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The Action and Interaction of Different Planting Dates and Organic Fertilizers on the Growth and Yield of Okra Plants

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Authors' contributions

This work was carried out in collaboration between all authors. Author MMHGEM designed the study, wrote the protocol and wrote the manuscript. Author AAAM wrote the manuscript, managed the economic part of the study and proof read the final manuscript. Authors ATE and AAF managed the literature searches and statistical analysis of the experiment. All authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

A field experiment was conducted, at the Central Laboratory for Agricultural Climate-Dokki, Giza, during two seasons (2014 and 2015), to study the effect of three Planting dates (February 15th, March 15th, and April 15th) and four organic fertilizers (Cattle manure, compost, rabbit manure and poultry manure) and their interaction, on the growth and yield of okra *Abelmoschus esculentus* (L.).
Data on the effect of each and combined treatments were collected on: vegetative growth (Plant height, number of leaves per plant, leaf area, flower number, total chlorophyll, fresh and dry weight); nutrients content (nitrogen, phosphorus, potassium) and total yield. The soil and air temperature during the experiment were recorded. The experimental design was a split- plot with three replicates.
The obtained results indicated that April 15th gave the highest yield followed by March 15th, with significant differences between them. Using poultry manure gave the highest yield followed by

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rabbit manure with significant differences between them. The lowest yield was found with compost treatment. The interaction between planting date and organic fertilizer was found at April 15th, with poultry manure, which gave the highest yield during both experimental seasons. The economic assessment of costs and returns from different treatments, were calculated. Gross margin per feddan (4200 m^2) were analyzed using yield data, price structures and production costs. The poultry manure had the highest gross margin for February 15th with poultry manure (5010 and 5630 Egyptian pound (LE) for the first and second seasons, respectively).
According to the benefit cost ratio (BCR) indicators cattle manure (OF1) in the 15th of February (D1) is the most profitable and cost-effective rate of producing okra that would be beneficial to the farmer in the study area in both seasons with 1.86 and 1.98 respectively.

Keywords: Okra; planting dates; organic fertilizers; soil and air temperature; benefit cost analysis; gross margin; production costs.

1. INTRODUCTION

Okra *Abelmoschus esculentus* (L.) is an important and popular vegetable crop in tropical and sub- tropical regions. It is a tender plant, grows well in hot weather, resulting in early emergencies and higher yields than in cool season. In Egypt, there is different production seasons that due to the mild climatic conditions. Okra is mainly considered as a summer crop. The fresh fruit is a good source of vitamins, minerals and plant protein [1].

India stands first in okra production in world, contributing 66.1 per cent share of total world production during 2014, Nigeria came in the second place with 21.2 per cent, while Egypt came in the ninth place of total world production during 2014 [2].

The total cultivated area in Egypt around 11592 feddan, with 56040 tones of production during 2015, while the average yield of the crop was (4.8 t/ feddan) [3].

Okra plants require warm temperature and unable to tolerate low temperature for long time or tolerate any threat of frosts. The optimum temperatures are in the range of 21- 30°C, with minimum temperature of 18°C and maximum of 35°C [4].

Okra seed can only geminate in relatively warm soils, no germination occurs below 16°C. A monthly average temperature range between 21 - 30°C is considered appropriate for growth, flowering and pod development. Being a warm season crop, it requires high day and night temperatures for best production, but the growers start its cultivation from January as off season-early crop to get higher prices [5].

The use of organic fertilizer allows improvement in fertility, in addition to being excellent soil conditioner, improving their physical, chemical and biological characteristics, such as water retention, aggregation, porosity, increased the cation exchange capacity, increased fertility and increased soil life microbial activities, however the value of compound fertilizer depends on the material used as raw material [6].

The mineral fertilizers and organic manures have its own roles to play in soil fertility management, but we cannot individually depend on one of them to supply all the nutrients and other conditions of growth for production [7].

Rabbit manure contains a much larger amount of nutrients than other animal manure. One ton of rabbit manure contains 108.5 kg ammonium sulfate, 100.9 kg superphosphate and 17.85 kg potassium sulfate. Since the nutrient and water contents in rabbit manure are very high, if the manure were used directly, it would be unsustainable in the long-term and lead to pollution of soil [8].

Tiamiyuet et al. [9] stated that okra responded well to the application of poultry manure compared to other sources of organic manures and control treatment in the study.

Present study aimed to determine the effect of planting dates and using different organic fertilizers on the growth and yield of okra plant. Furthermore, identify the most profitable rate of different treatments.

2. MATERIALS AND METHODS

This experiment was carried out, during the two successive seasons of 2014 and 2015, at the Central Laboratory for Agricultural Climate (CLAC) Dokki site, Giza Governorate, Egypt (30.04588 N Latitude and 31.20463 E

Longitude). The study included the effect of three planting dates (15th of February, 15th of March and 15th of April) and four organic fertilizers (Cattle manure (OF1), compost (OF2), rabbit manure (OF3) and poultry manures (OF4)) on the growth and yield of okra *Abelmoschus esculentus* (L.) (Hybrid Dokki2).

