STUDIES ON COTTON-WHEAT INTERCROP PATTERNS

H.M.H. Mohamed, A.A. Darwish and W.M.O. El-Shazly
Cotton Res. Inst., Agric. Res. Center
Giza, Egypt

Abstract

Two field experiments were carried out at Gemmeiza Agric. Res. St. Gharbia Governorate during 1993/1994 and 1994/1995 seasons to study the possibility of intercropping cotton with wheat 45 days before its harvest and cotton transplanting after wheat harvest and their effects on cotton growth, earliness, yield and its components, wheat yield, land use efficiency and total net income from unit area during full season compared to cotton and wheat sole croppings.

The obtained results can be summarized as follow:

1. Growing cotton as a pure stand after fallow gave the highest values of seed cotton yield and its components. It gave the first fruiting branch on significantly lower node and significantly reduced the number of days to first flower and increased earliness percentage.
2. Pure crop plants gave the higher grain and straw yields of wheat than those of the other tested patterns.
3. Results showed that intercropping cotton with wheat 45 days before its harvest in is more profitable than cotton transplanting after wheat harvest where, cotton transplanting after wheat harvest significantly reduced seed cotton yield per feddan and its components, increased node number of first fruiting branch, delayed days to first flower, reduced earliness percentage and gave the lowest monetary returns.
4. No significant differences were detected among different intercropping patterns in seed cotton yield and most of its components as well as yield of wheat.
5. Results showed that intercropping cotton with wheat in ridges 90 cm apart and hills 30 cm apart on both sides of the ridge with four rows of wheat at 10 cm apart (pattern 5) was the most profitable pattern since it increased land use efficiency by 4% and total net income during full season by about 16.72-18.55% compared to cotton sole cropping.

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Introduction

In view of the new cotton price policy and the limited cultivated area, farmers are used to planting cotton after their winter crops i.e., wheat, faba bean, etc. to increase their net income. This of course results in a drop in cotton yield due to delaying cotton planting, therefore it become necessary to use intercropping as one of the most suitable way for increasing cotton suitable way for increasing cotton area without any shortage of what area to meet rising demands and to overcome the problem of delaying cotton planting.

Growing cotton as an intercrop with wheat or transplanted after wheat harvest has been studied by some investigators. Diao (1984) found significant cotton yield increases when cotton intercropped with wheat. GAO (1988) reported that the net income gained by wheat intercropped with spring cotton was 21-29.1% higher than that of single cropped cotton and 6.7-18.2% higher than that of wheat intercropped with summer cotton. Lin et al. (1990) reported that dibbling of cotton seeds in the wheat row around 20 May gave a lint yield higher than that from transplanting cotton seedlings after wheat (on 5 June). Mohamed et al. (1990) indicated that grain yield of wheat was not significantly affected by intercropping with cotton. On the other hand, cotton yield was significantly reduced by growing cotton after wheat, whereas seed cotton yield was not adversely affected by intercropping cotton with wheat. Porter and Khalilian (1995) reported that relay intercropping of cotton (*Gossypium hirsutum* L.) into standing wheat (*Triticum aestivum* L.) allows for earlier planting of the cotton than with sequential double crop systems.

With regard to cotton transplanting, El-Shazly (1992) found that transplanted cotton plants differ in growth habit and yield than direct sown ones.

The objective of this study was to evaluate the effect of growing cotton as a pure crop of as an intercrop with wheat or transplanting after wheat harvest on cotton growth, earliness, yield and its components, wheat yield, land use efficiency and total net income from unit area during full season compared to cotton and wheat sole cropping to help farmers to use best pattern when they apply intercropping.

Materials and Methods

Two field experiments were carried out at Gemmeiza Agricultural Research Station, Gharbia Governorate, during 1993/1994 and 1994/1995 seasons to study the possibility of intercropping cotton with wheat 45 days before its harvest and cotton transplanting after wheat harvest and their effects on cotton growth, earliness, yield and its components, where yield, land use efficiency and total net income from unit area during full season compared to cotton and wheat sole croppings. The experimental design was randomized complete blocks with four replications.

