ISSN 1110-0419

Annals Of Agric. Sc., Moshtohor,
Vol. 43(1): 89-103, (2005).

EFFECT OF RELAYING COTTON ON SOME CROPS UNDER BIO-MINERAL N FERTILIZATION RATES ON YIELD AND YIELD COMPONENTS

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ABSTRACT

Two field experiments were carried out at Mallawi Agricultural Research Station (Middle Egypt), during 2002/2003 and 2003/2004 seasons to investigate the effect of cropping systems and rates of nitrogen fertilizer on yield and yield components of cotton relayed with some crops (onion, faba bean and wheat). The experimental design was split plot with four replications. Four cropping systems were arranged in the main plots; solid cotton, cotton relayed on onion, cotton relayed on faba bean and cotton relayed on wheat, while the levels of N fertilizer were arranged in the sub plots (30, 45, 60kg N/fed, 30 kg N + microbin, 45 kg N +microbin and 60 kg N/fed +microbin). The results indicate that: Relaying cotton had a significant effect on studied cotton traits and yield. Plant height, number of open bolls/plant, number of fruiting branches/plant, seed cotton yield/plant and seed cotton yield/fed. Pure stand of cotton were superior to all other relayed pattern followed by that relayed on faba bean, while the lowest values were observed when cotton was relayed on wheat. Increasing nitrogen fertilizer rate from 30 to 60 kg N/fed. increased all the studied cotton traits, similarly, inoculation with microbin significantly increased all the studied traits as compared with the uninoculated cotton. Application of microbin+60 kg N/fed. resulted in the highest values, whereas, the lowest values for all growth traits of cotton were obtained with 30 kg N/fed. Solid cotton fertilized with microbin+60 kg N/fed. was superior in all studied traits followed by cotton plants relayed on faba bean and received microbin+60 kg N/fed. Data also revealed that the intercropped crops (onion, faba bean and wheat) were significantly affected by the cropping systems. The cropping systems reduced yield/fed of onion, faba bean and wheat as compared to those grown in monoculture. Cotton relayed on faba bean had the highest values of land equivalent ratio (LER) (1.82) while cotton relayed on onion had the highest values of gross benefit and net return.

INTRODUCTION

The most common advantages of relaying cotton on some winter crops in Egypt are the complementary of resource use between the component crops, the improved efficiency use of both space and time, and the insurance of these systems against crop failure. The efficient utilization of resources by plants of both components in the intercrop which have different growth habits; such as the rate of growth, differences in height of both components and other growth traits in the intercrop.

Relaying cotton on some long duration winter crops may tackle the problem of delaying cotton from the timely date of seeding and save costs and time of land preparation to enable farmers to grow long duration winter crops such as wheat, faba bean and onion and without altering the prevailing structure. However, the literature bound with the observations round these aspects:

Balasabramanian and Sckayange (1990) reported that LER values, which are commonly used as an 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 through the year; thus it underestimates the advantages of the intercrops. To avoid these problems. The mean value of LER + ATER is used as an arbitrary compromise.

Kamel *et al.*, (1992) reported that land equivalent ratio (LER) of the intercropping systems was 1.40-1.64 when cotton was relayed on onion. El-Habbak *et al.*, (1993) found that plant height, number of bolls/plant, number of fruiting branches/plant, number of open bolls/plant, seed cotton/plant and seed cotton/fed were decreased when cotton was relayed on onion. Relaying cotton on onion plants resulted in reduction of onion yield and yield components compared with onion pure stand. Also they added that LER ranged from 1.44 to 1.70 and the highest gross profit resulted from relaying cotton on onion. El-Naggar *et al.*, (1996) found that cotton relayed on onion gave higher values of cereal units and gross profit than cotton alone. Abou-Zaid *et al.*, (1997) found that cotton sown after clover gave the highest seed cotton yield (average 7.61 kentar/fed over the two years) followed by that preceded by faba bean (7.52), while the lowest yield was obtained when cotton was grown after wheat (4.27) kentar/fed. Abou-Kresha (1998) found that seed cotton yield/plant and seed cotton yield/fed of cotton relayed on faba bean were superior to those grown in pure stand. Gross profit in L.E. reached maximum value when cotton was relayed on faba bean. Selim *et al.*, (1998) concluded that relay cotton on faba bean had no adverse effect on yield and yield components of both faba bean and cotton. Hussein (1998) found that seed cotton yield was not significantly different from the yield obtained when cotton was relayed on wheat. Wheat grain yield was not affected when cotton was relayed on it. Zahira (1999) found that highest values of cotton yield and yield components were obtained when cotton was grown in pure stand.

