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Response of Cotton Plant to Organic Fertilization with Compost and Economic Feasibility in Comparison with Mineral Fertilization

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Abstract

Two field experiments were performed at Sakha Agricultural Research Station, Kafr Elshiekh Governorate, Egypt, during 2021 and 2022 seasons, in order to evaluate effects of Compost and/or biofeed in combination with graded proportions of mineral NPK fertilizers on growth and yield components of Super Giza 94 Egyptian cotton cultivar and Estimating the economic return from providing quantities of mineral fertilizer.

Application of compost was added during soil preparation, Biofeed (as a liquid) was added after planting with irrigation water, mineral NPK fertilizers was applied as the recommended dose as control. The treatments were, [1] Control 100% mineral NPK, [2]75% Mineral + 25 % Compost, [3] 75% Mineral + 25 % Biofeed, [4] 50 % Mineral + 25% Biofeed + 25% Compost, [5] 25 % Mineral + 50 % Biofeed + 25% Compost [6] 50 % Biofeed + 50% Compost). Results showed that treatment No.[4] gave the highest values of Chlorophyll a (4.94 in the first season), Chlorophyll b (3.05 in the first season), Carotenoids (1.23 in the first season), Total soluble sugar (17.91 and 18.50), plant height (142.25 in the first season) No. of fruiting branches (17.62 in the first season) , No. of open bolls (28.67 and 25.31) , % Earliness (61.82 in the first season), Seed cotton yield / kentar (9.51 and 8.49), boll weight (2.42 and 2.50) , seed index (14.05 and 11.03) and lint % (38.61 in the first season) respectively in the first and second seasons (most traits not significant) compared with other treatments and control.

Key words: Cotton, Biofeed, Compost, Fertilizer and Yield.

INTRODUCTION

Cotton plays a key role in economic activities all around the world and in Egypt as well. Egyptian cotton (*Gossypium barbadense* L.) is the most important commercial fiber crop with higher fiber quality (**Sohair *et al.* 2018**). The current production of cotton fiber is not sufficient to meet gradually increasing demand of the world population. Although Egyptian cotton is very valuable in the world market. Some agronomic practices were widely adopted by farmers, but most of them were discarded due to low efficiency.

Last few years, farmers used to apply a greater amount of chemical fertilizers to increase the production of crop yield. The excessive use of chemicals led to detrimental effects on the environment, especially, displayed toxic impacts in water and soil resources. In despite of continues warning from scientists, the production and application of chemicals are increasing in agricultural production. A major part of the applied chemical fertilizers are not used by crops, they remain in the soil as insoluble inorganic compounds and promote toxicity of the soil or leached with draining water.

Compost is an excellent source of micro and macro nutrients depending on the composition and nature of wastes (**Morales-Corts *et al.*, 2018**). Composted organic waste materials are regarded for their effectiveness to enhance crop yields compared to non – composted material due to improvement physical, chemical and biological characters of soil and reduced mineralization rate. Compost stabilizes soil pH and supplies significant quantities of organic matter to soil. It acts as disease suppressant, as it is associated with biological control agents to alleviate plant pathogens. (**Ahmed *et al.*, 2006**).

Biofeed is a liquid organic fertilizer includes sea food extractions, algae extraction, protioletiv a slyolitc bacterial species in addition to activated organic acids macronutrients, N.P.K, traces of different microelements and microbial species like protioly-tic and sylioltic species.

Economic feasibility, Rameez, et al (2014) they were stated that the cost of production means all types of cost, fixed cost, variable cost as well as marketing cost etc. The costs incurred on production of cotton were estimated from the values of land preparation, sowings, farm yard manure (FYM), fertilizer, pesticide, irrigation charges, labors and other expenses. Overhead costs were presented in variable cost, fixed cost and opportunity cost or the depreciation and opportunity cost of all production factors owned by cotton growers.

The aim of the experiment was to study the effects of total or partial substitution of NPK mineral fertilizers by biofeed and/or compost application on cotton yield and its components, with estimating the economic feasibility (cost-benefit analysis) for using organic fertilizers in comparison with the mineral ones in relation to the costs and benefits.

