Response of Sesame Plants Productivity and Seed Quality to Different Fertilization Methods

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ABSTRACT: Two filed experiments were conducted at the Experimental Station Farm of Faculty of Agriculture (Saba Basha), Alexandria University during 2014 and 2015 seasons. The objective of this study was to investigate the response of sesame plants productivity and seed quality to different fertilization methods. The results could be summarized as follows: Foliar spraying of amino acid gave higher plant height, number of pods/plant, weight of pods (g), number of seeds/pods, 1000-seed weight (g), seed yield (g/plant), seed, straw and biological yields (ton/ha), as well as, oil yield (t/ha) in both seasons. Whereas, phosphorus fertilizer at 30 unit resulted in a significant increment in yield components and chemical composition of sesame seed in both seasons. Significant variation was recorded between the tested biofertilizer treatments for yield, yield components and percentages of oil, N, P and K of sesame seeds in both seasons. The effective treatments for all characters and chemical composition were obtained from foliar spraying of amino acid with phosphorein inoculation in both seasons. The effective treatments for oil percentage, phosphorus percentage and potassium percentage in both seasons were obtained from applying phosphorus at 30 units with phosphorein inoculation.

Keywords: Seasme, nitrogen, phosphorus, Biofertilizers, yield, Chemical composition.

INTRODUCTION

Sesame (*Sesamum indicum* L.), is as important oil seed crops grown in the tropics and subtropics, however, most of its cultivated area are grown in developing countries where usually grown by small holders. Sesame crop has an important advantage because it could be grown under fairly high temperature low supply and low levels of others inputs (Ghosh and Mohiuddin 2000 and El-Habbasha *et al.,* 2007).

In Egypt, sesame is consider as food crop rather than oil seed crop because most of its seeds production is used for snacks, confectionery bakery products, tehena and halawa purposes. The cultivated area of sesame in Egypt increased markedly during the last few years, while, the productivity was not increased by the same relative.

Nitrogen and phosphorus are essential nutrients required by the plants for their growth and vigor. Nitrogen is considered as an essential element of bio-molecules such as amino acids, proteins, nucleic acids, phytohormones and a number of enzymes and coenzymes. N strongly stimulates growth, expansion of the crop canopy and interception of solar radiation (Mengel and Kirkby, (2001). Similarly, phosphorus is an essential nutrient both as a part of several key plant structure compounds and as catalysis in the conversion of numerous key flower formation and seed production, more uniform and earlier crop maturity , improvements in crop quality and increased resistance to plant diseases (Bill, 2010 and Kashani *et al.,* 2015).

Recently, under Egyptian condition, a great attention is being devoted to reduce the high rates of mineral fertilizers, the cost of production and decrease environmental pollution via reducing doses of chemical fertilizer by using bio-forming systems (El-Habbasha *et al.,* 2007 and El-Nagdy *et al.,* 2010).

Using bio-fertilizers for non-legume crops (a symbiotic N-fixing bacteria, phosphate dissolving bacteria and bio-control) had a marked influence and had a positive effect on seed yield and recorded significant increases in all growth and yield tested parameter compared to uninoculation plants (Kumar *et al.,* 2009, Ziedan *et al.,* 2011 and Mahrous *et al.,* 2015). The aim of this study was to examine the effect of the different fertilization methods on the seed yield, its components and oil content of sesame crop.

MATERIALS AND METHODS

Two filed experiments were carried out at the Experimental Farm of the Faculty of Agricultural (Saba Basha), Alexandria University, during the two successive summer seasons of 2014 and 2015 seasons. Filed experiments were conducted to study the response of sesame plant productivity and seed quality to different fertilization methods (cv. shandawel 3).

Soil samples of the experimental sites were taken at the depth of (0-30 cm), physical and chemical analysis are presented in Table (1) were done according to Chapman and Pratt (1978). The split-split plot designs with three replicates were used. The main plot included three nitrogen application methods (soil application N, foliar spraying of amino acid and mixture soil + foliar), while, the phosphorus fertilizer (i.e. control, 15 and 30 kg P_2O_5/fed) was arranged in the sub plots. Bio-fertilizers (uninoculation, phosphorein and ceraline) were allocated to sub-sub plots.