Garcia *et al.*, (1995) and El-Komy *et al.*, (1993) reported that adding bio fertilizer to some field and vegetable crops increased yield by 15.5 %. El-Naggar (1997) found an increase in number of fruiting branches/plant, boll number/plant, number of open bolls/plant, seed cotton yield/plant and seed cotton yield/fed due to increase of nitrogen levels up to 60Kg N/fed. Hussein (1998) found that seed cotton yield was higher with 60 than 40kg N/fed. Mitkees *et al.*,(1996) and Said. (1998) indicated that inoculation with N-fixing bacteria increased yield of wheat and barley. Hamissa *et al.* ,(2000) reported that application of nitrogen fertilizer at 60Kg N/fed increased plant height, number of fruiting branches/plant, number of open bolls/plant, boll weight, number of seeds/boll, lint%, seed cotton yield/plant and seed cotton yield/fed. as compared with adding half of the dose (30Kg N/fed) They also added that application of bio-fertilizer (Microbein, Rhizobacterein and

Nitrobein) increased significantly plant height, boll weight, number of seeds/boll, seed cotton yield/plant and seed cotton yield/fed as compared with uninoculated.

The present investigation is aiming to evaluate the effect of relaying cotton on some winter crops, rate of nitrogen fertilizer and the addition of bio-fertilizer on growth, yield and yield component of the Egyptian cotton.

MATERIALS AND METHODS

The present investigation was conducted at Mallawi Agricultural Research Station, during the seasons of 2002/2003 and 2003/2004, to study the effect of relaying cotton on some field crops and bio-mineral N fertilizer levels on growth, yield and yield components of the Egyptian cotton cultivar Giza 83.

The treatments were arranged in split-plot design with four replications in each season. The cropping systems were arranged in the main plots, while the N-levels with or without biofertilizer were arranged at random in the sub-plots. The experiment treatments were the combinations of four cropping systems and six levels of N fertilizer and microbin.

The cropping systems were as follows:

1- Cotton after berseem (two cuts).
2- Cotton relayed on onion.
3- Cotton relayed on faba bean, and
4- Cotton relayed on wheat.

Fertilizer levels were as follows:

1- 30 Kg N/fed.
2- 45 Kg N/fed.
3- 60 Kg N/fed.
4- 30 Kg N/fed + Microbin.
5- 45 Kg N/fed + Microbin.
6- 60 Kg N/fed + Microbin.

The sub-plot area was 7.2×6.0 m included wide ridges (120 cm apart) or narrow ridges (60 cm apart), 6 m. long. Planting and harvesting dates of berseem, onion, faba bean, wheat and cotton are presented in table (1).

Cotton grown after berseem was planted on the southern side of narrow ridges (60 cm.) while, cotton grown with onion, faba bean or wheat was planted on both sides of wide ridges (120 cm.) at a distance of 20 cm. between hills and thinned at two plants/hill (70.000 plant/fed). Onion and faba bean were planted on the top of wide ridges (four rows on the top of the ridges), the distance between rows was 20 cm. and 10 cm. between hills, whereas, wheat was sown in five rows on the top of the ridges at a distance of 20 cm. apart. All crops were given their normal cultural treatments (fertilizer, irrigation, weed and pests control, etc...)

Table (1): Varieties, planting and harvesting dates of berseem, onion, faba bean, wheat and cotton in the two seasons.

