SINAI Journal of Applied Sciences (ISSN: 2314-6079) Vol. (6) Is. (3), Dec. 2017 273-284

SINAI Journal of Applied Sciences

ARU-EGYPT SJAS Trust Science | It Creates

INFLUENCE OF NITROGEN FERTILIZATION AND ACTIVE DRY YEAST ON LAVANDER (*Lavandula officinalis*) PLANTS PRODUCTIVITY UNDER NORTH SINAI CONDITIONS

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ABSTRACT

The present work aimed to improve lavender plants (*Lavandula officinalis* L.) and volatile oil by using N fertilization and dry yeast in field experiment during the two seasons of 2013/2014 and 2014/2015. Four rates of nitrogen fertilizer were used in this work; 0, 50, 100 and 150 kg/fed as urea (46 %N) combined with four dry yeast concentrations (0%, 10%, 20% and 30%). The results were recorded that vegetative growth (plant height, herb fresh and dry weights/plant), root system (fresh and dry weights of root/plant), oil yield (oil yield/plant and per fen) and some chemical constituents (N, P and K percentages). Generally the highest values of vegetative growth and oil content per plant and per fed were obtained by using urea at level (150 kg.fed^{-1}) combined with spraying plants' leaves by 30% dry yeast as foliar spry under North Sinai conditions.

Key words: Lavander (*Lavandula officinalis* L.), Nitrogen fertilization, Urea, Active dry yeast.

INTRODUCTION

Lavandula officinalis L. is belongs to family Labiatae. Lavender is a strongly aromatic shrub with pale green, narrow, linear leaves and violet-blue flowers. The herb has been popular for centuries as stomachic and diuretic, carminative, spasmolytic. Its powerful antiseptic properties are able to kill many frequent bacteria such as typhoid **(Kulevanova *et al*., 2000)**. The fragrant leaves and flowers are used fresh in salads and dishes, dried are used as a tea, for calming baths and as insect repellent in linen cupboards **(Kuhn and Winston, 2008)**. The extensive lavender oil production is due to its widespread uses by various industries, such as pharmaceutical, foods, beverages, liqueurs, perfumery and cosmetics, and ecofriendly pesticides **(Tonutti and Liddle, 2010;Topalov, 1989).**

Nitrogen is considered a master element in plant nutrition. Nitrogen uptake as ammonium compounds form serves as starting material for amino acid biosynthesis and additional N-containing compound such as pyrimidine, purine bases, chlorophyll, proteins, nucleic acid, vitamins and other organic compounds. Therefore, the higher plants require larger amount of nitrogen than is any of the mineral nutrients and the absence of an external supply of nitrogen reduced plant growth, root and stem growth also directly reduce photosynthesis, protein synthesis and respiration **(Strafford, 1973)**. Urea or carbamide is an organic composition with chemical formula $CO(NH_2)_2$, more than 90% of urea in the world is produced in order to application as nitrogen chemical fertilizers. Urea with 46% nitrogen, has the greatest nitrogen amount among all nitrogen solid fertilizers and on this basis, urea has the lowest transportation cost in

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lieu of each nitrogen unit. Urea is presented as small pearl grains, which is called "Sugar fertilizer" **(Salardini, 1987)**.

The dry bread yeast (*Saccharomyces cerevisiae*) is a kind of the used biofertilizers in soil fertilization or in foliar application on the shoots of vegetable crops **(El-Ghamriny *et al*., 1999)**. This is because its content of many nutrient elements and being productive compounds of semi growth regulator compounds like auxins, gibberellins and cytokinins **(Glick, 1995)**.

So that the present work aimed to improve lavander plants (*Lavandula officinalis*) productivity by using nitrogen fertilization and active dry yeast.

MATERIALS AND METHODS

Two field experiments were carried out at the Experimental Farm of Fac. of Environ. Agric. Sci., Arish University, North Sinai Governorate during the two successive winter seasons of 2013/2014 and 2014/2015, to study the effect of nitrogen fertilizer, active dry yeast on the vegetative growth, root system, oil yield and some chemical constituents of *Lavandula officinalis* plant.

The experimental soil used was sandy in texture. It was sampled before fertilizer application to a depth of 0-30 cm and analyzed for some chemical and physical characteristics as shown in Table 1. The experiment was conducted under drip irrigation system conditions using well water. Chemical analysis for irrigation is also presented in Table (1).

Fertilizer Description

Nitrogen fertilization was applied at rates (0, 50, 100 and 150 kg.fed^{-1}) as urea (46% N). The amounts were added in two equal doses; the first after one month from sowing and the remainders, one month later. Calcium supper phosphate (15.5% $P_2O_{5)}$ and potassium sulphate (48% k_2o) were added in one dose prior to sowing during soil preparation at the rate of 200 and 30 kg/fed^{-1}, respectively.

