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The Impact of Bio, Organic and N, P, K Fertilizers on The Growth and Yield of Sesame

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ABSTRACT

Bio and organic fertilization are essential for plant growth and optimum performance. This study has been carried out at the Faculty of Environmental Agricultural Science (FEAS) - Arish University (AU) during the two successive growing seasons 2020/2021. This investigation aimed to assess the response of Sesame (Giza32 cv.) vegetation growth and yield production for tow organic fertilization sources as follows (chicken manure, farmyard manure), furthermore, to evaluate the effect of NPK and bio fertilizer as follows (control, NPK, EM_1). Effective microorganisms), and TS (Technology of smart fertilizer)) as well as their interaction. The obtained results showed that the highest values of leaves number, stem diameter and leaf area were obtained both seasons when Sesame were fertilized with chicken manure and EM1 bio- fertilizer, while the highest values of plant height were obtained when sesame plants were fertilized with chicken manure and TS bio- fertilizer. Concerning to yield component, the highest values of capsules number, seeds number, 1000seeds weight and yield were obtained in both seasons when Sesame were fertilized with chicken manure and TS bio- fertilizer.

Keywords: Sesame, chicken manure, organic fertilization, bio-fertilization, yield components.

Introduction

Sesame (*Sesamum indicum L.*) belongs to Pedaliaceae family. It contains high levels of protein (20-25%), carbohydrates (15%) and minerals (7-5%). Moreover, it is rich in calcium, phosphorus, iron, and essential vitamins like thiamin, riboflavin, and niacin. **(Rizk and Ali, 1982)**. It's whole seed is used on breads and snacks, fried and consumed with sugar, not dried or ground and used to make soup. Furthermore, it's leaves are used to make vegetable soup **(Onwueme and Sinha 1991)**. It's oil is a high quality oil that is frequently called the "queen" of vegetable oils, This is due to its stability, high conservation quality and resistance to rancid. It's oil is used in the manufacture of paints, soaps, cosmetics, fragrances, insecticides, canned sardines and canned beef, as well as in pharmaceutical and ethanol botany applications **(FAO, 2002 & RMRDC, 2004)**.

For bio-fertilizer (microbial inoculants) and organic amendments are consider low-cost sources of nutrients that could replace chemical fertilizers and increase crop production in low-input agriculture. By adding organic amendments, soil organic carbon is increased, and microbial activity is stimulated, supplying N and P to the soil. On the other side, soil microorganisms are essential to their capacity to supply and recycle nutrients for plant growth **(Weil and Magdoff, 2004).** In addition to reflecting soil environmental conditions, their population and activities may also reflect soil quality. **(Leaungvutiviroj et al., 2010).** They engage in symbiotic or free-living interactions with plant roots that increase plant nutrient uptake, boost crop production, and enhance soil quality**. (Okon and Itzisohn, 1995; Shah et al., 1992 &Wu et al., 2005).**

It is common knowledge that organic manure improved the soil's structure, which in turn encouraged healthy plant growth. Furthermore, the organic manure's slowly released nutrients enable the plants to use it to their advantage. According to **Yolcu et al. (2010),** manure increases the yield and quality of crops and enhances the chemical, physical, and biological characteristics of soils, all of which contribute to better plant growth. **(Filip and Muller, 1984; Kadhim ,1986; and Borin et al.,1987)** also provided examples of such findings. **(Haruna and Abimiku, 2012 & Hassaan and Bughdady, 2018)** found that both yield and yield attributes of sesame were significantly increased by organic fertilization.

On the other hand, as a substitute for various chemical fertilizers to improve soil fertility for sustainable agricultural production, biofertilizers have been proposed **(Wu et al., 2005)**. A wide range of Rhizosphere soil bacteria that could enhance the growth of the majority of medicinal plants have been discovered in recent years. Some of these beneficial bacterial species include those from the genera Azotobacter, *Azospirillum, Bacillus*, and Pseudomonas **(Tilak et al., 2005).** Sesame yield significantly affected by Bio fertilization **(Boghdady et al., 2012 & Abdel-Rahman,2014)**. A significant effect of biofertilizer on sesame growth and yield was found by **(Ghosh ,2000 and Asl, 2017).**

This study and trial sought to examine whether organic and bio-fertilizers could replace chemical fertilizers to improve the quality and productivity of sesame.