Crops	Variety	2002/2003 season		2003/2004 season	
		Planting date	Harvesting date	Planting date	Harvesting date
Berseem	Giza 15	5/11	3/1 and 20/2*	10/11	15/1 and 28/2*
Onion	Giza 6	25/11**	5/5	20/11**	7/5
Faba bean	Giza 2	17/11	20/4	10/11	18/4
Wheat	Giza 168	17/11	28/4	10/11	27/4
Cotton	Giza 83	20/3	5/10	21/3	8/10

* Cut ** Transplanted

The bio-fertilizer used was microbin, (Azospirilium sp., Azotobacter sp., Bacillus megatheruim var. phosphaticum, pseudomonas sp. And Mycorriza sp.); which produced and distributed commercially by the General Organization for Agricultural Equalization Fund (GOAEF), Ministry of Agriculture. Egypt. Inoculation with biofertilizers was performed by mixing seeds with the appropriate amount at a rate of bio-fertilizer 1g : 100 gm seeds. (each inoculated seed received approximately 10 millions bacteria on its surface.) Nitrogen fertilizer was applied as ammonium nitrate 33.5% in two equal doses before the first and second cotton irrigations. Inculcation was done by microbin half-hour before planting.

The soil texture was clay loam. The chemical analysis of the soil are presented in table (2).

Table (2): Chemical analysis and NPK before and after relay intercropping.

Chemical analysis	Before starting the experiment	After harvesting			
		Wheat	Faba bean	Berseem Two cuts	Onion
Ph 1 : 2.5 Soil :water	7.6	7.9	8.0	7.8	8.0
Ecmnohs/cm1:5,Soil:water	0.31	0.32	0.30	0.31	0.30
N *PPm*	80	52	110	100	85
P *PPm*	9.13	7.6	11.5	10.5	9.0
K *PPm*	550	500	580	570	575
Ca Co_3 %	2.91	2.95	2.96	2.90	2.93

Random sample of 10 plants were chosen for each sub-plot to determine growth traits and yield components. Estimated traits were as follows:

Cotton: Plant height, number of fruiting branches/plant, height of first fruiting branch, lint weight of ten bolls, seed cotton yield/plant and seed cotton yield/fed.

Onion : Weight of fresh bulb, bulb diameter and yield of bulbs per fed.

Faba bean: Plant height, seed yield/plant, seed yield/fed and straw yield/fed.

Wheat: Number of grains/spike, spike length, weight of grains/spike, grain yield/fed and straw yield/fed.

Berseem: Forage fresh yield/fed and dry yield/fed.

Yield of all crops were determined on plot basis and converted to one feddan.

Competitive relationships :

1- Land Equivalent Ratio (LER) was calculated according to (Willey, 1979).

LER= (Yco or Ycf or Ycw/Ycc)+(Yoc or Yfc or Ywc/Yoo or Yff or Yww).

Where:

Yco or Ycf or Ycw = yield of intercropped cotton with onion or faba bean or wheat.

Yoc or Yfc or Ywc = yield of intercropped onion or faba bean or wheat with cotton.

Ycc = yield of pure stand of cotton.

Yoo or Yff or Yww = yield of pure stand of onion or faba bean or wheat.

2- Area Time Equivalent Ratio (ATER)

A concept that considers the time factor along with land area is ATER proposed by Hiebsch and McCollum (1987 a) and Hiebsch (1978). It is calculated as follows:

$$ATER = \left(\frac{tm}{ti} \times \frac{yab}{yaa}\right) + \left(\frac{tm}{ti} \times \frac{yba}{ybb}\right)$$

where:

tm = duration of crop in monocropping,

ti = total duration of the intercrop system.

The ATER accurately estimates the biological efficiency, which is defined as the rate at which radiant energy is converted to harvestable biological energy via the myriad processes that take place in green plants (Hiebsch and McCollum, 1987 b). Also, we used the method utilized by Balasabramanian and Sckayange (1990).

Economical evaluation :

The total income for each treatment was calculated in Egyptian pound per/feddan at market price of the averages of 2002/2003 and 2003/2004 seasons at Mallawi region. Seed cotton price was 550 L.E./kentar, onion was 600 L.E./ton, faba bean seed was 320 L.E./ardab, faba bean straw was 240 L.E./ton, wheat grain was 155 L.E./ardab, wheat straw was 240 L.E./ton and berseem forage yield was 45 L.E./ton.

