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Original research

Effect of foliar treatment with yeast and nitrogen fertilization on the productivity of sesame

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Abstract:

The goal of the current study was to determine the appropriate amount of yeast extract and level of nitrogen fertilization on growth, yield, and yield components of sesame (cv. shandaweel-3) under drip irrigation system. The investigation was conducted in the experimental farm of the faculty of agriculture and natural resources at Aswan University in the Aswan governorate during the summers of 2020 and 2021. Three replications were employed in the experiment, which was set up using a strip-plot layout and randomized complete block design (RCBD). the main plots were set up using yeast extract, and the sub-plots had nitrogen fertilization. the experiment included two factors: 1- yeast extract: no spray (control), One spry after 20 days from planting and tow spry after 20 and 30 days from planting. 2- Nitrogen fertilization: 30,45 and 60 unit / fed. The results showed that the studied yeast extract and their interaction (yeast extract + nitrogen fertilization) had no significant effects on the majority of the traits. These traits included plant height, frouting zone, number of capsules per plant, 1000-seed weight (g), seed weight plant^{-1} (g), seed yield kg fed^{-1}, seed oil %, and seed protein %. In addition, nitrogen fertilization levels at 60 units per fed had significant or highly significant effects on the majority of the traits.

Keywords: Sesame, yeast extract, nitrogen fertilization, Yield, components, Aswan

1- Introduction

Because its seeds have high levels of protein and oil, sesame (*Sesamum indicum L.*) is one of the most significant oil crops in the world. A lot of efforts are being made to increase the total production of oil crops, particularly sesame, in order to close the gap in oil availability since the majority of the seed produced in Egypt is used to make edible products like tahena, halawa tahiniya, and bakery goods. The total production of edible oil accounts for about 10% of Egypt's total oil consumption. Sesame production is currently dominated by India and China, with Myanmar, Sudan, Uganda, Nigeria, Pakistan, Tanzania, Ethiopia, Guatemala, Turkey, and Egypt coming in third and fourth (**Noorka *et al.* 2011).**

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Nitrogen affects respiration, photosynthesis, cellulose synthesis, root growth, maturity, nodulation, and seed production since it is a component of amino acids, proteins, chlorophyll, nucleic acids, ATP, and phospholipids. one of the most crucial elements for increasing crop yields per unit area is N Fertilizer (**El-Sherif, 2016).**

Bread yeast extract (Saccharomyces cerevisiae), which enhances and increases growth and yield characteristics, has shown to be useful on numerous crops. According to some sources, the ancient Egyptians were the first to use yeast in the production of bread and wine, since it was discovered in jars going back to the year 3511 BC. It also appears that man has used yeast for bread since ancient times. without realizing what it was, they undoubtedly utilized it in the production of bread. Saccharomyces cerevisiae was the term given to beer yeast by Mayen in 5921 AD. The manufacture of alcohol (ethanol) for use as a biofuel is one of the numerous industrial domains where yeast has found new uses. 52 amino acids are found in bread yeast (**Maeini and Al-Isawi ,2017).**

The cultivated area of Sesame in Egypt is 66000 fed and the productivity was 35000 tons for the year 2018. The life cycle of plants depends on nitrogen, an important nutrient. However, using too much of this element in agriculture leads to significant issues. It is capable of obstructing the growth of numerous significant plants. Sesame, sometimes known as Indian sesame, is one of the oldest and most economically significant oil crops in the world. In actuality, numerous biological processes use its seeds .

Therefore, the aim of this study was to examine:-

1- Effect of different rates of yeast extract on the productivity of sesame.
2- Effect of different rates of nitrogen fertilization levels (30, 45, and 60 kg N/fed) on the productivity of sesame.

2- Materials and Methods

The current study was conducted at the Aswan University Experimental Farm in the Aswan Governorate during the summers of 2020 and 2021. Random soil samples from the experimental field were taken prior to planting, at a depth of 0–30 cm. the soil in the experimental farm was sandy. Table (1) displays mechanical and chemical study of the soil. This investigation aimed to identify the suitable yeast extract and nitrogen fertilization on growth, yield and yield components of sesame (shandaweel-3) under drip irrigation under the region of Aswan conditions **.**

2.1. Treatments and experimental design

The experiment was conducted in a randomized complete block design (RCBD) with a strip-plot set up and three replications. The main plots were set up using yeast extract, while the sub-plots were given nitrogen fertilizer.