The experimental unit area was 10.5m^2 (i.e. 1/400 feddan) consisting of five rows (3.5 m long and 60 cm between rows). Sesame seeds were sown on May 18th and 15th in the first and second season, respectively. The sesame seeds (Shandawel 3 cv.) was coated just before sowing with biofertilizers (phosphorein and ceraline), using arabic gum as an adhesive agent amounted 5kg/feddan. The preceding winter crop was wheat (*Triticum aestivum,* L.) and barssem (*Trifolium alexandrinum*, L.) in the first and second seasons, respectively. Sesame was manually harvested on September 22th and 24th in the first and second seasons, respectively.

Data recorded: At harvest, a random sample of 10 plants from the two central rows in each plot was taken to determine the studied characters

- Plant height (cm), Number of pods /plant, weight of pods / plant (g), Number of seeds/pods, 1000-seeds Weight (g), Seed yield /plant (g), Seed, straw and biological yield ton/ha and seed oil yield ton/ha. were estimated.
- Two random seed samples were drawn from each subplot to determine oil content using soxhlet apparatus and n-hexane (60°C) as an extraction solvent according to A.O.A.C. (1980) and seed content of N, P and K were determined according to A.O.A.C. (1980).

Data were subjected to statistical analysis of variance as described by Gomez and Gomez (1984). Mean value of the recorded data were compared by using the least significant differences (L.S.D. 5%).

Table (1). Some Physical and chemical properties of the experimental soil in 2014 and 2015 seasons

Soil properties	Season	
	2014	**2015**
A) Mechanical analysis :		
Clay %	38	37
Sand %	32	33
Silt %	30	30
Soil texture	Clay loam soil	
B) Chemical properties		
pH (1 : 1)	8.20	8.31
EC. (dS/m)	3.80	3.70
1) Soluble cations (1:2) (cmol/kg soil)		
K^+	1.52	1.54
Ca^{++}	9.40	8.70
Mg^{++}	18.3	18.5
Na^{++}	13.50	13.8
2) Soluble anions (1 : 2) (cmol/kg soil)		
$CO_3^{--} + HCO_3^-$	2.90	2.80
Cl^-	20.4	19.80
SO_4^{--}	12.50	12.60
Calcium carbonate (%)	6.50	7.00
Total nitrogen %	1.00	0.91
Available phosphate (mg/kg)	3.70	3.55
Organic matter (%)	1.41	1.40

RESULTS AND DISCUSSIONS

A. Yield and its components:

Results recorded in Tables (2 and 3) revealed that plant height (cm), number of pods /plant, weight of pods/ plant (g), number of seeds/pods, 1000-seeds Weight (g), Seed yield/ plant (g), Seed yield (t/ha), straw yield (t/ha), biological yield (t/ha) and oil yield (t/ha) in both seasons were significantly affected by application nitrogen.

The highest values of yield and its components were obtained by foliar spraying of amino acids and without significant between foliar spraying and mixture application soil+ foliar on number of seeds/pods, Seed yield (t/ha), straw, biological and oil yield (t/ha) in both seasons. This may be due to the provision of nutrients at latter stages which might have enhanced accumulation of assimilate of the seeds and thus resulting in hover seeds of sesame. Such findings is in agreements with those of El-Nkhlawy and Shaheen (2009), Shehu *et al.* (2010), Haruna (2011), Ulmar *et al.* (2012) and Kashani *et al.* (2015).

Data in Tables (2 and 3) revealed significant differences between the phosphorus fertilizer units in yield components i.e. plant height (cm), number of pods /plant, weight of pods / plant (g), number of seeds/pods, 1000-seeds weight (g), seed yield /plant (g), seed yield (t/ha), straw yield (t/ha), biological yield (t/ha), as well as, oil yield (t/ha) in both seasons.

Phosphorus application at 30 units significantly surpassed (zero, without phosphorus) in all characters under study. The positive effect of phosphorus fertilization on yield components of sesame might be attributed to the soil of the experimental site, which was very poor in its phosphorus content. Also, P plays important role in enhancing translocation of metabolites which might be the reason for the increases observed on yield component (Hafiz and El-Bramawy, 2012). These results are in harmony with those reported by Okpara *et al.* (2007), Shehu *et al.* (2010) and Haruna (2011).

With regarded to the effect of bio-fertilization on sesame yield and its components, the results were given in Tables (2 and 3). These results reveal generally showed that all characters under this study were significantly affected by inoculation of sesame seeds with phosphorein when compared with uninocultion (control treatment).

Result presented in Tables (2) show the effect of phosphorein (bacterial) inoculation on plant height, number of pods /plant, weight of pods / plant (g), number of seeds/pods of sesame plants.