Egyptian cotton Giza 75 cultivar (*Gossypium barbadense* L.) was examined under six growing patterns with wheat Sakha 69 variety (*Triticum aestivum* L.). The six growing patterns were as follows:

Patterns 1: Wheat sole cropping was drilled in rows 10 cm apart and followed by cotton transplanted on ridge 60 cm apart on one side of the ridge, in hills 20 cm apart.

Patterns 2: Cotton sole cropping after fallow grown on ridges 60 cm apart on one side of the ridge, in hills 20 cm apart.

Patterns 3: Intercropping cotton with wheat in ridges 120 cm apart. Wheat was drilled in 6 rows 10 cm apart on the top of the ridge. Cotton was sown 45 days before wheat harvest on both sides of the ridge, in hills 20 cm apart.

Patterns 4: Intercropping cotton with wheat in ridges 103 cm apart. Wheat was drilled in 5 rows 10 cm on the top of the ridge. Cotton was sown 45 days before wheat harvest on both sides of the ridge, in hills 25 cm apart.

Patterns 5: Intercropping cotton with wheat in ridges 90 cm apart. Wheat was drilled in 4 rows 10 cm apart on the top of the ridge. Cotton was sown 45 days before wheat harvest on both sides of the ridge, in hills 30 cm apart.

Patterns 6: Intercropping cotton with wheat in ridges 80 cm apart. Wheat was drilled in 3 rows 10 cm apart on the top of the ridge. Cotton was sown 45 days before wheat harvest on both sides of the ridge, in hills 35 cm apart.

The tested ridge width was 60, 60, 120, 103, 90 and 80 cm for patterns 1, 2, 3, 4, 5 and 6 in both seasons, respectively.

Wheat was sown on 1/12/1993 and 15/12/1994, whereas cotton was sown on 1/4/1994 and 4/4/1995. Transplanting cotton seedlings 30 days old, grown in paper pots on 17/5/1994 and 21/5/1995. Details of nursery preparation were given in previous publication (Abou-Zeid et al., 1995).

A summary of these growing patterns and initial number of cotton plants is presented in Table (1).

The size of each plot was 43.2 m² (7.2m x 6 m) in 1993/1994 and 36 m² (7.2 m x 5 m) in 1994/1995 season included 12, 12, 6, 7, 8 and 9 ridges/plot for the same respective tested patterns in both seasons.

Phosphorus fertilizer was added at the rate of 22.5 kg P_2O_5/fed as calcium superphosphate 15.5% at land preparation. With regard to wheat, nitrogen fertilizer was applied at the rate of 75 kg N/fed as ammonium nitrate (33.5%) splitted into two equal portions, the first portion of N was applied before the first irrigation, while the second portion of N was added before the second irrigation. With concern to cotton plants, nitrogen fertilizer was applied at the rate of 60 kg N/fed as ammonium nitrate (33.5%) splitted into two equal doses, the first dose was applied before the first irrigation, while the second dose of N was applied before the second irrigation. Potassium fertilizer was added at a rate of 24 kg K_2O/fed as potassium sulphate (48% K_2O) in one dose with the first dose of N.

Ten guarded representative cotton plants from each plot were taken at random to determine the yield components per cotton plant. Number of survival cotton plants at harvest and seed cotton yield per feddan as well as grain and straw yields of wheat per feddan were calculated from the data obtained from the total ridges of each plot.

The traits under study were:

1. Cotton plant height at harvest (cm).
2. Number of stem internodes per plant.
3. Average internode length (cm).
4. Number of fruiting branches per plant.
5. Node number of first fruiting branch.
6. Days from sowing to first flower.
7. Yield earliness, as a percentage of first pick to total yield.
8. Number of open bolls per plant..
9. Boll weight (g).
10. Seed cotton yield per plant (g).
11. Lint percentage.
12. Seed index (g).
13. Number of survival cotton plants per feddan at harvest.
14. Survival cotton plants %, as

$$\frac{\text{Number of survival plants}}{\text{Number of initial plants}} \times 100$$

15. Seed cotton yield per feddan* in kentars**
16. Grain yield of wheat pert feddan, in ton.
17. Straw yield of wheat per feddan, in ton.
18. Land equivalent ratio was determined according to DeWit and Van Den Bergh (1965):

L_{wheat} = (intercropping grain yield of wheat/solid grain yield of wheat)

L_{cotton} = (intercropping yield of cotton/solid yield of cotton).

