# Impact of Sowing Method and Humic Acid on Sesame (*Sesamum indicum* L.) Production

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**ABSTRACT:** To improve yield, its components and quality of sesame (*Sesamum indicum* L.), two different sowing methods and various humic acid levels were evaluated in at El-Horreya village, Abou El-Matamir, El-Behira governorate, Egypt, during two successive summer seasons of 2013 and 2014 in sandy loam soil. The two field experiments were design as split plot design with three replications.The treatments were distributed at random as follows; sowing methods (broadcasting or in ridges) were applied in the main plot, while humic acid levels (without, 1200, 2400, and 3600 g/ha) at two doses with first and second irrigation were allocated in the subplot. The obtained results reported that broadcasting method and Humic acid at rate of 3600 g/ha., increased yield, its components and quality of sesame (*Sesamum indicum* L.) crop i.e. plant height (cm), number of capsules/plant, capsule length (cm), number of seeds/capsule, 1000-seed weight (g), seed, straw and biological yields (kg/ha), oil seed content (%), protein %, P %, K %, Fe, Mn and Zn concentration (mg $kg^{-1}$)in seeds of sesame under study conditions.
**KEYWORDS**: *Sesame, sowing method, humic acid, yield, components, oil, El-Behira, Egypt*

## INTRODUCTION

Sesame (*Sesamum indicum* L.) is considered as one of the important oil seed crops. Sesame has high oil content (46 – 64 %) and a dietary energy of 6355 Kcal/kg. The seeds serve as a rich source of protein (20 – 28 %), Sugar (14 – 16 %) and minerals (5 – 7%), **Thanvanathan** *et al.* (**2001**). It is one of the most important crops grown for oil production in Egypt. The crop is grown for its seeds, which contain 50-60% oil, 8% protein, 5.8% water, 3.2% crude fiber, 18% carbohydrate, 5.7% ash and it is very rich in minerals such as Ca, P and vitamin E (**Dasharath** *et al*., **2007**). Also, sesame oil has a very high level of unsaturated fatty acids, which is assumed to have reducing effect on plasma cholesterol, as well as on coronary heart disease (**Agboola, 1979**). On contrary to the decline in production, the need for sesame is steadily growing for human consumption and health. Seed shattering, indeterminate growth habit , undeveloped cultivars, poor cultural practices and management, some diseases, low harvest index, and poor crop rotations (**Uzun** *et al***., 2004; Uzun and Cagirgan, 2009; Furat and Uzun, 2010**) all contribute to lower production. Lack of mechanized harvest also increases the cost of production. Above all, the high cost of sowing sesame deters some farmers, causing to cease sesame production. Production practices should; therefore, be reconsidered for sustainable and profit table sesame farming.

**Imoloame *et al.* (2007)** reported that broadcasting method of sowing has produced taller sesame (*Sesamum indicum* L.) plants in the second season, greater number of flowers and pods per plant in both years and the average of two years data. **Mkamilo and Bedigian (2007)** attributed the yield increases of sesame are due both to development and use of improved varieties and improved agronomy practices and crop protection. The potential yield of sesame still is much higher than actual yield, as still much damage occurs by pests and diseases, insufficient weed control, to high levels of monocropping, lack of mechanization (amongst others causing seed shattering when not enough labour is available during harvest) and unrealized genetic potential. Potential yields are probably as high as 2000 kg/ha.

In addition, humic acid (HA) is one of the most important components of bioliquid complex. Because of its molecular structure, it provides numerous benefits to crop production. It helps break up clay compacted soils, assists in transferring micronutrients from the soil to the plant, enhances water retention, increases seed germination rates, improves water, air, and roots penetration, and stimulates development of microflora population in soils. Humic acid is not a fertilizer, but as considered as a compliment to fertilizer (**Mackowiak** *et al*., **2001**). On this respect, **Wahdan** *et al*. (**2006)** and **El-Bassiouny** *et al.* (**2014)** indicated that humic acid (HA) is not a fertilizer as it does not directly provide nutrients to plants, but is a compliment to fertilizer. Its benefits include:
i) Addition of organic matter to organically-deficient soils; ii) increase root vitality, iii) improved nutrient uptake, iv) better formation and stability of soil aggregates, v) increased both water and fertilizer retention, and vi) stimulate beneficial microbial activity.

