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EFFECT OF PRECEDING CROPS IN THREE-YEAR CROP ROTATIONS AND N RATES ON YIELD AND YIELD COMPONENTS OF EGYPTIAN COTTON

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Abstract

Four types of cotton rotations have been started since 1995/ 1996 season at Shandaweel Agric. Res. St. (Upper Egypt) to evaluate the effect on cotton production of different crop sequences and N rates on yield and yield components of cotton. Four preceding crop sequences viz., wheat/maize (P_1), wheat/soybean (P_2), faba bean/maize (P_3) and faba bean/soybean (P_4) were studied as main plots. Three nitrogen levels, i.e. 45,60 and 75 Kg N/fed. were applied to the cotton crop in the sub-plots. Results in 1999 and 2000 seasons indicated that preceding crops significantly affected plant height, number of fruiting branches/ plant, total open bolls/plant, average bolls weight and weight of seeds/ boll. In both seasons seed cotton yield was 11.4 and 15.7% higher when cotton followed soybean than cotton grown after the cereal crops.

All studied cotton characters were increased by increasing N levels up to 75 Kg N/fed. Seed cotton yield from 75Kg N/fed. Was higher than at 60 and 45 Kg N/fed. by 8.5, 15.9%, 6.73 and 16.88% in first and second seasons, respectively.

The highest performance of cotton was observed when cotton was grown after legume crops and fertilized with 75 Kg N/fed., while the lowest performance was obtained following cereal crops and the lowest N level in both seasons.

INTRODUCTION

Cotton contiues to be the main crop in Egypt playing an important role in the national economy. Cotton yield is influenced by several factors including crop sequence, fertilization, tillage and soil type. The sequence of crops in a particular crop rotation may have an effect on yield even when soil fertility and other agriculture practices are at optimal conditions. Smith and Varvil, (1982) found that seed cotton yield increased from 35 to 50% for short-season cotton varieties double cropped after wheat, compared with monocropping. El-Moghazy et al., (1984) and Badr et al., (1993) indicated that preceding crops significantly affected cotton plant height, number of fruiting branches, number of bolls/plant and seed cotton per plant and per feddan. Brown et

al., (1985) showed that cotton yield after rye and vetch cover crops were equal to yields obtained with the fall plow-fallow system. Crookston and Kurle, (1989) and Bordovske et al., (1994) noticed that yields of most field crops improved with crop rotation than when grown continually. Abou-Zaid et al., (1993) reported that cotton sown after berseem clover gave the highest seed cotton yield followed by cotton after faba bean with the lowest yield being obtained after wheat.

Nitrogen plays a major role in determining the expression of a wide range of cotton plant variables including plant size, fruiting intensity, boll retention, boll size and total boll number/plant.

Several investigators studied the effect of nitrogen fertilizer on growth and yield of cotton under Egyptian condition. El-Shinnawy et al., (1984), Abd-El-Hadi et al., (1987), Yassen et al., (1990), El-Kalla et al., (1994), Makram and Abdel-Malak, (1997) and Ibrahim et al., (1997) reported that increasing nitrogen level from 60 to 90 Kg N/ fed. increased the plant height, number of ftuiting branches and open bolls/plant as well as seed cotton yield per plant and per faddan. However, EL-Debaby and Hamman (1987) reported that nitrogen has insignificant effect on number of open bolls/plant and seed cotton yield/plant. Sawan et al. (1991) noted that drymatter yield, N uptake/ plant, number of opened bolls/plant, boll weight, seed index, lint index, seed cotton yield per plant and per hectar increased with increasing N rate.

Results from other states recorded the same trend. Boquet et al. (1993) in USA, found that the total harvestable bolls/plant and cotton yield was improved by application of higher rates of N fertilization. Damo et al. (1998) and Avila and Aragon (1998) Philippien showed that seed cotton yield and other traits such as plant height, weight/ boll and number of bolls/plant were significantly affected by increasing added N up to 100 Kg N/ha.

