1000- Grain weight (g). A random sample of 1000 – grain was taken from each sub – plot, hand counted and weighted to estimate the 1000- grain weight.
- Straw yield (ton/fed). The straw yield of the previous sample was in kg/m^2= biological yield (kg/m^2) - grain yield (kg/m^2), then it was converted to ton/fed.
- Grain yield (ton/fed) was recorded from the harvested area (2.8m^2) after threshing and then converted to (ton/fed.) on the basic of 14.5% moisture).

II. Egyptian Clover Var. (Fahl) characters:

- Plant height (cm) was determined from soil surface to the stem top in (cm). Measured for 10 randomly selected plants per each plot.
- Total fresh weigh (ton/fed.) was determined as plant fresh weight (PFW) kg/per plot and transformed to forage yield (ton/fed.).
- Total dry weight (ton/fed.) was determined as plant dry weight (PDW) kg/per plot and transformed to dry forage yield (ton/fed.).
- Crude protein (%) was determined by the micro-kjeldahl method as outlined by the A.O.A.C. (1980) to estimate the total nitrogen. Nitrogen percentage was multiplied by 6.25 to obtained crude protein.
- Weight of 1000 seed weight (g): The seeds obtained from 100 randomly selected inflorescences had been used for determination of 1000 – seed weight in (g.)
- Seed yield (kg /fed.): It was determined by harvest every plot at maturity seed stage and weight good seed only g/plot and transformed to seed yield kg/fed.

III. Applied Irrigation water: -

Amount of irrigation applied water (m^3fed^{-1}) was calculated as follow:

$$AWR = IW + R_{fe}$$

Where:
IWR = Irrigation water requirement (m^3fed^{-1})
IW = Irrigation water applied (m^3)
R_{fe} = Effective rainfall (m^3), note effective rainfall which it equals the incident rainfall×0.7 (Novica, 1979).

IV. Water consumptive use (m^3fed^{-1}):

Water consumptive use was calculated as soil moisture depletion (SMD) according to Hansen *et al.* (1979).

$$Cu = SMD = \sum_{i=1}^{i=N} \frac{\theta_2 - \theta_1}{100} * Dbi * Di * 4200$$

Where:
CU = Water consumptive use in the effective root zone (0.6 m),
Ө2 = Gravimetric soil moisture percentage 48 hours after irrigation,
Ө1= Gravimetric soil moisture percentage before irrigation,
Dbi = soil bulk density (Mg m^{-3}) for the given depth,
Di = soil layer depth (0.2 m),
i = Number of soil layers each (0.15 m) depth.

V. Productivity of irrigation water (PIW, kg m^{-3}):

It is defined as the weight of marketable crop production per the volume unit of irrigation water applied as cubic metre of water. It was calculated according to Bos, 1981 as follows:

$$\text{PIW} = \frac{Yield\ (kg/\text{fed})}{applied\ water\ m3/fed}$$

VI. Water productivity (WP, kg/m^3):

Water productivity is defined as crop production per unit amount of water used (Molden, 1997). was calculated according to Ali et al., (2007).

$$\text{Wp} = \frac{Yield\ (kg/\text{fed})}{ET\ m3/fed}$$

Where:

WP = water productivity (kg m^{-3}),
Y = Yield (kg fed-1) and
ET = Total water consumption, m^3 fed^{-1}.

VII. Land Equivalent Ratio (LER): The ratio of area needed under sole cropping to that of intercropping at the same management level to produce an equivalent yield, according to Mead and Willey (1980). It is calculated as follows:

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

Where, $\mathbf{y_{aa}}$ and $\mathbf{y_{bb}}$ are the sole crop yields of crops a and b, respectively, $\mathbf{y_{ab}}$ is the intercrop yield of crop a, and $\mathbf{y_{ba}}$ is the intercrop yield of crop b.

2.2. Economic evaluation:

Farmer's benefit was calculated by determining the total costs and net return of intercropping culture as compared to recommended solid culture of wheat.