Seeds of each treatment were planted in three rows; each row was 18 m long. The distance between two rows was 0.75 cm. The total area for each plot was 40 m^2. The distance between seed two hills was 50 cm. Three seeds were placed in each hill. The organic fertilizer was added to the soil two weeks before sowing date. Each organic fertilizer treatment was mixed with the soil to the depth of 15 cm at the rate of 20 m^3/ feddan. Each plot (40 m^2) received 190 liter of organic fertilizer. The recommended dose of mineral fertilizers was added according to Ministry of Agriculture recommendations [10] as follow:

228 kg ammonium sulfate (20.5% N), 50 kg potassium sulfate (48% k_2O) and 145 kg calcium superphosphate (15.5% P_2O_5).

Soil samples from (0- 30 cm) were collected in the study to analyze the physical and chemical properties (Table 1). Sample of each organic fertilizers were analyze as shown in Table 2.

The following meteorological variables were recorded daily, at 10 cm depth using a digital soil temperature, throughout the crop growing seasons (2014 and 2015): maximum and minimum air temperatures and maximum and minimum soil temperatures.

A samples of three plants from each experimental plot were taken to determine growth parameters (plant height, number of leaves, stem diameter, flower number, leaf area (cm^2), total chlorophyll (spad), plant fresh weight (g/ plant), plant dry weight (g/ plant) and the percentage of N, P and K contents.

The total yield of okra fruits was estimated by collecting a week picking and the total yield was estimated, at the end of harvesting season (Kg/ plant) for each treatment.

Leaves chemical analysis was recorded. Leaves were dried at 70°C and wet digested to determine N, P and K contents. Total nitrogen per cent in leaves was determined by using the micro kjeldahl by A.O.A.C. [11]. Phosphorus percent was determined calorimetrically, while potassium per cent was determined by flame photometer by A.O.A.C. [11].

Data was statistically analyzed using Statistical Analysis System software [12]. Split plot design with three replicates was used. Organic fertilizer treatments were randomly arranged in the main-plots and planting dates were distributed randomly in the sub- plots. Significant means were separated using Duncan's New Multiple Range Test (DNMRT) at P≤ 0.05.

The okra is furrow irrigated throughout the growing seasons; the total amount of 4000- 5000 m^3 was applied for each treatment (Ec of water irrigation 0.8 m/mohs).

An economic analysis of the farm operations carried out to determine the total revenue and gross margin of the okra under four different fertilizer types with three different planting dates. The farm budgeting based on averages of farm gate prices for the periods considered was used for the analysis.

The benefit cost analysis was obtained with the formula used by Gittinger [13]. According Gittinger [13], the benefit cost analysis is defined as the value today of all benefits divided by the value today of all costs.

Table 1. The physical and chemical properties of the soil

Particle size distribution		OM (%)	0.35
Sand	15%	**Cations and anions (meq / l)**	
Silt	35%	Ca	6.0
Clay	50%	Mg	3.0
Texture	clay	Na	20.1
PH (1:2:3)	8.2	K	1.2
EC (dS / m)	2.4	Cl	13.0
$CaCo_3$ (%)	16.0	HCO_3	2.6

Table 2. The chemical composition of manure, compost, rabbit manure and poultry manure

Organic fertilizer (OF)	EC (dS/ m)	pH (1:2.5)	O.M (%)	N (%)	C/N ratio	P (%)	K (%)
Cattle manure (OF1)	4.15	0.9	39.6	1.35	21:1	0.5	0.56
Compost (OF2)	1.91	8.06	26.2	0.52	20:1	0.4	0.6
Rabbit manure (OF3)	1.5	8.95	77.29	1.79	15:1	0.59	0.67
Poultry manure (OF4)	2.96	7.64	57.82	2.75	30:1	1.17	1.5

3. RESULTS AND DISCUSSION

3.1 Soil Temperature

Data presented in Table 3, Figs. 1 and 2 showed the effect of planting dates with different organic fertilizers on soil temperature during both growing seasons. The highest values of soil temperature (°C) obtained by (OF4) followed by (OF3). The lowest values of soil temperature obtained by (OF1) in both growing seasons. These results revealed that poultry manure was the most suitable organic fertilizer. This result was in agreement with Abd El - Kader et al. [4]. Okra plants require warm temperature and are unable to withstand low temperature for long times or tolerate any threat of frost. Optimum temperature is in the range of 21 to 30°C, with minimum and maximum temperatures of 18°C and 35°C, respectively [4].

3.2 Growing Degree Days (GDDs)

Growing Degree Days (GDDs) or Accumulated Heat Unit (AHU) for okra plant was estimated in different planting dates during both growing seasons (Fig. 3). The maximum increments of GDDs were obtained by planting on April 15th (D3) in both growing seasons (1884.1 and 1979.6, respectively). On the other hand, the minimum amount of GDDs resulted from planting

Table 3. Average maximum and minimum air temperature during growing seasons

Organic matter	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.
Soil temperature in the first season 2014								
OF1	18.7	21.7	24.3	26.2	27.6	28.1		
OF2	18.8	21.9	24.5	26.5	27.9	28.5		
OF3	18.9	22.1	24.8	26.9	28.1	28.8		
OF4	19.0	22.5	25.1	27.2	28.5	29.1		
OF1		21.7	24.3	26.2	27.6	27.9	28.01	
OF2		21.9	24.6	26.3	27.8	28.1	28.5	
OF3		22.0	24.9	26.7	28.1	28.9	29	
OF4		22.5	25.4	27.0	28.9	29.3	29.7	
OF1			24.3	26.2	27.6	27.9	28.17	28.4
OF2			24.5	26.7	28.1	28.3	28.4	28.9
OF3			24.9	26.9	28.5	28.6	28.8	29.3
OF4			25.1	26.9	28.6	28.9	30	30.4
Soil temperature in the second season 2015								
OF1	18.1	21.2	24	26	27.1	28		
OF2	18.2	21.3	24	26.2	27.4	28		
OF3	18.3	22	24.1	26.3	28	28.3		
OF4	18.8	22.3	25	26.2	28.1	28.9		
OF1		21.2	24.1	26	27.3	27.5	28	
OF2		21.3	24.2	26	27.5	28	28.2	
OF3		21.9	24.5	26.3	28	28.5	28.9	
OF4		22.1	25.3	26.8	28.6	29	29.6	
OF1			24	26	27	27.4	28	28.3
OF2			24.3	26.5	28.1	28.2	28.4	28.6
OF3			24.5	26.7	28.4	28.5	28.6	29
OF4			25	26.4	28.3	28.7	30.2	30.4