The aim of the present investigation was to study the effect of preceding crops via different cotton crop rotations and N applied to the cotton crop on seed cotton yield and yield components.

MATERIALS AND METHODS

Four types of cotton rotations were started in 1995/1996 season at Shandaweel Agric. Res. St. (Upper Egypt) to evaluate the effect of different crop sequences on cotton production during 1999 and 2000 seasons.

The four cotton rotations types are as follows:

	1995/96		96/97		97/98		98/99		99/2000	
	W	S	W	S	W	S	W	S	W	S
P_1	Berseem	Cotton	Faba bean	Soybean	Wheat	Maize	Berseem	*Cotton	Faba bean	Soybean
	Wheat	Maize	Berseem	Cotton	Faba bean	Soybean	Wheat	Maize	Berseem	**Cotton
	Faba bean	Soybean	Wheat	Maize	Berseem	Cotton	Faba bean	Soybean	Wheat	Maize
P_2	Berseem	Cotton	Faba bean	Maize	Wheat	Soybean	Berseem	*Cotton	Faba bean	Maize
	Wheat	Soybean	Berseem	Cotton	Faba bean	Maize	Wheat	Soybean	Berseem	**Cotton
	Faba bean	Maize	Wheat	Soybean	Berseem	Cotton	Faba bean	Maize	Wheat	Soybean
P_3	Berseem	Cotton	Wheat	Soybean	Faba bean	Maize	Berseem	*Cotton	Wheat	Soybean
	Faba bean	Maize	Berseem	Cotton	Wheat	Soybean	Faba bean	Maize	Berseem	**Cotton
	Wheat	Soybean	Faba bean	Maize	Berseem	Cotton	Wheat	Soybean	Faba bean	Maize
P_4	Berseem	Cotton	Wheat	Maize	Faba bean	Soybean	Berseem	*Cotton	Wheat	Maize
	Faba bean	Soybean	Berseem	Cotton	Wheat	Maize	Faba bean	Soybean	Berseem	**Cotton
	Wheat	Maize	Faba bean	Soybean	Berseem	Cotton	Wheat	Maize	Faba bean	Soybean

* First season 1999 cotton experiment

** Second season 2000 cotton experiment

A field experiment was carried out in each of 1999 and 2000 to study the effect of crops grown in the preceding year and N rates applied to cotton on the performance ov cv. Giza 90 cotton (Gossypium barbadense L.).

The four preceding crops wheat/maize(P_1), wheat/soybean(P_2), faba bean/maize (P_3) and faba bean/soybean(P_4) were assigned in the main plots. While sub-plots were devoted to the three nitrogen levels, i.e. 45,60 and 75 Kg N/fed. Cotton was sown at seed rate of 30 Kg/fed. on 18 th and 20 th of March in the first and second season, respectively. Sub Plot were 5 x 3.5 m^2, comprising 6 ridges 60 cm wide with two plant/hills on space 20 cm apart on one side of the ridge. Superphosphate fertilizer was applied at 30 Kg. P_2O_5/fed. Nitrogen fertilizer was divided into two equal doses applied at the first and second irrigations, respectively. Plants were harvested on 18 and 23 September in the first and second season, respectively. Ten plants were chosen at

random within each sub-plot for determination of yield components. Data collected for statistical analysis were i,e. plant height, height of the first fruiting branch, number of fruiting branches/plant, number of open bolls/plant, boll weight, lint weight of ten bolls, seed weight of ten bolls, seed cotton weight of ten bolls, seed cotton yield/plant and seed cotton yield/fed.

Representative soil samples from the experimental site were taken before starting the experiment 1995/1996, and also after harvesting summer crops 1999 season to determine some chemical properties according to Jackson (1958).

Simple and multiple correlations and linear regression were used to study the nature of relationships between seed-cotton yield and both preceding crop and nitrogen fertilizer as follows:

1. Simple correlation: A matrix of simple correlation coefficients between seed-cotton yield and both preceding crops (X_1) and nitrogen fertilizer (X_2) were computed according to Snedecor and Cochran (1988).