- Total return of intercropping cultures = Price of wheat yield + price of Egyptian clover var. (fahl) yield (L.E.).
- Net return/fad = Total return – (fixed costs of wheat + variable costs of Egyptian clover var. (fahl) according to intercropping pattern). The market price for wheat was 700 and 800 LE Ardab and Egyptian clover var. (fahl) seeds was 2500 LE ton in two seasons respectively.

2.3. Statistical analysis:

The collected data of wheat and Egyptian clover var. (fahl) were subjected to analysis of variance and combined analysis (where the variance of two seasons were homogenous) and the differences among means were determined by Duncan multiple tests, according to Gomez and Gomz (1984).

3. Results and Discussion

3.1. Wheat

Presented data in Table (3) revealed that plant height of wheat from intercropping systems gave the highest values of all traits studied except plant height under (100%wheat +10 % fahl berseem (2kg). in both seasons. The lowest values were obtained using (100% wheat +25% Fahl Berseem (5kg) in all traits except plant height in both seasons. There was no significant effect of seed rates on straw yield in ton/fed in the second seasons**.** The same results were obtained by Moshira *et al.* (2017) and Abdel-Zaher *et al.* (2009).

Table 3: Effect of mixed intercropping with fahl berseem on growth, yield, and yield components of wheat in2019/2020and 2020/2021 seasons.

Parameter / Intercropping patterns	Plant height (cm)	Spike length (cm)	No. of spikes m^{-2}	Weight of grains $spike^{-1}$ (g)	1000- grain weight (g)	Grain yield fed^{-1} (ardab)	Straw yield fed^{-1}(ton)
				2019/2020			
W + 10% FB	108.3	13.7	399.7	3.56	48.8	22.2	4.21
W + 17.5% FB	109.9	12.8	384.6	3.33	44.4	23.1	3.93
W + 25% FB	113.1	12.7	372.6	3.04	42.3	20.2	3.91
Wheat solid	117.4	14.0	411.0	3.27	48.6	24.3	4.43
$LSD_{0.05}$	0.72	0.21	1.11	0.11	0.32	0.68	0.57
				2020/2021			
W + 10% FB	107.6	13.3	398.3	3.27	48.5	22.0	3.82
W + 17.5% FB	107.2	12.8	383.2	2.97	44.1	20.9	3.61
W + 25% FB	113.3	12.3	371.2	2.63	42.2	19.8	3.50
Wheat solid	115.2	13.9	411.3	2.83	48.3	23.8	4.42
$LSD_{0.05}$	1.04	0.31	1.11	0.07	0.27	0.23	ns

Means followed by the same letter in the same column are not significantly different at the 5 % probability level.
W= wheat, FB= fahl berseem.

Presented data in Table (4) generally showed that wheat plants from intercropping systems gave the highest values of all traits studied except plant height under 25th November in both seasons. The lowest values were obtained 15th November in all traits in both seasons. There was no significant effect of sowing date on straw yield (ton/fed) in both seasons. Solid planting of wheat gave maximum values compared with intercropping system. These results are in great harmony with those reported by Abou-Kerisha *et al.* (1996) , Abdel-Zaher *et al.* (2009) and Moshira *et al.* (2017).

Table 4: Effect of sowing date on growth, yield and yield components of wheat in 2019/2020 and 2020/2021 seasons.

Parameter / Sowing dates	Plant height (cm)	Spike length (cm)	No. of spikes m^{-2}	Weight of grains $spike^{-1}$ (g)	1000- grain weight g)	Grain yield fed^{-1} (ardab)	Straw yield fed^{-1} (ton)
				2019/2020			
15th November	111.3	9.9	370.9	2.96	43.5	20.8	4.73
25th November	105.6	12.1	396.5	3.64	46.2	23.0	5.22
5th December	108.3	11.3	384.6	3.15	44.4	22.7	4.92
$LSD_{0.05}$	0.58	0.32	2.31	0.10	064	0.49	ns
				2020/2021			
15th November	110.7	9.6	370.1	2.58	42.8	20.6	4.28
25th November	105.2	11.8	395.6	3.16	45.6	22.8	4.84
5th December	108.1	11.1	374.5	2.84	43.7	22.3	4.55
$LSD_{0.05}$	0.79	0.76	2.11	0.11	0.58	0.36	ns