Humic acid increased significantly all morphological criteria (plant height, leaves number, fresh and dry weights of shoots), metabolism (photosynthetic pigment, total soluble sugar, total carbohydrates, total amino acids and proline), mineral contents (N, P, K, Ca and Mg) and grain, straw and biological yields of both cultivars of wheat (**El-Bassiouny** *et al*., **2014**).However, the following references enhance this facts. For instance, **Singaravel** *et al*. **(1993)** detected that the seed yield of sesame (*Sesamum indicum* L.) plants increased with increasing the addition rate of HA from 0 to 40 kg/ha., sprayed on the soil surface. However, yield of sesame was found to be greatest with nitrogen application along with humic acid over application of Azospirillum (**Singaravel and Govindaswamy, 1998**). **Porass** *et al.* **(2010)** stated that application of half of the recommended dose of N- fertilizer combined with *Azospirillum* and humic acid led to the highest significant increases in number of branches, number of capsules, 1000- seed weight, seed yield and oil percent, for Giza 32 cv. and Shandweel 1 cv. sesame (*Sesamum indicum* L.) genotypes.

The highest yields for peanut and sesame (*Sesamum indicum* L.) seeds achieved upon treating by gypsum application and humic acid as foliar spray increases 104.36 % and 91.62% for peanut and sesame seeds, respectively over control plant. The highest values of proteins yield, P and K contents and oil yield were achieved upon treating by 4.76 tons/ha gypsum and foliar spray with 6 g H.A./l. Significant increases in proteins%, P%, K%, and oil % and protein, P and K content and oil yield for sesame seeds were taken place due to gypsum application, foliar spray by humic and/or amino acids were obtained. The highest values were achieved for proteins yield, P and K contents and oil's yield, with treating by 4.76 tons/ha., of gypsum and foliar spray with 6 g/l humic acid (**Eisa, 2011**).

The objective of this study was to investigate the effect of different two sowing methods and humic acid levels, on yield and yield components and quality of sesame (*Sesamum indicum* L.)

## MATERIALS AND METHODS

Two field experiments were carried out to study effect of two sowing methods and four humic acid levels, on yield, yield components and quality of sesame (*Sesamum indicum* L.) cv. " Shandaweel 3". Field experiments were conducted in El-Horreya village, Abou El-Matamir, El-Behira governorate, Egypt, during the two successive summer seasons 2013 and 2014 in sandy loam soil. Some physical and chemical characteristics of the studied soil before planting are presented in Table (1) which, were determined according to Klute (1986) and Page *et al.* (1982).

**Table (1): Physical and chemical properties of the experimental soil sites during 2013 and 2014.**

| Soil characteristics | | |
|---|---|---|
| **Properties** | **Seasons** | |
| Particle size distribution | **2013** | **2014** |
| Sand % | 60.90 | 61.03 |
| Silt % | 10.60 | 10.05 |
| Clay % | 28.50 | 28.92 |
| Soil texture (%) | Sandy loam | Sandy loam |
| pH (1: 2.5 water suspension) | 8.10 | 7.99 |
| EC ($dSm^{-1}$) | 2.10 | 1.95 |
| **Soluble Cations (meq/L.)** | | |
| $Ca^{++}$ | 7.60 | 9.10 |
| $Mg^{++}$ | 5.20 | 4.85 |
| $Na^{+}$ | 4.10 | 4.00 |
| $K^{+}$ | 0.20 | 0.25 |
| **Soluble Anions (meq/L.)** | | |
| $HCO_3^{-}$ | 2.00 | 1.95 |
| $Cl^{-}$ | 3.85 | 3.77 |
| $SO4^{--}$ | 10.50 | 12.20 |
| O.M. (%) | 1.85 | 1.90 |
| $CaCO_3$ (%) | 22.50 | 23.70 |
| Available Mineral N(mg/kg) | 92.40 | 85.60 |
| Available P (mg/kg) | 23.12 | 25.50 |

The experiments were designed as split plot design with three replications, where the sowing methods (broadcasting or hills on ridges) at the rate of 10 kg seeds/ha were distributed at random within main plot, while humic acid levels (untreated, 1200, 2400, and 3600 g/ha) applied at sowing and first irrigation at two equal doses were allocated at random within the subplot. The humic acid (Techno potas- humic acid) analysis is presented in Table (2).