$LER = L_{wheat} + L_{cotton}$

19. Area time equivalent ratio (ATER) was calculated according to Hiebsch and McCollum (1987) as:

$ATER = [(RY_W \times t_W) + (RY_C \times t_C)]/T$

where RY_W, RY_C = relative yield of wheat and cotton, respectively i.e., (Yield of intercrop/fed)/(Yield of monocrop/fed).

t_W, t_C = duration (days) for wheat and cotton from planting to harvest, respectively.

T = duration (days) of intercropping pattern.

20. Net income per feddan in Egyptian pounds (L.E.) was calculating as:
    Net income/feddan = Total value of products - total cost of production.

Statistical analysis was done according to the procedures outlined by Snedecor and Cochran (1967). The mean values were compared according to Duncan's Multiple Range Test (Duncan, 1955).

Results and Discussion

Plant Height at Harvest, Number of Stem Internodes and Average Internode Length

Data in Table (2) show that plant height at harvest and number of its stem internodes were significantly responded to cotton growing patterns in both seasons. Average internode length was significantly responded to cotton growing patterns only in 1995 season. The tallest plants were resulted from pattern 1 followed by patterns 3, 4, 5 and 6 and the shortest plants were obtained from pattern 2. The increase in transplanted cotton plant height may be attributed mainly to the increase in number of its stem internodes and/or internode length. Bodade (1965) and Abou Zeid et al. (1996) found that plant height was greater in favour of transplanting compared with direct sowing.

Among the intercropping patterns the taller plants were produced from dense sowing (patterns 3 and 4) and this was accompanied by elongation in internodes length, which might be due to the shading effect occurred in dense plant population. In this concern, El-Gahel et al. (1995) found that cotton plants growing in a dense stand tend to grow taller for capture more sunlight. Internodes are elongated to position leaves in regions of higher sunlight intensity.

Number of Fruiting Branches per Plant

Table (2) shows that number of fruiting branches per plant in both seasons was significantly affected by growing patterns in favour of intercropping cotton with wheat on 90 cm spaced ridges at wide hill spacing (30 cm) (pattern 5). In this concern, Darwish (1991) found that the increase in plant population decreased the number of fruiting branches per plant and this may be due to more competition between plants for nutrients, moisture and light.

First Fruiting Node

Data in Table (2) show that first fruiting node was initiated on significantly lower node in case of growing cotton in pure stand (pattern 2) compared with growing cotton by transplanting after wheat harvest (pattern 1) in both seasons. However, in the first season, the differences among intercropping patterns and pattern 2 were not significant. In this concern, El-Shinnawy and Ghaly (1985) found that row width and hill spacing had insignificant effect on height of first fruiting branch.

Days to First Flower

Concerning the date of first flower appearance, the results in Table (2) show that the differences among the six growing patterns were significant in both seasons. It is clear that growing cotton after fallow as a pure crop (pattern 2) was the earliest followed by patterns of growing cotton as an intercrop with wheat and the latest one was obtained by transplanting cotton after wheat harvest (pattern 1). This result is in accordance with that found by El-Shazly (1992), who reported that transplanting delayed days to first flower appearance compared with direct seeding. Abou Zeid et al. (1996) suggested that the delaying of first flower in case of cotton transplanting may be attributed to a) the keen competition occurred between the crowded seedlings on light and nutrients during their early stage of life in the nursery and b) the recovery period which the seedlings took to start their regrowth after transplanting. However, no significant differences were obtained among intercropping patterns in this concern, El-Shinnawy and Ghaly (1985) found that row width and hill spacing and insignificant effect on days to first flower. Previous finding of Mohamed et al. (1990) may support our present result since they found that intercropping cotton before wheat harvest had no effect on number of days to first flower of cotton.

Earliness Percentage

Pattern of growing cotton had a pronounced effect on earliness percentage during the two seasons (Table 2), where superiority was found in favour of pattern 2. Growing cotton as an intercrop with wheat on wide or narrow ridge gave significantly higher earliness % than growing cotton by transplanting after wheat harvest in both seasons. These differences were expected, since pattern 2 plant gave its first flower earlier than that of transplanting or intercropping plant. This result may be support by that of El-Shazly (1992) who reported that transplanting significantly decreased earliness percentage compared with seed planting.