Statistical analysis:

The χ^2 test for errors variances were computed to determine the homogeneity variances. If the null hypothesis is not rejected, i. e., χ^2 is not significant calculated χ^2 less than tabulated, then we do the combined analysis and vice versa. In the present study tables of the combined analysis of the two seasons were used according to Snedecor and Cochran (1967).

RESULTS AND DISCUSSION

(1) Effect of cropping systems on cotton yield and traits :

Data presented in table (3) indicate clearly that all studied cotton traits except the height of the first fruiting branch were significantly affected by

cropping systems. Plant height reached its maximum value when cotton plants were relayed on faba bean while the lowest value was observed when relayed on wheat. Height of the first fruiting branch reached its maximum value when cotton plants were relayed on faba bean, while the number of fruiting branches/plant reached its maximum value (8.39) with solid cotton. Results also showed that the number of open bolls/plant were significantly affected by cropping systems. The highest values were observed when cotton plants were grown after berseem followed by that relayed on faba bean, while the lowest values were obtained when cotton plants were relayed on wheat. Regarding lint, seeds and seed cotton weights, the pure stand of cotton was superior while cotton plants relayed on wheat recorded the lowest values. These results are in agreement with those obtained by El – Habbak *et al.*, (1993).

Seed cotton yield per plant or per feddan pure stand of cotton were superior to all other treatments followed by those grown with faba bean, while the lowest value was observed when cotton was relayed on wheat. The seed cotton yield/fed of cotton grown with faba bean, onion and wheat were 93.18, 87.12 and 82.95% of the solid cotton respectively. It is evident that cotton grown with faba bean was superior if compared with that grown with onion in most studied traits. These results are in agreement with those obtained by Abou-Zaid *et al.*, (1997), Abou-Kresha (1998) and Zahira (1999).

(2) Effect of fertilizer on cotton traits :

Data presented in table (4) indicate that growth and cotton yield attributes were significantly affected by fertilizer rates except height of first fruiting branch. Increasing nitrogen levels from 30 to 60 kg N/fed increased all the studied traits (growth and yield components).The application of microbin + 60 kg N/fed. resulted in the highest values of all cotton traits whereas, the lowest values were associated with 30 kg N/fed. Microbin + 45 kg N/fed. ranked the second in case of plant height, number of fruiting branches/plant, seed cotton yield/plant and seed cotton yield/fed. The increases in most yield components as nitrogen rates increased may be due to the stimulating effect of nitrogen to enhance metabolic and merstimic activities which in turn had positive effects on yield and yield components. Similar results were reported by El-Naggar (1997) and Hamissa *et al.*, (2000).

The application of microbin resulted in significant increases in most studied traits as compared to the uninoculated. Microbin + 60 kg N/fed. was significantly superior to the uninoculated one and received 60 kg N/fed. by 3.1% for plant height; 9.3% for number of fruiting branches/plant; 2.5% for height of first fruiting branch; 9.7% for number of open bolls/plant; 7.4% for weight of lint; 2.8% for weight of seeds; 4.6% for weight of seed cotton; 4.6% for seed cotton yield/plant and 0.3% for seed cotton yield/fed. the average of the two seasons. The application of microbin+ 45 kg N/fed. resulted in significant increases compared to the application of 60 kg N/fed. by 1.6% for plant height; 1.8% for number of fruiting branch; 3.0% for height of first fruiting branch; 4.2% for number of open bolls/plant; 0.6% for weight of lint; 9.7% for seed cotton yield/plant and 4.0% for seed cotton yield/fed. These results are in harmony with those obtained by Garcia *et al.*, (1990), El-Komy *et al.*, (1993) and Hamissa *et al.*, (2000).

Table (3): Effect of cropping systems on yield and yield components of cotton. (Combined analysis of the two studied seasons 2002/2003 and 2003/2004).

Traits / Cropping systems	Plant height cm.	Height of first fruiting branch	No. of fruiting branches /plant	No. of open bolls/ plant	Wit. of ten bolls (g)			seed cotton yield/ plant (g)	seed cotton yield/ fed kentar
					Lint	seeds	Seed cotton		
Solid cotton	107.64	5.18	8.39	15.93	5.12	8.07	13.19	55.33	10.56
Cotton + onion	107.06	5.40	7.40	13.28	4.69	7.22	11.91	47.74	9.20
Cotton + faba bean	111.25	5.21	7.54	13.78	4.85	7.55	12.40	51.54	9.84
Cotton + wheat	97.56	4.96	7.25	12.88	4.44	6.99	11.43	44.44	8.76
L.S.D. at 5%	2.39	N.S.	0.40	0.19	0.10	0.10	0.11	0.43	0.18

Table (4): Effect of Bio-mineral N fertilizer on the yield and yield components of cotton. (Combined analysis of the two studied seasons 2002/2003 and 2003/2004).