**Table (2). Techno potas- humic acid analysis**

| Product analysis | |
|---|---|
| **Product name** | **Techno Potas- Humic acid** |
| Formula (W/W) | 12% $K_2O$ – HA 75 % |
| Potassium $K_2O$ (on dry basis) | 12 % (W/W) |
| Humic acid (on dry basis) | 75 % (W/W) |
| Moisture | 15% (Max.) |
| pH | 9 -10 (Max.) |
| Water solubility | 95 % (Min.) |

The sub plot area was 10.5 $m^2$ (3 m width and 3.5 m length) in broadcasting sowing method, while in ridges planting method, the sub plots consisted of 6 ridges 3.5 meters in length, 60 cm in width and 20 cm between hills. However, Nitrogen fertilizer was applied as urea fertilizer (46% N) at the rate of 75 kg N/ha, at two doses. Phosphorus fertilizer was applied before planting as Calcium- Super Phosphate (15.5 % $P_2O_5$) at the rate of 480 kg/ha. Potassium Sulphate (48 % $K_2O$) was added before the second irrigation at rate of 120 kg/ha. Sesame (*Sesamum indicum* L.) cv. "Shandaweel 3" was sown on $10^{th}$ and $15^{th}$ of June in 2013 and 2014 seasons, respectively. The preceding crop was clover (*Trifolium alexanderinum*, L.) during both seasons of the study. All other agricultural treatments for growing sesame plants were done as recommended by the Ministry of Agriculture.

At harvest time 120 days from sowing stage, the following data were recorded: plant height (cm), number of capsules/plant, capsule length (cm), number of seeds/capsule, 1000- seed weight (g), seed yield, straw yield, biological yield (kg/ha), harvest index and oil seed content % (was determined according to AOAC 1990).

Samples of sesame seeds were ground and 0.5 g powder of each was digested by concentrated mixture of $H_2SO_4$// $HClO_4$ acids according to Sommers and Nelson (1972). Nitrogen was determined by micro- Keldahl, according to Jackson (1976) and multiply by 6.25 to determine protein percentage. Phosphorus was determined, spectrophotometrcally, using ammonium molybdate/ stannus chloride method according to Chapman and Pratt (1978). Potassium was determined by a flame photometer, according to Page *et al*. (1982). Fe, Mn, and Zn concentrations were determined by using Atomic Absorption apparatus.

Data were, statistically, analyzed as a split plot design according to Snedecor and Cochran (1990). The least significant differences (LSD at 0.05) used to compare the treatment means using CoStat (2005) program.

# RESULTS AND DISCUSSION

## A. Effect of sowing methods

Results in Tables (3 and 4) showed that sowing methods and humic acid rates were, significantly affected most of the studied characters; i.e., plant height (cm), number of capsules/plant, capsule length (cm), number of seeds/capsule, 1000- seed weight (g), seed, straw and biological yields kg/ha., harvest index and oil seed content % of sesame (*Sesamum indicum* L.). Whereas, the sowing sesame plants by broadcasting method recorded the highest mean values of most of the previous parameters i.e. yield, its components and oil content in sesame seeds, while the lowest ones were obtained by planting sesame plants in ridges as planting method. However, planting in ridges achieved the heaviest straw yield kg/ha. Meanwhile, there was no significant difference between both sowing methods on harvest index (H.I. %) during the second season. The similar results, more or less, were with agreement with those obtained by **Imoloame** *et al*. (**2007**).

Data of Table (5) revealed that there was no significant difference between planting methods respective Zn concentration in seeds of sesame in both seasons. Also, data in Table (5) showed that planting methods affected, significantly, on Fe and Mn contents in seeds during both seasons, while, planting methods affected, significantly, protein % and K % in sesame seeds during first season of this study and P content in the second season only. In addition, broadcasting method achieved the higher concentration of all the pervious studied characters. These could be due to intra-plant competition in the drilled crop compared with the broadcast crop (**Imoloam, 2004**).

**B. Effect of humic acid**

Humic acid levels had significant effects on most of the studied characteristics, where the highest level of humic acid (3600 g/ha.) gave the highest average values from these traits of sesame (*Sesamum indicum* L.) as compared with others rates of humic acid. However, the lowest mean values were obtained with untreated (without humic acid) during both growing seasons. Similar conclusion was also, suggested by **Singaravel** *et al*. **(1993)**; **Porass** *et al.* **(2010); Eisa (2011).**

**Hermann** *et al.* (**2000**) reported that the positive effect of HA and organic fertilization on the yield capacity of soil consists of many components. The first, these components concerning nutrient supply to plants. The second, physical soil properties are affected resulting in differences in root penetration, gas exchange and water supply. Humic acid essentially helps the movement of micronutrients from soil to plant.