Number of Open Bolls per Plant

Results presented in Table (3) indicated that number of open bolls per plant was affected significantly by growing patterns only in the second season in favour of intercropping cotton with wheat patterns (4, 6 and 5) followed by growing cotton in pure stand (pattern 2) and the least resulted from intercropping cotton with wheat by transplanting after wheat harvest (pattern 1). However, no significant differences were obtained among all tested patterns in the first season. Similar result was obtained by Mohamed et al. (1990).

Boll Weight

Data presented in Table (3) show that cotton growing patterns exhibited significant differences in boll weight only in 1994 season. The mean value for this trait reached its maximum for growing cotton as a pure crop (pattern 2) followed by intercropping cotton with wheat patterns of 6, 4, 5 and 3 and the least resulted from growing cotton by transplanting after wheat harvest (pattern 1). Mohamed et al. (1990) fond that boll weight was not affected by intercropping cotton with wheat at different systems.

Seed Cotton Yield per Plant

Table (3) shows that experienced growing patterns exerted a significant effect on seed cotton yield per plant in both seasons. The seed cotton yield per plant was significantly higher when cotton was grown as a pure crop (pattern 2) or as an intercrop with wheat (patterns 4, 5 and 6) due to increase the number of open bolls per plant and the boll weight. While, the yield of plant was significantly decreased with growing cotton by transplanting after wheat harvest (pattern 1) and intercropping with wheat in pattern 3. This reduction may be due to decrease number of open bolls and/or boll weight. This results is in agreement with that obtained by Mohamed et al. (1990) who reported that seed cotton yield per plant was significantly reduced by growing cotton after harvesting wheat or intercropping cotton with wheat before its harvesting at higher densities of wheat in one season.

Lint Percentage and Seed Index

Data in Table (3) show that lint percentage and seed index were significantly responded in cotton growing patterns only in 1994 season. Transplanting cotton after wheat harvest (pattern 1) had lower lint percentage and seed index than growing cotton as a pure crop or as an intercropping with wheat. There were no significant differences among intercropping patterns for lint percentage and seed index in both seasons. Shahine (1986) found that lint % and seed index were not significantly affected by distance between hills.

Number and Percentage of Survival Cotton Plants per Feddan at Harvest

The results obtained in Table (3) indicated that cotton growing patterns had a significant effect on number and percentage of survival cotton plants per feddan at harvest in both seasons. Transplanting cotton after wheat harvest gave the lowest number and percentage of survival cotton plants per feddanin the first season, while the reverse was true in the second season. In comparison among the intercropping patterns, it could be noticed that there are insignificant differences among these patterns for number of survival cotton plants per feddan at harvest in both seasons. However, in both seasons, growing cotton as an intercrop with wheat on narrow ridges (patterns 5 and 6) gaver higher percentage of survival cotton plants per feddan at harvest than growing cotton as a pure crop (pattern 2) or as an intercrop with wheat on wide ridge (pattern 3 and 4). In this respect, Hussein *et al.* (1983) found that stand was relatively high at different stages of growth as plant population increased, while the percentage of surviving plants to theoretical number at sowing date followed the reversed trend.

Seed Cotton Yield per Feddan

Seed cotton yield per feddan was significantly affected by cotton growing patterns in both seasons (Table 3). Growing cotton as a pure crop (pattern 2) increased seed cotton yield per feddan by 38.49, 15.63, 12.05, 11.28 and 12.05% in the first season and by 47.62, 19.92, 17.08, 14.92 and 16.08% in the second season as compared with patterns 1, 3, 4, 5 and 6, respectively.

The high yield of cotton plants in pure stand over all intercropping patterns of cotton with wheat or transplanting cotton after wheat harvest may be due to that cotton sole cropping give chance to better growth and consequently produced the largest number of open bolls, and heaviest boll weight, seed index, and seed cotton yield per plant.

On the contrary, the lower yield of growing cotton by transplanting after wheat harvest could be due to the delay in seedlings recovery and consequently shorted the vegetative and fruiting periods which were reflected in lower number of open bolls per plant, inferior boll weight, lower seed index and seed cotton yield per plant.

These results are in agreement with those obtained by Lin et al. (1990) and Mohamed et al. (1990).