3.2. Interaction effect:

The interaction between intercropping pattern and sowing date significantly affected spike length, number of spikes/m^2, weight of grains $spike^{-1}$ and grain yield/fed. In the first season. While, plant height, spike length and straw yield were insignificantly. Data presented in Table (5) show that the effect of interaction between intercropping system and sowing date was significant effect on all traits studied except plant height, 1000-grain weight and straw yield in the first season. While, plant height, spike length and straw yield in the second season. The highest values of all traits studied except plant height were recorded from100% grain of wheat +10% seed of fahl berseem and sowing date25th November while the lowest ones were found under intercropping pattern of 100% grain of wheat + 25% seed of fahl berseem and sowing date 5thDecember. These results were in line with were reported by Banik *et al.* (2006) and Abdel-Zaher *et al.* (2009).

Table 5: Effect of the interaction between sowing dates and intercropping patterns on growth, yield and its components of wheat during both of growing seasons

Treatment	Parameter	Plant height (cm)	Spike length (cm)	No. of spikes m^{-2}	Weight of grains $spike^{-1}$ (g)	1000-grain weight (g)	Grain yield fed^{-1} (ardab)	Straw yield (ton fed^{-1})
Sowing methods	**Intercropping patterns**				**2019/2020**			
W 10%FB	15th November	103.3	12.5	385.51	3.16	43.4	22.0	5.02
	25th November	105.1	12.9	412.10	4.04	49.3	24.1	5.22
	5th December	107.6	12.8	407.21	3.83	45.2	22.9	5.12
W+17.5% FB	15th November	105.71	11.80	364.80	2.91	41.5	20.5	4.65
	25th November	107.31	12.29	377.51	3.41	47.5	23.1	5.11
	5th December	111.10	12.21	372.50	3.12	43.3	21.6	4.92
W +25% FB	15th November	108.61	10.30	360.81	2.89	40.9	18.21	4.60
	25th November	110.51	10.91	368.40	3.17	46.2	19.71	4.95
	5th December	113.50	10.70	361.50	2.99	42.9	18.90	4.84
$LSD_{0.05}$		Ns	0.21	1.80	0.17	Ns	0.57	ns
					2020/2021			
W +10%FB	15th November	103.11	11.41	375.10	2.86	42.8	21.71	4.75
	25th November	104.70	12.35	409.61	3.56	48.8	23.81	4.95
	5th December	107.28	11.90	401.73	3.15	44.6	22.71	4.92
W+17.5% FB	15th November	105.21	11.74	354.10	2.56	41.0	19.22	4.39
	25th November	107.21	12.11	372.03	3.03	47.0	22.79	4.87
	5th December	111.02	11.93	366.88	2.84	42.7	21.22	4.65
W +25% FB	15th November	108.51	9.59	351.10	2.32	40.2	17.94	4.21
	25th November	110.18	10.13	360.50	2.85	45.6	19.32	4.55
	5th December	113.45	9.99	358.00	2.49	42.4	18.63	4.45
$LSD_{0.05}$		Ns	Ns	2.11	0.13	0.48	0.39	ns

ns= not significant; FB= Fahl berseem; W= wheat

3.3. Fahl Berseem

Data presented in table (6) show generally that fahl berseem plants from intercropping systems gave the highest values of all traits studied under (100% wheat+25 % fahl berseem) in both seasons, while the lowest values were obtained under (100% wheat+10% fahl lberseem) in both seasons, Solid planting of fahl berseem gave maximum values compared with intercropping system. Parallel results were achieved by Abou- Kerisha *et al.* (1996) and Moshira *et al.* (2017).

Data presented in Table (7) show generally that fahl berseem plants from sowing date gave the highest values were obtained at sowing date 15th November of all traits studied in both seasons, while the lowest values were obtained at sowing date 5th December in all traits in both seasons. These results were in line with were reported by Banik *et al.* (2006) and Moshira *et al.* (2017).