The obtained results might be attributed to better development of inoculted plants compared to uninoculated ones creating a more favorable environment in terms of natural and concentration of root exudates for cell growth and metabolic activities of rhizospheric microorganisms (El-Khawas, 1990).Many investigators reported the positive effect of biofertilization on these characters El-Habbasha *et al.* (2007), Babajide *et al.* (2012), Abdullahi *et al.* (2013) and Wayase *et al.* (2014).

The effect of the interaction between N application and phosphorus fertilizer units on plant height (cm), number of pods /plant, weight of pods / plant (g), number of seeds/pods, 1000-seeds weight (g), seed yield /plant (g), seed yield (t/ha), straw yield (t/ha), biological yield (t/ha), as well as, oil yield (t/ha) were significant in both seasons (Tables 2 and 3).

The effect of the interaction between N application and biofertilization on yield and its components were significant (Tables 2 and 3).

The effect of the interaction phosphorus fertilizer and biofertilization were significant for yield and its components in both seasons Tables (2 and 3). Application phosphorus at 30 units gave the highestmean value of yield and its components under using inoculation phosphorein.

Also, the foliar spraying of amino acids and application phosphorus at 30 units with inocultion phosphorein gave the highest mean value of yield and its components.

B. Seed quality

Results recorded in Table (4) revealed that percentage of oil, nitrogen, phosphorus and potassium in seeds were significantly affected by adding nitrogen by spraying methods.

The highest means values of all chemical compositions character were obtained using foliar spraying (amino acids) in both seasons, while, the lowest ones was recorded by soil application nitrogen. On the other hand, without in significant variations foliar spraying and mixture soil + foliar on oil % and nitrogen (%) in the second season. The present results are in line with those obtained by Shehu *et al.* (2010) and Haruna (2011).

Data illustrated that in Table (4) showed that the mean values of oil, nitrogen, phosphorus and potassium percentages of sesame plants were significantly increased using zero to 30 unit phosphorus fertilizers in both seasons. Application phosphorus at 30 units gave the highest value of oil, N, P and K percentages than the control treatment. Thus phosphorus is an important nutrient for seed development and seed filling contributing to better yield formation (Shrawat and Islam, 1990). These results in agreement with Mian *et al*. (2011), Khaled *et al*. (2012) and Kashani *et al*. (2015).

Data in Table (4) indicated that percentages of oil, nitrogen, phosphorus and potassium significantly increased by inoculation of sesame seeds with phosphorein and cerealine when compared with uninoculation (control treatment) during the two seasons. The maximum increment was obtained by using phosphorein followed by cerealine. The increment percentages attained 13.67 and 9.08% for oil % 1.78 and 39.40% for nitrogen %, 17.81 and 12.10% for phosphorus% and 16.67% and 10.22% for potassium % as an average two seasons for treatment (phosphorein + cerealine), respectively, compared with uninoculation treatment. This may be due to the role of phosphorus dissolving and nitrogen fixation bacteria on increasing the endogenous phytohormonas (IAA, GAs and CKs), which play an important role in formation a big active root system, increasing the nutrient uptake and photosynthesis and translocation, as well as, accumulation within different plant parts (El-Khawas, 1990). These results are in agreement with those obtained by El-Habbasha *et al.* (2007), Hasonpour *et al.* (2012), and Abdullahi *et al.* (2013).

The interaction between N-application and phosphorus fertilizers on percentages for oil, N, P and K in both seasons was significant as presented in Table (4). Foliar spraying with phosphorus application at 30 units gave the highest oil, N, P and K percentages in both seasons.

The interaction between N-application and bio-fertilizer (AXC) significant for oil (%), nitrogen (%), phosphorus (%) and potassium (%). It is clear from data in Table (4) that application P at 30 with inoculation phosphorein significantly increase all studied chemical composition characters.

The highest value of oil (%), nitrogen (%), phosphorus (%) and potassium (%) were recorded by foliar spraying of amino acids and phosphorus at 30 units with phosphorein inoculation.

Table (2). Effect of N-application, phosphorus units and bio-fertilization on some yield and its components for sesame plants during 2014/2015 seasons.