The differences among intercropping patterns did not reach the level of significance in both seasons although we reduce the stand from 70000 plants per feddan to 60000 plants per feddan. In this concern, El-Shinnawy et al. (1984) found that the row width x hill spacing interaction had no significant effect on seed cotton yield per feddan.

Grain and Straw Yields per Feddan

The results obtained in Table (4) indicated that the experienced growing patterns exerted a significant effect on grain and straw yield per feddan in the second seasons. Moreover, its clear that wheat plants grown in pure stand were superior to those intercropped with cotton in grain and straw yields per feddan in both seasons. In comparison among the intercropping patterns, it could be noticed that there are insignificant differences among these patterns for grain and straw yields per feddan. This results may be due to the contributing balance between the number of grown rows per unit area and number of tillers per plant. Similar results were obtained by Mohamed et al. (1990). However, it is clear that intercropping cotton with wheat at wide cotton hills, i.e. 30 or 35 cm shows a slight increase in grain and straw yields per feddan compared to the other intercropping patterns. This result may be attributed to that wider distances between cotton plants caused a lower competition between cotton and wheat plants of slight, water and minerals. In this respect, Porter and Khalilian (1995) found that yields of wheat planted in skip-row schemes designed to allow for early intercropping of cotton were not significantly different from yield of conventionally planted wheat.

Land Equivalent Ratio (LER)

The data in Table (5) cleared that the values of land equivalent ratio of wheat (LER_W) and cotton and cotton (LER_C) were reduced less than one when cotton transplanted after wheat harvest or intercropped with wheat at all patterns compared to their yields of sole cropping (equal one) in both seasons. In spite of this depression in each of LER_W and LER_C, the land equivalent ratio per unit area (LER), i.e. $LER_W + LER_C$ was more than one under all tested growing patterns. The land usage was increased by 62, 68, 76, 84 and 84% in the first season and by 52, 50, 49, 65 and 57% in the second season when cotton transplanted after wheat harvest and intercropped with wheat in patterns of 3, 4, 5 and 6, respectively compared to the sole cropping of what or cotton. These results are in agreement generally with those obtained by Mohamed et al. (1990) who found that LER exceeded one when cotton was intercropped with wheat before its harvesting in two seasons.

Area Time Equivalent Ratio (ATER)

The data obtained in Table (5) showed that the values of ATER did not go parallel with LER values, where the values of ATER were less than that of PER at al tested patterns in both seasons. Moreover, it is clear that ATER values were less than one when cotton was transplanted after wheat harvest in both seasons as well as when it was intercropped with wheat using pattern 3 in the first season and using patterns 3, 4, 5 and 6 in the second season. This indicated that the land use efficiency decreased when cotton was transplanted after wheat harvest or intercropped with wheat before its harvest under these patterns compared to wheat or cotton monoculture. The depression in ATER values less than LER and less than one also may be due to that LER estimation does not take into consideration the duration time of the two crops in the land from planting to harvest. Similar conclusion was obtained by Hiebsch and McCollum (1987). On the other hand, the data show that intercropping cotton with wheat in ridges 90 and 80 cm apart in hills 30 and 35 cm (patterns 5 and 6) produced ATER more than one amounted to 1.04 in the first season only, indicating that the productivity of unit area increased by 4% more than the sole cropping of the two crops under such patterns.

Net Income per Feddan

The data in Table 6 indicated that either transplanting cotton after wheat harvest or intercropping cotton with wheat decreased the net income per feddan of wheat or cotton compared to their sole croppings in both seasons. On the other hand, the data show that the total net income per feddan (wheat + cotton) during full season was more than that obtained by wheat or cotton sole cropping for all tested intercropping patterns in both seasons. The highest total net income per feddan during full season was gained when cotton intercropped with wheat in ridges 90 cm apart and hills 30 cm apart (pattern 5) and amounted to 18.55 and 16.72% more than the net income obtained by cotton sole cropping in the first and second seasons, respectively.

From these results it could be concluded that in case of growing cotton into wheat rotation, intercropping cotton with wheat 45 days before its harvest is more profitable than cotton transplanting after wheat harvest.

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Table 1. A summary of growing wheat and cotton patterns.