MATERIALS AND METHODS

Egyptian cotton cultivar Super Giza-94 (*Gossypium barbadence* L.) was used in this study and the seeds of this cotton cultivar were given by Cotton Research Institute, Egypt, for two summer seasons, 2021 and 2022. The experimental treatments were arranged in completely randomized block design with three replicates. The experimental treatments were as follows:

1- Control (as recommended dose, 100% NPK Mineral)
2- NPK 75% Mineral fert. + 25% compost
3- NPK 75% Mineral fert. + 25% biofeed
4- NPK 50 % Mineral fert. + 25% compost + 25% biofeed
5- NPK 25 % Mineral + 25 % compost + 50 % biofeed
6- 50% compost + 50 % biofeed

Each experimental plot was 14 m^2 in area, including 5 ridges; 4 m long and 70 cm apart. Mineral fertilizers as Urea (46 % N) was added at a rate of 60 kg N/fed-at two times 30 and 45 days after sowing as equal doses. Super Phosphate was added during soil tillage at a rate of 30 kg P_2O_5/fed). Potassium sulphate (48 % K_2O) was added at a rate of 50 kg at two times 45 and 60 days after sowing.

Compost was prepared by admixing of 45 kg rice straw with 1 m^3 of farmyard manure. The mixture was sprayed with water to reach 60 % humidity. The pile was stirred every seven days till maturation. Compost was added as 5 ton / fed after tillage and before sowing.

Biofeed (liquid compost) was prepared by mixing 5 gallon bucket with a lid organic materials (such as green leaves, weeds and sea organisms and filling the bucket with water until it covered the organic materials completely , leaving some space at the top for fermentation gases, cover the bucket with a loose – fitting lid to allow gases , let the mixture sit for anywhere about two weeks , after fermentation , strain out the solid organic material using affine mesh strainer or cloth, and was added at 20 liter / fed at two times directly with irrigation at 30 and 45 days after sowing.

Before planting, soil samples from the surface layer (0-30), (30-60) and (60-90) cm have been taken from the experiment site. The soil samples were air- dried and analyzed for some physical and chemical characteristics, i.e., soil pH, organic matter and cation exchange capacity according to the methods described by **Page et al.(1982)**.

Table 1: Some physical and chemical properties of the experimental soil.

Characters				
	PH	**EC , ds m^{-}**	**O.M %**	**ESP %**
2021 **2022**	8.22 8.18	7.33 7.41	1.56 1.65	21.27 20.72
Particle Size Distribution %				
	Sand	**Silt**	**Clay**	**Texture grad**
2021 **2022**	28.22 28.76	24.11 24.60	47.67 46.64	Clayey Clayey
Soluble Cations, meq L $^{-1}$				
	Ca $^{+2}$	**Mg $^{+2}$**	**Na^{+}**	**K^{+}**
2021 **2022**	7.32 8.11	5.12 5.38	24.22 23.67	0.38 0.34
Soluble Anions , meq L $^{-1}$				
	Co_3^{-2}	**Hco_3^{-}**	**cl^{-}**	**So4^{-2}**
2021 **2022**	-- --	4.01 3.98	20.00 21.13	13.03 12.39

Chemical composition of leaves

Samples of the forth uppermost leaves were collected from each plot at peak of flowering stage to determine the leaves contents of photosynthetic pigments and total soluble sugars as follows:

- **Chlorophyll a , Chlorophyll b and Carotenoids**:

Spectrophotometric Analysis, Once extracted, the concentrations of chlorophyll a, chlorophyll b, and carotenoids were determined using spectrophotometry, according to **Moran (1982)**, Specific wavelengths are used for measuring each pigment: Chlorophyll a is measured at 663 nm, Chlorophyll b at 645 nm, Carotenoids typically at around 480 nm.

Chlorophyll a $=12.7\times A_{663}-2.69\times A_{645}$, Chlorophyll b$=22.9\times A_{645}-4.68\times A_{663}$

Carotenoids = $(A_{480}) - (0.114\times A_{663}) - (0.638\times A_{645}) / 1000$.