Materials and Methods

This study was carried out at the Faculty of Environmental Agricultural Sciences, Arish University in the Experimental Farm during 2020/2021. It included 8 treatments which resemble the interaction between two organic fertilizers (chicken manure, farmyard manure), which were at 10 m^3 fed^{-1} (This is based on bulletin of the Egyptian Ministry of Agriculture's recommendations) and NPK as well as bio fertilizers as follows (Control, NPK 15:15:15, TS (Technology of smart fertilizer) bio- fertilizer, and EM_1 ((Effective microorganisms (bio-fertilizer)). Plant received all the proper agricultural procedures for sesame (Giza32 cv.) production according to the estimated recommendations. Treatments

were distributed in Randomized complete block design in a split plot system. The main plot size was 76 m^2, while the subplot size was19 m^2. Main plots were devoted to tow organic fertilizers (Chicken manure and Farmyard manure) and NPK as well as bio fertilizer (Control, NPK, TS and EM_1) were distributed in sub-plots. The sowing distances were 60 cm between rows and 25 cm within each row. Seeds were sown on 15th April in both seasons. After one-month plants were thinned to 4 plants per hill then they singled to one plant after 45 days from planting. Organic fertilizers at the rate of 10 m^3/fed^{-1}were added during land preparation. NPK(15:15:15 at a rate of 50 kg/fed.) and EM_1as well as TS (5 ml/m^2) were added at a rate of (5 ml/m^2) in two equal portions (This is based on the manufacturer's recommendations: EM_1 solution injected through the drip irrigation system in the sandy lands), the first portion after the second thinning , while , the second was added at the beginning `of the emergence of floral siliqua at the studied rates. Soil mechanical and chemical analysis are shown in **Table 1 and 2**.

Organic manure analysis

Table 3 show the total nitrogen, organic carbon and available phosphorus were determined according to **American Public Health Association ,1995.**

Table (1): Soil mechanical analysis (Average of the two seasons).

Soil Depth (cm)	Coarse sand (%)	Fine Sand (%)	Silt (%)	Clay (%)	Soil Texture
0 - 30	66.1	19.9	2.8	11.2	Sandy loam

Table (2): Soil chemical analysis (Average of the two seasons).

Soil Depth (cm)	Organic carbon (g kg^{-1})	pH	EC (dS m^{-1})	$CaCO_3$ (%)	Organic matter (g kg^{-1})
0 - 30	1.08	8.519	1.7	3.90	2.07
Soluble Cations (meq L^{-1})				Soluble Anions (meq L^{-1})	
K^+	Na^+	Mg^{++}	Ca^{++}	Cl^-	HCO_3^-
0.47	2.62	2.17	2.5	1.276	2.404

Table (3): Chemical analyses of the used organic manure.

Organic Parameters	**(FYM)**	(CM)	(FYM)	**(CM)**
	2020		**2021**	
Total nitrogen (g kg^{-1})	35.7	44.3	38.6	50.22
Total phosphor (g kg^{-1})	0.45	0.50	0.44	0.53
Total potassium (g kg^{-1})	21.5	27.8	22.13	29.99
Organic carbon (g kg^{-1})	440	520	452	529
Organic matter (g kg^{-1})	751	864	768	899
C/N Ratio	14	15.6	15	15.9

Table (4): Biofertilization composition

Component	EM_1	TS
Photosynthetic bacteria	*Rhodopseudomonas plustris,Rhodobacter sphacerodes*	*Bacillus circulance*
Lactic acid bacteria	*Lactobacillus plantarum, L.casei, Streptococcus lactis*	*Bacillus Polmyxa* *Bacillus megatherium*
Yeast	*Saccharamyces cereresiae*	
Fungi	*Apergillus, Penicilium*	

Data Recorded

Yield component

The harvesting was done on 25th July in both seasons. Six plants were pulled up from each sub plot unit and the following characters were recorded: leaves number, plant height (cm), stem diameter (cm), leaf area (cm^2), capsules number, seeds number/capsule, 1000seeds weight (g) and yield (kg/fed.).