The interaction between intercropping pattern and sowing date significantly affected plant height and weight of 1000-seeds in the first season. While, all traits studied were insignificantly in the second season. Data presented in Table (8) show that the effect of interaction between intercropping system and sowing date was significant effect on all traits studied except plant height in two seasons. The highest values of all traits studied except plant height were recorded from100% grain of wheat +25% seed of fahl berseem and sowing date15th November in the two seasons. These results are in harmony with those obtained by Hussain and Abdel-Latif (1982).

3.4. Competitive relationships and yield advantage

Competitive relationships and total income of intercropping wheat with fahl berseem cleared its results as in Table 9: At (100% grain of wheat +10% seed of fahl berseem) and sowing date25th November produced the highest values of land equivalent ratio (1.19and 1.21) and total income (10495, and 12248LE) in the first and second seasons respectively. These results were in line with were reported by Abou- Kerisha *et al.* (1996); Banik *et al.* (2006); Abdel-Zaher *et al.* (2009) and Moshira *et al.* (2017).

Table 6: Effect of intercropping patterns on growth, yield and yield components of fahl berseem in 2019/2020 and 2020/2021 seasons.

Parameter / Treatment	Plant height (cm)	Fresh weight fad^{-1} (ton)	Dry weight fad^{-1} (ton)	Crude protein (%)	1000- weight seed (g)	Seed yield fad^{-1} (ardab)
			2019/2020			
W + 10% FB	104.7	7.12	1.68	14.2	3.71	0.45
W + 17.5% FB	103.4	8.04	1.89	14.2	3.93	0.52
W + 25% FB	106.6	8.29	1.92	14.3	4.08	0.57
LSD$_{5\%}$	1.70	Ns	Ns	ns	0.08	ns
Fahl berseem	114.8	9.68	1.97	14.5	4.65	2.36
			2020/2021			
W + 10% FB	104.6	8.14	1.65	14.2	3.77	0.37
W + 17.5% FB	104.1	7.63	1.67	14.2	3.85	0.48
W + 25% FB	104.8	7.92	1.72	14.3	3.84	0.51
LSD$_{5\%}$	Ns	Ns	Ns	ns	ns	ns
Fahl berseem	115.3	9.52	1.96	14.3	4.23	2.26

ns= not significant; FB= Fahl berseem; W= wheat

Table 7: Effect of sowing date on growth, yield and yield components of fahl berseem in 2019/2020 and 2020/2021 seasons.

Parameter / Sowing dates	Plant height (cm)	Fresh weight fad^{-1} (ton)	Dry weight fad^{-1} (ton)	Crude protein (%)	1000- weight seed (g)	Seed yield fad^{-1} (ardab)
			2019/2020			
15th November	105.6	8.32	1.87	14.5	3.95	0.55
25th November	105.7	7.82	1.83	14.3	3.93	0.52
5th December	103.4	7.21	1.77	14.4	3.84	0.42
LSD$_{5\%}$	1.00	0.53	Ns	ns	Ns	ns
			2020/2021			
15th November	105.5	8.23	1.74	14.4	3.92	0.54
25th November	105.6	7.63	1.63	14.3	3.73	0.50
5th December	102.8	7.06	1.61	14.2	3.72	0.41
LSD$_{5\%}$	2.10	Ns	Ns	ns	0.22	ns

ns= not significant

Table 8: Effect of the interaction between intercropping patterns and sowing date on some fahl berseem, characters in both seasons.