2. Multiple linear regression: Multiple linear regression and multiple coefficient of determination (R^2) were estimated according to Snedecor and Cochran (1988) to evaluate the relative contribution of the studied treatments on seed-cotton yield (Y) according to this formula:

$$Y = a + b_1 x_1 + b_2 x_2 .$$

Where:

a = the intercept, (the equation constant)

b_1, b_2 = partial regression coefficients for X_1 and X_2 respectively.

Qualitative independent variable were coded for regression analysis. Dummy or suitable coding for the independent qualitative variables can be done in various ways to facilitate calculations and to improve the accuracy of results. However, in this study, the effect of crop sequences on cotton was assigned a value of 2 for the wheat/maize sequence, 3 for the faba bean/maize sequence, 4 for the wheat/soybean sequence and 5 for the faba bean/soybean sequence preceding the tested cotton crop. This scale (codes) was prepared from available information on the residuals of N, and P esti-

mated from the experimental soil after each of these four crop sequences, in a manner similar to Voss *et al.* (1970).

Data of the two seasons were statistically analyzed according to Snedecor and Cochran (1988) using MSTAT computer V4 (1986) L.S.D test at 0.05 level was used to compare the differences between treatment means.

RESULTS AND DISCUSSION

1. Effect of the preceding crop on cotton yield.

Data of cotton yield and its components as affected by the sequence of crops preceding cotton are shown in Table (1). Results indicated that the height of the first fruiting branch and lint weight of ten bolls in both seasons and boll weight and seed-cotton weight of ten bolls in the first season were not significantly affected by preceding crop. However, it is noted that plant height, number of fruiting branches, total open bolls/plant, boll weight, seed cotton yield/plant and seed-cotton yield/fed. were higher when cotton was grown after wheat/soybean (P_2) and faba bean/soybean (P_4), while lint weight per ten bolls was not affected by preceding crops in both seasons. The lowest values were obtained when cotton was grown after wheat/maize (P_1). Seed-cotton yield/plant and seed-cotton yield/fed were significantly higher when cotton was grown after wheat/soybean (P_2) and faba bean/soybean (P_4) in both seasons. The increment in seed-cotton yield/plant were 18.14 and 23.95 % and 11.4 and 15.7 % for seed-cotton yield/fed. when cotton was grown after legume crops (P_2 and P_4) compared with cotton grown after cereal crops (P_1 and P_3)in both seasons, respectively.

These results are in agreement with El-Moghazy et al., (1984), Badr, et al., (1993), Bordovsk, et al., (1994) and Abou-Zaid et. Al., (1993).

2. Effect of N, fertilizer rates:

Data presented in Table (2) clearly indicate that all studied cotton characters were significantly affected by nitrogen fertilizer except height of first fruiting branches in both seasons. Plant height, number of fruiting branches, open bolls/plant and average bolls weight reached maximum values when adding 75 Kg N/fed. On the other hand, the lowest values were observed when 45 Kg N/fed. was added. Results also

Table 1. Effect of preceding crops on plant characteristics, yield and components of cotton-in the two seasons 1999 and 2000

Preceding crops	Plant (cm) height	Height of first fruiting branch	No. of Fruiting branches/ plant	No. of open bolls/plant	Average boll weight, g	Average weight of 10 bolls, g			Seed cotton yield/plant (gm)	Seed cotton yield/fed (Kanter)
						Seed cotton	Seeds	Lint		
Season 1999										
P1	138.333	19.189	13.311	21.844	1.281	12.989	7.869	5.108	29.072	6.373
P2	142.222	19.211	13.600	26.033	1.341	13.411	8.142	5.264	34.997	7.175
P3	136.778	18.633	13.367	22.711	1.334	13.278	8.063	5.212	30.243	6.600
P4	141.778	19.778	13.844	27.422	1.321	13.200	8.028	5.154	35.626	7.301
L.S.D at 0.05	1.960	N.S.	0.179	1.356	N.S.	N.S.	0.099	N.S.	1.406	0.157
Season 2000										
P1	142.778	17.756	14.144	24.122	1.341	13.433	8.102	5.333	33.530	6.585
P2	146.222	16.989	14.456	28.878	1.393	13.777	8.451	5.428	40.436	7.758
P3	142.556	17.289	14.278	25.100	1.362	13.611	8.263	5.327	34.303	6.740
P4	145.889	17.622	14.667	30.344	1.398	13.953	8.401	5.552	43.668	7.660
L.S.D at 0.05	1.453	N.S.	0.328	1.429	0.044	0.402	0.236	N.S.	1.412	0.124