Dry Yeast Concentrations

Dry yeast as foliar spray was applied at (0, 10%, 20% and 30%). Spray was applied twice first one after one month from sowing and the second one after month later.

Field Trials

The experimental unit area was 45 m^2. Every unit contained three dripper lines with 15 m length. The distance between lines was 1.0 m and between drippers was 50 cm between plants (8400 plants per fed.). Control plots were cultivated in the same way. Treatments were laid out in split -plot design with three replicates. Nitrogen fertilization rates were randomly arranged in the main plot. The dry yeast concentrations were randomly distributed in sub plots.

Vegetative Growth Parameters

Plant height (cm), herb fresh weight (g), herb dry weight (after drying at 70 ^{0}C for 24 hours) (g), root fresh weight (g) and root dry weight (g) (after drying at 70 ^{0}C for 24 hours) were recorded.

Oil yield

Oil percentage was determined from fresh samples (100g) at harvest on May for the two seasons. Each sample was transferred to distillation flask to which 500 ml water were added and subjected to water steam distillation. The process was continued to about 5 hours according to **British Parmacopia (1963)**. However, oil yield/plant (g) was calculated by multiplying the oil percentage by the average fresh weight per plant.

Table (1): Some initial chemical and physical characteristics of soil and well water.

Parameter	Soil		Well water
	1st season	2nd season	
Soluble ions* meq.L^{-1} (soil past extract)			
Ca^{++}	3.03	2.10	18.12
Mg^{++}	2.11	2.20	20.20
Na^{+}	1.18	4.49	17.72
K^{+}	0.48	0.31	0.25
Cl^{-}	1.02	2.30	38.40
Co_3^{--}	Nd	Nd	Nd
Hco_3^{-}	2.00	2.40	6.25
So_4^{--}	3.78	4.40	11.64
EC*e* (dsm^{-1})	0.68	0.91	5.65
pH (1:2.5)	8.10	8.20	6.70
Concentration (ppm)			3200 – 3400
Organic carbon (g.kg^{-1})	0.93	1.22	-
Organic mater (g.kg^{-1})	1.60	2.10	-
Ca CO_3 (g.kg^{-1})	3.95	3.95	-
Particular size distribution (%)			
Clay	0.16	0.16	-
Silt	0.33	0.33	-
Fine sand	76.1	76.1	-
Coarse sand	18.71	18.71	-
Soil texture	Sandy soil	Sandy soil	-

Experiment design and statistical analysis

The complete randomized block design (CRBD) was used in this experiment with three replicates. All collected data were analyzed with analysis variance (ANOVA) procedure using MSTAT-C statistical software package **(Michigan State University, 1983)**. Differences between means were compared by using Duncan multiple range test at 0.05 **(Duncan, 1955)**.

RESULTS AND DISCUSSION

Effect of Interaction between Nitrogen Fertilization and Dry Yeast Foliar Spray Treatments on Growth, Oil Yield and Some Chemical Constituents of Lanvander Plants

Vegetative Growth

Plant height

Results presented in Table 2 show that interaction between N fertilization and dry yeast significantly increased lavender plant height compared to control. Results cleared that addition of urea at 150 kg.fed^{-1} combined with dry yeast as foliar spray at 30% recorded the highest values of plant height in the two seasons (42.33 cm and 58.66 cm), respectively. While, control treatment recorded the lowest values of plant height in the two seasons (26.66 cm and 30.66 cm), respectively.

These results are in a harmony with those found by **Migahed and El-Kased (1998)** on dill plants, they concluded that using urea at the rates of 150 and 300 kg/fed. increased plant height.

Herb fresh weight / plant

Results illustrated in Table 2 show that the interaction between N fertilization and dry yeast, significantly increased lavander herb fresh weight compared to control. Results cleared that addition of urea at 150 kg.fed^{-1} combined with dry yeast as foliar spray at 30% recorded the highest values of herb fresh weight in the two seasons (150.00g and 125.99 g), respectively. In addition, control treatment recorded the lowest values of herb fresh weight/plant in the two seasons (70.60 g and 73.53 g), respectively.

These results are in the same way with those found by **El-Sherbeny *et al.* (2007)** on *Ruta graveolens* plants they found that applying dry yeast at level of 2500 ppm increased fresh weight of leaves, stem and root.

Herb dry weight / plant

Results presented in Table 2 show that application of nitrogen fertilization with dry yeast, significantly increased lavender herb dry weight compared to control. Results cleared that addition of urea at 150kg. fed^{-1} combined with dry yeast as foliar spray at 30% recorded the highest values of herb dry weight in the two seasons (67.41g and 68.21g). On the other hand, control treatment recorded the lowest values of herb dry weight in the two seasons (30.24g and 26.02g).These results are in a harmony with those found by **Matter and El-Sayed (2015)** on caraway they reported that spraying active dry yeast at 0, 2 or 4g/l improved plant growth characters.