Treatment: Intercropping patterns	Parameter: Sowing dates	Plant height (cm)	Fresh weight fad^{-1} (ton)	Dry weight fad^{-1}(ton)	Crude protein (%)	1000- weight seed (g)	Seed yield fad^{-1}(ardab)
				2019/2020			
W +10%FB	15th November	104.7	8.24	1.93	14.4	3.94	0.58
	25th November	105.2	8.05	1.85	14.4	3.88	0.45
	5th December	106.8	7.12	1.76	14.3	3.62	0.38
W+17.5% FB	15th November	104.3	7.87	1.86	14.3	4.09	0.61
	25th November	105.7	7.62	1.85	14.2	3.95	0.46
	5th December	107.1	6.33	1.64	14.3	3.85	0.45
W +25% FB	15th November	100.5	8.74	2.01	14.5	4.18	0.63
	25th November	101.8	8.45	1.86	14.3	4.09	0.58
	5th December	107.7	7.85	1.68	14.4	3.93	0.54
LSD$_{5\%}$		2.92*	Ns	ns	ns	0.15**	ns
				2020/2021			
W +10%FB	15th November	101.9	8.47	1.85	14.4	3.84	0.57
	25th November	102.4	8.32	1.82	14.4	3.74	0.44
	5th December	104.5	7.74	1.56	14.3	3.61	0.34
W+17.5% FB	15th November	104.4	8.42	1.73	14.4	3.86	0.52
	25th November	105.8	7.73	1.62	14.3	3.79	0.45
	5th December	106.5	6.44	1.42	14.2	3.73	0.44
W +25% FB	15th November	103.5	8.71	1.92	14.4	3.95	0.62
	25th November	106.5	7.76	1.66	14.2	3.91	0.55
	5th December	106.6	7.54	1.55	14.1	3.85	0.51
LSD$_{5\%}$		Ns	Ns	ns	ns	ns	ns

Table 9: Effects of intercropping system and sowing dates wheat with fahl berseem, on LER and Economic evaluation.

Treatments		Relative yield (RY)		LER	Gross return For wheat	Gross return For fahl berseem	Total return	Net return
Intercropping system	Sowing dates	Wheat	fahl berseem					
			2019/2020					
W +10%FB	15^{th} November	0.91	0.25	1.16	15400	1450	16850	9350
	25^{th} November	0.99	0.20	1.19	16870	1125	17995	10495
	5^{th} December	0.94	0.17	1.11	16030	950	16980	9480
W+17.5% FB	15^{th} November	0.84	0.27	1.11	14350	1525	15875	8375
	25^{th} November	0.95	0.20	1.15	16170	1150	17320	9820
	5^{th} December	0.89	0.20	1.09	15120	1125	16245	8745
W +25% FB	15^{th} November	0.75	0.28	1.03	12747	1575	14322	6822
	25^{th} November	0.82	0.25	1.07	13797	1450	15247	7747
	5^{th} December	0.78	0.24	1.02	13230	1350	14580	7080
			2020/2021					
W +10%FB	15^{th} November	0.91	0.25	1.16	17368	1425	18793	10893
	25^{th} November	1.01	0.20	1.21	19048	1100	20148	12248
	5^{th} December	0.95	0.15	1.11	18168	850	19018	11118
W+17.5% FB	15^{th} November	0.81	0.23	1.04	15376	1300	16676	8776
	25^{th} November	0.96	0.20	1.16	18232	1125	19357	11457
	5^{th} December	0.89	0.19	1.09	16976	1100	18076	10176
W +25% FB	15^{th} November	0.75	0.27	1.03	14352	1550	15902	8002
	25^{th} November	0.81	0.24	1.06	15456	1375	16831	8931
	5^{th} December	0.78	0.23	1.01	14904	1275	16179	8279

FB= Fahl berseem; W= wheat; LER= land equivalent ratio; L.E.= Egyptian pound

3.5. Effect of sowing date and intercropping system treatments on:

3.5.1. Seasonal water applied and water consumptive use (Cu):

Presented data in Tables (10 &11) clearly showed that, the average values for amount of seasonal water applied and water consumptive use for wheat which intercropped on fahl berseem were affected by both sowing date and intercropping system treatments. The total amount of the rainfall during the two growing seasons of crops as reported in Table (1) was 15.7 cm. (462.168 m^3fed^{-1}) and 9.77 cm. (287.18 m^3fed^{-1}) in the two growing seasons, respectively. The highest amount of seasonal water applied values were recorded under the first sowing date (15th November, sowing irrigation plus five irrigations) where the values are 51.5 cm (2164 m^3fed^{-1}) and 48.5 cm (2037 m^3fed^{-1}.) in the first and second growing seasons, respectively. Meanwhile, the lowest amount of seasonal water applied values were recorded under the three sowing date (5^{th} December, sowing irrigation plus four irrigations) and the values are 43.6 cm (1832 m^3fed^{-1}) and 42.6 cm (1788 m^3fed^{-1}) in the first and second growing seasons, respectively.