The experiment included two factors:-

A- Yeast Extract:

1. No spray of yeast extract.
2. One spray after 20 days from planting.
3. Two spray of yeast extract after 20 and 30 days from planting.

B- Nitrogen Fertilization levels:

1. 30 kg N Fed^{-1} (89.5 kg Ammonium nitrate Fed^{-1}).
2. 45 kg N Fed^{-1} (134.3 kg Ammonium nitrate Fed^{-1}) .

3. 60 kg N Fed^{-1} (179.1 kg Ammonium nitrate Fed^{-1}).

2.2. Cultural practices

The plot measured 10.5 m (3.5 meter× 3 meter). Certified seeds of sesame (cv. shandaweel-3) obtained from Shandawil research center, Sohag, Egypt were sown (4 to 6 seeds in a hole) on one side of the ridge with 30 cm spacing. Seeds were grown in 22thapril at the rate of 6 kg fed-1 during the two growing seasons. A drip irrigation system was used in the study with a 30 cm distance between dippers (2L h^{-1}). After germination, after 15 days from sowing, the plants were thinned to two plants $hill^{-1}$. Phosphorus and potassium fertilizers in the form of potassium sulphate (48% K_2O) and calcium superphosphate (15.5% P_2O_5), respectively, were added during the preparation of the seedbed.

The emphasis is the same in all dosages of the three levels of yeast extract treatments sprayed: one level no spray, after 20 days from planting in the second concentration, and after 20 and 30 days from planting in the third concentration.

Ammonium nitrate (33.5% N) was added under plants and then watering it, in three equal doses of 30, 45, and 60 units of N fed^{-1}; the first dose was applied 20 days after sowing, and the second and third doses, respectively, at 30 and 40 days after sowing.

Plots were kept free of weeds through hand hoeing. Wheat was the previous winter crop in both years. Except for the parameters under research, all other agricultural procedures required for sesame were carried out according to the region's agriculture ministry's recommendations.

2.3. Characters studied

Data were recorded as means of ten (10) individual plants concerning growth characters after the spraying at 90 days from planting which were taken randomly from each plot representing the three replications. Sesame plants were harvested after 120 days from the planting. For yield characters, at harvest time another sample was assigned for this purpose. The procedure of recording the various data was carried out in the following manner:

A. Vegetative and growth characters

1- Plant height (cm): Before harvest, the main stem's length from the soil's surface to the plant's peak was measured with a ruler.
2- Frouting zone (cm): The length of the area from the first capsule from the bottom of the main plant stem to the top of the capsule has been measured using a ruler.
3- Number of capsules $plant^{-1}$: Ten randomly chosen plants from each unit plot had their capsule counts made, and their mean values were recorded.

B. Yield and its components

1- 1000-seed weight (g): 1000 seeds were counted and weighed according to treatment combination using a digital scale that expressed weight in grams (g).
2- Seed weight $plant^{-1}$ (g).
3- Seed yield kg fed^{-1}: From each plot, mature capsule pods were collected, and the seeds were removed in order to weigh. Ultimately, the yield of seeds per plot was converted to yield per *kilogram* and expressed in ton per ha (kg/ha).

C. Chemical analysis

1- Seed oil (%): The oil content was determined from a seed sample of five grams (total lipids were determined in dried samples according to the method of **A.O.A.C (2000).** Two gram of dry weight of each sample was extracted by using a mixture of chloroform-methanol

(2:1) for six hours at 45-50 °C in soxhelt apparatus. After extraction of total lipids, solvent was evaporated and the residue was evaporated and the residue was dried to a constant weight.

2- Seed protein content (%):

A- The total nitrogen concentration is estimated: For determination of total nitrogen concentration, the **Kjeldahl** method was used. 1 g of ground seeds, per treatment, was digested with 8 mL of concentrated H_2SO_4 in the presence of a catalyst. Then, to distill the sample, sodium hydroxide was added using a semiautomatic unit. 4% boric solution was used to collect nitrogen as ammonia (NH3). The titration was conducted with H_2SO_4 in the presence of an indicator (bromocresol green and methyl reed).