Treatments		Cotton transplanted after wheat harvest	Cotton sole cropping	Cotton inter-cropped with wheat	Cotton Inter-cropped	Cotton inter-cropped	Cotton Inter-cropped
Wheat							
Sowing date	1993	1/12		1/12	1/12	1/12	1/12
	1994	15/12		15/12	15/12	15/12	15/12
No. of cultivated rows/ridge		drills		6	5	4	3
Harvesting date	1994	15/5		15/5	15/5	15/5	15/5
	1995	18/5		18/5	18/5	18/5	18/5
Cotton							
Sowing date	1994	17/5*	1/4	1/4	1/4	1/4	1/4
	1995	21/5*	4/4	4/4	4/4	4/4	4/4
Ridge width in cm		60	60	120	103	90	80
No. of cultivated ridge sides		1	1	2	2	2	2
Hill distance in cm		20	20	20	25	30	35
Initial number of cotton plants/feddan		70000	70000	70000	65242	62222	60000
First picking date	1994	20/9	20/9	20/9	20/9	20/9	20/9
	1995	23/9	23/9	23/9	23/9	23/9	23/9
Second picking date	1994	20/10	20/10	20/10	20/10	20/10	30/10
	1995	27/10	27/10	27/10	27/10	27/10	27/10

* Transplanting

Table 2. Effect of cotton growing pattern on plant growth and earliness for Egyptian cotton Giza 75 cultivar during 1994 and 1995 seasons.

Character	Season	Patterns						F-test
		1	2	3	4	5	6	
Final plant height (cm)	1994	131.5a	117.3c	128.3ab	124.0abc	120.3bc	118.5c	*
	1995	148.0a	129.8c	139.3b	137.5bc	136.3bc	130.5c	**
No. of stem internodes/plant	1994	22.1abc	20.5c	22.6ab	20.8bc	23.0a	20.7c	*
	1995	20.2b	21.7a	21.6a	22.3a	22.3a	21.4a	**
Average internode length (cm)	1994	5.95	5.72	5.68	5.96	5.23	5.72	NS
	1995	7.33a	5.98b	6.45b	6.17b	6.11b	6.10b	**
No. of fruiting branches/plant	1994	13.3b	13.6b	15.0a	13.3b	15.7a	13.5b	*
	1995	11.0b	13.7a	12.5a	13.2a	13.5a	13.1a	**
First fruiting node	1994	7.9a	6.1b	6.6b	6.5b	6.3b	6.2b	*
	1995	8.2a	7.0c	8.1a	8.1a	7.8ab	7.2bc	*
Days from sowing to first flower	1994	103.0a	83.3c	90.3b	90.5b	89.b	89.3b	**
	1995	111.5a	86.3c	94.5b	93.8b	93.8b	92.5b	**
First pick %	1994	74.5c	84.8a	80.3b	80.3b	80.3b	80.5b	**
	1995	21.4c	70.2a	45.4b	47.9b	49.7b	47.7b	**

*, ** and NS indicate $P < 0.05$, 0.01 and not significant, respectively.
Means designated by the same letter within each row are not significantly different at 5% level according to Duncan's Multiple Range Test.

Table 3. Effect of cotton growing pattern on seed cotton yield per feddan and its components during 1994 and 1995 seasons.

Character	Season	Patterns						F-test
		1	2	3	4	5	6	
No. of survival plants at harvest (thousands)	1994	33.75b	51.55a	54.90a	51.43a	54.30a	53.10a	**
	1995	49.12a	45.67b	42.85c	40.17c	42.17c	41.72c	**
Survival plants %	1994	48.2c	73.6b	78.4ab	78.8ab	87.3a	88.5a	**
	1995	70.2a	65.2bc	61.2c	61.6c	67.8ab	69.5a	**
No of open bolls/plant	1994	12.8	15.0	13.7	13.6	13.9	13.0	NS
	1995	8.3c	14.2ab	10.9bc	15.6a	15.1a	15.3a	**
Boll weight (g)	1994	2.19d	2.65a	2.21cd	2.51ab	2.40bc	2.53ab	**
	1995	2.55	2.82	2.56	2.68	2.70	2.65	NS
Seed cotton yield/ plant (g)	1994	28.0c	39.7a	30.3bc	34.1b	33.4bc	32.9bc	**
	1995	21.2b	40.1a	28.0b	41.8a	40.8a	40.6a	**
Lint percentage	1994	34.0b	36.3a	35.1ab	35.5a	35.2ab	35.0ab	*
	1995	35.4	36.0	36.4	35.6	37.7	37.9	NS
Seed index (g)	1994	9.05c	9.48a	9.32ab	9.45ab	9.17bc	9.15bc	*
	1995	9.71	10.61	10.61	10.01	10.58	10.21	NS
Seed cotton yield/fed (hektars)	1994	7.91c	12.86a	10.85b	11.31b	11.41b	11.31b	**
	1995	6.81c	13.00a	10.41b	10.78b	11.06b	10.91b	**