- **Total soluble sugar.**: Add phenol solution (usually 5% w/v) to an aliquot of the sugar extract. Then add concentrated sulfuric acid carefully and mix well. Allow it to stand for about 10 minutes; this will develop a color due to sugar reaction with phenol and sulfuric acid. Measure absorbance at 490 nm using a spectrophotometer. The intensity of color correlates with sugar concentration, method as described by **Rangnna (1977).**

Growth and yield characteristics:

At harvest time ten plants were randomly collected from the inner ridges to determine the following attributes:

Growth attributes

- **Plant height (cm).** The measurement begins at the base of the plant where it emerges from the soil.
- **Number of fruiting branches /plant.**

Yield and yield components:

- **Number of open bolls /plant.** The average of No. of open bolls were determined before harvest
- **Boll weight (g).** Calculated as the mean of weight of 25 bolls in grams.
- **Earliness %.** Earliness in cotton refers to the time it takes for the plant to reach maturity, which is typically measured from =

weight of seed cotton yield in the first picking / weight of seed cotton yield in the first and second picking x 100

- **Seed cotton yield (Kentar/fed.).**
- **Seed index (100 seeds weight in g).** As the weight of 100 seeds in grams.
- **Lint percentage.** Lint percentage can be defined mathematically as:

= (weight of Lint / weight of seedcotton) ×100

Statistical analysis

Statistical analysis of data was done by the analysis of variance (ANOVA) according to **Snedecor & Cochran, 1980.** Multiple comparisons of treatment means were done by least significant difference test (LSD) at $P \leq 0.05$ level. The analysis was performed using CoStat program, ver. 6.4, CoHort software.

RESULTS AND DISSCUSSION

In general, organic fertilization treatments had positive effects on cotton yield and other parameters (Table 2 and 3). The results mostly revealed significant variations in the two growing seasons.

Data of Table (2) illustrated the effect of different fertilizers on chl.a, chl.b, total chl. , carotenoids and total soluble sugar showed that , treatment 4 (50% chemical + 25% compost + 25 % Biofeed) gave the highest values in the first season , at the first season it gave 4.9٤ ,3.0٥ ,8.0٩, N.S and 17.9١ for chl.a, chl.b, total chl. , caretonoids and total soluble sugar compared to 3.5٢, 2.٢2 , 5.7٤ , ١.٠٥ and 13.4٢ due to 100 % chemical (control) respectively, while at season 202٢ was non-significant effect on these characters studied except total soluble sugar which was ١٨.٥٠ in the first season compared to 13.9٢ in the second season due to 100% chemical (control) respectively . Both powder compost and Biofeed can enhance chlorophyll concentration in plant leaves. This increase is often attributed to improved nutrient availability, particularly nitrogen and phosphorus (**Zhang et al, 2023**). The application of 50% chemical + 25% compost + 25 % Biofeed can improve a plant resistance to environmental stresses which indirectly supports higher chlorophyll levels. Healthy plants tend to maintain their chlorophyll content, **Semida et al. (2014)** focuses on how organic manures affect soil characteristics and crop performance, providing evidence for increased sugar levels due to improved nutrient dynamics from compost applications. In comparative studies where cotton plants were subjected to different treatments (including control groups without compost), those receiving organic amendments consistently showed elevated levels of total soluble sugars. The synergistic effect observed when combining various organic fertilizers with traditional fertilization methods further supports the notion that compost not only enhances growth but also improves metabolic processes related to sugar accumulation.

Table 2: Effect of organic fertilizers as a substitute of mineral fertilizers on some of cotton leaves chemical constituents in 2021 and 2022 seasons.

TREATMENTS	Chlorophyll a mg/g. d.w	Chlorophyll b mg/g. d.w	Total chlorophyll mg/g. d.w	Carotenoids mg/g. d.w	Total soluble \ Sugar mg/g,d w
	2021				
1: 100% chemical (control)	3.52 c	2.22 b	5.74 b	1.05	13.42 c
2: 75 % chemical + 25% compost	4.14 b	2.31 b	6.45 ab	0.82	16.03 a
3: 75 % chemical + 25% Biofeed	4.50 a	2.53 b	7.03 a	0.90	15.90 b
4: 50 % chemical + 25% compost + 25% Biofeed	4.94 a	3.05 a	8.09 a	1.23	17.91 a
5: 25 % chemical + 25% compost + 50 % Biofeed	4.62 a	2.71 ab	7.43 a	0.98	16.52 a
6: 50% compost + 50% Biofeed	4.01 b	2.10 b	6.11 b	0.88	15.94 b
LSD at 5 %	**0.56**	**0.73**	**1.20**	**N.S**	**0.99**
	2022				
1: 100% chemical (control)	3.44	2.00	5.44	0.82 b	13.92 c
2: 75 % chemical + 25% compost	3.93	2.25	6.28	0.80 b	18.03 a
3: 75 % chemical + 25% Biofeed	4.32	2.42	6.74	0.83 b	16.34 b
4: 50 % chemical + 25% compost + 25% Biofeed	4.95	3.13	8.17	0.96 a	18.50 a
5: 25 % chemical + 25% compost + 50 % Biofeed	4.56	2.60	7.45	0.94 a	16.61 b
6: 50% compost + 50% Biofeed	3.84	2.01	5.85	0.72c	15.72 b
LSD at 5 %	**N.S**	**N.S**	**N.S**	**0.13**	**1.11**