Statistical analysis

Data of two seasons for experiment was subjected to proper statistical analysis of variance **(Snedecor and Cochran,1990)** using M-STATC program. Mean values were compared at $P \leq 0.05$ using the multiple range test **(Duncan,1955).**

Results and Discussion

1. Effect of bio, organic and NPK fertilizations on sesame vegetative growth

As regard to effect of organic fertilizers, data in **Table 5** show significant effects on all studied traits; viz, leaves number/plant, plant height, stem diameter, leaf area in both seasons. The highest values of all traits were recorded with application of chicken manure, while the lowest values were recorded with control treatment. The increasing of Sesame growth by fertilizing with organic manure, it is due to improve the soil structure, which in turn encouraged healthy plant growth. Furthermore, it's slowly released nutrients allow plants to use it to their advantage. The additive effect of organic fertilizers refers to the slow or gradual release of nutrients by these substances. These results agree with the results obtained by **Okon and Itzisohn (1995), Shah et al., (1992), Wu et al., (2005) and Yolcu et al. (2010).**

Concerning the effect of bio and NPK fertilizations, data in Table 5 show significant effects for bio and NPK fertilizations on all studied traits in both seasons, the highest values of almost studied traits were recorded with EM1 followed by TS bio- fertilizer, while the lowest values were recorded with control treatment. However, the highest values of plant height were obtained with TS bio- fertilizer. Therefore, biofertilizers could be thought of as microbial inoculants that contain actively living soil microbe cells that are able to induce significant water and nutrient uptakes when inoculated to seeds, seedlings, or soils, enriching the soil with organic nutrients and providing enough soil moisture for improved crop performance **(Fagbola et al., 2001; Bhaskara et al., 2005; Ananthanaik et al., 2007& Abd El-Gawad, 2008)**. The majority of biofertilizer sources are bacteria, fungi, and cyanobacteria, particularly blue-green algae, which have been shown to have a number of additional advantages (aside from improving plant nutrition), including disease resistance and tolerance to unfavorable soil and climatic conditions **(Fagbola et al., 2001; Ananthanaik et al., 2007 & Boureima et al., 2007).** A few examples of helpful microsymbionts or biofertilizers include *Mycorrhiza spp.*, *Azospirillum spp*., *Azotobacter spp*., and *Rhizobium spp.* These organisms have been shown to increase the uptake of nutrients and water by numerous crops in both tropical and temperate climates. **(Fagbola et al., 1998; Ghosh & Mohiuddin, 2000; Vessey, 2004; Ananthanaik et al., 2007 & Neveen & Amany, 2008).** These results are in harmony with those obtained by each of **(Wu et al., 2005; Tilak et al., 2005; Haruna and Abimiku, 2012 & Hassaan & Bughdady, 2018).**

2. Effect of bio, organic and NPK fertilizations on sesame yield components

Data in **Table 6** clear significant effects for organic fertilizers, NPK and bio on all studied traits in both seasons.