The following equation was used to estimate the total nitrogen concentration:

$$N(\%) = \frac{V(H_2SO_4) \times N(H_2SO_4) \times 1.4}{DW}$$

where V(H_2SO_4) is the volume of H_2SO_4 used for titration, N(H_2SO_4) is the normality of H_2SO_4 used for titration, and DW is the sample dry weight.

B- The protein content is measured:
(Total nitrogen × 6.25) according to **Jackson (1973) .**

2.4. Statistical analysis: According to **Gomez and Gomez (1984)**, data from experimental treatments were analyzed statistically using the strip-split plot design and the MSTAT-C (Russel, 1986) software programmer. LSD was used to compare the treatment means at a 5% level of probability.

Table 1: Mechanical and chemical analysis of the experimental site in the two seasons

Soil property *	**Season** **1st**	**2nd**
Physical properties		
Clay (%)	3.00	3.50
Silt (%)	0.00	0.00
Sandy (%)	97.00	96.50
Textural class	Sandy	Sandy
Chemical properties		
Soluble cations in (1:1) soil to water extract mmol/L)		
Ca++	3.06	3.10
Mg++	1.02	1.05
K+	0.83	0.85
Na+	0.76	0.80
Soluble anions in (1:1) soil to water extract(mmol/L)		
CO3-- 0	0.00	0.00
HCO3-	7.10	7.06
Cl-	3.60	3.07
SO4--	0.40	0.44
pH (1:1 soil suspension)	7.64	7.70
EC (ds/cm) at 25°C	0.33	0.32
Available N (mg/kg soil)	128.31	130.00
Available P (mg/kg soil)	8.00	10.00
Available K (mg/kg soil)	175.00	180.00

3- Results and Discussions

3.1. Vegetative growth traits

Average of plant height, frouting zone and Number of capsules plant^{-1} as affected by yeast extract, Nitrogen Fertilization and their interactions during 2020 and 2021 seasons. Data presented in Table 2 clear that plant height, frouting zone and Number of capsules plant^{-1} was significant affected by Nitrogen Fertilization in both seasons, the highest value for all previous character resulted from using nitrogen fertilization at a rate of 60 unit/fed in both seasons.

Different between plant height was significant based on yeast extract in 2020 season only, this in agreement with **Huthily *et al.* (2020)**, who demonstrated that the yeast's presence on amino acids, proteins, enzymes, and other significant things is the cause of this. these elements are necessary for the synthesis of nucleic acids and nitrogenous bases (RNA and DNA). Additionally, they included vitamins B1, B2, which were necessary for the synthesis of certain coenzymes and played a variety of significant roles in oxidative and reductive activities that took place across numerous metabolic processes, positively impacting plant growth. Also, Similar results were detected by **Mohamed *et al*. (2018)**, it has been showed that yeast increases cell division and nutritional state, enhancing stem elongation. Fertilization with nitrogen has a considerable impact on plant height in both seasons, this in agreement with **Kithan and Singh (2017)** It was discovered that the buildup of dry matter increased when nitrogen levels rose from 0 kg N ha^{-1} to 60 kg N ha^{-1}. Due to the fact that nitrogen is a major component of cells and aids in cell division and elongation, which may have eventually improved plant growth, the application of 60 kg N ha^{-1} resulted in higher plant dry weight. It encourages vegetative expansion. the yeast extract and nitrogen fertilization interaction was significant on plant height in 2021 season only which was (175.92), it was recorded when spraying plants with yeast extract twice and nitrogen fertilization at a rate of 60 unit / fed.

The frouting zone variation for the spray of yeast were significant differences between level of yeast extract in the first season this in agreement with **Abdel-Rahman *et al.* (2020)**. yeast may have an enhancing impact since it is a natural supply of phytohormones, particularly cytokine's, which promote cell division and cell expansion. Nitrogen fertilization on frouting zone is significant in both seasons: **Noorka *et al.* (2011);** these findings were anticipated since nitrogen stimulates cell elongation and division, which increases the number and length of internodes and causes plants to grow higher**.** The interaction impact between yeast extract x nitrogen fertilization was significant on frouting zone in sesame crop in the first season only.