Growth and yield attributes:

Table 3, indicated the effect of different fertilizers on growth parameters and yield , treatment 4 (50% chemical fertilization + 25% compost + 25% Biofeed) fertilizer gave higher levels over control, 100% chemical fertilization, plant height (cm), integrating organic materials like compost with chemical fertilizers not only increases plant height but also enhances overall yield quality due to improved root development and soil health., **Rasheed et al. , (2010)**, The combination of 50% chemical fertilizer, 25% compost, and 25% Biofeed is designed to optimize both immediate nutrient supply for cotton fruiting branches while also fostering long-term soil health. This balanced approach should ideally lead to improved yields without compromising sustainability. No. of open bolls , The combination of 50% chemical fertilization + 25% compost + 25% Biofeed is expected to increase the number of open bolls in crops due to enhanced nutrient availability and improved soil health **(Dongxu et al., 2024)** . plant height, no. of fruiting branches , no. of open bolls , earliness , seed cotton yield, boll weight, seed index and lint percentage, exhibited at season 2021 which mostly obtained a significant values (142.٢٥ , 17.6٢, ٢٨.٦٧,61.8٢,٩.٥١,2.4٢,14.0٥ and 38.6١ compared to 130.12 , 14.08 , 21.34, 51.86 ,6.03 , 2.01 , 10.65 and 35.36 for 100% chemical (control) respectively (Table 3) in the first season, in the second season most of these characters were not affected except No. of open bolls and seed cotton yield which were 25.31 and 8.49 compared to 19.92 and 5.91 for control values .

Chemical Fertilizers (50%): These fertilizers provide readily available nutrients to the plants. Commonly used chemical fertilizers include ammonium nitrate or urea for nitrogen, superphosphate for phosphorus, and potassium sulfate or muriate of potash for Potassium. The immediate availability of these nutrients can help meet the rapid demands during critical growth phases.

Table (3): Effect of organic fertilizers as a substitute of mineral fertilizers on Plant growth, yield and yield components in 2021 and 2022 seasons.

treatments	Plant height (cm)	No. of fruiting branches /plant	No. of open bolls / plant	Earliness %	Seed cotton yield / (kentar / fed.)	Boll weight	Seed index	Lint%
	2021							
1: 100% chemical (control)	130.12 d	14.08 d	21.34 c	51.86 d	6.03 d	2.01 b	10.65 c	35.36b
2: 75 % chemical + 25% compost	130.51 d	15.07 c	22.55 c	54.74c	6.53 d	2.01 b	11.65 b	35.55 b
3: 75 % chemical + 25% Biofeed	138.33 b	16.01 b	26.36 b	57.03 b	7.93 c	2.12 b	13.05 ab	36.00 b
4: 50 % chemical + 25% compost + 25% Biofeed	142.25 a	17.62 a	28.67 a	61.82 a	9.51 a	2.42 a	14.05 a	38.61 a
5: 25 % chemical + 25% compost + 50 % Biofeed	139.56 b	16.33 b	27.67 b	58.92 b	9.12 b	2.32 a	13.05 ab	36.25 b
6: 50% compost + 50% Biofeed	133.71c	15.33 bc	23.01 c	55.42 c	7.10 c	2.11 b	12.03 b	36.05 b
LSD at 5 %	4.73	1.03	0.13	2.36	0.20	0.20	1.00	1.70
2022								
1: 100% chemical (control)	132.04	16.46	19.92 a	54.02	5.91 b	2.22	11.11	39.99
2: 75 % chemical + 25% compost	129.44	17.16	22.21 bc	55.75	6.40 ab	2.12	11.13	40.51
3: 75 % chemical + 25% Biofeed	130.45	17.65	23.21 b	55.26	7.03 ab	2.23	11.03	40.61
4: 50 % chemical + 25% compost + 25% Biofeed	130.06	17.64	25.31 a	58.05	8.49 a	2.50	11.03	41.10
5: 25 % chemical + 25% compost + 50 % Biofeed	129.07	16.94	22.31 bc	57.80	7.45 ab	2.43	11.11	40.32
6: 50% compost + 50% Biofeed	129.43	16.82	20.84 cd	56.33	6.56 ab	2.33	11.27	40.32
LSD at 5 %	N.S	N.S	1.73	N.S	1.42	N.S	N.S	N.S