Table (5): Effect of bio, organic and NPK fertilizations on sesame vegetative growth during two successive growing seasons 2020 and 2021:

Parameters / Fertilization	leaves number	Plant height (cm)	Stem diameter (cm)	Leaf area (cm^2)
First season 2020				
FYM	118.16^{b}	60.00^{b}	0.65^{b}	35.67^{b}
CHM	152.66^{a}	74.91^{a}	0.79^{a}	99.36^{a}
Control	89.8 ^{d}	49.8 ^{d}	0.550^{d}	34.68^{c}
Em_1	177^{a}	70.6^{b}	0.933^{a}	96.93^{a}
Ts	152.6^{b}	86.3 ^{a}	0.767^{b}	77.66^{b}
NPK	122.1^{c}	63.0^{c}	0.650 ^{c}	60.80^{b}
2021 *Second season*				
FYM	120.16^{b}	66.33^{b}	0.892^{b}	41.09^{b}
CHM	155.83^{a}	80.75^{a}	0.992^{a}	106.11^{a}
Control	92.6^{d}	56.83^{d}	0.783^{b}	38.60^{d}
Em_1	180.1^{a}	76.33^{b}	1.100^{a}	104.17^{a}
Ts	154.8^{b}	92.00^{a}	1.017^{a}	85.23^{b}
NPK	124.3^{c}	69.00^{c}	0.867^{b}	66.40^{c}

FYM=Farmyard manure, CHM=Chicken manure, EM_1=type of biofertilizer, TS= type of biofertilizer

As regard to effect of organic fertilizers, the highest values of all yield component traits were recorded CHM, followed by FYM were applied in both seasons. According to **Yolcu et al., (2010)**, manure increases the yield and quality of crops and enhances the chemical, physical, and biological characteristics of soils, all of which lead to better plant growth. The same results were obtained by **(Filip & Muller,1984; Kadhim, 1986; Borin et al. 1987; Haruna & Abimiku, 2012 and Hassaan & Bughdady, 2018).**

Table (6): Effect of bio, organic and NPK fertilizations on sesame yield components during two successive growing seasons 2020 and 2021:

Parameters / Fertilization	**Capsule number**	**Seed number capsule^{-1}**	**1000 Seed weight (g)**	**Yield/fed (kg)**
***First season* 2020**				
FYM	55.49^{b}	27.75^{b}	3.72^{b}	168.11^{b}
CHM	68.08^{a}	31.75^{a}	3.89^{a}	248.04^{a}
Control	46.50^{d}	22.50^{d}	3.63^{c}	107.03^{d}
Em_1	68.17^{a}	31.83^{b}	3.83^{b}	235.45^{b}
Ts	76.17^{b}	36.83^{a}	4.06^{a}	323.75^{a}
NPK	57.17^{c}	27.83^{c}	3.70^{bc}	166.07^{c}
***Second season* 2021**				
FYM	62.66^{b}	35.66^{b}	4.04^{b}	260.48^{b}
CHM	75.50^{a}	39.08^{a}	4.22^{a}	365.23^{a}
Control	53.33^{d}	30.17^{d}	3.94^{c}	178.17^{d}
Em_1	75.00^{a}	40.00^{a}	4.14^{b}	351.46^{b}
Ts	84.00^{b}	44.50^{b}	4.44^{a}	470.75^{a}
NPK	64.00^{c}	34.83^{c}	4.00^{c}	251.04^{c}

FYM=Farmyard manure, CHM=Chicken manure, EM_1=type of biofertilizer, TS= type of biofertilizer

Concerning the effect of bio fertilization and NPK, the highest values of capsule number were obtained when sesame were fertilized EM1 in both seasons, while the highest values of 1000 seed weighted, and yield/fed were recorded when TS bio- fertilizer were applied in both seasons. Seed number/capsule which achieved the highest values by using EM1, when compared to the control. Every bacterial strain significantly mimicked the growth and yield parameters in the field, which was accompanied by an increase in auxin and protein content as well as peroxidase and acid phosphate activities (Shaukat et al., 2006). Furthermore, the bio fertilizer was increased yield by increased it supply and availability the nutrient to absorbed by root system, as well as nonhazardous and non-toxic products **(Basher et al, 2016).** These results agree with the results obtained by **Ghosh (2000), Boghdady et al., (2012), Abdel-Rahman, (2014), and Asl, (2017).**