Generally, the amount of seasonal water applied can be descended in this order 15^{th} November > 25^{th} November > 5^{th} December. Increasing the seasonal values for applied water under sowing date treatment 15^{th} November in comparison with other sowing date treatments 25^{th} November and 5^{th} December might be attributed to increasing number of irrigations (increasing the applied water). These results are in harmony with those obtained by Ali *et al.* (2007).

Concerning, water consumptive use (Cu) data in Table (11) and showed that the highest average values for (Cu) were recorded under the first sowing date treatment (15^{th} November) and the values is 30.0, 28.5 and 27.5 cm (1260.3, 1197.3 and 1155.3 m^3fed^{-1}). Meanwhile, the lowest average values were recorded under the three sowing date treatment (5^{th} December) and the value is 25.9, 24.6 and 23.7 cm. (1086, 1031.7 and 995.5 m^3fed^{-1}).

Generally, the average values of water consumptive use can be descended in order 15^{th} November > 25^{th} November > 5^{th} December and under intercropping system treatments W +25% FB >W+17.5% FB > W +10%FB, respectively. Increasing the average values of Cu under the first sowing date treatment 15^{th} November in comparison with other sowing date treatments 25^{th} November and 5^{th} December might be attributed to increasing the quantity of applied water under and forming strong plants with a thick vegetative growth. Consequently, increasing the exposed area to sunlight, increasing transpiration from plant surfaces. These results were in line with were reported by Kassab *et al.* (2019).

Table 10: Effect of sowing dates wheat with fahl berseem and intercropping systems on seasonal water applied in the two growing seasons.

Intercropping system	Sowing dates	1st growing season 2019/2020		2nd growing season 2020/2021		The overall mean values during the two growing seasons	
		cm.	$m^3\ fed^{-1}$	cm.	$m^3\ fed^{-1}$	cm	$m^3\ fed^{-1}$
W +10%FB	15th November	51.5	2164	48.5	2037	50.0	2100.5
	25th November	47.9	2012	46.1	1935	47.0	1973.5
	5th December	43.6	1832	42.6	1788	43.1	1810
Mean		47.7	2002.7	45.7	1920	46.7	1961.3
W +17.5%FB	15th November	51.5	2164	48.5	2037	50.0	2100.5
	25th November	47.9	2012	46.1	1935	47.0	1973.5
	5th December	43.6	1832	42.6	1788	43.1	1810
Mean		47.7	2002.7	45.7	1920	46.7	1961.3
W +25%FB	15th November	51.5	2164	48.5	2037	50.0	2100.5
	25th November	47.9	2012	46.1	1935	47.0	1973.5
	5th December	43.6	1832	42.6	1788	43.1	1810
Mean		47.7	2002.7	45.7	1920	46.7	1961.3

FB= Fahl berseem; W= wheat

Table 11: Effect of sowing dates wheat with fahl berseem and intercropping systems on water consumptive use in the two growing seasons.

Intercropping system	Sowing dates	1st growing season 2019/2020		2nd growing season 2020/2021		The overall mean values during the two growing seasons	
		cm.	$m^3\ fed^{-1}$	cm.	$m^3\ fed^{-1}$	cm	$m^3\ fed^{-1}$
W +10%FB	15th November	28.3	1190.2	26.7	1120.4	27.5	1155.3
	25th November	26.4	1106.6	25.3	1064.3	25.8	1085.4
	5th December	24.0	1007.6	23.4	983.4	23.7	995.5
Mean		26.2	1101.5	25.1	1056	25.7	1078.7
W +17.5%FB	15th November	29.4	1233.5	27.6	1161.1	28.5	1197.3
	25th November	27.3	1146.8	26.3	1103.0	26.8	1124.9
	5th December	24.9	1044.2	24.3	1019.2	24.6	1031.7
Mean		27.2	1141.5	26.1	1094.4	26.6	1118.0
W +25%FB	15th November	30.9	1298.4	29.1	1222.2	30.0	1260.3
	25th November	28.7	1207.2	27.6	1161.0	28.2	1184.1
	5th December	26.2	1099.2	25.5	1072.8	25.9	1086.0
Mean		28.6	1201.6	27.4	1152.0	28.0	1176.8