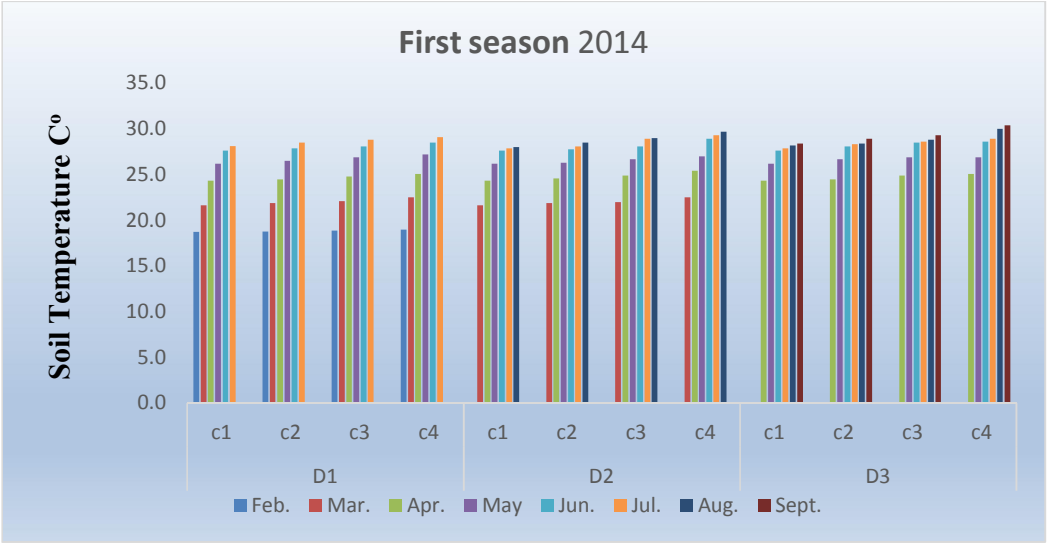

Fig. 1. The effect of different planting dates and different organic fertilizers on soil temperature during 2014

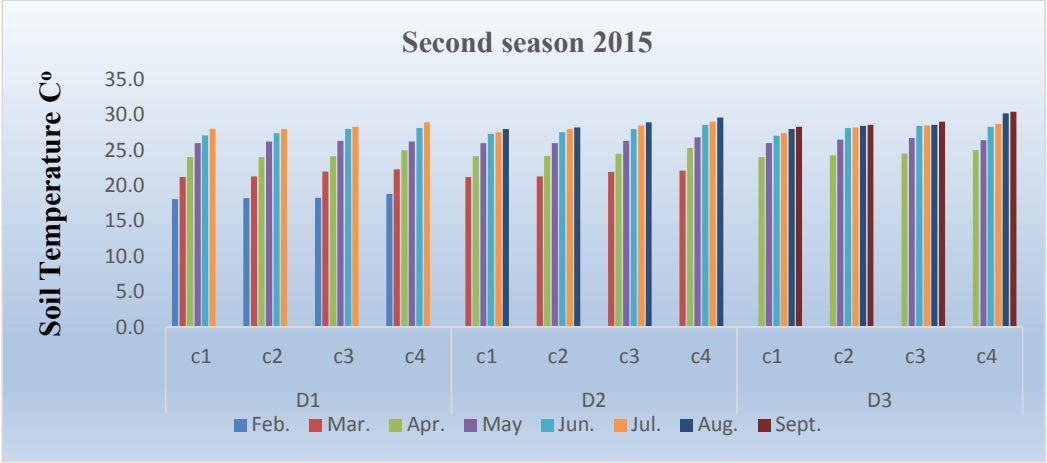

Fig. 2. The effect of different planting dates and different organic fertilizers on soil temperature during 2015

on February, 15th (D1) in both seasons (1414.9 and 1513.5, respectively). Results cleared that the amount of AHU or GDDs depends on average air temperatures in the agro-climatic region and we can control it by using different planting dates. These results are matched with those of Parthasarathi et al. [14].

3.3 Vegetative Growth

Results from Tables 4 and 5 revealed that planting dates and organic fertilizers significantly affected vegetative growth during the two growing seasons. The 15th of April showed the highest plant height, number of leaves, stem diameter, leaf area, total chlorophyll, fresh weight and dry weight in both seasons, compared with other planting dates with significantly differences between them.

Results also cleared that adding poultry manure, gave the highest vegetative growth with significant difference when compared with other manure treatments during the two growing seasons. The lowest vegetative growth was found with cattle manure (OF1) treatment. The plant dry weight under manure and compost treatments gave the lowest value.