2. Effect the interaction of bio, organic and NPK fertilization.

1.Vegetative growth

Data in **Tables 7 and 8** illustrate significant effects for bio, organic and NPK fertilization on all yield traits in both seasons. Concerning effects on vegetative growth **(Table 7)**, The application of chicken manure fertilizers with EM1 bio- fertilizer recorded the highest values of almost traits, viz, leaves number (199 and 203.33, in first season and second season, respectively), stem diameter (1.00,1.133 cm in first and second season, respectively) and leaf area (152.96, 162.15 cm2 in first and second season, respectively).As regard to effect on plant height **(Table 7**), the application of chicken manure fertilizer with TS fertilizer recorded the highest values (95.33 and 101.00 cm in first and second season, respectively).The superiority of EM_1 as a reason of its stimulating photosynthetic activity in plants, which increases the production of chlorophyll, proteins, and a **variety of** enzymes, most notably peroxidase activity. **(Winget and Gold, 2007).** This is a crucial element promoting the development and growth of plants. The ability of EM_1 to speed up the production of chlorophyll-green pigment, which is responsible for the processes of absorbing carbon dioxide, sunlight, other substances and enabling plant growth and development. The effect of EM_1 on plant root growth, followed by better nutrient fostering, may be the cause of the higher leaf area. This suggests increased photosynthesis and biomass production. A study by **(Yamada and Xu, 2000)** assert that EM_1 contains phytohormones or other biologically active compounds that prevent plants from going dormant and boost photosynthetic activity.

2. Yield components

As regard to effect on yield components **(Table 8),** the highest values of all yield components traits were obtained when sesame plants were fertilized with chicken manure and TS bio- fertilizer followed by chicken manure and EM1 bio- fertilizer in both seasons. The superiority of TS fertilizer for increasing yield components, because of it is prepared in the form of compound combinations of more than one, bacteria viz, Bacillus megaterium, *Bacillus polmyxa* a phosphate-dissolving bacteria, and *Bacillus circulance* as a potassium-dissolving, together, and testing their effectiveness in processing nutrients in the soil. One of the most effective live vaccines as the phosphate-dissolving bacteria and potassium- dissolving bacteria in the soil have a high ability to increase the ability of the plant to absorb phosphorus and potassium in order to increase the yield.

Table (7): Effect the interaction of organic, NPK and bio fertilization on vegetative growth of sesame plants in both growing seasons 2020and 2021

Parameters / Fertilization		leaves number	Plant height (cm)	Stem diameter (cm)	Leaf area (cm^2)
			***First season* 2020**		
FYM	**Control**	82.66^{g}	44.33^{f}	0.500^{e}	14.84^{e}
	Em_1	155.00^{c}	63.00^{d}	0.867^{b}	40.89^{cd}
	Ts	132.66^{e}	77.33^{b}	0.667^{c}	56.32^{c}
	NPK	102.33^{f}	55.33^{e}	0.600^{d}	30.63^{de}
CHM	**Control**	97.00^{f}	55.33^{e}	0.600^{d}	54.52^{c}
	Em_1	199.00^{a}	78.33^{b}	1.00^{a}	152.96^{a}
	Ts	172.66^{b}	95.33^{a}	0.867^{b}	99.01^{b}
	NPK	142.00^{d}	70.66^{c}	0.700^{c}	90.97^{b}
			***Second season* 2021**		
FYM	**Control**	86.33^{g}	52.66^{f}	0.733^{d}	18.36^{e}
	Em_1	157.00^{c}	68.66^{d}	1.133^{a}	46.20^{cd}
	Ts	134.66^{e}	83.00^{b}	0.900^{c}	65.14^{c}
	NPK	102.66^{f}	61.00^{e}	0.800^{cd}	34.65^{de}
CHM	**Control**	99.00^{f}	61.00^{e}	0.833^{cd}	58.83^{c}
	Em_1	103.33^{a}	84.00^{b}	1.067^{ab}	162.15^{a}
	Ts	175.00^{b}	101.00^{a}	1.133^{a}	105.32^{b}
	NPK	146.00^{d}	77.00^{c}	0.933^{bc}	98.15^{b}

