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Relay Intercropping of Cotton with Wheat in Reclaimed Land

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A FIELD trial was carried out at the Nubaria Agricultural Research Station, Egypt during 2007/2008 and 2008/2009 seasons to study the effect of relay intercropping of cotton (*Gossypium barbadense* L.) with wheat (*Triticum aestivum* L.) at different sowing dates of cotton (1st of March, 15th of March and 1st of April) and three different varieties of wheat (Gemmiza 7**,** Sakha 93 and Giza 168) on growth, yield and yield, components of both crops. Results indicated that all intercropping treatments showed yield advantage compared with solid planting. The maximum value of land equivalent ratio (LER) were 1.97 and 1.88 in first and second season, respectively, and area time equivalent ratio (ATER) were 1.16 and 1.10 in the two seasons respectively were recorded when cotton was planted at date 15th March through relay intercropping with wheat variety cv Sakha 93. The yield and yield components of wheat were affected significantly by different varieties of wheat. The highest wheat yield was obtained when wheat cv. Giza 168 was relayed on cotton at 1th March whereas, the lowest value was obtained when wheat cv. Gemmiza 7 was relayed intercropped with cotton at late date (1st April). The yield and yield components of cotton were affected significantly by planting date of cotton. The highest cotton yield was produced when wheat cv Sakha 93 relayed intercropped with cotton at 15th March whereas, the lowest value was recorded when wheat cv. Gemmiza 7 was intercropped with cotton at latest date (1st April). The total income was the highest when relay intercropping wheat cv. Giza 168 were grown with cotton at (15th March). It could be concluded that relay intercropping of cotton with wheat as intensive cropping system is recommended to increase the productivity of the unit area.

Keywords: Intercropping, Planting dates, Wheat, Cotton, Land equivalent ratio.

Cotton (*Gossypium barbadense* L.) growers suffered much from a rapid increase of cost production during last decades which has not been matched by an equal increase in price policy. Moreover, predominant deterioration of cotton productivity was a cogent reason for farmers to avoid cotton planting. Farmers tried hardly to activate cotton rotation by inclusion of some long duration winter crops particularly wheat (*Triticum aestivum* L.) which we suffer a deficit to approximately 50% and to achieve maximum utilization with higher gross income. In wheat-cotton relay intercropping system both wheat and cotton are

grown on the same field in one year. In theses systems, strips of winter wheat, sown in the fall, are sown with cotton in the spring. From March to April, both two crops are grown together on the same field, with seedling phase of cotton and maturation phase of wheat overlapping in time and space. After the wheat harvest in early summer, the whole space is occupied by cotton. Hussein (2005, 2006), and Toaima *et al.* (2007), reported the possibility of relaying cotton on wheat successfully. On other hand, Abou- Zaid (1991), revealed that delaying planting date of cotton to mid- May decreased cotton yield, number of flowers and open bolls/plant, earliness and lint percent. Kamel *et al.* (1992), and Selim *et al.* (1998), also reported that early cotton seeding significantly increased cotton yield. They also revealed that relaying cotton with faba bean had no any detrimental effect on growth, yield and yield components of cotton. In extensive studies Hussein (1998 a,b), stated that sowing cotton as relay intercropping with either wheat or sugar beet had no any deleterious effects on their yield and yield components. Hussein (1999), also reported that relay cotton with faba bean in old or new reclaimed sandy soil produced the highest seed cotton and seed yield per plant and per feddan. Abou El-Nour *et al.* (2000), found that early sowing increased the yield components and yield of seed cotton, while it decreased plant height and internodes length, but it delayed the first flower appearance and added that sowing date had no effect on boll weight, lint percent and seed index. El- Beilly *et al.* (1996), found that number of days to first flower decreased by delaying the date of sowing. Further, Makram *et al.* (2001), found that sowing cotton early on 25th March exceeded late sowing on 25th April in number of bolls, total bolls/plant and open bolls/plant. Early flowering was correlated with early sowing. Moreover, early sowing outyielded late sowing, where cotton plant received more heat units, through the growing season. In continuation study on relaying cotton on wheat Hussein (2005), reported that sowing cotton as solid grown on March, 25 gave the highest value of cotton yield and its attributes. The best sowing date to intercropping cotton with wheat was on March 25th or 15th April which produced the highest yield and did not differ significantly as compared with the sole planting, whereas, the early date (5th March) or late sowing (15th May) caused reduction in seed yield. The effect of relay cotton with wheat was also studied by Hussein (2006) who revealed that relay intercropping significantly increased plant height, the first sympodium height, number of days to the first flower appearance, number of plants at picking/fed and seed yield /fed, but decreased yield components and lint percentage. She also reported that there was no significant difference between sole and intercropped cotton in seed cotton yield /fed.