*P1: wheat/maize P2: wheat/soybean P3: faba bean/maize P4: faba bean/soybean.

Table 2. Effect of N-rate on cotton plant characteristics, seed cotton yield and yield components in 1999 and 2000

N-rate Kg/fed.	Plant height (cm)	Height of first fruiting branch	No. of Fruiting branches /plant	No. of open bolls/plant	Average boll weight, g	Average weight of 10 bolls, g			Seed cotton yield/plant, g	Seed cotton yield/fed (Kanter)
						Seed cotton	seeds	Lint		
Season 1999										
45 Kg	134.333	19.192	13.208	21.458	1.270	12.750	7.713	5.034	27.409	6.380
60 Kg	141.250	18.983	13.517	24.358	1.343	13.458	8.118	5.243	32.648	6.812
75 Kg	143.750	19.433	13.867	27.692	1.345	13.450	8.245	5.278	37.397	7.395
L.S.D at 0.05	1.249	N.S.	0.202	0.575	0.022	0.221	0.148	0.150	1.048	0.166
Season 2000										
45 Kg	138.500	17.208	14.100	23.983	1.319	13.167	8.073	5.093	31.784	6.605
60 Kg	146.167	17.442	14.283	27.183	1.379	13.925	8.490	5.419	37.591	7.233
75 Kg	148.417	17.592	14.775	30.167	1.415	13.990	8.349	5.717	42.078	7.720
L.S.D at 0.05	1.245	N.S.	0.266	0.506	0.027	0.257	0.171	0.129	1.160	0.144

Table 3. Effect of the interaction between preceding crops and N-rate on plant characteristics, seed cotton yield and yield components in 1999 and 2000