Interaction between planting dates and organic fertilizers showed that, planting date of April the 15th with poultry manure gave the highest vegetative growth during the two growing seasons, with significant differences with other treatments. The lowest vegetative growth was found with planting date of February the 15th with cattle manure (OF1) treatment.

These results may be due to the effect of 15th April planting date on cultivated soil, which increased soil temperature. These results agreed with of Amzad et al. [15] and Moreno and Moreno, [16]. The effect of organic fertilizers, obtained data illustrated that using poultry manure gave the highest values of studied plant characteristics. On the contrary, using compost gave the lowest plant characteristics.

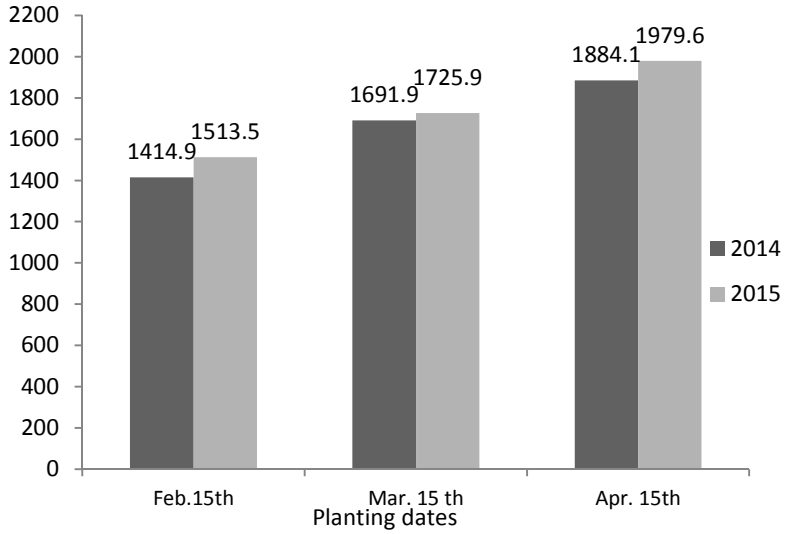

Fig. 3. Growing degree days (GDDs) for okra plants estimated in different planting dates during both growing seasons

Table 4. The effect of different planting dates and organic fertilizers on plant height, number of leaves and stem diameter of okra plant during both growing seasons

Plant height (cm)										
	First season (2014)					**Second season (2015)**				
	OF1	**OF2**	**OF3**	**OF4**	**Mean**	**OF1**	**OF2**	**OF3**	**OF4**	**Mean**
D1	95h	106f	113de	115d	107C	96h	108f	114d	116cd	109C
D2	101g	108f	119c	121bc	112B	101g	108f	119bc	122ab	113B
D3	106f	111e	122ab	125a	116A	108f	111ef	123a	125a	117A
Mean	100D	108C	118B	120A		102D	109C	118B	121A	
Number of leaves										
D1	28f	29ef	34cd	36bc	32b	29f	30ef	34d	37bc	33B
D2	28f	30def	34c	36bc	32b	39f	31ef	35cd	36cd	33B
D3	30def	32cde	39b	41a	36a	31ef	33de	40b	42a	36A
Mean	296D	30C	36B	38A		29D	31C	37B	39A	
Stem diameter										
D1	2.1c	2.2c	2.6b	2.7b	2.4B	2.1e	2.2de	2.6c	2.7b	2.4C
D2	2.1c	2.2c	2.6b	2.7b	2.4B	2.2de	2.3d	2.6c	2.7b	2.4B
D3	2.3c	2.6b	2.7b	2.9a	2.6A	2.3d	2.3c	2.7bc	3.0a	2.6A
Mean	2.2D	2.3C	2.6B	2.8A		2.2D	2.4C	2.6B	2.8A	

15th February= D1, 15th March =D2, 15th April =D3
Cattle manure= OF1, Compost= OF2, Rabbit= OF3, Poultry= OF4

Table 5. The effect of different planting dates and organic fertilizers on leaf area (cm^2), T. chlorophyll, fresh weight and dry weight of okra plant during both growing seasons

	Leaf area (cm^2)									
	First season (2014)					Second season (2015)				
	OF1	OF2	OF3	OF4	Mean	OF1	OF2	OF3	OF4	Mean
D1	28f	29ef	34cd	36bc	31.6B	41.6f	43f	45e	47de	44C
D2	28f	30def	34c	36bc	32.0B	47.5d	49d	49c	50c	49B
D3	30def	32cde	39b	41a	35.5A	50.4c	53c	55b	58a	54A
Mean	28.6D	30.4C	35.6B	37.6A		29.4D	31C	37B	39A	
	Total chlorophyll									
D1	23j	24l j	26hi	27gh	25C	23g	24fg	26fg	24fg	24C
D2	28g	31f	34e	37d	33B	29efg	31def	34de	37cd	33B
D3	38d	42c	46b	49a	44A	38cd	43bc	46ab	50a	44A
Mean	30D	33C	35B	38A		30D	33C	35B	38A	
	Plant fresh weight (g)									
D1	337j	340i	342h	344g	341C	338k	341j	344i	347h	342C
D2	355f	361e	263e	429d	377B	358g	362f	364ef	366e	363B
D3	429d	434c	453b	462a	445A	431d	436c	455b	464a	446A
Mean	374D	378C	386B	412A		376D	380C	388.B	393A	
	Plant dry weight (g)									
D1	41f	42ef	43ef	44de	42C	41e	43e	44de	44de	43C
D2	46cd	37g	46c	54a	47B	46cd	38f	49bc	55a	47B
D3	43ef	51b	53ab	54a	50A	43e	51ab	53a	55a	50A
Mean	43C	43C	48B	51A		43C	44C	49B	51A	