The effect on wheat crop was studied by several investigators. Abd El-Hady *et al.* (2002), examined different patterns when cotton was relayed with wheat. They revealed that cotton yield was not affected but wheat yield of sole cropping was higher than the intercropped. Hussein (2005, 2006), obtained highest values of number of grains/ spike, weight of spike and 1000-grain weight and yield of kernels of wheat /plant and per feddan when cotton was relayed on wheat on late March in comparison with relaying cotton with wheat on 5th April or 15th May. Toaima *et al.* (2007), revealed that the effect of relay cropping patterns of cotton with wheat yield and their components was significant. The grain yield was 89% of pure stand wheat. Nevertheless, plant

height and yield components of wheat (length of spike, number of spikes/m^2, grain weight /spike and 1000 kernel weight) under relay intercropping were higher than those grown as control crop.

This study aimed to maximize the productivity of land units area by relay cropping of cotton with wheat using the suitable cotton planting date and wheat cultivar under the conditions of reclaimed land at Nubaira, Egypt.

Materials and Methods

A field trial was carried out to evaluate three cotton planting dates and wheat relay intercropping using three different wheat varieties. These experiments were carried out at the Nubaria Research Station in 2007/2008 and 2008/2009. The experiment was laid out in split plot design and the treatments were replicated three times, keeping wheat varieties in the main plots and the cotton planting dates in the sub plots. Wheat varieties were Gemmiza 7, Sakha 93 and Giza 168. Cotton planting dates were 1^{st} of March, 15^{th} of March and 1^{st} of April.

Solid plots of cotton, as well as the three wheat varieties were also included in each replication for comparison, determination of the competitive relationships.

The physical and chemical analysis of the soil at a depth of 0-30 cm is shown in Table 1.

TABLE 1. Physical and chemical analysis of the experimental soil at 0-30 cm depth.

Mechanical analysis	
Sand %	55.83
Silt %	23.46
Clay %	20.71
Soil texture %	Sandy loam
Chemical analysis	
pH	8.20
CaCo3 %	23.50
Organic matter %	0.42
Soluble cations meg/ IL	
Ca^{++}	4.40
Mg^{++}	1.59
Na^{+}	4.60
K^{+}	0.51
Soluble anion meg/ IL	
Cl^{-}	4.68
HcO_3^{-}	2.02
CO_3^{--}	-
$SO_4^{—}$	4.39
Exchangeable cations meg/ 100 gm soil	
Ca^{++}	4.40
Mg^{++}	1.59
Na^{+}	4.60
K^{+}	0.51

Wheat was drilled in four- rows on bed at 15cm apart on 15 and 17 November in the two successive seasons. Cotton Giza 85cv. was seeded on both sides of beds (120 cm) in hills 25 cm apart with 2 plants per hill. Solid planting of wheat was drilled in flat land in rows 10 cm apart. Cotton was seeded in pure stand in 24th March and 25th March in the two seasons, respectively after berseem (as a catch crop) in dry soil in rows 60 cm apart and one side of the ridges (60 cm width) in hills 25 cm apart with seeding rate of 30 kg/fed. The plants were thinned to two plants/hill.

The plot size was 42 m^2 including 5 beds of 1.2 m width and 7 m length. All cultural practice for wheat and cotton were done as recommended.

Air temperature was recorded during the two growing years as presented in Table 2.

TABLE 2. Monthly average of maximum (max), minimum (min) and average (avg) air temperature (^{O}C) at the experimental site in 2007/08 and 2008/09.

Month	2008								2009							
Record	3	4	5	6	7	8	9	10	3	4	5	6	7	8	9	10
Max.	23.4	22.7	26.2	30.0	29.9	29.2	30.6	25.8	19.5	23.4	25.5	29.9	30.3	30.4	29.6	28.7
Avg.	16.9	18.0	20.7	24.4	25.6	24.7	25.6	21.1	14.2	17.6	20.3	24.9	26.1	25.7	25.0	22.9
Min.	10.2	13.3	14.9	18.5	21.1	21.5	20.5	15.7	8.6	11.7	14.8	19.8	21.9	20.9	20.2	17.0

Data recorded

Wheat

At maturity, days to maturity and number of spikes/m^2 were estimated, and then ten wheat plants were taken randomly from each plot to determine plant height (cm), number spikelets/spike, 1000-grain weight (g). Grain yield (ardab /fed) and straw yield (ton/fed) were determined on whole plot basis.