Number of capsules plant^{-1} was influenced by spray of yeast extract in 2021 seasons. In this respect According to a report, yeast extract treatment increased the number of capsules per plant^{-1} and their set in some plants because of the yeast's high auxin and cytokines content and favorable impact on the buildup of carbohydrates. Effect of nitrogen fertilization on number of capsules plant^{-1} is significant in both seasons. The previous results are in accordance with those obtained by **Badshah *et al*. (2017).** They showed that increasing nitrogen fertilizer increased the number of capsules plant^{-1}, with the maximum number of capsules plant^{-1} (122.0) being seen at 40 kg N ha^{-1}. Following that, adding more nitrogen did not result in an increase in the number of capsules plant^{-1}; too much nitrogen merely increases plant growth at the expense of yield and fruit number. As noted by **El Mahdi (2008)** raising nitrogen levels resulted in more capsules per plant, which could be linked to nitrogen's role in promoting vegetative development. These results are in agreement with those reported by **Noorka *et al*. (2011)**; The increased number of capsules produced by plant^{-1} may be related to N's beneficial influence on the amount of metabolites produced and pod formation.. The interactions effect between yeast extract x nitrogen fertilization on number of capsules plant^{-1} was no significant in both seasons.

Table 2: Means of Vegetative growth traits of sesame as affected by yeast extract, Nitrogen Fertilization and their interactions during 2020 and 2021 seasons.

Traits		Plant height (cm)		Frouting zone (cm)		No. capsules plant^{-1}	
		2020	2021	2020	2021	2020	2021
yeast extract (A)							
A1: Control		123.91	137.87	81.99	107.13	74.59	42.38
A3: On 20 Day		130.12	147.84	97.38	117.59	78.63	53.55
A2: On 20,30 Day		141.41	159.14	102.54	120.61	92.04	65.59
LSD at 5%		N.S	7.35**	15.09	N.S	N.S	12.23**
Nitrogen Fertilization (B)							
b1: 30 unit/fed		123.48	134.18	87.33	100.53	70.74	43.14
b2: 45 unit/fed		130.93	146.31	86.73	117.25	80.21	53.71
b3: 60 unit/fed		141.04	164.35	107.86	127.56	94.85	64.66
LSD at 5%		4.11**	4.42**	16.34	6.80**	7.37**	5.44**
yeast extract × Nitrogen Fertilization (A × B)							
A1	b1	111.97	165.13	81.06	89.08	63.46	36.25
	b2	124.02	165.47	67.97	111.06	73.92	40.18
	b3	135.76	160.67	96.94	121.26	86.40	50.71
A2	b1	124.21	164.00	89.13	103.53	68.67	42.69
	b2	126.82	163.87	93.15	119.49	78.31	54.37
	b3	139.33	162.33	109.87	129.76	88.91	63.58
A3	b1	134.25	165.13	91.78	108.98	79.29	50.48
	b2	141.95	165.47	99.07	121.19	88.40	66.59
	b3	148.02	160.67	116.77	131.67	108.43	79.68
LSD at 5%		N.S	5.36	N.S	4.22	N.S	N.S

3.2. Yield and its components

The available data in table 3 showed that the 1000- seed weights for spray of yeast extract twice were significantly high and gave the heaviest weights in second seasons, respectively. This in agreement with **Dewedar and Ibrahim (2016),** Due to yeast's capacity to increase the production of plant growth stimulants, particularly gibberellins, auxins, and cytokines that act to improve plant cell division and growth, the main effect of foliar yeast spray may be that yeast induces nutrient minerals absorption through general improvement. The previous results are in accordance with those obtained by **Mady. (2009)** This enhanced effect of yeast extract may be explained by their favourable effects on biological function and metabolism, as well as by their stimulation of enzyme and photosynthetic pigment activity, which in turn promotes vegetative growth. the impact of nitrogen fertilizer on the weight of 1000- seed is notable in both seasons, this in agreement with **Noorka *et al.* (2011)**. The fact that N encouraged plant development, such as plant height and branch count plant^{-1}, increased the quantity of light energy captured by leaves may be the cause of nitrogen fertilizer's favorable influence on 1000-seed weight. N also enhanced the amount of photosynthetic pigments and the rate of photosynthesis, which in turn boosted the production of metabolites and, as a result, led to a higher accumulation of dry matter in the leaves and partitioning to the seeds. Additionally, the data demonstrated that neither season's yeast extract x nitrogen fertilizer combination had a significant impact on the weight of 1000-seeds.