Traits / Bio-mineral N fertilizer	Plant height cm.	Height of first fruiting branch	No. of fruiting branches /plant	No. of open bolls/ plant	Wit. of ten bolls (g)			seed cotton yield/ plant (g)	seed cotton yield/ fed kentar
					Lint	seeds	Seed cotton		
30 Kg N/fed	101.13	5.11	6.56	11.82	4.36	6.88	11.24	42.94	8.67
45 Kg N/fed	103.50	4.98	7.27	13.52	4.65	7.36	12.01	46.65	9.24
60 Kg N/fed	106.46	5.19	7.98	14.28	4.85	7.68	12.53	49.04	9.64
30KgN/fed+microbin	106.17	5.16	7.21	13.59	4.63	7.33	11.96	49.96	9.35
45KgN/fed+microbin	108.17	5.35	8.13	14.88	4.88	7.61	12.49	53.80	10.03
60KgN/fed+microbin	109.83	5.32	8.73	15.67	5.21	7.90	13.11	56.20	10.63
L.S.D. at 5%	2.72	N.S.	0.40	0.12	0.10	0.14	0.14	0.68	0.10

(3) Interaction effects :

Data in table (5) showed that all studied traits were significantly affected by the interaction of cropping systems X fertilizer treatments except lint weight. The highest values in most cotton traits were observed when microbin+60 kg N/fed. was applied to the pure cotton stand followed by cotton plants relayed on faba bean and the application of microbin+60 kg N/fed. The lowest values were observed when minimum rate of mineral nitrogen (30 kg N/fed.) was applied to cotton plants relayed on wheat.

Table (5): Effect of the interaction between cropping systems and Bio-mineral N fertilizer on yield and yield components of cotton. (Combined analysis of the two seasons).

Cropping systems	Traits / Bio-mineral N fertilizer	Plant height cm.	Height of first fruiting branch	No. of fruiting branches /plant	No. of open bolls/ plant	Wit. of ten bolls (g)			seed cotton yield/ plant (g)	seed cotton yield/fed kentar
						Lint	seeds	Seed cotton		
Solid cotton	30 Kg N/fed	100.67	4.87	6.83	12.45	4.80	7.80	12.60	46.83	9.75
	45 Kg N/fed	101.33	4.58	7.83	16.41	4.93	7.95	12.88	52.83	10.35
	60 Kg N/fed	104.17	4.75	8.66	17.38	5.12	8.33	13.45	56.80	10.67
	30 Kg N/fed + microbin	108.83	5.17	7.42	14.70	5.00	8.13	13.12	53.47	10.25
	45Kg N/fed + microbin	114.17	6.00	9.25	17.13	5.20	7.98	13.18	59.20	10.90
	60Kg N/fed + microbin	116.67	5.70	10.33	17.56	5.63	8.22	13.85	62.87	11.45
Relay intercropping cotton with onion	30 Kg N/fed	103.00	5.33	6.67	11.21	4.25	6.48	10.73	40.33	8.27
	45 Kg N/fed	105.50	5.33	7.17	12.41	4.63	7.22	11.85	44.33	8.78
	60 Kg N/fed	106.67	5.92	8.00	13.05	4.81	7.42	12.23	46.93	9.25
	30 Kg N/fed + microbin	105.00	5.50	6.75	12.98	4.52	7.10	11.62	48.30	9.05
	45Kg N/fed + microbin	109.17	5.17	7.75	14.58	4.85	7.32	12.17	52.50	9.65
	60Kg N/fed + microbin	113.00	5.17	8.08	15.53	5.06	7.77	12.83	54.07	10.22
Relay intercropping cotton with faba bean	30 Kg N/fed	105.00	5.58	6.50	12.15	4.28	6.82	11.10	45.30	8.92
	45 Kg N/fed	110.00	5.17	7.08	13.13	4.76	7.42	12.18	48.53	9.50
	60 Kg N/fed	116.67	5.92	7.92	14.13	4.92	7.88	12.80	50.43	9.83
	30 Kg N/fed + microbin	113.33	5.07	7.42	13.46	4.70	7.23	11.93	52.80	9.38
	45Kg N/fed + microbin	110.83	5.17	8.08	14.25	4.87	7.93	12.80	55.43	10.42
	60Kg N/fed + microbin	111.67	5.33	8.25	15.40	5.30	8.03	13.33	56.77	11.00
Relay intercropping cotton with wheat	30 Kg N/fed	95.83	4.67	6.25	11.50	4.00	6.40	10.40	39.30	7.73
	45 Kg N/fed	97.17	4.83	7.00	12.21	4.28	6.84	11.12	40.90	8.33
	60 Kg N/fed	98.33	5.17	7.33	12.58	4.58	7.08	11.66	42.00	8.80
	30 Kg N/fed + microbin	97.50	4.92	7.25	13.21	4.32	6.83	11.15	45.27	8.70
	45Kg N/fed + microbin	98.50	5.08	7.41	13.58	4.58	7.23	11.81	48.07	9.15
	60Kg N/fed + microbin	98.00	5.08	8.25	14.20	4.83	7.57	12.40	51.10	9.87
L.S.D. at 5 %		5.43	0.60	0.81	0.25	N.S	0.28	028	1.36	0.19