Cotton data

At maturity, ten cotton plants were taken randomly from each plot to determine plant height (cm), number of sympodia /plant , number of monopodia /plant, number of open bolls /plant, boll weight (g). Lint percentage, seed index, seed cotton yield kintar /fed were determined per plot (42 m^2) and consequently yield/ fed was calculated. (ardab wheat = 150 kg, kentar cotton = 157.5 kg, fed = 4200 m^2).

The statistical analysis was carried out for each crop separately according to Snedecor & Cochran (1982), using MSTAT computer V4 (1986). LSD at 0.05 level of probability was used to compare between treatment means.

Competitive relationships

Land equivalent ratio (LER)

It was described by Mead and Willey (1980), as follows:

$$LER = \sum_{i=1}^{n} (Y_i^{I} / Y_i^{M})$$

where Y_i^I = yield of crop i in intercropping
Y_i^M = yield of crop i in monocropping,
n = number of crops in the intercropping system

Area time equivalent ratio (ATER)

It considers time factor along with land area. It proposed by Hiebsch & Mc Collum (1987), and calculated as:

$$ATER = \sum_{i=1}^{n} [(T_i^M / T_i^I) (Y_i^I / Y_i^M)]$$

where T_i^M = Duration of crop i in monocropping.
T_i^I = Total duration of the intercropping system.

The total income per faddan was calculated for each treatment in Egyptian pounds, using the average market price for both years. The farm price were 383L.E/ardab for grain and 102 L.E / ton for straw in 2008 and 242L.E/ardab for grain and 105 L.E / ton for straw in 2009 for wheat and 806L.E/kentar in 2008 and 679L.E/kentar in 2009. for cotton and 1819 price of berssem / fed in 2008 and 2074 price of berssem/ fed in 2009.

Results and Discussion

Wheat

Performance of wheat varieties under the condition of relay intercropping with cotton

Table 3 indicated that grain and straw yield of wheat varieties varied significantly under the conditions of relay intercropping with cotton in both years. Obtained data indicated that grain yield of Giza 168 cv surpassed the yield of Sakha 93 and Gemmiza 7 by 11.39 and 30.21%, respectively as average of both seasons. This was due to the greater number of spikes/m^2 of Giza 168 cv. which outnumbered that of Sakha 93 and Gemmiza 7 by 10.28% and 28.19%, respectively, as an average of both seasons (Table 3). On the other hand, Gemmiza 7 showed the highest value of number of spikelets/spike and 1000-grain weight, but it ranked the least regarding grain yield/ faddan. This may be due to least number of spikes/m^2 (Table 3). Menshawy (2008) emphasized superiority of Giza 168 over six bread wheat genotypes. From another angle of data, wheat varieties in the solid state outyielded the same respective cultivar in the intercrop. The excesses of grain yield/ fed of Giza 168, Sakha 93 and Gemmiza 7 in the solid state over those in the intercrop were 8.82, 9.33 and 14.33% in the first season and were 9.19, 10.39 and 17.78% in the second season, respectively, Abd El- Hady *et al*. (2002) and Toaima *et al.* (2004 , 2007), found that wheat yield of sole cropping was higher than in the intercrop. Hussein (2005, 2006), obtained contradictory results. She reported highest values of number of grains/spike, weight of spike, 1000-grain weight and yield of grains of wheat per fed when cotton was relayed with wheat.

TABLE 3. plant height, yield and yield components of wheat varieties as affected by intercropping with cotton in 2007/2008 and 2008/2009.