Data in Table (4) showed that oil content in sesame seeds increased with increasing H.A. up to 3600 g/ha. The increase of humic acid from 1200 up to 3600 g/ha., had increased, significantly, oil content of seeds. These findings were in agreement with those obtained by **Thanvanathan** *et al.* **(2001).**

Data of protein, P and K % in sesame seeds presented in Table (5) showed that adding humic acid up to 3600 g/ha., exerted significant increase in P and K %. The highest mean value of P and K % in seeds increased by using 3600 HA/ha, in comparison with others treatments during both seasons. These results are in agreement with those of **Antoun** *et al.* (**2010**).

However, Fe, Mn and Zn concentrations affected significantly by using humic acid rates, whereas, the highest values were recorded using 3600 g/ha. The micronutrient concentrations in seeds were within sufficient limits according to **Benton** *et al*. (**1992**).

The highest values of protein, P and K contents in seeds of sesame were achieved by soil application of humic acid. The application of all treatments recorded marked increases in the concentration of Mn and Zn in sesame seeds, in both seasons. From the obtained results it could be concluded that bio-fertilizer and organic materials like, compost, humic acid and compost tea could producing higher sesame yield quantity and quality. Moreover, application of such materials conserves the environment from chemical pollution hazards (**Khaled** *et al*. **2012**). The above- mentioned data cope with the significance role of humic acid; whereas, it improves physical, chemical and biological properties of the soil and influences plant growth. In this concern, humic acids are important soil components; they can improve nutrient availability and have impact on other important chemical, biological, and physical properties of soils. Also, foliar application of humic acids increased the uptake of P, K, Mg, Na, Cu and Zn (**Hussein and Hassan, 2011**).

### C. Effect of Interaction effects

Data in Tables (3, 4 and 5) illustrate the effect of interaction between sowing methods and humic acid levels on all of the studied characters i.e. yield, its components, protein, micronutrients and macronutrients in seeds of sesame (*Sesamum indicum* L.) during the two cropping seasons. Whereas, the highest mean values of the studied parameters were obtained by sowing sesame plants by broadcasting with humic acid at rate of 3600 g/ha., while the lowest ones were recorded with planting on ridges with untreated (0 humic acid) in both seasons. These results showed that sowing methods and humic acid rates act dependently on those pervious studied characters.

Increases in macronutrient concentrations in sesame seeds may be taken place due to the availability of them in the soil as a result of decreasing soil pH and salinity caused by the action of organic materials or biofertilizer. These results agreed with those obtained by **Moussa** *et al.* (**2006**) and **Nasef** *et al.* (**2009**). Furthermore, the relative increases of Fe, Mn and Zn concentrations in sesame seeds are depending on their available contents and their solubility in soil caused by soil amendments **(Khaled** *et al*. **2012).**However, the micronutrient concentrations in seeds were within sufficient limits according to **Benton** *et al.* **(1992).**

## CONCLUSION:

As a result of this two cropping seasons field' study, it was concluded that yield, its components and quality of sesame crop increased with broadcasting method and humic acid at rate of 3600 g/ha., under study conditions at Abou El-Matamir, El-Behira governorate, Egypt.

**Table (3). Average of plant attributes of sesame (*Sesamum indicum* L.) as affected by sowing methods (M), humic acid rates (H.A.) and their interaction during 2013 and 2014 seasons**