15^{th} February= D1, 15^{th} March =D2, 15^{th} April =D3
Cattle manure= OF1, Compost = OF2, Rabbit = OF3, Poultry =OF4

The results obtained were in agreement with the findings of Sanwal et al. [17] Altieri and Esposito, [18] with turmeric (Curcuma longa), Premsekhar and Rajashree [19] with okra (*A. esculentus*) in which they reported that higher yield response of crops due to organic manure application could be attributed to improved physical and biological properties of the soil resulting in better supply of nutrients to the plants.

3.4 Mineral Contents

Obtained results (Table 6) revealed that planted dates and organic fertilizers significantly affected mineral contents during the two growing seasons.

Concerning the affected of planting dates, the 15^{th} April (D3) showed the highest value in both seasons compared with other sowing dates with significantly differences between them. The production of okra in of-season may meet up the market demand during the lean period of vegetable supply and can improve the nutritional status was reported by Amzad et al. [15].

Regarding organic fertilizers treatment, results cleared that using poultry manure gave the highest value with significant differences with other treatments during the two growing seasons. While, the lowest value was found at cattle manure treatment. Poultry manure gave the advantage of enhancing soil chemical and physical properties which encouraged plant growth. These results are in agreement with those of Altieri and Esposito [18].

Interaction between planted dates and organic fertilizers data showed that sowing date April 15^{th} with poultry manure gave the highest value during the two growing seasons with significant differences with other treatments. The lowest growth value was found on February15^{th} with cattle manure treatment.

These results due to the effect of April 15^{th} sowing on cultivated soil which increased soil temperature content. These results agreed with Amzad et al. [15], Moreno and Moreno [16]. Concerning the effect of organic fertilizers, obtained data illustrated that poultry manure gave the highest values of studied characteristics. The lowest values were obtained using (OF1). The results obtained were in agreement with the findings of Sanwal et al. [17], Altieri and Esposito, [18] and Premsekhar and

Rajashree [19] with okra (*A. esculentus*), All reported that higher yield response of crops due to organic manure application could be attributed to improved physical and biological properties of the soil resulting in better supply of nutrients to the plants.

Data in Table 6 stated the interaction between planting dates and organic fertilizers on okra mineral contents. The best results obtained by combined April 15th planting date with the poultry manure. Obtained were in agreement with Louisa and Taguiling [20] and Amzad et al. [15].

3.5 Yield

Data displayed in Table 7 show that planting date significantly affects fruit yield of okra. The highest total yield was found with April (D3). These results are supported by the data of Fig. 1, the soil temperature tended to be higher in April around the root zone area. This increased the ability of plant uptake of available water and nutrients which ultimately accelerated the rate of vegetative growth and led to the increase of fruit yield. The results obtained were in agreement with the findings of Dilruba et al. [21]. They said that the plants gave the maximum fruit yield (1332.76 g) when it was planted on the 6th of April. It was followed by 21st of April (1036.05 g). The lowest fruit yield per plant was obtained at the 22nd of March planting date.

Fruit yields were influenced by different organic fertilizers, during both studied seasons. The highest fruit yield was found with poultry manure (OF4), while the lowest fruits yield was obtained with cattle manure (OF1), in both growing seasons. This result is due to that poultry manure has an advantage over other fertilizers, which enhanced soil chemical and physical properties and led to encouraging plant growth. These results are in agreement with Tiamiyu, et al. [10]. The results obtained revealed that okra responded well to the application of poultry manure, compared to other sources of organic manures and control treatment, in the study. Based on the finding of this study, it may be recommended that applying cow manure was adequate for maximum growth parameters studies and sheep manure may be applied in the absence of poultry manure for greater fresh pod weight of okra production.

The interaction effect of planting dates and organic fertilizers, on fruit yield of okra, was shown in Table 7. The best results were obtained by combined April (D3) with the poultry manure (OF4) in both seasons. These results are in agreement with Dilruba et al. [21] and Tiamiyu, et al. [10].

Table 6. The effect of different planting dates and organic fertilizers on N, P and K contents on okra during both growing seasons

	Nitrogen content (%)									
	First season (2014)					Second season (2015)				
	OF1	OF2	OF3	OF4	Mean	OF1	OF2	OF3	OF4	Mean
D1	3.67d	4.07d	3.67d	4.07d	3.87C	3.90e	4.13de	3.90e	4.06e	3.99C
D2	4.13d	4.77c	4.79c	5.30b	4.75B	4.50cd	4.63c	5.10b	5.30b	4.88B
D3	5.92a	5.93a	6.03a	6.23a	6.03A	6.27a	6.23a	6.00a	6.30a	6.20A
Mean	4.57C	4.83B	4.92B	5.20A		4.89B	4.99B	5.00B	5.21A	
	Phosphorus content (%)									
D1	0.44g	0.53f	0.63de	0.69cd	0.57b	0.45g	0.50fg	0.54e	0.57ef	0.58B
D2	0.48d	0.55ef	0.66d	0.69cd	0.59b	0.65de	0.67d	0.70cd	0.72cd	0.61B
D3	0.72cd	0.79bc	0.83b	1.13a	0.87a	0.74cd	0.81bc	0.86b	1.23a	0.91A
Mean	0.558D	0.62C	0.71B	0.84A		0.56D	0.64C	0.72B	0.88A	
	Potassium content (%)									
D1	2.93g	3.70fc	4.47f	5.17ef	4.07B	3.07g	3.90fg	4.63f	5.33ef	4.23C
D2	3.75de	4.37d	4.81cd	4.53cd	4.37B	3.87de	4.63d	5.17cd	4.90cd	4.64B
D3	4.55cd	4.70bc	4.89b	5.17a	4.83A	4.70cd	4.93bc	5.20b	5.53a	5.09A
Mean	3.74D	4.26C	4.72B	4.96A		3.88D	4.49C	5.00B	5.26A	