Preceding crops	N-rate Kg N/fed	Plant height (cm)	Height of First fruiting branch	No. of fruiting branches /plnat	No. of open bolls/plant	Average bolls weight, g	Average weight of 10 bolls, g			Seed cotton yield/plant ,g	Seed cotton yield/kntar
							Seed cotton	Seeds	Lint		
Season 1999											
P1	45 Kg	132.7	18.4	13.3	19.8	1.2	12.4	7.5	4.9	24.6	5.9
	60 Kg	140.3	18.7	13.1	21.9	1.3	13.5	8.1	5.1	29.1	6.3
	75 Kg	142.0	20.4	13.6	23.8	1.3	13.1	8.0	5.3	33.4	6.9
P2	45 Kg	136.7	19.4	13.4	22.2	1.3	13.1	7.9	5.2	29.1	6.7
	60 Kg	145.0	19.5	13.6	26.3	1.3	13.2	8.0	5.2	34.8	7.1
	75 Kg	145.0	18.8	12.8	29.6	1.4	13.9	8.5	5.3	41.0	7.8
P3	45 Kg	131.0	19.2	13.7	20.8	1.2	12.4	7.5	4.9	25.8	6.0
	60 Kg	137.7	18.4	13.5	22.2	1.4	13.7	8.3	5.4	30.4	6.7
	75 Kg	141.7	18.3	13.9	25.1	1.4	13.8	8.4	5.4	34.6	7.1
P4	45 Kg	137.0	19.8	13.4	23.0	1.3	13.1	7.9	5.2	30.1	6.9
	60 Kg	142.0	19.4	13.8	27.0	1.3	13.4	8.1	5.2	36.3	7.2
	75 Kg	146.3	20.2	14.8	32.3	1.3	13.1	8.1	5.0	40.5	7.8
L.S.D. at 0.05		N.S.	1.4	0.4	1.2	0.0	0.4	0.3	N.S	2.1	N.S.
Season 2000											
P1	45 Kg	138.0	17.5	14.0	22.0	1.3	12.8	7.9	4.9	28.6	6.0
	60 Kg	144.3	17.2	14.0	23.7	1.4	13.7	8.4	5.3	32.5	6.6
	75 Kg	146.0	18.6	14.5	26.7	1.4	13.8	8.0	5.7	39.5	7.1
P2	45 Kg	141.3	17.3	14.3	25.6	1.4	13.5	8.3	5.2	34.6	7.3
	60 Kg	149.0	17.9	14.3	29.1	1.4	13.8	8.4	5.4	39.7	7.8
	75 Kg	148.3	15.8	14.7	32.0	1.4	14.0	8.6	5.7	47.0	8.3
P3	45 Kg	135.7	17.1	13.8	22.9	1.3	12.7	7.7	5.0	29.3	6.1
	60 Kg	145.0	17.3	14.3	25.4	1.4	14.1	8.6	5.4	34.9	6.9
	75 Kg	147.0	17.5	14.7	27.0	1.4	14.0	8.5	5.5	38.7	7.3
P4	45 Kg	139.0	16.9	14.4	25.4	1.4	13.6	8.3	5.2	34.7	7.1
	60 Kg	146.3	17.4	14.5	30.6	1.4	14.1	8.6	5.5	42.3	7.8
	75 Kg	152.3	18.5	15.7	35.0	1.4	14.2	8.3	5.9	43.1	8.2
L.S.D. at 0.05		2.5	1.6	N.S.	1.0	N.S.	N.S.	N.S.	N.S	2.3	N.S.

show that lint weight and seeds weight/ten bolls were higher when 75 Kg N/fed. was added. Seed-cotton yield/plant as well as seed-cotton yield/fed. were higher under 75 Kg N/fed. than under 60 and 45 Kg N/fed. The increments of seed-cotton yield/fed. were 8.5, 15.9% , 6.73 and 16.88% in first and second seasons, respectively. Similar results were observed by Abd-El-Hadi et al, (1987), Yaseen et al, (1990), Boquet et al, (1993), Sawan, (1997) and Aragon, (1998).

3. Preceding crop x N-fertilizer interaction effect on cotton:

The interaction between the preceding crops and N-fertilizer (Table 3) had a significant effect on some cotton traits such as number of fruit branches/plant, bolls weight and seed cotton yield/fed. in both seasons, number of open bolls/plant, lint weight of ten bolls and seed cotton yield /plant in the first season and plant height and height of first fruit branch in the second season. The heighest values were observed when cotton was grown after a legume crop and fertilized with 75 Kg N/fed., while the lowest values were obtained after cereal crops and the addition of 45 Kg N/fed. in both seasons. The results also show that seed-cotton yield grown after legume crops (P_2 and P_4) and with 60 Kg N/fed. was higher than yield after cereal crops (P_1 and P_3) and the addition of 75 Kg N/fed. It is clear that nitrogen fertilizer needed for cotton grown after legume crops is lower than after cereal crops with 15 – 20 Kg N/fed.

4. Relationship between seed cotton yield/fed. and both preceding crops and fertilizer:

Simple correlation coefficients for preceding crops and N-fertilizer are presented in Table (4), and figures (1 and 2). The simple correlation coefficient between seed-cotton yield and preceding crops was 0.55 and 0.54 in the first and the second seasons, respectively, suggesting a moderately strong relationship. However, simple correlation coefficients between seed-cotton yield and N-levels were 0.77 and 0.75 in the first and the second seasons, respectively, indicating a stronger association between yield and N level.