| Attributes | Humic acid rates (H.A.) g/ha. | 2013 Sowing methods (M) Ridges | 2013 Sowing methods (M) Broadcasting | 2013 Average (H.A.) | 2013 L.S.D. (M) at 0.05 | 2013 L.S.D. (HA) at 0.05 | 2013 L.S.D. (M x HA) at 0.05 | 2014 Sowing methods (M) Ridges | 2014 Sowing methods (M) Broadcasting | 2014 Average (H.A.) | 2014 L.S.D. (M) at 0.05 | 2014 L.S.D. (HA) at 0.05 | 2014 L.S.D. (M x HA) at 0.05 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Plant height (cm) | Untreated | 116.33 | 141.67 | 129.00 | 9.34 | 7.84 | 17.44 | 125.67 | 151.33 | 138.50 | 8.40 | 17.12 | 38.10 |
| | 1200 | 120.33 | 133.33 | 126.83 | | | | 137.33 | 156.67 | 147.00 | | | |
| | 2400 | 127.00 | 146.00 | 136.50 | | | | 143.33 | 185.67 | 164.50 | | | |
| | 3600 | 141.67 | 152.67 | 147.17 | | | | 161.00 | 195.67 | 178.33 | | | |
| Average (M) | | 126.33 | 143.42 | | | | | 141.83b | 172.33 a | | | | |
| Number of capsules/plant | Untreated | 67.83 | 82.33 | 75.08 | 7.56 | 4.47 | 9.95 | 61.67 | 83.67 | 72.67 | 4.93 | 6.55 | 14.59 |
| | 1200 | 78.50 | 93.33 | 85.92 | | | | 75.67 | 99.00 | 87.33 | | | |
| | 2400 | 76.83 | 107.67 | 92.25 | | | | 90.67 | 104.33 | 97.50 | | | |
| | 3600 | 105.00 | 114.33 | 109.67 | | | | 107.67 | 116.67 | 112.17 | | | |
| Average (M) | | 82.04 | 99.42 | | | | | 83.92 | 100.92 | | | | |
| Capsule length (cm) | Untreated | 1.93 | 2.87 | 2.40 | 0.072 | 0.227 | 0.505 | 1.96 | 2.87 | 2.42 | 0.271 | 0.183 | 0.407 |
| | 1200 | 2.23 | 3.10 | 2.67 | | | | 2.40 | 3.10 | 2.75 | | | |
| | 2400 | 2.37 | 3.17 | 2.77 | | | | 2.37 | 2.77 | 2.57 | | | |
| | 3600 | 2.83 | 3.37 | 3.10 | | | | 2.70 | 3.20 | 2.95 | | | |
| Average (M) | | 2.34 | 3.13 | | | | | 2.36 | 2.98 | | | | |
| Number of seeds/capsule | Untreated | 30.67 | 37.67 | 34.17 | 1.90 | 2.03 | 4.52 | 31.83 | 36.33 | 34.08 | 1.97 | 1.77 | 3.95 |
| | 1200 | 34.00 | 44.00 | 39.00 | | | | 35.93 | 40.00 | 37.97 | | | |
| | 2400 | 37.33 | 46.67 | 42.00 | | | | 36.67 | 44.67 | 40.67 | | | |
| | 3600 | 42.67 | 48.67 | 45.67 | | | | 40.50 | 51.17 | 45.83 | | | |
| Average (M) | | 36.17 | 44.25 | | | | | 36.23 | 43.04 | | | | |
| 1000 seed weight (g) | Untreated | 3.17 | 3.60 | 3.39 | 0.374 | 0.199 | 0.444 | 2.97 | 3.40 | 3.18 | 0.199 | 0.164 | 0.364 |
| | 1200 | 3.40 | 3.87 | 3.64 | | | | 3.20 | 3.77 | 3.48 | | | |
| | 2400 | 3.70 | 4.30 | 4.00 | | | | 3.57 | 3.97 | 3.77 | | | |
| | 3600 | 4.07 | 4.60 | 4.34 | | | | 4.07 | 4.33 | 4.20 | | | |
| Average (M) | | 3.59 | 4.09 | | | | | 3.87 | 3.45 | | | | |

**Table (4). Average of seed yield attributes of sesame (*Sesamum indicum* L.) as affected by sowing methods (M), humic acid rates (H.A.) and their interaction during 2013 and 2014 seasons.**