Trait / Treatment	Plant height (cm)	Number of spikes/ (m^2)	No. of spikelets / spike	1000-grain weight (g)	Days to maturity	Grain Yield / fed (ardab)	Straw yield / fed (ton)
Wheat varieties	2007/2008						
Gemmiza 7	103.40	351.78	67.98	68.76	160.21	13.12	3.15
Sakha 93	100.67	408.90	59.94	50.07	150.21	15.32	3.49
Giza 168	107.91	450.95	53.49	50.82	153.50	17.00	4.13
L.S.D 0.05	N. S	N.S	7.53	8.70	3.07	2.31	0.38
Solid Gemmiza 7 grain yield ardab /fed				15.39 &	Straw yield ton /fed		3.90
Solid Sakha 93 grain yield ardab /fed				16.75 &	Straw yield ton /fed		4.10
Solid Giza 168 grain yield ardab /fed				18.50 &	Straw yield ton /fed		4.50
	2008/2009						
Gemmiza 7	104.19	350.43	65.83	68.52	159.81	13.16	3.22
Sakha 93	99.00	408.23	59.57	50.20	150.16	15.40	3.77
Giza 168	109.12	450.04	55.09	51.39	153.22	17.22	4.07
L.S.D 0.05	N. S	50.31	3.22	3.68	4.62	0.95	0.40
Solid Gemmiza 7 grain yield ardab /fed				15.50 &	Straw yield ton /fed		4.00
Solid Sakha 93 grain yield ardab /fed				17.00 &	Straw yield ton /fed		4.00
Solid Giza 168 grain yield ardab /fed				18.80 &	Straw yield ton /fed		4.50

Effect of planting date of cotton on wheat performance

The effect of planting date of cotton on growth, yield and yield components of wheat was not pronounced (Table 4). The differences were insignificant for all traits in both seasons. This may be due to that cotton was planted when the wheat plants reached a relatively later growth stage, and growth of plant became slow at the begging of its growing season. Thus wheat crop reached full maturity before cotton plants become a strong competitor for wheat plants. These results are in contrast with those obtained by Kamel *et al.* (1992) and Hussein, (1998) as they recorded the highest value of wheat traits by relaying cotton with wheat on 25^{th} March followed by 15^{th} April, whereas the lowest values of wheat grain yield and its components were recorded in 5^{th} March in both seasons. They interpreted these results as to may be due to the prolonged competition period between cotton and wheat.

Effect of interaction between wheat varieties and planting date of cotton treatments

The interaction effect of planting date of cotton and wheat varieties was insignificant on all the studied traits of wheat in both seasons. This means that wheat varieties showed similar performance at the different planting dates of cotton as a relay intercrop with wheat and the planting date of cotton had no significant effect on wheat performance for all wheat varieties in both seasons (Table 5).

TABLE 4. Effect of planting date of cotton intercropped with wheat on plant height, yield and yield components of wheat in 2007/2008 and 2008/2009.

Trait / Treatment	Plant height (cm)	Number of spikes/ (m^2)	No. of spikelets / spike	1000-grain weight (g)	Days to maturity	Grain yield/ fed (ardab)	Straw yield / fed (ton)
Planting date of cotton	2007/2008						
1st March	103.73	404.32	61.97	57.31	155.23	15.31	3.74
15th March	103.54	401.02	59.33	56.50	154.42	15.15	3.59
1st April	104.10	406.28	60.11	55.84	154.27	14.98	3.43
L.S.D 0.05	N. S	N.S	N.S	N.S	N.S	N.S	N. S
2008/2009							
1st March	103.79	404.63	60.52	57.45	154.30	15.49	3.81
15th March	104.74	402.62	60.69	56.40	154.41	15.20	3.71
1st April	103.78	401.46	59.27	56.26	154.48	15.09	3.54
L.S.D 0.05	N. S	N.S	N.S	N.S	N.S	N.S	N. S

Cotton

Effect of wheat varieties on cotton

Data presented in Table 6 indicated insignificant effects for wheat varieties on growth, yield components and yield of cotton. This means that relay intercropping of cotton with wheat had no marked effect on growth of cotton plant even when different wheat varieties were used. This may be due to that cotton was planted during March when wheat reached early grain filling period at milk stage, thus the rest period up to wheat harvesting is relatively short to cause marked effect on cotton growth.

Effect of planting date on yield and yield components in cotton

Data in Table 7 indicated that planting date of cotton had significant effect on growth, yield and yield components of cotton grown in relay intercropping wheat. The greatest seed cotton yield per faddan was obtained when cotton was planted on mid March in both seasons. It yielded 6.4 kantar/ faddan, it decreased by 30.31% and 50.78% when cotton was planted on 1st March or 1st April, respectively, as an average of both seasons. Data in Table 7 also indicated that the highest seed cotton yield of mid March was associated with the highest values of number of sympodia per plant, number of open bolls/plant, boll weight, lint percentage and seed index in both seasons. These results were supported by Kamel *et al.* (1992) and Selim *et al.* (1998). On other hand, delay planting significantly decreased number of monopodia/ plant in both seasons. Similar results were obtained by Hussein (2005). Abou El-Nour (2000) found also that early sowing increased the yield components and yield of cotton, while

it decreased plant height and internodes length, delayed the first flower appearance, whereas, had no effect on boll weight and seed index. On other hand Hussein (2005), reported that sowing cotton as solid grown on March, 25th gave the highest value of cotton yield and its attributes. The best sowing date for intercropping cotton with wheat was 25th March or 15th April, whereas, the early date (5th March) or late sowing (15th May) caused reduction in seed yield.