Data showed that yeast extract impact on Seed weight plant^{-1} was not statistically significant during either season. while, nitrogen fertilization was significant respectively in the first and second season. These results are in line with the findings of **Ibrahim *et al.* (2014)** reported that higher nitrogen doses had the highest number of seed weight plants, while lower nitrogen doses (control) had the lowest number of seed weight plants; this led to an increase in seed weight plant^{-1}. This might be because the plant has more leaves, they use nitrogen more efficiently, and they block more sunlight, which means that more photosynthetic material gets assimilated by the sesame seed, which is the reproductive component of the plant. These findings are in harmony with those obtained by **Noorka *et al*. (2011)** who discovered that the number of seed weight plant^{-1} and 1000-seed weight increased when N fertilizer was added because N promoted plant growth. While the interactions effect between yeast extract x nitrogen fertilization on seed weight plant^{-1} was no significant in both seasons.

Table 3: Means of yield and its components of sesame as affected by yeast extract, Nitrogen Fertilization and their interactions during 2020 and 2021 seasons.

Traits		1000-seed weight (g)		Seed weight plant^{-1} (g)		Seeds yield kg fed^{-1}	
		2020	2021	2020	2021	2020	2021
yeast extract (A)							
A1: Control		2.55	3.68	12.58	8.31	366.49	265.76
A3: On 20 Day		2.61	3.97	15.71	11.30	461.13	318.56
A2: On 20,30 Day		2.93	4.06	18.69	16.30	533.52	434.10
LSD at 5%		**0.25****	**N.S**	**N.S**	**N.S**	**N.S**	**N.S**
Nitrogen Fertilization (B)							
b1: 30 unit/fed		2.49	2.55	12.77	9.15	394.87	313.11
b2: 45 unit/fed		2.70	2.61	15.42	12.35	449.87	329.41
b3: 60 unit/fed		2.90	2.93	18.78	14.40	516.41	375.90
LSD at 5%		**0.9****	**0.22****	**0.63****	**1.49****	**34.33****	**N.S**
yeast extract × Nitrogen Fertilization (A × B)							
A1	**b1**	2.34	3.48	9.56	6.53	307.73	260.00
	b2	2.53	3.51	12.60	8.82	356.07	248.87
	b3	2.79	4.05	15.57	9.57	435.67	288.42
A2	**b1**	2.46	3.92	13.43	7.87	407.93	287.60
	b2	2.62	3.90	15.02	12.28	454.87	310.40
	b3	2.75	4.09	18.68	13.73	520.60	357.67
A3	**b1**	2.66	3.70	15.32	13.04	468.93	391.73
	b2	2.96	4.07	18.65	15.96	538.67	428.97
	b3	3.17	4.40	22.09	19.89	592.97	481.60
LSD at 5%		**N.S**	**N.S**	**N.S**	**N.S**	**N.S**	**N.S**

Seed yield kg fed^{-1} for spray of yeast extract was not statistically significant during either season, while nitrogen fertilization has a substantial impact on seed yield kg fed^{-1} only in the 2020 season, these results are agreement with **Haruna (2011)** Sesame grain yield per hectare was optimized at moderate nitrogen application rates rather than the greatest rates as in growth indices. This may be the result of excessive nitrogen application, which has increased plant growth while reducing production. Similar trend was recorded by **Noorka *et al*. (2011).** The benefit of nitrogen in promoting plant growth may account for the beneficial effect of increasing N fertilizer level on sesame seed yield fed^{-1}. Plant characteristics like plant height and fruiting zone length support yield characteristics like plant^{-1} capsule count, 1000-seed weight, and plant-per-seed weight, which increases seed production ha^{-1}. Also interactions effect between yeast extract x nitrogen fertilization on seed yield kg fed^{-1} was no significant in both seasons.