| Attributes | Humic acid rates (H.A.) g/ha. | Season 2013: Sowing methods (M): Ridges | Season 2013: Sowing methods (M): Broadcasting | Season 2013: Average (H) | Season 2013: L.S.D. (M) at 0.05 | Season 2013: L.S.D. (HA) at 0.05 | Season 2013: L.S.D. (M x H) at 0.05 | Season 2014: Sowing methods (M): Ridges | Season 2014: Sowing methods (M): Broadcasting | Season 2014: Average (H.A.) | Season 2014: L.S.D. (M) at 0.05 | Season 2014: L.S.D. (HA) at 0.05 | Season 2014: L.S.D. (M x HA) at 0.05 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Seed yield kg/ha. | Untreated | 680.00 | 1246.00 | 963.00 | | | | 606.67 | 763.33 | 685.00 | | | |
| | 1200 | 861.67 | 1530.00 | 1195.83 | | | | 760.00 | 846.67 | 803.33 | | | |
| | 2400 | 948.33 | 1533.33 | 1240.83 | 273.00 | 432.94 | 963.42 | 691.67 | 1343.33 | 1017.50 | 197.05 | 244.64 | 544.41 |
| | 3600 | 1200.00 | 1686.67 | 1443.33 | | | | 1213.33 | 1493.00 | 1353.33 | | | |
| Average (M) | | 922.50 | 1499.00 | | | | | 817.92b | 1111.67 | | | | |
| Straw yield kg/ha. | Untreated | 2970.00 | 4354.00 | 3662.00 | | | | 3043.33 | 4836.67 | 3940.00 | | | |
| | 1200 | 3631.00 | 4370.00 | 4000.83 | | | | 3733.33 | 5053.33 | 4393.33 | | | |
| | 2400 | 3351.67 | 5233.33 | 4292.50 | 273.00 | 432.94 | 963.42 | 3608.33 | 5423.33 | 4515.83 | 112.32 | 556.06 | 1237.41 |
| | 3600 | 3993.33 | 6330.00 | 5161.67 | | | | 3980.00 | 6523.33 | 5251.67 | | | |
| Average (M) | | 3486.00 | 5071.83 | | | | | 3591.25 | 5459.17 | | | | |
| Biological yield kg/ha. | Untreated | 3650.00 | 5600.00 | 4625.00 | | | | 3650.00 | 5600.00 | 4625.00 | | | |
| | 1200 | 4493.33 | 5900.00 | 5196.67 | | | | 4493.33 | 5900.00 | 5196.67 | | | |
| | 2400 | 4300.00 | 6766.67 | 5533.33 | 309.36 | 452.70 | 1007.41 | 4300.00 | 6766.67 | 5533.33 | 309.36 | 452.70 | 1007.4 |
| | 3600 | 5193.33 | 8016.67 | 6605.00 | | | | 5193.33 | 8016.67 | 6605.00 | | | |
| Average (M) | | 4409.17 | 6570.83 | | | | | 4409.17 | 6570.83 | | | | |
| Harvest index % (H.I.) | Untreated | 18.64 | 22.28 | 20.46 | | | | 16.63 | 13.63 | 15.13 | | | |
| | 1200 | 19.20 | 26.01 | 22.61 | | | | 16.98 | 14.48 | 15.73 | | | |
| | 2400 | 22.05 | 22.74 | 22.39 | 1.41 | 1.87 | 4.16 | 16.17 | 20.03 | 18.10 | N.S. | 5.76 | 12.83 |
| | 3600 | 23.10 | 21.06 | 22.08 | | | | 23.37 | 18.65 | 21.01 | | | |
| Average (M) | | 20.75 | 23.02 | | | | | 18.29 | 16.70 | | | | |
| Oil seed content % | Untreated | 33.17 | 45.23 | 39.20 | | | | 34.53 | 38.67 | 36.60 | | | |
| | 1200 | 37.67 | 44.33 | 41.00 | | | | 47.60 | 51.27 | 49.44 | | | |
| | 2400 | 47.27 | 44.00 | 45.64 | 2.81 | 3.99 | 5.65 | 51.00 | 54.37 | 52.69 | 2.56 | 1.48 | 2.09 |
| | 3600 | 42.23 | 53.97 | 48.10 | | | | 54.97 | 56.33 | 55.65 | | | |
| Average (M) | | 40.09 | 46.88 | | | | | 47.03 | 50.16 | | | | |