FYM=Farmyard manure, CHM=Chicken manure, EM_1=type of biofertilizer, TS= type of biofertilizer

Table (8): Effect the interaction of organic, NPK and bio fertilization on yield components of sesame plants two successive growing seasons 2020and 2021

Parameters / Fertilization		Capsule number	Seed number capsule^{-1}	1000 Seed weight (g)	Yield/fed (kg)
			***First season* 2020**		
FYM	**Control**	41.67^{f}	21.66^{e}	3.610^{d}	91.20^{g}
	Em_1	61.00^{d}	29.66^{c}	3.743^{cd}	189.64^{d}
	Ts	67.67^{c}	34.66^{b}	3.863^{bc}	253.68^{c}
	NPK	53.33^{e}	25.00^{d}	3·693^{d}	137.92^{c}
CHM	**Control**	51.33^{e}	23.33^{de}	3.660^{d}	122.85^{f}
	Em_1	75.33^{b}	34.00^{b}	3.923^{b}	281.27^{b}
	Ts	84.67^{a}	39.00^{a}	4.267^{a}	393.82^{a}
	NPK	61.00^{d}	30.66^{c}	3.710^{d}	194.23^{d}
			***Second season* 2021**		
FYM	**Control**	48.00^{f}	29.00^{e}	3.92^{d}	152.77^{f}
	Em_1	67.66^{d}	37.66^{c}	4.06^{c}	290.01^{d}
	Ts	74.66^{c}	43.00^{b}	4.18^{b}	376.33^{c}
	NPK	60.33^{e}	33.00^{d}	3.99^{cd}	222.80^{e}
CHM	**Control**	58.66^{e}	31.33^{d}	3.96^{cd}	203.57^{e}
	Em_1	82.33^{b}	42.33^{b}	4.23^{b}	412.91^{b}
	Ts	93.33^{a}	46.00^{a}	4.70^{a}	565.17^{a}
	NPK	67.66^{d}	36.66^{c}	4.02^{cd}	279.28^{d}

FYM=Farmyard manure, CHM=Chicken manure, EM_1=type of biofertilizer, TS= type of biofertilizer

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تأثير الاسمدة العضوية والحيوية و NPK على نمو وانتاج السمسم

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الملخص

أجريت هذه الدراسة في كلية العلوم الزراعية البيئية، جامعة العريش، خلال موسمي الزراعة المتتاليين (2020–2021). تهدف هذه الدراسة إلى تقييم استجابة النمو الخضري ومكونات لمحصول السمسم لنوعين من التسميد العضوي (سبلة الكتكوت والسماد البلدي)، علاوة على تقييم تأثير NPK والاسمدة الحيوية على النمو الخضري ومكونات المحصول وهما على النحو التالي (المعاملة القياسية، السماد الحيوي TS، السماد الحيوي EM1، NPK) وتقييم تأثير التفاعل بينهما. حيث أظهرت النتائج المتحصل عليها أن أعلى قيم لعدد الأوراق وقطر الساق ومساحة الورقة في كلا الموسمين عندما تم تسميد السمسم بسبلة الكتكوت والسماد الحيوي EM_1 معا بينما تم الحصول على أعلى قيم ارتفاع النبات عند تسميد السمسم بسبلة الكتكوت والسماد الحيوي TS. أما فيما يتعلق بمكونات المحصول، تم الحصول على أعلى قيم لعدد الكبسولات/النبات، وعدد البذور/الكبسولة، ووزن الألف بذرة وكمية المحصول في كلا الموسمين عندما تم تسميد السمسم بسبلة الكتكوت والسماد الحيوي TS.

الكلمات الارشادية: سمسم، تسميد حيوي، تسميد عضوي، سبلة كتكوت، سماد بلدي، مكونات محصول