TABLE 5. Interaction effect of wheat varieties and planting date of cotton on yield and yield components of wheat in 2006/2007 and 2007/2008.

Trait / Treatment		Plant height (cm)	Number of spikes/ (m^2)	No. of spikelets / spike	1000-grain weight (g)	Days to maturity	Grain yield / fed (ardab)	Straw yield / fed (ton)
2007/2008								
Gemmiza 7	1st March	103.53	351.00	69.47	69.83	160.90	13.18	3.73
	15th March	103.27	351.00	67.20	68.99	159.80	13.12	3.16
	1st April	103.40	353.33	67.27	67.44	159.93	13.08	2.93
Sakha 93	1st March	99.20	412.47	61.97	50.02	150.33	15.56	3.63
	15th March	100.00	408.13	59.60	50.30	150.53	15.28	3.38
	1st April	101.00	406.10	58.27	49.89	149.77	15.12	3.45
Giza 168	1st March	108.47	449.50	54.47	52.09	154.47	17.20	4.22
	15th March	107.37	443.93	51.20	50.19	152.93	17.04	4.23
	1st April	107.90	459.41	54.80	50.18	153.10	16.75	3.92
L.S.D $_{0.05}$		N. S	N.S	N.S	N.S	N.S	N.S	N. S
C.V		9.07	9.42	13.17	6.73	6.53	10.32	14.52
2008/2009								
Gemmiza 7	1st March	104.13	349.67	65.43	69.01	159.90	13.26	3.48
	15th March	104.60	349.33	68.38	68.00	159.43	13.14	3.32
	1st April	103.83	352.30	63.68	68.57	160.10	13.07	2.85
Sakha 93	1st March	98.60	410.90	60.87	50.41	150.10	15.87	3.89
	15th March	100.20	408.20	58.07	50.18	150.23	15.33	3.72
	1st April	98.20	405.60	59.77	50.00	150.13	15.00	3.69
Giza 168	1st March	108.63	453.33	55.27	52.93	152.90	17.33	4.06
	15th March	109.43	450.33	55.63	51.03	153.57	17.13	4.09
	1st April	109.30	446.47	54.37	50.20	153.20	17.20	4.07
L. S. D $_{0.05}$		N.S	N.S	N.S	N.S	N.S	N.S	N. S
C.V		9.57	11.44	16.74	10.66	6.72	12.67	10.71

TABLE 6. Effect of wheat varieties on plant height, yield and yield components of cotton in 2007/2008 and 2008/2009.

Trait / Treatment	Plant height (cm)	No. of sympo-dia/ plant	No. of monopo-dia/plant	No. of open bolls	Boll weight (g)	Lint %	Seed cotton yield/ fed (kentar)	Seed index (g)
Wheat varieties	2007/2008							
Gemmiza 7	123.11	9.18	2.13	7.43	2.14	35.04	4.39	7.98
Sakha 93	122.76	9.65	3.38	7.76	2.32	35.57	5.09	8.47
Giza 168	124.51	9.27	2.27	7.45	2.22	35.35	4.83	8.14
L.S.D 0.05	N. S	N. S	N. S	N. S	N. S	N. S	N. S	N. S
2008/2009								
Gemmiza 7	125.98	11.79	2.32	6.53	2.10	32.77	4.18	8.36
Sakha 93	121.46	12.30	2.55	6.70	2.20	34.06	4.91	8.71
Giza 168	127.73	11.99	2.47	6.51	2.14	33.07	4.60	8.51
L.S.D 0.05	N. S	N. S	N. S	N. S	N. S	N. S	N. S	N. S

TABLE 7. Effect of planting date of cotton on plant height, yield and yield components of cotton in 2007/2008 and 2008/2009.