Results also, indicated that seed cotton yield of cotton plants relayed on onion and received 60 kg N/fed. + microbin was equal to that of cotton grown after berseem and fertilized with 30 kg N/fed + microbin. The yield of cotton plants relayed on faba bean and received 60 kg N/fed. was equal to that relayed on wheat and fertilized with 60 kg N + microbin. It is clear that preceding crops before cotton had significant effects on yield and yield components of cotton. It could be concluded that berseem or faba bean as legume crops could supply high amounts of required N for the production of seed cotton. These results coincided with those obtained by Abou-Zaid *et al.*, (1997).

(4) Effect on the intercropped crops:

Data in table (6) indicated that most of the studied traits of onion, faba bean and wheat were significantly affected by cropping systems. The results indicated that relay cropping systems reduced yield and yield components of onion and faba bean as compared to those grown in pure stand. Although, the yield components of wheat were increased the yield per fed. was reduced as compared with that grown in pure stand. The reduction in grain yield of wheat relayed on cotton was due to the reduction in wheat area when intercropped with cotton. The reduction reached 2.13 ton/fed for onion, 1.4 ardab/fed for faba bean and 1.98 ardab/fed for wheat (averages of both seasons). These results are in agreement with those obtained by El-Habbak *et al.*, (1993) and Zahira (1999).

(5) Effect on competitive relationships :

5-1- Land Equivalent Ratio: (LER)

Data presented in table (7) showed the effect of relay cropping systems on land equivalent ratio (LER). The values of LER were greater than one by relaying cotton on onion, faba bean or wheat, this showed that the actual productivity was higher than the expected productivity when cotton grown with onion, faba bean or wheat. The results showed that the highest LER was observed when cotton grown with faba bean 1.82 while the lowest value was observed when cotton grown with onion 1.70. Cotton relative yield (RY_a) decreased when relayed on wheat while it increased when relayed on faba bean. Similar results were obtained by Kamel *et al.*, (1992) and El-Habbak *et al.*, (1993).

5-2- Area Time Equivalent Ratio: (ATER)

The data on area time equivalent ratio (ATER) indicated lower values than those recorded on LERs as the crops remained longer on land compared with the crops grown in pure stand. The trend was parallel to LER but with lesser values due to time loss. Cotton relayed on faba bean had the highest value followed by cotton relayed on wheat, whereas, lowest values were obtained when cotton was relayed on onion. These results were in harmony with those obtained by Hiebsch and McCollum (1987a) and Balasabramanian and Sckayange (1990).