3.3. Chemical analysis

Seed oil % variation for spray of yeast extract is presented in table (4). It was clear from data, that effect of yeast extract on seed oil % is significant in both seasons. These results are agreement with **Abdallah *et al.* (2016).** This may be because to its high nutrient content and ability to produce semi-growth-regulating substances including auxins, gibberellins, and cytokine's. The yeast was able to increase simulative growth substances including auxins, cytokine's, and gibberellins, which help plants divide and grow more quickly. the physiological effects of vitamins and amino acids in yeast extract, which accelerated metabolic processes and raised levels of native hormones, may also be responsible for these outcomes. Also effect of nitrogen fertilization on seed oil % is significant in both seasons. Similar results have been reported by **Elhanafi *et al.* (2019)** who applied a high dose of N and demonstrated that little oil content was recorded. This could result from putting more effort and resources into producing proteins than oil, which would lower the concentration of oil. These results are in a same trend with those found by **Noorka *et al*. (2011)** who founded that seed oil content (%) increased with a decrease in nitrogen level; these findings were anticipated given that the smaller seeds produced by low nitrogen rates (measured as the weight of one thousand seeds) may have been at the expense of carbohydrate storage rather than oil production, which led to an increase in the percentage of the latters. Additionally, interaction between yeast extract and nitrogen fertilizer on seed oil was significant in both seasons.

Data showed significant effect among different yeast extract on Seed protein % in both seasons this is consistent with what **Al-Shamary and Huthily (2019)** found various components of yeast, such as acids, vitamins, growth regulators, and nutrients that actively contribute to boosting the protein yield, may be to blame for this. Also nitrogen fertilization was significant effect in both seasons. **Elhanafi *et al.* (2019)** reported that the nitrogen delivery enhanced the total amount of soluble proteins in seeds. In fact, the absorbed nitrogen is transformed to amino acids that make proteins after numerous energy-intensive processes. Additionally, the nitrogen supplies to proteins increased at the expense of the synthesis of fatty acids. To be more specific, nitrate that has been assimilated is changed to nitrite by the enzyme nitrate reductase, which is then changed back to ammonium by the metabolic pathway. Then, via the GS/GOGAT pathways, this element is converted into amino acids, necessitating certain physiological processes to raise the protein amount. The interactions effect between yeast extract x nitrogen fertilization on seed protein % was significant in both seasons.

Table 4: Means of Chemical compositions of sesame seeds as affected by yeast extract, Nitrogen Fertilization and their interactions during 2020 and 2021 seasons

Traits		Seed Oil %		seed protein %	
		2020	2021	2020	2021
		yeast extract (A)			
A1: Control		51.33	52.07	21.73	21.90
A3: On 20 Day		50.58	51.27	22.27	22.75
A2: On 20,30 Day		49.88	50.40	22.94	22.86
LSD at 5%		**0.06****	**0.03****	**0.18****	**0.17****
		Nitrogen Fertilization (B)			
b1: 30 unit/fed		51.59	52.26	21.73	21.90
b2: 45 unit/fed		50.55	51.13	22.55	22.75
b3: 60 unit/fed		49.65	50.33	22.66	22.86
LSD at 5%		**0.05****	**0.02****	**0.34****	**0.42****
		yeast extract × Nitrogen Fertilization (A × B)			
A1	b1	52.43	53.12	21.24	21.36
	b2	51.22	51.49	21.53	21.90
	b3	50.33	51.14	22.43	22.44
A2	b1	51.61	52.44	21.82	22.10
	b2	50.52	51.03	23.48	22.65
	b3	49.62	50.33	21.52	23.52
A3	b1	50.73	51.23	22.13	22.25
	b2	49.90	50.43	22.64	22.63
	b3	49.91	49.54	24.04	23.71
LSD at 5%		**0.08****	**0.01****	**0.38****	**0.44****

4. Conclusion

It is concluded from present results that planting sesame plants (cv. shandaweel-3) using 60 units / fed from nitrogen fertilization led to a significant increase in most traits of sesame under the climatic conditions of the Aswan Governorate.

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