Trait / Treatment	Plant height (cm)	No. of sympo-dia/plant	No. of monopo-dia/plant	No. of open bolls	Boll weight (g)	Lint %	Seed cotton yield/ fed (kentar)	Seed Index (g)
planting date of cotton	2007/2008							
1st March	135.64	8.18	2.70	7.72	2.16	35.54	4.68	8.18
15th March	119.51	10.17	2.09	8.39	2.60	37.12	6.41	9.12
1st April	115.22	9.75	1.99	6.44	1.93	33.30	3.21	7.29
L.S.D 0.05	8.18	1.52	0.39	1.49	0.29	2.83	0.82	1.16
Cotton solid yield: 6.50 kentar /fed								
2008/2009								
1st March	131.41	10.63	2.79	6.84	2.15	32.82	4.23	8.98
15th March	124.07	13.04	2.39	7.61	2.29	35.90	6.38	9.14
1st April	119.69	12.31	2.15	5.29	2.00	31.19	3.08	7.47
L.S.D 0.05	7.84	1.47	0.36	1.29	0.21	3.45	0.80	1.24
Cotton solid yield: 6.65 kentar /fed								

Effect of interaction between wheat varieties and planting date of cotton treatments

Data presented in Table 8 revealed that the interaction effect of wheat varieties and planting date of cotton on yield and yield components of cotton was not significant. This means that the performance of relayed cotton plants was not changed even when it was grown with different wheat varieties at different planting dates of cotton.

TABLE 8. Effect of interaction between wheat varieties and planting date of cotton on plant height, yield and yield components of cotton in 2007/2008 and 2008/2009.

Trait / Treatment		Plant height (cm)	No. of sympodia/ plant	No. of monopodia plant	No. of open bolls	Boll weight (g)	Lint %	Seed cotton Yield / fed (kentar)	Seed index (g)
		2007/2008							
Gemmiza 7	1st March	135.87	8.09	2.50	7.55	2.07	35.21	4.02	8.00
	15th March	118.07	9.80	2.00	8.24	2.46	36.75	6.10	8.92
	1st April	115.40	9.65	1.90	6.23	1.89	33.15	3.06	7.01
Sakha 93	1st March	134.53	8.35	2.89	7.85	2.25	35.78	5.02	8.39
	15th March	119.73	10.51	2.18	8.59	2.71	37.50	6.88	9.41
	1st April	114.00	10.09	2.08	6.85	2.00	33.45	3.36	7.61
Giza 168	1st March	136.53	8.11	2.70	7.76	2.15	35.64	5.00	8.14
	15th March	120.73	10.19	2.10	8.35	2.62	37.10	6.26	9.02
	1st April	116.27	9.52	2.00	6.25	1.90	33.03	3.30	7.25
L.S.D 0.05		N. S	N. S	N. S	N. S	N. S	N. S	N. S	N. S
C.V		6.45	15.80	16.69	19.36	12.88	7.80	16.67	13.72
		2008/2009							
Gemmiza 7	1st March	135.00	10.46	2.56	6.82	2.09	32.65	3.51	8.88
	15th March	124.53	12.83	2.33	7.55	2.27	35.00	6.17	9.01
	1st April	118.40	12.08	2.07	5.23	1.94	30.67	2.85	7.19
Sakha 93	1st March	123.90	10.80	2.97	6.85	2.21	33.59	4.75	9.12
	15th March	122.40	13.30	2.48	7.84	2.31	36.72	6.55	9.37
	1st April	118.07	12.50	2.20	5.40	2.08	31.89	3.43	7.65
Giza 168	1st March	135.33	10.63	2.84	6.84	2.15	32.22	4.43	8.94
	15th March	125.27	13.00	2.37	7.43	2.28	35.98	6.43	9.03
	1st April	122.60	12.35	2.19	5.25	1.98	31.01	2.96	7.57
L.S.D 0.05		N. S	N. S	N. S	N. S	N. S	N. S	N. S	N. S
C.V		6.10	11.96	14.43	19.17	9.79	10.07	17.09	14.20

Competitive relationships

Competitive relationships of wheat and cotton as affected by wheat cultivar and planting date