*, ** and NS indicate $P < 0.05$, 0.01 and not significant, respectively.
Means designated by the same letter within each row are not significantly different at 5% level according to Duncan's Multiple Range Test.

Table 4. Effect of growing patterns on grain and straw yields of wheat in 1993/1994 and 1994/1995 seasons.

Character	Season	Patterns						F-test
		1	2	3	4	5	6	
Grain yield/fed., (ton)	1994	1.90	-	1.60	1.68	1.80	1.83	NS
	1995	2.41a	-	1.69b	1.58b	1.93b	1.77b	**
Straw yield/fed., (ton)	1994	4.08	-	3.47	3.54	3.64	3.59	NS
	1995	4.89a	-	3.71b	3.33b	3.87b	3.88b	*

*, ** and NS indicate $P < 0.05$, 0.01 and not significant, respectively.
Means designated by the same letter within each row are not significantly different at 5% level according to Duncan's Multiple Range Test.

Table 5. Effect of growing patterns on some competitive relationships at 1993/1994 and 1994/1995 seasons.

Relationship	Season	Patterns						F-test
		1	2	3	4	5	6	
LER_{cotton}	1994	0.62c	1.00a	0.84b	0.88b	0.89b	0.88b	**
	1995	0.52c	1.00a	0.80b	0.83b	0.85b	0.84b	**
LER_{wheat}	1994	1.00	-	0.84	0.88	0.95	0.96	NS
	1995	1.00a	-	0.70b	0.66b	0.80b	0.73b	**
$LER_{intercropping}$	1994	1.62a	1.00b	1.68a	1.76a	1.84a	1.84a	**
	1995	1.52a	1.00b	1.50a	1.49a	1.65a	1.57a	**
ATER	1994	0.81	1.00	0.95	1.00	1.04	1.04	NS
	1995	0.75c	1.00a	0.86b	0.86b	0.94ab	0.90ab	**

*, ** and NS indicate $P < 0.05$, 0.01 and not significant, respectively.
Means designated by the same letter within each row are not significantly different at 5% level according to Duncan's Multiple Range Test.

Table 6. Net income per feddan gained from growing cotton by transplanting after wheat harvest or as an intercrop with wheat compared with cotton pure in 1993/1994 and 1994/1995 seasons.

Patterns	Total value of products (L.E.)				Total cost (L.E.)			Net income (L.E.)		
	Wheat		Cotton***	Total	Wheat	Cotton	Total	Wheat	Cotton	Total
	Grain*	Straw**								
1993/1994 season										
1	1254	979	3955	6188	450	1176	1626	1783	2779	4562
2	-	-	6430	6430	-	980	980	-	5450	5450
3	1056	833	5425	7314	450	839	1289	1439	4586	6025
4	1109	850	5655	7614	450	853	1303	1509	4802	6311
5	1188	874	5705	7767	450	856	1306	1612	4849	6461
6	1208	862	5655	7725	450	853	1303	1620	4802	6422
1994/1995 season										
1	1591	1174	3405	6170	450	1143	1593	2315	2262	4577
2	-	-	6500	6500	-	984	984	-	5516	5516
3	1115	890	5205	7210	450	826	1276	1555	4379	5934
4	1043	799	5390	7232	450	837	1287	1392	4553	5945
5	1274	929	5530	7733	450	845	1295	1753	4685	6438
6	1168	931	5455	7554	450	841	1291	1649	4614	6263

Average value of the local market for products:
* Ton of wheat grain = 660 L.E.
** Ton of wheat straw = 240 L.E.
*** One kentar of seed cotton = 500 L.E.