Table 4. Matrix of simple correlation (r) between seed-cotton yield and studied factors:

Season	X_1	X_2
1 st	0.55	0.77
2 nd	0.54	0.75

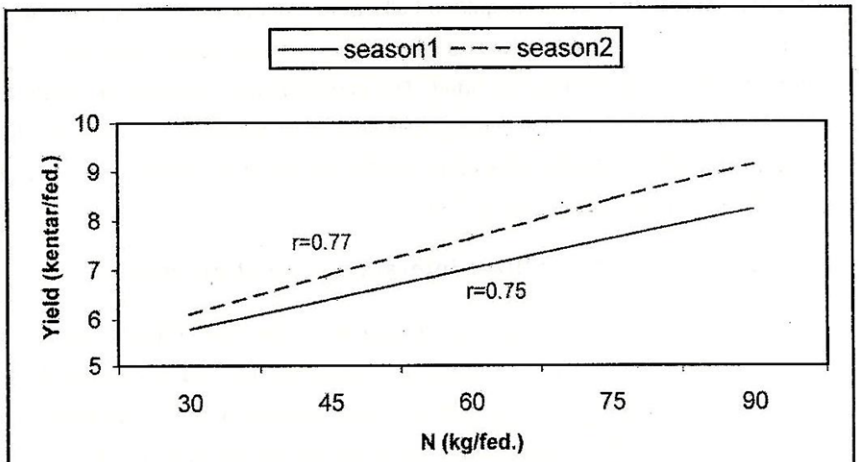

Fig. 1. Relation between seed cotton yield and Nitrogen fertilization.

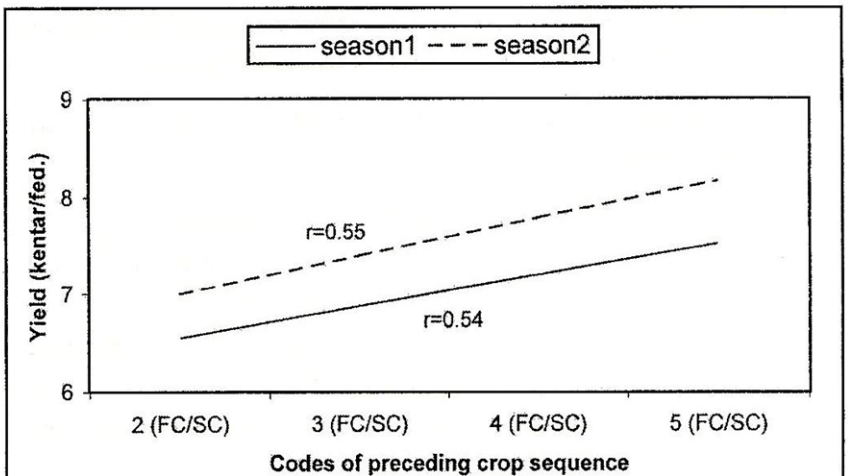

Fig. 2. Seed cotton yield as affected by preceding crop sequence.

FC = First crop, SC = Second crop

Multiple linear regression was estimated as follows:

$Y = 3.259 + 0.3851\ x_1 + 0.0495\ x_2$ (first season) $R^2 = 0.92^{**}$

$Y = 3.489 + 0.319\ x_1 + 0.04\ x_2$ (second season) $R^2 = 0.86^{**}$

Where Y = Yield , x_1 = N (kg/fed.), and x_2 = Crop sequence.

The relative contribution of the two studied treatments (X1 and X2) on variation of seed-cotton yield was 92% and 86% in the first and the second seasons, respectively. These results clearly indicate that both preceding crops and nitrogen fertilizer had high correlation coefficient with seed-cotton yield.

Table (5) shows the analysis of the soil before and after each experiment for the different preceding crops. Data show that both of the pH value and E.C of the soil are the same. For available plant nutrients, available potassium did not show marked changes as compared with zero time analysis. Figures of available N show obvious changes between the different preceding crops with superior values for the legumes: faba bean/ soybean followed by wheat/soybean, with the least value recorded for the cereals wheat/maize. These differences could led attributed to biological N fixation by legumes through rhyzobia in root nodules and the high demand of cereals for N on the other side.