The latter reported that both area and time factors have to be considered to quantify resources use efficiency in multiseasonal intercropping. Data on the mean values of LER + ATER also revealed a similar trend to both LERs and ATERs as influenced by the relay cropping systems. However, the values obtained were medium and between both LER and ATER. Balasabramanian and Sckayange

Table (6): Effect of intercropping(onion, faba bean and wheat) with cotton on growth, yield and yield components of onion, faba bean and wheat. (Combined analysis of the two seasons).

Crops	Onion			Faba bean				Wheat				
Traits / Treatments	Bulb diam-eter (cm)	Wt.of fresh bulb (g)	Bulbs yield/ fed. (ton)	Plant height (cm)	Seed yield/ plant (g)	Seed yield/ fed. (ardab)	Straw yield/ fed. (ton)	No.Of grains /spike	Spike length (cm)	Wt.of grains /Spike (g)	Grain yield/ fed. (ardab)	Straw yield/ fed. (ton)
Solid	5.43	113.17	13.03	107.33	32.37	13.03	1.57	44.20	7.50	18.00	23.40	3.20
Intercropped	4.88	96.67	10.90	105.33	29.88	11.62	1.40	50.48	8.03	18.68	21.42	2.79
F. test	*	*	*	**	*	N.S.	**	**	N.S.	N.S.	**	**
L. S. D. at 0.05	0.37	9.69	1.00	1.24	1.37	N. S.	0.06	0.81	N. S.	N. S.	0.50	0.15
L. S. D. at 0.01	0.86	22.39	2.32	2.87	3.17	N. S.	0.13	1.87	N. S.	N. S.	1.16	0.35

(1990) reported that LER values, which are commonly used as an 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 through the year; thus it underestimates the advantages of the intercrops. To avoid these problems. The mean value of LER + ATER is used as an arbitrary compromise. The data of land equivalent ratio (LER) and the average of both (means of LER + ATER) indicate that all the relay cropping systems achieved yield advantage as compared with sole cropping of both components the three relayed cropping system recorded values exceeded the unit. It seemed that the added production due to the substantial leaf canopy is the cause and effect. Onion proved to be good and compatible companion crop with cotton. Success of the system fell heavily upon erectophile and limited leaf canopy of onion. Onion also grow and matures only together with cotton during the first growth stages (germination, seedling emergence, growth and apart of plant establishment prior squaring) where cotton plants are still with very small leaf area index and leaf area density. Success of relaying cotton on faba bean or wheat might be due to the very short period which cotton participate wheat space and time (last two irrigations of wheat) cotton seedlings are also protected from insect attack and weather fluctuation which frequently occur during cotton germination and seedling growth.

(6) Economic evaluation :

Data presented in table (8) showed that gross benefit and net benefit were affected by cropping systems. It is evident that the highest gross benefit and net benefit were observed when cotton was relayed on onion (11605.5 and 7055.5) followed by cotton relayed on faba bean (9522 and 5739) respectively. The lowest values were observed when cotton was grown as solid (7402 and 3926) respectively. It is clear that the increases of gross benefit and net benefit were 56.7% and 79.7% when cotton relayed on onion, 28.6% and 46.1% when cotton relayed on faba bean and 11.7% and 10.6% when cotton relayed on wheat respectively, as compared to solid cotton. These results are in agreement with those obtained by El-Habbak *et al.*, (1993), El-Naggar *et al.*, (1996) and Abou-Kresha (1998).

Table (7): Land equivalent ratio (LER) and area time equivalent ratio (ATER) of cotton relay cropping on onion, faba bean and wheat. (Combined analysis of the two seasons).

Cropping systems	0	ATER	Mean of LER+ATER
	LC. + L crop = Total		
Cotton + onion	0.87 + 0.83 = 1.70	0.98	1.34
Cotton + faba bean	0.93 + 0.89 = 1.82	1.00	1.41
Cotton + wheat	0.83 + 0.92 = 1.75	0.96	1.36

LC. : Land equivalent ratio cotton.

Lcrop : Land equivalent ratio for onion, faba bean and wheat.

Table (8) : Economic evaluation for intercropping systems (averages of the two seasons).