FB= Fahl berseem; W= wheat

Regarding, the effect of intercropping system treatments under all sowing date treatments, the highest overall average values were recorded under intercropping system treatment W +25% FB and the values are 30.0 cm (1260.3 m^3/fed^{-1}.), 28.2 cm (1184.1 m^3/fed^{-1}.) and 25.9 cm (1086 m^3/fed^{-1}.) under 15th November, 25th November, 5th December sowing date treatments, respectively. Also, as shown in the same Table, increasing values of water consumptive use resulted in increasing plant densities (intercropping systems). So, the values of Cu can be descended in order W +25% FB > W+17.5% FB > W +10%FB under the two growing seasons. These findings are in the same line with those reported Abdelkhalek *et al*. (2015) and Udom *et al*. (2013).

3.6. Irrigation efficiencies (PIW and WP):

Presented data in Table (12) clearly indicated that the values of irrigation productivity (PIW and WP) were affected by both the two studied treatments (sowing date and intercropping system). Concerning, the effect of sowing date treatments on PIW and WP, the highest average values were recorded under the first sowing date treatment (25th December) in the first and second growing seasons and the values are 1.98, 1.88 and 1.66 kg m^{-3} for PIW, 3.61, 3.28 and 2.75 kg m^{-3} for WP as average in the two growing seasons, respectively. Meanwhile, the lowest average values were recorded under 15th

November treatment and the values are 1.71, 1.55 and 1.38 kg m^{-3} for PIW and 3.01, 2.64 and 2.36 kg m^{-3} for WP in the two growing seasons, respectively. Generally, the average values for PIW and WP can be descended in order 5th December > 25th November >15th November and W +10%FB >W+17.5% FB > W +25% FB in the two growing seasons under furrow width treatments. Increasing the average values of PIW and WP under the three sowing date treatment (5th December) in comparison with other sowing date treatments (15th November and 25th November) in the two growing seasons may be attributed to increasing yield and decreasing the seasonal of applied water and Cu under the conditions of the three sowing date treatment comparing with the first date treatment (15th November) which recorded the increasing applied water and Cu. Consequently, under these conditions the lowest average values for PIW and WP were recorded. These results are in a great harmony with those obtained by Dukes *et al*. (2010).

Table 12: Effect of sowing dates wheat with fahl berseem and intercropping systems on productivity of irrigation water (PIW, kgm-3) and water productivity (Wp, kgm-3) in 2019/20 and 2020/21 growing seasons

Intercropping System	Sowing dates	PIW			Wp		
		1st growing season 2019/20	2nd growing season 2020/21	The overall mean values during the two growing seasons	1st growing season 2019/20	2nd growing season 2020/21	The overall mean values during the two growing seasons
		kgm^{-3}	kgm^{-3}	kgm^{-3}	kgm^{-3}	kgm^{-3}	kgm^{-3}
W +10%FB	15th November	1.72	1.69	1.71	2.94	3.08	3.01
	25th November	1.89	1.94	1.92	3.44	3.53	3.49
	5th December	1.97	1.99	1.98	3.58	3.63	3.61
Mean		1.86	1.87	1.87	3.32	3.03	3.18
W +17.5%FB	15th November	1.60	1.50	1.55	2.65	2.63	2.64
	25th November	1.81	1.86	1.84	3.18	3.26	3.22
	5th December	1.86	1.88	1.87	3.27	3.29	3.28
Mean		1.76	1.75	1.75	3.03	3.06	3.05
W +25%FB	15th November	1.35	1.41	1.38	2.36	2.35	2.36
	25th November	1.51	1.59	1.55	2.60	2.65	2.63
	5th December	1.64	1.66	1.65	2.74	2.76	2.75
Mean		1.50	1.55	1.53	2.57	2.59	2.58

FB= Fahl berseem; W= wheat.

4. Conclusion

From the previous results, we observed that intercropping 100% wheat with Egyptian clover Var. Fahl under system 10 % seeds of fahl berseem at sowing date 25th November attained the highest values of yield and components, land equivalent ratio and total income for in 2019/2020 and 2020 /2021 seasons.

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