Treatments	Plant height (cm)		Number of pods /plant		Weight of pods / plant (g)		Number of seeds/ pods		1000-Seeds weight (g)	
	2014	**2015**	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
N-applicaction (A)										
Soil application	141.52b	140.63b	103.05c	111.33c	226.70c	249.79c	36.79b	39.08b	3.60c	3.96c
Foliar application	145.10a	147.00a	115.38a	127.13a	254.24a	286.30a	41.18a	44.26a	4.10a	4.55a
Soil + Foliar	138.25c	141.08b	112.07b	123.28b	246.80b	272.16b	41.47a	44.05a	3.96b	4.37b
L.S.D.(0.05)	**1.45**	**1.60**	**1.80**	**2.05**	**7.80**	**6.70**	**0.72**	**0.55**	**0.09**	**0.10**
P- units (B)										
Control	135.50c	134.50c	101.74c	112.00b	224.47c	249.34c	35.12c	37.15c	3.54c	3.92c
15 unit	140.55b	143.34b	108.88b	120.46b	241.88b	266.18b	40.39b	42.63b	3.89b	4.28b
30unit	147.83a	150.87a	118.99a	128.68a	261.78a	288.02a	44.50a	47.60a	4.24a	4.67a
L.S.D.(0.05)	**1.90**	**2.20**	**2.10**	**2.30**	**8.40**	**9.10**	**1.02**	**1.09**	**0.12**	**0.14**
Bio-fertilization (C)										
Uninoculation	119.30b	136.92c	100.43c	110.83c	221.62c	243.76c	32.96c	35.27c	3.46c	3.80c
Phosphorein	145.14a	148.03a	119.22a	128.95a	262.32a	288.57a	45.08a	47.70a	4.23a	4.69a
Cerealine	144.49a	143.69b	110.86b	121.96b	244.20b	269.22b	42.68b	44.63b	3.98b	4.39b
L.S.D.(0.05)	**1.50**	**2.30**	**2.30**	**2.50**	**9.30**	**8.90**	**1.10**	**1.15**	**0.15**	**0.16**
Interactions										
Ax B	*	*	*	*	*	*	*	*	*	*
AxC	*	*	*	*	*	*	*	*	*	*
BxC	*	*	*	*	*	*	*	*	*	*
AxBx C	*	*	*	*	*	*	*	*	*	*

Means of each factor designated by the same letter not significantly different at 5% using least significant difference (L.S.D.)
*: Significant at 0.05 level of probability.

Table (3). Effect of N-application, phosphorus units and bio-fertilization on some yield and its components for sesame plants during 2014/2015 seasons.

Treatments	Seed yield /plant (g)		Seed yield (t/ha)		Straw yield (t/ha)		Biological yield (t/ha)		Oil yield (t/ha)	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
N-applicaction (A)										
Soil application	94.57c	104.04c	1.83b	2.08b	3.97b	4.13b	5.84b	6.17c	1.18b	1.31b
Foliar application	110.83a	122.25a	2.23a	2.45a	4.09a	4.55a	6.30a	7.01a	1.27a	1.40a
Soil + Foliar	105.14b	116.11b	2.21a	2.41a	4.15a	4.51a	6.35a	6.91a	1.26a	1.38a
L.S.D.(0.05)	**8.75**	**4.50**	**0.05**	**0.07**	**0.06**	**0.05**	**0.07**	**0.10**	**0.03**	**0.04**
P- units (B)										
Control	89.02c	98.26c	1.89c	2.09c	4.00c	4.29b	5.88c	6.41c	1.17c	1.31c
15 unit	104.18b	114.67b	2.11b	2.30b	4.10b	4.39a	6.15b	6.53b	1.24b	1.31b
30unit	117.37a	129.42a	2.33a	2.58a	4.17a	4.42a	6.44a	6.97a	1.30a	1.43a
L.S.D.(0.05)	**4.50**	**5.40**	**0.06**	**0.11**	**0.04**	**0.05**	**0.10**	**0.12**	**0.04**	**0.03**
Bio-fertilization (C)										
Uninoculation	89.07c	97.85c	1.86c	2.05c	3.91c	4.34b	5.79c	6.41c	1.11b	1.23b
Phosphorein	115.35a	127.29a	2.28a	2.51a	4.17a	4.53a	6.44a	6.84a	1.31a	1.44a
Cerealine	106.47b	117.21b	2.19b	2.38b	4.13b	4.38b	6.27b	6.73b	1.29a	1.41a
L.S.D.(0.05)	**5.70**	**5.50**	**0.07**	**0.10**	**0.03**	**0.06**	**0.11**	**0.09**	**0.04**	**0.05**
Interactions										
Ax B	*	*	*	*	*	*	*	*	*	*
AxC	*	*	*	*	*	*	*	*	*	*
BxC	*	*	*	*	*	*	*	*	*	*
AxBx C	*	*	*	*	*	*	*	*	*	*

Means of each factor designated by the same letter not significantly different at 5% using least significant difference (L.S.D.)
*: Significant at 0.05 level of probability.