Available phosphorus gave nearly the same trend of available N which could be attributed to the fertilizer phosphorus applied to legumes and the beneficial effect of legume root oxidates on the unavailable native phosphorus of the soil.

Table 5. Soil chemical analyses of the experimental soil properties.

Chemical Analysis	Before starting the crop rotation	After harvesting summer crops 1999 season			
		Wheat/ maize	Fababean/ maize	Wheat/ soybean	Fababean/ soyabean
PH (1:2.5, soil: water)	7.99	8.13	8.2	7.93	8
EC mmohs/cm (1:5, soil)	0.45	0.46	0.45	0.44	0.44
Available N (ppm)	80	55	70	110	120
Available P (ppm)	7.6	7.2	8	10.2	12.5
Available K (ppm)	465	430	440	475	490
Codes of crop sequence		2	3	4	5

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تأثير المحاصيل السابقة لزراعة القطن فى الدورة الثلاثية والتسميد الآزوتى على محصول القطن ومكوناته

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بدأت تجربة الدورة الزراعية منذ موسم ١٩٩٥ / ١٩٩٦ بمحطة البحوث الزراعية بشندويل حيث زرع القطن فى إطار أربع دورات ثلاثية بهدف دراسة تأثير المحاصيل الشتوية والصيفية السابقة ومعدلات التسميد الآزوتى للقطن على انتاجية هذا المحصول.

ولقد استخدم تصميم القطع المنشقة مرة واحدة فى ثلاثة مكررات وكانت المحاصيل السابقة للقطن فى القطعة الرئيسية والتى هى :

١ – قمح / ذرة شامية
٢ – قمح / فول صويا
٣ – فول بلدى / ذرة شامية
٤ – فول بلدى / فول صويا.

بينما اشتملت القطع المنشقة على معدلات التسميد الآزوتى وهى ٤٥ ، ٦٠ ، ٧٥ كجم/فدان.

وتشير أهم النتائج المتحصل عليها خلال الموسمين ١٩٩٩ ، ٢٠٠٠ إلى الآتى :

١- كانت المحاصيل السابقة ذات تأثير معنوى على بعض صفات المحصول للقطن وهى طول النبات ، عدد الأفرع الثمرية واللوز الكلى واللوز المتفتح بالنبات وكذلك وزن اللوزة ومحصول النبات والفدان من القطن الزهر كانت أعلى عند الزراعة بعد المحاصيل البقولية بالمقارنة بالزراعية بعد محاصيل الحبوب. كما أوضحت النتائج أن محصول الفدان من القطن الزهر المنزرع بعد محاصيل البقول فى التتابعات (قمح/فول صويا ،فول بلدى / فول صويا) كان أعلى بالمقارنة بالقطن بعد محاصيل الحبوب (قمح / ذرة شامية ، فول بلدى / ذرة شامية) بحوالى ١١,٤ ١٥,٧٪ على التوالى فى موسمى التجارب.
٢- زادت متوسطات كل الصفات التى تمت دراستها مع زيادة معدلات التسميد الآزوتى المضافة حتى ٧٥ كجم / فدان. كما أن محصول الفدان من القطن المضاف له ٧٥ كجم آزوت تفوق على مثيله من ٦٠ ، ٤٥ كجم آزوت بنسبة ٨,٥ و ١٥,٩٪ فى الموسم الأول ١٦,٩ و ٦,٧ ٪ لها فى الموسم الثانى على التوالى.
٣- أظهرت النتائج أن الزراعة بعد المحاصيل البقولية مع اضافة ٧٥ كجم آزوت للفان أدت إلى زيادة محصول القطن الزهر للفدان.
٤- وجد إرتباط معنوى متوسط القوة بين محصول القطن الزهر والمحاصيل السابقة وارتباط قوى مع التسميد الآزوتى للقطن.