Compost (25%): Compost enriches the soil with organic matter, improving soil structure, water retention, and microbial activity. It slowly releases nutrients over time, which can enhance nutrient availability throughout the growing season. Additionally, compost contributes to long-term soil health by increasing biodiversity in the soil ecosystem.

Biofeed (25%): Biofeed typically refers to organic amendments that may include various biological materials such as seaweed extracts or other bio stimulants. These products can enhance plant resilience against stressors and improve nutrient uptake efficiency. They may also promote beneficial microbial activity in the rhizosphere.

Economic Feasibility for two season cultivar (2021 and 2022)

Economic feasibility is a cost–benefit analysis that examines whether all the required inputs and contracts are in place for the business to be operational, and whether the resulting benefits and impacts are significant which cleared from Table (4).

• Total revenue

Total revenue is a total Egyptian pounds received from the sale of any assumed number of outputs. Formula: Total quantity = Price x Quantity.

Total costs

Total Cost is calculated by adding the fixed, variable and the opportunity costs for any level of production meaning fixed cost plus total variable cost. The cost concepts which are commonly called as some used cost are as follows.

Table (4). Means of cotton net income/fed. as affected by compost , Biofeed and mineral fertilizer during 2021 and 2022.

Treat ment	Fertilizer costs/fed (pounds) (by 1000 pounds)		Un changes and changes costs (Total cost) (by 1000 pounds)		Seed cotton yield kentar / fed		Income/fed (pounds) Sale prices / LE (by 1000 pounds)		Net Income / fed (by 1000 pounds)	
	2021	**2022**	**2021**	**2022**	**2021**	**2022**	**2021**	**2022**	**2021**	**2022**
T. 1	2.300 a	2.900 a	17.400 a	21.540 a	6.03 c	/ 5.91 c	33.000 f	50.150 d	15.600 d	28.610 e
T. 2	2.030 b	2.800 a	15.900 b	19.610 b	6.53 bc	6.40 c	35.820 e	54.400 cd	19.920 c	34.790 d
T. 3	1.750 c	2.300 b	15.590 b	19.220 b	7.93 b	7.03 b	41.250 c	59.500 bc	25.660 b	40.280 b
T. 4	1.520 d	2.200 b	14.400 c	17.800 c	9.51 a	8.49 a	52.250 a	71.400 a	37.850 a	53.600 a
T. 5	1.000 d	1.600 c	14.580 c	18.960 bc	9.12 a	7.45 b	50.050 b	62.900 b	35.470 a	43.940 b
T.6	0.740 e	1.500 c	14.830 bc	18.500 c	7.10 b	6.56 b	39.050 d	57.200 c	24.220 bc	37.700 c
LSD at 5%	**0.22**	**0.48**	**1.15**	**1.54**	**1.20**	**1.00**	**2.30**	**4.21**	**4.70**	**3.56**

Total cost (changes and un changes cost), contains field rent, sowing seeds, irrigation, fertilization, weed management, bestside management picking cotton yield.

From Table (4), it can observed that, T.(1) treatment gave the highest values of Fertilizer costs/fed and un changes and changes costs (Total cost) at the next T.(2) and the third one, T.3. One of the primary reasons for the high cost of mineral fertilizers is the surge in input costs, particularly for natural gas and coal, which are essential for producing nitrogen–based fertilizers. The Haber–Bosch process, used to produce ammonia (a key component of nitrogen fertilizers), requires substantial amounts of natural gas. (**Brunelle et al., 2014**).