15th February= D1, 15th March =D2, 15th April =D3
Cattle manure= OF1, Compost = OF2, Rabbit = OF3, Poultry =OF4

Table 7. The effect of different planting dates and organic fertilizers, and their interaction, on fruit yield of okra during both growing seasons

	Total yield (ton/ Feddan)				
	First season (2014)				
	OF1	**OF2**	**OF3**	**OF4**	**Mean(B)**
D1	1.69h	1.75h	1.87g	1.98g	1.82C
D2	2.17f	2.42e	2.65d	2.89c	2.53B
D3	2.45c	2.7b	2.8a	3.1a	3.23A
Mean (A)	2.29D	2.45C	2.62B	2.76A	
	Second season (2015)				
D1	1.73g	1.75fg	1.89f	2.1e	1.87C
D2	2.2e	2.53d	2.7c	3.1b	2.65B
D3	2.5b	2.85b	2.95a	3.2a	3.31A
Mean(A)	2.35D	2.51C	2.69B	2.89A	

15^{th} February= D1, 15^{th} March =D2, 15^{th} April =D3
Cattle manure=OF1, Compost = OF2, Rabbit = OF3, Poultry =OF4

3.6 Economic Analysis

The major objective of any producer (farmer) is to get the maximum total revenue, which is basically depending upon yield level, price of the product and the expenditure incurred. While producer have little control over prices, they may certainly increase production and cut-down costs through proper utilization of available resources and planning.

3.6.1 Total costs of production

Data presented in Table 8 showed the total cost of production of okra under different planting dates and different rates of organic fertilizers. The result showed that the application of poultry manure was the highest total production cost (LE 6650), followed by rabbit manure (LE 5900), while the lowest was LE 5200 for the cattle manure.

3.6.2 Total return

Table 9 covers a broader scenario of analysis of returns at various yields and prices for the first season. Prices varied during the harvesting season. Early season farm gate prices for the 15^{th} of February (D1) planting date began at over LE 13 per kg, so the value of total production during first harvesting month is very high, represented a (43%, 43%, 44% and 45% of the total value during harvesting season in OF1, OF2, OF3 and OF4 respectively). The farm gate prices decline to less than LE 2.00 per kg later during the end of harvest season. While, early season prices for 15^{th} of March (D2) and 15^{th} of April (D3) planting dates begin at over LE 6 per kg and then decline to less than LE 2.00 per kg later in the season.

Table 8. Total production costs of okra under different planting dates and different rates of organic fertilizer (per feddan)

Items	**Cattle manure (OF1)**	**Compost (OF2)**	**Rabbit manure (OF3)**	**Poultry manure (OF4)**
Land preparation (LE)	400	400	400	400
Manure (LE)	1000	1200	1500	2000
Mineral fertilizers (LE)	1100	1100	1100	1100
Seeds (LE)	300	300	300	300
Irrigation (LE)	400	400	400	400
Herbicides (LE)	300	200	200	250
Insecticide (LE)	150	150	150	150
Harvesting (LE)	1500	1700	1800	2000
Others (LE)	50	50	50	50
Total (LE)	**5200**	**5500**	**5900**	**6650**

Table 9. Production, prices and values for different treatments of okra in the first season (per feddan)

	D1				D2				D3			
	Months	**Quantity (Kg)**	**Price LE**	**Value LE**	**Months**	**Quantity (Kg)**	**Price LE**	**Value LE**	**Months**	**Quantity (Kg)**	**Price LE**	**Value LE**
OF1	1	320	13	4160	1	650	6	3900	1	650	6	3900
	2	420	6	2520	2	850	4	3400	2	900	4	3600
	3	570	4	2280	3	670	2	1340	3	990	2	1980
	4	380	2	760	-	-	-	-	-	-	-	-
Total		**1690**		**9720**		**2170**		**8640**		**2450**		**9480**
OF2	1	340	13	4420	1	737	6	4422	1	670	6	4020
	2	440	6	2640	2	887	4	3548	2	830	4	3320
	3	580	4	2320	3	796	2	1592	3	1200	2	2400
	4	390	2	780	-	-	-	-	-	-	-	-
Total		**1750**		**10160**		**2420**		**9562**		**2700**		**9740**
OF3	1	370	13	4810	1	760	6	4560	1	700	6	4200
	2	468	6	2808	2	990	4	3960	2	850	4	3400
	3	610	4	2440	3	900	2	1800	3	1250	2	2500
	4	422	2	844	-	-	-	-	-	-	-	-
Total		**1870**		**10902**		**2650**		**10320**		**2800**		**10100**
OF4	1	400	13	5200	1	800	6	4800	1	750	6	4500
	2	500	6	3000	2	1100	4	4400	2	900	4	3600
	3	650	4	2600	3	990	2	1980	3	1450	2	2900
	4	430	2	860	-	-	-	-	-	-	-	-
Total		**1980**		**11660**		**2890**		**11180**		**3100**		**11000**