Data presented in Table 9 revealed that the means of the relative yield of the three varieties (Gemmiza 7, Sakha 93 and Giza 168) were ever higher than those of the relative yield of cotton crop indicating that cotton plants were much

more influenced by intercropping rather than wheat crop. Data on the relative yield also revealed that when Sakha 93 was used in the intercrop, RYs of both wheat and cotton were higher than other two varieties under the same respective dates of planting cotton. These observations seemed valid in the first season with slight deviation in case of RY of wheat in the second season, where RY of Giza 168 was little higher than Sakha 93. The mean values of land equivalent ratio of Sakha 93 cultivar surpassed the other two wheat varieties in both seasons. However the mean values of LERs of the three varieties achieved yield advantage of 55, 70 and 65% in the first season and 47, 64 and 61% in the second as compared with solid planting. From another angle of data, cotton planting at the mid date (15^{th} March) resulted in better land equivalent rations when the three wheat varieties were used. Sakha 93 grown with cotton at mid date (15^{th} March) produced approximately one fold per unit area of land in the first season and with only 12% loss in second season. Hussein (2006) and Toaima *et al.* (2004 and 2007), reported that intercropping cotton with wheat achieved yield advantage with LERs values exceeded the unit. Area time equivalent ratio and the mean values of land equivalent ratio and area time equivalent ratio followed the same trends as influence by the treatment imposed. ATER and the mean values of LER + ATER of Sakha 93 were higher than Giza 168 were also higher than Gemmiza7. From another angle of data, whatever wheat variety, mid of March was associated with higher values of ATER and that of LER + ATER, whereas, least values were associated with the latest date of planting wheat (first of April). As a consequence to these observation, highest values of all land equivalent ratio were obtained when Sakha 93 was planted at mid of March, whereas, the least of these values were obtained when Gemmiza 7 was planted at the earliest date (first of March). It is also evident that in general, values of the area time equivalent ratio were lower than those of land equivalent ratio under same respective treatment, Toaima *et al.* (2004,2007), came to similar conclusion. Furthermore, seeding wheat at both the earliest and latest dates diminished ATER to less than the unit in most cases indicating loss rather than yield advantage. However, Balasubaramanian & Sekayange (1990), reported that LER values which are commonly used as indicator of efficiency, are not suitable because it considers only the area factor to estimate intercrop advantages. The area time equivalent ratio (ATER) unrealistically assumes continuous crop growth throughout the year, thus it under estimates the advantages of the intercrops. To avoid these problems it is suggested to use the mean value of LER + ATER as an arbitrary compromise. Generally, these results indicated that cotton could be grown successfully in relay intercropping system with wheat. Results also indicated that, under the conditions of this study, to obtain high seed cotton yield from this system wheat should be seeded on November and cotton on Mid-March. Result also showed that wheat cultivar Giza 168 outyielded the other two varieties (Gemmiza 7 and Sakha 93) under the condition of this intercropping system at Nubaria district.

TABLE 9. Effect of wheat varieties and planting date of cotton on land equivalent ratio (LER), area time equivalent ratio (ATER) and mean of LER+ATER in 2007/2008 and 2008/2009.

Treatment	Trait	Yield		Relative yield		LER	ATER	Mean LER+ ATER
		Wheat	Cotton	Ry Wheat	Ry cotton			
2007/2008								
Gemmiza 7	1st March	13.18	4.02	0.88	0.62	1.50	0.89	1.20
	15th March	13.12	6.10	0.87	0.94	1.34	1.05	1.20
	1st April	13.08	3.06	0.87	0.47	1.34	0.72	1.03
	Solid	15.39	6.50			1.00		
Sakha 93	1st March	15.56	5.02	0.93	0.77	1.70	1.02	1.36
	15th March	15.28	6.88	0.91	1.06	1.97	1.16	1.57
	1st April	15.12	3.36	0.90	0.52	1.42	0.76	1.09
	Solid	16.75	6.50			1.00		
Giza 168	1st March	17.20	5.00	0.93	0.77	1.70	1.02	1.36
	15th March	17.04	6.26	0.92	0.96	1.82	1.09	1.46
	1st April	16.75	3.30	0.91	0.51	1.42	0.77	1.10
	Solid	18.50	6.50			1.00		
2008/2009								
Gemmiza 7	1st March	13.26	3.51	0.85	0.53	1.38	0.82	1.10
	15th March	13.14	6.17	0.84	0.93	1.77	1.04	1.41
	1st April	13.07	2.85	0.84	0.43	1.27	0.67	0.97
	Solid	15.50	6.65					
Sakha 93	1st March	15.87	4.75	0.93	0.72	1.65	0.99	1.32
	15th March	15.33	6.55	0.90	0.98	1.88	1.10	1.49
	1st April	15.00	3.43	0.88	0.52	1.40	0.75	1.10
	Solid	17.00	6.65					
Giza 168	1st March	17.33	4.43	0.92	0.67	1.59	0.95	1.27
	15th March	17.13	6.43	0.91	0.97	1.88	1.09	1.49
	1st April	17.20	2.96	0.92	0.45	1.37	0.73	1.05
	Solid	18.80	6.65					