On the other hand, T.(4) and T.(5) gave the lowest values of total costs depending on the lowest values of fertilizer costs/fed, these back to the low price of iqued or powder compost compared to mineral fertilizers, Compost is an organic material created from decomposed plant and animal matter. It is often considered one of the most cost-effective options for gardeners. The cost of compost can vary widely depending on whether you make it yourself or purchase it commercially. Consider to the net income of all treatments we observe that T. 4 treatment gave the highest value of Net income compared to other treatments , kentar of cotton sold in 2021 (5.500 L.E/ 1000 pounds) and in 2022 (8.500 L.E/ 1000 pounds) also, the fertilizer cost or total cost is lowest in comparison with mineral fertilizer. Also, it obtained high yield and it markets with high price.

In general, the production of plants involves various costs that can be categorized into fixed and variable costs. Understanding these costs is crucial for growers to establish a sustainable pricing strategy.

CONCLOUSION

Organic fertilization or compost, whether liquid or powder, is very important to preserve the environment and reduce production costs while giving a high yield. Treatment No. 4 (50 % Mineral + 25% Biofeed + 25% Compost) which is a total cost savings of 57% compared to total mineral fertilization (control) and giving high yield increasing about 2.5 kantar (42.2%) and saving total costs by 21.5%.So we can be recommend using this combination in the fertilization process, which is: 50% Mineral (NPK) + 25% Biofeed (liquid Compost) + 25% Compost for cotton plants and yield management. (The dose and the time of adding are, (NPK mineral) was added at a rate of 30 kg N/fed-at two times 30 and 45 days after sowing as equal doses (15). Super Phosphate was added during soil tillage at a rate of 15 kg P_2O_5/fed). Potassium sulphate (48 % K_2O) was added at a rate of 25 kg at two times 45 and 60 days after sowing. Compost was added as 1.25 ton / fed after tillage and before sowing and finally, Biofeed (liquid compost) was added at 5 liter / fed at two times directly with irrigation at 30 and 45 days after sowing).

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استجابة نبات القطن للتسميد العضوي بالكمبوست والجدوى الاقتصادية مقارنة بالتسميد المعدني

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المستخلص

أجريت تجربتان حقليتان بمحطة البحوث الزراعية بسخا بمحافظة كفر الشيخ، مصر. وذلك لتقييم مدى استجابة نباتات القطن المصرى للتسميد العضوى والحيوى مقارنة بالتسميد المعدنى على حسب النسب موضع التجربة على النمو والمحصول لصنف القطن المصرى سوبر جيزة ٩٤ خلال موسمى الزراعة ٢٠٢١، و٢٠٢٢. وقد تمت اضافة التسميد المعدنى فى مواعيده وجرعاته المقررة فى معاملة الكنترول وكانت المعاملات موضع الدراسة كالتالى:

١- كنترول.

٢ – ٧٥% معدنى + ٢٥ % كمبوست.

٣- ٧٥% معدنى + ٢٥ % بيوفييد (تغذية حيوية).

٤- ٥٠% معدنى + ٢٥% بيوفييد + ٢٥ % كومبوست مسحوق.

٥- ٢٥ % معدنى + ٥٠ % بيوفييد + ٢٥% كومبوست مسحوق

٦- ٥٠ % بوفييد + ٥٠% كومبوست باودر.

أوضحت النتائج:

ان المعاملة رقم ٤ (٥٠% معدنى + ٢٥% بيوفييد + ٢٥ % كومبوست) أعطت أعلى القيم لكلوروفيل أ (٤.٩٤ –٤.٩٥) وكلوروفيل ب (٣.٠٥ –٣.١٣) والكاروتين (١.٢٣ –٠.٩٦) والسكريات الكلية (١٧.٩١ –١٧.٥٠)، وطول النبات (١٤٢.٢٥ –١٣٠.٦)، وعدد الافرع الثمرية (١٧.٦٢ – ١٧.٦٤)، وعدد اللوز (٢٨.٦٧ –٢٥.٣١)، والنسبة المئوية للتبكير (٨١.٨٢–٥٨.٠٠)، ومحصول القطن / قنطار، وزن اللوزة (٢.٥١ – ٢.٤٩)، دليل البذرة (١١.٠ – ١٤.٠)، والنسبة المئوية للشعير (٣٨.٦١– ٤١.١٠)، وذلك فى الموسمى الاول والثانى من الزراعة مقارنة بباقى المعاملات والكنترول.

الكلمات المفتاحية: القطن، التسميد العضوى، العائد الإقتصادى.