15^{th} February= D1, 15^{th} March =D2, 15^{th} April =D3

Cattle manure=OF1, Compost = OF2, Rabbit = OF3, Poultry =OF4

Table 10. Production, prices and values for different treatments of okra in the second season (per feddan)

	D1				D2				D3			
	Months	**Quantity (Kg)**	**Price LE**	**Value LE**	**Months**	**Quantity (Kg)**	**Price LE**	**Value LE**	**Months**	**Quantity (Kg)**	**Price LE**	**Value LE**
OF1	1	370	14	5180	1	660	6	3960	1	750	6	4500
	2	450	6	2700	2	860	3	2580	2	970	3	2910
	3	600	3	1800	3	680	2	1360	3	780	2	1560
	4	310	2	620	-	-	-	-	-	-	-	-
Total		**1730**		**10300**		**2200**		**7900**		**2500**		**8970**
OF2	1	400	14	5600	1	690	6	4140	1	820	6	4920
	2	460	6	2760	2	970	3	2910	2	1090	3	3270
	3	560	3	1680	3	870	2	1740	3	940	2	1880
	4	330	2	660	-	-	-	-	-	-	-	-
Total		**1750**		**10700**		**2530**		**8790**		**2850**		**10070**
OF3	1	410	14	5740	1	720	6	4320	1	850	6	5100
	2	470	6	2820	2	1080	3	3240	2	1140	3	3420
	3	560	3	1680	3	900	2	1800	3	970	2	1940
	4	450	2	900	-	-	-	-	-	-	-	-
Total		**1890**		**11140**		**2700**		**9360**		**2960**		**10460**
OF4	1	450	14	6300	1	820	6	4920	1	900	6	5400
	2	500	6	3000	2	1280	3	3840	2	1240	3	3720
	3	680	3	2040	3	1000	2	2000	3	1070	2	2140
	4	470	2	940	-	-	-	-	-	-	-	-
Total		**2100**		**12280**		**3100**		**10760**		**3210**		**11260**

15^{th} February= D1, 15^{th} March =D2, 15^{th} April =D3

Cattle manure=OF1, Compost = OF2, Rabbit = OF3, Poultry =OF4

Table 11. Total production costs, total revenue, gross margin and benefit cost ratio for different treatments of okra in both seasons (per feddan)

	First season											
	D1				D2				D3			
	Production costs LE	Total revenue LE	Gross margin LE	BCR	Production costs LE	Total revenue LE	Gross margin LE	BCR	Production costs LE	Total revenue LE	Gross margin LE	BCR
OF1	5200	9720	4520	**1.86**	5200	8640	3440	1.66	5200	9480	4280	1.82
OF2	5500	10160	4660	1.84	5500	9562	4062	1.73	5500	9740	4240	1.77
OF3	5900	10902	5002	1.84	5900	10320	4420	1.75	5900	10100	4200	1.71
OF4	6650	11660	5010	1.75	6650	11180	4530	1.68	6650	11000	4350	1.65
	Second season											
	D1				D2				D3			
	Production costs LE	Total revenue LE	Gross margin LE	BCR	Production costs LE	Total revenue LE	Gross margin LE	BCR	Production costs LE	Total revenue LE	Gross margin LE	BCR
OF1	5200	10300	5100	**1.98**	5200	7900	2700	1.52	5200	8970	3770	1.72
OF2	5500	10700	5200	1.94	5500	8790	3290	1.59	5500	10070	4570	1.83
OF3	5900	11140	5240	1.89	5900	9360	3460	1.58	5900	10460	4560	1.77
OF4	6650	12280	5630	1.84	6650	10760	4110	1.62	6650	11260	4610	1.69

15^{th} February= D1, 15^{th} March =D2, 15^{th} April =D3

Cattle manure=OF1, Compost = OF2, Rabbit = OF3, Poultry =OF4

Table 10 covers a broader scenario of analysis of returns at various yields and prices for the second season. Early season farm gate prices for the 15th of February (D1) planting date began at over LE 14 per kg, so the value of total production during first harvesting month is very high, represented a (50%, 52%, 51.5% and 51.3% of the total value during harvesting season in OF1, OF2, OF3 and OF4 respectively). The farm gate prices decline to less than LE 2.00 per kg later during the end of harvest season. While, early season prices for 15th of March (D2) and 15th of April (D3) planting dates begin at over LE 6 per kg and then decline to less than LE 2.00 per kg later in the season.

3.6.3 Gross margin

Regard to economic performance, the results of Table 11 indicated that the maximum gross margin in the first season was (LE 5010) and in the second season was (LE 5630) were obtained from using the poultry manure (OF4) in the 15th of February (D1) planting date.

3.6.4 Benefit cost analysis

The value for the benefit cost ratio must be one, if the value is greater than one, then it is making profit and if less than one, then the business is running at a loss. From the Table 11, it can be showed that all the treatments were profitable.