Total income

Seeding cotton at mid of March resulted in highest total income whatever the variety of wheat was in the association with cotton. On other hand, seeding cotton early at the first of March resulted in better total income rather than delayed to the first of April. These results hold true in both seasons when cotton was relayed on wheat Giza 168 was associated with highest gross revenue. Sakha 93 ranked the second whereas Gemmiza 7 ranked the third. However maximum revenue was obtained when Giza 168 was grown with cotton planted on 15 of March in both season. Whereas the minimum gross revenue was obtained when cotton sown on first of April was relay on Gemmiza 7. It is also evident the relayed cotton on wheat under any date or variety of wheat exceeded the prevailing system berseem followed by cotton (Table 10).

TABLE 10. Effect of wheat varieties and planting date of cotton on total income (LE) in 2007/2008 and 2008/2009.

Trait / Treatment		Total income LE		
		Wheat	Cotton	Total
2007/2008				
Gemmiza 7	1st March	5428.0	3240.0	8668.0
	15th March	5347.0	4917.0	10264.0
	1st April	5308.0	2466.0	7774.0
Sakha 93	1st March	6330.0	4026.0	10356.0
	15th March	6197.0	5545.0	11742.0
	1st April	6143.0	2708.0	8851.0
Giza 168	1st March	7018.0	4030.0	11048.0
	15th March	6958.0	5046.0	12004.0
	1st April	6815.0	2660.0	9475.0
Control: Berseem: 1819 Cotton:5239 Total:7058 LE				
2008/2009				
Gemmiza 7	1st March	3574.0	2383.0	5957.0
	15th March	3528.0	4189.0	7717.0
	1st April	3462.0	1935.0	5397.0
Sakha 93	1st March	4249.0	3225.0	7474.0
	15th March	4100.0	4447.0	8547.0
	1st April	4017.0	2329.0	6346.0
Giza 168	1st March	4620.0	3008.0	7628.0
	15th March	4575.0	4366.0	8941.0
	1st April	4580.0	2010.0	6600.0
Control: Berseem: 2074 Cotton:4515 Total:6589 LE				

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التحميل المناوب للقمح مع القطن في الأراضي الجديدة

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أجريت تجربة حقلية بمحطة التجارب والبحوث الزراعية بالنوبارية موسمي ٢٠٠٧– ٢٠٠٨و ٢٠٠٨– ٢٠٠٩ لدراسة تأثير ميعاد زراعة القطن محملا مع القمح (١ مارس- ١٥ مارس– ١ ابريل) وكذلك ثلاث أصناف من القمح (جميزة ٧– سخا ٩٣ وجيزة ١٦٨) وتأثير ذلك على نمو وإنتاجية كلا المحصولين٠ حققت جميع المعاملات ميزة محصولية بالمقارنة بالزراعة المنفردة لكلا المحصولين وجاءت أعلى قيمة لمعدل كفاءة استخدام الأرض (٩٧, ١ – ٨٨, ١) في الموسم الأول والثاني على الترتيب ومعدل استخدام الأرض والزمن (١,١٦–٠ ١,١) في الموسمين بالترتيب عندما زرع القطن في ١٥ مارس محملا تحميلا مناوبا مع القمح صنف سخا ٩٣٠فقد وجد أن مكونات المحصول ومحصول القمح تأثرا تأثيرا معنويا باختلاف أصناف القمح٠ فقد تم الحصول على أعلى محصول للقمح من زراعة القمح صنف جـ ١٦٨ وتحميل القطن تحميلا مناوبا في أول مارس واقل محصول للقمح عندما زرع صنف جميزة ٧ وتحميل القطن في أول ابريل٠ كذلك تأثرا مكونات المحصول ومحصول القطن تأثيرا معنويا بميعاد زراعة القطن٠ تم الحصول على أعلى محصول للقطن عندما زرع القطن محملا تحميلا مناوبا في منتصف مارس مع صنف القمح سخا ٩٣ واقل محصول منه عندما زرع القطن محملا مناوبا في أول ابريل مع صنف القمح جميزة ٧ وجاءت أعلى قيمة للعائد النقدي الكلى عندما زرع صنف القمح جيزة ١٦٨ وحمل معه القطن تحميلا مناوبا في منتصف مارس٠