- **N.S.: Not significant at 0.05 level of probability.**

**Table (5). Averages of protein %, P %, K%, Fe, Mn and Zn concentrations (mg/kg) of sesame (*Sesamum indicum* L.)as affected by sowing methods (M), humic acid rates (H.A.) and their interaction during 2013 and 2014 seasons**

| Attributes | Humic acid rates (H.A.) g/ha. | Season 2013: Sowing methods (M) Ridges | Broadcasting | Average (HA) | L.S.D. (M) at 0.05 | L.S.D. (HA) at 0.05 | L.S.D. (M x HA) at 0.05 | Season 2014: Sowing methods (M) Ridges | Broadcasting | Average (H.A.) | L.S.D. (M) at 0.05 | L.S.D. (HA) at 0.05 | L.S.D. (M x HA) at 0.05 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Protein % | Untreated | 18.00 | 21.76 | 19.88 | | | | 19.80 | 25.7 | 22.75 | | | |
| | 1200 | 20.18 | 21.58 | 20.88 | | | | 21.44 | 23.38 | 22.41 | | | |
| | 2400 | 24.00 | 24.83 | 24.42 | **2.38** | **1.50** | **2.12** | 26.50 | 22.16 | 24.33 | **N.S.** | **1.63** | **2.33** |
| | 3600 | 21.65 | 25.70 | 23.68 | | | | 26.30 | 26.63 | 26.47 | | | |
| Average (M) | | 20.96 | 23.47 | | | | | 23.51 | 24.47 | | | | |
| P % | Untreated | 0.38 | 0.46 | 0.42 | | | | 0.48 | 0.58 | 0.53 | | | |
| | 1200 | 0.46 | 0.52 | 0.49 | | | | 0.52 | 0.57 | 0.55 | | | |
| | 2400 | 0.52 | 0.56 | 0.54 | **N.S.** | **0.024** | **0.034** | 0.58 | 0.58 | 0.58 | **0.0223** | **0.0264** | **0.0373** |
| | 3600 | 0.61 | 0.59 | 0.60 | | | | 0.59 | 0.63 | 0.61 | | | |
| Average (M) | | 0.49 | 0.53 | | | | | 0.54 | 0.59 | | | | |
| K % | Untreated | 0.72 | 1.00 | 0.86 | | | | 0.71 | 0.81 | 0.76 | | | |
| | 1200 | 0.80 | 1.05 | 0.93 | | | | 0.88 | 0.99 | 0.94 | | | |
| | 2400 | 0.85 | 1.07 | 0.96 | **0.066** | **0.041** | **0.058** | 0.96 | 1.05 | 1.01 | **N.S.** | **0.243** | **0.344** |
| | 3600 | 0.98 | 1.09 | 1.04 | | | | 1.04 | 1.36 | 1.20 | | | |
| Average (M) | | 0.84 | 1.05 | | | | | 0.90 | 1.05 | | | | |
| Fe (mg $kg^{-1}$) | Untreated | 64.53 | 83.67 | 74.10 | | | | 66.37 | 78.67 | 72.52 | | | |
| | 1200 | 70.00 | 80.67 | 75.34 | | | | 76.00 | 82.10 | 79.05 | | | |
| | 2400 | 79.33 | 85.17 | 82.25 | **4.77** | **5.28** | **7.46** | 84.17 | 86.80 | 85.49 | **4.17** | **2.00** | **2.84** |
| | 3600 | 82.40 | 81.93 | 82.17 | | | | 88.00 | 86.80 | 87.40 | | | |
| Average (M) | | 74.07 | 82.86 | | | | | 78.64 | 83.59 | | | | |
| Mn (mg $kg^{-1}$) | Untreated | 34.50 | 44.17 | 39.34 | | | | 36.40 | 44.77 | 40.59 | | | |
| | 1200 | 38.80 | 50.67 | 44.74 | | | | 40.20 | 48.13 | 44.17 | | | |
| | 2400 | 42.90 | 50.57 | 46.74 | **5.42** | **3.99** | **5.64** | 45.53 | 51.30 | 48.42 | **4.01** | **1.30** | **1.84** |
| | 3600 | 40.10 | 54.70 | 47.40 | | | | 47.07 | 55.97 | 51.52 | | | |
| Average (M) | | 39.08 | 50.03 | | | | | 42.30 | 50.04 | | | | |
| Zn (mg $kg^{-1}$) | Untreated | 20.40 | 31.77 | 26.09 | | | | 23.73 | 30.43 | 27.08 | | | |
| | 1200 | 28.00 | 32.70 | 30.35 | | | | 32.67 | 32.50 | 32.59 | | | |
| | 2400 | 29.47 | 29.47 | 29.47 | **N.S.** | **2.88** | **4.07** | 36.00 | 35.47 | 35.74 | **N.S.** | **2.47** | **3.49** |
| | 3600 | 29.93 | 29.97 | 29.95 | | | | 35.17 | 37.43 | 36.30 | | | |
| Average (M) | | 26.95 | 30.98 | | | | | 31.89 | 33.96 | | | | |