Among the different treatments, the highest BCR in the first season was recorded 1.86 in cattle manure (OF1) in the 15th of February (D1) planting date; meanwhile, the lowest BCR in the first season was recorded 1.65 poultry manure (OF4) in the 15th April (D3) planting date (Table 11). In the second season the highest BCR among the different treatments was recorded 1.98 in cattle manure (OF1) in the 15th of February (D1) planting date; meanwhile, the lowest BCR in the first season was recorded 1.52 cattle manure (OF1) in the 15th March (D2) planting date (Table 11).

4. CONCLUSION

The application of cattle manure, compost, rabbit manure and poultry manure and three Planting dates (February 15th, March 15th, and April 15th had a significant effect on plant height, number of leaves per plant and fresh pod weight of okra *Abelmoschus esculentus* (L.) grown during 2014 and 2015. The results obtained revealed that okra responded well to the application of poultry manure and April 15th, compared to other sources of organic fertilizers and other planting dates in the study. Based on the finding of this study, it pays better to apply poultry manure for maximum growth parameters studied for greater fresh pod weight of okra production. On the other hand, planting date of April is enhancing vegetable production, especially during cold temperatures in the winter season by enhancing the soil environment through the rising of soil temperature and save available water. Likewise, it is important for farmers to know the costs and returns of the crops they grow are very relevant in order for them to fully evaluate the viability for specific crops and estimate potential profits. The economic assessment showed that the poultry manure (OF4) in the 15th of February (D1) planting date is the most profitable but not cost-effective rate of producing okra. According to the benefit cost ratio indicators cattle manure (OF1) in the 15th of February (D1) is the most efficient method in both season with 1.86 and 1.98 respectively.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Eke KA, Essiens BA, Ogbu JU. Determination of optimum planting time of okra in the derived savannah. Proc. of the 42nd Conf. of ASN at Abakaliki. 2008;242-245.
2. FAO. FAOSTAT database collections. Food and Agriculture Organization of the United Nations; 2014. Available:http://faostat.fao.org
3. Ministry of Agriculture and Land Reclamation, Economic Affairs Sector; 2015.
4. Abd El-Kader AA, Shaaban SM, Abd El-Fattah MS. Effect of irrigation levels and organic compost on okra plants (*Abelmoschus esculentus l.)* grown in sandy calcareous soil. Agric. Biol. J. N. Am. 2010;1(3):225-231.

5. Chattopadhyay, Dutta S, Chatterjee S. Seed yield and quality of okra as influenced by sowing dates. African Journal of Biotechnology. 2011;10(28): 5461-5467.
6. Fiorentino N, Fagnano M. Soil fertilization with composted solid waste: Short term effects on lettuce production and mineral N availability. Geophysical Research Abstracts. 2011;13:10520.
7. Suge JK, Omunyin ME, Omami EN. Effect of organic and inorganic sources of fertilizer on growth, yield and fruit quality of eggplant (*Solanum melongena* L). Scholars Research Library Archives of Applied Science Research. 2011;3(6):470-479.
Available:www.scholarsresearchlibrary.com
8. Anon J. Fertilizer value of some manure. Countryside & Small Stock. 1998;7:9-10.
9. Tiamiyu RA, Ahmed HG, Muhammad AS. Effect of sources of organic manure on growth and yields of okra (*Abelmoschus esculentus* L.) in Sokoto, Nigeria. Nigerian Journal of Basic and Applied Science. 2012;20(3):213-216.
10. Ministry of Agriculture and Land Reclamation. Symptoms of nutrient deficiency on some field and horticultural crops. Soil Water and Environment Research Institute, Agricultural Research Center- Egypt; 2013.
11. Association of Official Analytical Chemists. Official methods of analysis, 16th Ed. AOAC, Arlington Virginia, USA; 1995.
12. SAS. Statistical analysis system. SAS User's Guide: Statistics, SAS Institute Inc., Cary, USA; 2000.
13. Gittinger JP. Economic analysis of agricultural projects. Washington: The Johns Greene, W. Econometric Analysis, Upper Saddle River, NJ: Prentice Hall; 2003.
14. Parthasarathi T, Velu G, Jeyakumar P. Impact of crop heat units on growth and developmental physiology of future crop production: A review. Journal of Crop Science and Technology. 2013;2(1):2319–3395.
15. Amzad M, Anzum MA, Sajid H. Effect of different sowing dates and various doses of fertilizers of juvenility and productivity of okra. Pakistan J. Agril. Sci. 2001;38(1 & 2): 29-32.
16. Moreno MM, Moreno A. Effect of different biodegradable and polyethylene mulches on soil properties and production in a tomato crop. Scientia Horticulturae. 2008;116:256-263.
17. Sanwal SK, Lakminaragana K, Yadav RK, Yadav DS, Mousumi B. Effect of organic manures on soil fertility, growth, physiology, yield and quality of turmeric. Indian Journal of Horticulture. 2007;64(4): 444-449.
18. Altieri R, Esposito A. Evaluation of the fertilizing effect of olive mill waste compost in short-term crops. Int. Biodeter. Biodeg. 2010;64(2):124-128.
19. Premsekhar M, Rajashree V. Influence of organic manures on growth, yield and quality of okra. American Eurasian Journal of Sustainable Agriculture. 2009;3(1):6-8.
20. Louisa MA, Taguiling G. Quality improvement of organic compost using green biomass. European Scientific Journal. 2013;9(36):319-341.
21. Dilruba S, Mirza H, Karim R, Kamrun N. Yield response of okra to different sowing time and application of growth hormones. Journal of Horticultural Science & Ornamental Plants. 2009;1(1):10-14.

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