Table (4). Oil and macronutrients (N, P and K) percentages as affected by N-application, P- units and bio-fertilization on some yield and its components for sesame plants during 2014/2015 seasons.

Treatments	Seed oil (%)		N%		P%		K%	
	2014	2015	2014	2015	2014	2015	2014	2015
N-applicaction (A)								
Soil application	44.86c	45.25c	2.70c	2.84b	0.413c	0.453c	1.77c	1.95c
Foliar application	48.31a	49.29a	2.95a	3.06a	0.450a	0.539a	2.03a	2.24a
Soil + Foliar	47.58b	48.82b	2.89b	3.06a	0.434b	0.522b	1.98b	2.15b
L.S.D.(0.05)	**0.80**	**0.85**	**0.04**	**0.05**	**0.09**	**0.10**	**0.04**	**0.04**
P- units (B)								
Control	44.39c	45.06c	2.46c	2.78c	0.418c	0.460c	1.73c	1.91c
15 unit	46.32b	47.21b	2.92b	3.01b	0.449b	0.492b	1.93b	2.13b
30unit	50.02a	51.13a	2.98a	3.18a	0.504a	0.560a	2.12a	2.33a
L.S.D.(0.05)	**1.05**	**1.10**	**0.04**	**0.06**	**0.011**	**0.014**	**0.06**	**0.05**
Bio-fertilization (C)								
Uninoculation	43.78c	44.43c	2.29c	2.42c	0.417c	0.459c	1.77c	1.95c
Phosphorein	49.63a	50.64a	3.04b	3.17b	0.490a	0.541a	2.06a	2.27a
Cerealine	47.98b	48.25b	3.21a	3.37a	0.469b	0.513b	1.95b	2.15b
L.S.D.(0.05)	**0.95**	**0.05**	**0.06**	**0.07**	**0.015**	**0.016**	**0.05**	**0.06**
Interactions								
Ax B	*	*	*	*	*	*	*	*
AxC	*	*	*	*	*	*	*	*
BxC	*	*	*	*	*	*	*	*
AxBx C	*	*	*	*	*	*	*	*

Means of each factor designated by the same letter not significantly different at 5% using least significant difference (L.S.D.)
*: Significant at 0.05 level of probability.

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الملخص العربي

إستجابة إنتاجية نباتات السمسم وجودة البذور لطرق التسميد المختلفة

فتحي رضوان – محمود جمعة – إبراهيم رحاب – معمر سعد إمحمد محمد

قسم الإنتاج النباتي– كلية الزراعة (سابا باشا)– جامعة الأسكندرية

أجريت تجربتان في مزرعة كلية الزراعة (سابا باشا) جامعة الأسكندرية خلال موسمي ٢٠١٤، ٢٠١٥ لدراسة إستجابة إنتاجية نباتات السمسم (صنف شندويل) وجودة البذور لطرق التسميد المختلفة.

أوضحت النتائج مايلي:

١. أعطت الإضافة بالرش بالأحماض الأمينية أعلي إرتفاع نبات ، عدد القرون/نبات، وزن القرون (جم)، عدد البذور/قرن، وزن ١٠٠٠ بذرة، محصول البذور(جم)/ نبات ، محصول البذور، القش، البيولوجي (طن/هكتار) وأيضاً محصول الزيت (طن/هكتار) في كلا الموسمين، كما ان التسميد الفوسفوري عند ٣٠ وحدة أنتجت زيادة معنوية في المحصول ومكوناته والمكونات الكيمائية لبذور السمسم في كلا الموسمين.

٢. سجلت إختلافات معنوية بين معاملات التسميد الحيوي المختبرة للمحصول ومكوناته والنسبة المئوية للزيت، النيتروجين، الفوسفور، البوتاسيوم لبذور السمسم في كلا الموسمين.

٣. الإختلافات المعنوية لجميع صفات المحصول ومكوناته والمكونات الكيمائية تم الحصول عليها من معاملة الإضافة بالرش بالأحماض الأمينية مع التلقيح بالفوسفورين في كلا الموسمين. الفروق المعنوية في النسبة المئوية للزيت، الفوسفور، البوتاسيوم في كلا الموسمين تم الحصول عليها من إضافة الفوسفور عند ٣٠ وحدة مع التلقيح بالفوسفورين.