Costs and benefits / Cropping systems	Yield / fed							Total variable cost L.E. /fed	Gross benefit	Net benefit
	Cotton kentar	Berseem ton	Onion ton	Faba bean		Wheat				
				Seeds ardab	Straw ton	Seeds ardab	Straw ton			
Cotton + berseem (2 cuts)	10.56	35.42	-	-	-	-	-	3476	7402	3926
Cotton + onion	9.21	-	10.9	-	-	-	-	4550	11605.5	7055.5
Cotton+faba bean	9.84	-	-	11.7	1.40	-	-	3783	9522	5739
Cotton + wheat	8.76	-	-	-	-	17.93	2.75	3912	8275.15	4345.15

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تأثير التحميل المناوب للقطن مع بعض المحاصيل تحت مستويات مختلفه من التسميد الأزوتي المعدني والحيوي علي المحصول ومكوناته

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أقيمت تجربتان حقليتان بمحطة البحوث الزراعيه بملوي (مصر الوسطي) خلال موسمي الزراعه ٢٠٠٢/٢٠٠٣، ٢٠٠٣/٢٠٠٤ لدراسة تأثير نظم التحميل المناوب للقطن مع بعض المحاصيل ومستويات من التسميد الأزوتي المعدني والحيوي علي المحصول ومكوناته للقطن والمحاصيل المحمله (البصل، الفول البلدي والقمح) بإستخدام أربع نظم للتحميل وهي : القطن المنفرد وتم زراعته بعد برسيم، قطن محمل مع بصل، قطن محمل مع الفول البلدي، قطن محمل مع القمح. و٦ مستويات من التسميد الأزوتي المعدني والحيوي وهي: ٣٠، ٤٥، ٦٠ كجم نيتروجين للفدان، (٣٠ كجم نيتروجين+ميكروبين)، (٤٥ كجم نيتروجين+ميكروبين)، (٦٠ كجم نيتروجين+ميكروبين للفدان). وكان التصميم المستخدم هو تصميم القطع المنشقه مره واحده في أربع مكررات. **ويمكن تلخيص أهم النتائج المتحصل عليها كالأتي:**

١- أدي التحميل المناوب للقطن إلي نقص معنوي في صفات القطن وكمية الحاصل وهي : طول النبات، عدد الأفرع الثمريه، عدد اللوز المتفتح، حاصل النبات وحاصل الفدان حيث تفوق القطن المنفرد (بعد البرسيم)، ويليه القطن المنزوع محملاً مع الفولّ البلدي بينما كانت أقل قيمة متحصل عليها عند زراعة القطن محملا مع القمح.

٢- أدت زيادة التسميد الأزوتي من ٣٠ إلي ٦٠ كجم أزوت للفدان إلي زياده معنويه في معظم الصفات كما أدت إضافة التسميد الحيوي إلي زيادة معنويه بالمقارنه بعدم الإضافه. وأدي إستخدام ٦٠ كجم أزوت للفدان+الحيوي (ميكروبين) إلي أعلي القيم بينما جاءت أقل القيم عند إستخدام ٣٠ كجم أزوت للفدان وبدون إضافة السماد الحيوي.

٣- أظهر التفاعل بين نظم التحميل والتسميد الأزوتي المعدني والحيوي إلي الحصول علي أعلي القيم لصفات القطن عند أستخدام التسميد المعدني ٦٠ كجم أزوت للفدان+الحيوي (ميكروبين) و زراعة القطن المنفرد والذي تم زراعته بعد البرسيم،

يليه القطن المحمل مع الفول البلدي وأستخدام ٦٠ كجم أزوت للفدان + الحيوي (ميكروبين).

٤- تشير النتائج إلي أن المحاصيل المحمله (البصل، الفول البلدي والقمح) تأثرت معنويا بنظم التحميل. وأدت نظم التحميل إلي إنخفاض حاصل الفدان من البصل، الفول البلدي والقمح مقارنة بالزراعه المنفرده.

أدي التحميل إلي زيادة كفاءة إستغلال الأرض عن الواحد الصحيح. وكانت أعلي قيم كفاءة إستغلال الأرض عند تحميل القطن مع الفول البلدي هي ١,٨٢ بينما أعطي تحميل القطن مع البصل أعلي قيمه من إجمالي العائد وصافي العائد