- **N.S.: Not significant at 0.05 level of probability.**

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## الملخص العربى

# تأثير طريقة الزراعة وحامض الهيوميك على إنتاج السمسم

**عصام إسماعيل إسماعيل قنديل**

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أقيمت تجربتان حقليتان بقرية الحرية – أبو المطامير – محافظة البحيرة خلال موسمى زراعة ٢٠١٣ ، ٢٠١٤ تحت ظروف تربة رملية صفراء، لدراسة تأثير طرق الزراعة ، إضافة حامض الهيوميك بمعدلات مختلفة على محصول السمسم (صنف شندويل–٣). استخدم تصميم القطع المنشقة مرة واحدة فى ثلاثة مكرارات وكانت مساحة كل قطعة تحت رئيسية (١٠.٥م$^{٢}$ (٣.٥x٣م) ، حيث وزعت عشوائياً طريقتى الزراعة (البدار – فى جور على خطوط) بالقطع الرئيسية ، بينما إضافة أربعة معدلات من حامض الهيوميك (بدون ، ١٢٠٠ ، ٢٤٠٠ ، ٣٦٠٠ جم/هكتار) وزعت بالقطع تحت الرئيسية. وكان ميعاد الزراعة ٢٠١٣/٦/١٠ ،٢٠١٤/٦/15 على الترتيب خلال الموسمين

**وتتلخص أهم النتائج فيما يلى:**

– تفوقت طريقة الزراعة بدار فى أحواض حيث سجلت أعلى قيم لمعظم الصفات المدروسة مثل المحصول ومكوناته (إرتفاع النبات (سم) ، عدد الكبسولات/نبات ، طول القرن (سم)، عدد البذور/قرن ، وزن ١٠٠٠ بذرة (جم) ، محصول البذور ، محصول القش ،المحصول البيولوجى (كجم)/هكتار) وجودته (البوتاسيوم) ، (تركيز المنجنيز ، والحديد) ونسبة البروتين والزيت فى بذور السمسم بينما أقل القيم كانت عندما زرع السمسم بطريقة جور على خطوط فى حين انها اعطت أعلى محصول قش. وكان هناك فرق معنوى بين طرق الزراعة لصفة دليل الحصاد خلال موسم الزراعة الأول فقط.

– تأثر تركيز البروتين والبوتاسيوم فى بذور السمسم بطرق الزراعة خلال موسم الزراعة ٢٠١٣ فقط ، بينما تأثر تركيز الفوسفور معنوياً بها خلال موسم الزراعة ٢٠١٤ فقط ، حيث أعطت زراعة السمسم بالبدار أعلى نسبة للبروتين وأعلى تركيزات من البوتاسيوم والفوسفور.

– لم يتأثر محتوى بذور السمسم من الزنك بطرق الزراعة خلال موسمى الدراسة ٢٠١٣ و ٢٠١٤.

– حقق معدل حامض الهيوميك (٣٦٠٠ جم/هكتار) أعلى قيم لمحصول وإنتاجية ومكونات المحصول ، ومحتوى بذور السمسم من العناصر الصغرى والكبرى ، ونسبة الزيت ونسبة البروتين وايضاً تركيزات العناصر الكبرى والصغرى مقارنة بباقى المعاملات وأعطت المعاملة بدون إضافة حامض الهيوميك أقل القيم فى جميع الصفات المدروسة تحت ظروف التجربة خلال الموسمين.

– أعطى التداخل بين زراعة السمسم بدار فى أحواض مع إضافة الهيوميك اسيد (٣٦٠٠ جم/هكتار) أعلى قيم لمعظم الصفات المدروسة ، على العكس من زراعة السمسم فى جور على خطوط مع عدم اضافة الهيوميك أسيد والتى أعطت أقل القيم.

– توصى الدراسة بزراعة صنف السمسم (شندويل ٣) بطريقة الزراعة بدار فى أحواض ، مع التسميد بحامض الهيوميك بمعدل (٣٦٠٠ جم/هكتار) لزيادة انتاجيته ، وجودته تحت ظروف منطقة الزراعة.