Root System

Root fresh weight/plant

It is quite clear from the results in Table 2 that, interaction between N fertilization and dry yeast significantly increased lavander root fresh weight compared to control. Results show that addition of urea at 150 kg. fed^{-1} + dry yeast at 30% as foliar spray recorded the highest values of root fresh weight in the two seasons (42.33g and 45.66 g), respectively, compared with the lowest values of root fresh weight in the two seasons by control treatment (9.00 g and 7.91 g, respectively).

Table (2): Effect of interaction between N fertilization and dry yeast foliar spray treatments on vegetative growth of lavander during two seasons (2013/2014 and 2014/2015).

Treatment / Parameter		Plant height (cm)	Herb fresh weight / plant (g)	Herb dry weight / plant (g)	Root fresh weight / plant (g)	Root dry weight / plant (g)
N kg. fed^{-1}	Dry Yeast (%)					
First season (2013 - 2014)						
0.0	**0.0**	26.66 l	70.60 p	30.24 n	9.00 m	3.06 m
	10%	29.00 k	79.00 o	30.50 n	10.00 m	4.45 lm
	20%	29.26 k	90.66 n	32.64 m	12.20 l	5.42 l
	30%	30.33 k	97.12 m	34.78 l	14.17 k	7.43 k
50	**0.0**	31.33 ij	103.33 l	35.39 l	18.33 j	10.20 j
	10%	32.66 hi	106.45 k	37.07 k	21.00 i	12.11 i
	20%	33.66 gh	110.33 j	39.42 j	22.51 i	15.13 h
	30%	34.00 gh	113.42 i	44.55 i	24.33 h	17.50 g
100	**0.0**	35.00 fg	116.42 h	46.43 h	26.86 g	19.99 f
	10%	36.33 ef	123.00 g	49.14 g	27.66 g	21.24 f
	20%	37.00 de	128.33 f	52.34 f	29.66 f	24.05 e
	30%	38.33 cd	133.66 e	55.32 e	32.00 e	26.02 d
150	**0.0**	39.66 bc	138.70 d	57.27 d	34.33 d	29.70 c
	10%	40.66 ab	143.66 c	60.38 c	37.33 c	31.52 b
	20%	41.00 ab	147.00 b	66.26 b	39.33 b	33.16 b
	30%	42.33 a	150.00 a	67.41 a	42.33 a	36.60 a
Second season (2014 – 2015)						
0.0	**0.0**	30.66 k	73.53 p	26.02 m	7.91 n	3.08 m
	10%	33.33 j	75.72 o	29.18 l	9.38 n	4.54 m
	20%	35.66 i	77.77 n	33.21 k	11.58 m	6.71 l
	30%	38.00 h	80.76 m	35.47 j	13.09 m	8.49 k
50	**0.0**	39.33 gh	82.69 l	37.10 j	16.48 l	10.51 j
	10%	40.00 fg	85.29 k	40.23 i	19.31 k	12.67 i
	20%	40.00 fg	88.24 j	42.25 h	21.22 j	14.27 hi
	30%	40.66 e-g	91.24 i	45.10 g	23.16 i	15.37 h
100	**0.0**	41.33 d-f	94.97 h	48.64 f	26.11 h	17.67 g
	10%	42.00 de	97.34 g	50.06 f	28.44 g	19.39 f
	20%	42.33 c-e	102.61 f	52.87 e	32.13 f	20.30 f
	30%	43.00 cd	107.45 e	55.88 d	35.37 e	23.45 e
150	**0.0**	44.00 bc	111.85 d	57.23 d	37.83 d	27.06 d
	10%	44.00 bc	116.73 c	60.16 c	40.22 c	30.70 c
	20%	45.33 b	120.41 b	64.99 b	42.79 b	33.59 b
	30%	58.66 a	125.99 a	68.21 a	45.66 a	37.69 a

Means having the same letter within the same column are not significantly different according to Duncan's multiple range test at 5% level of probability.

These results are in accordance with those stated by **Narkhede *et al.* (2011),** they found significant increase in plant height, leaf length and fruit yield of pepper plants was observed in plots treated with vermicompost compared with urea as chemical fertilizer alone.

Root dry weight per plant

Results recorded in Table 2 show that interaction between nitrogen fertilization and dry yeast significantly increased lavender root dry weight compared to control. Results cleared that, addition of urea at 150 kg.fed^{-1} (N) with dry yeast as foliar spray at 30% recorded the highest values of root dry weight in the two seasons (36.60g and 37.69g) respectively.

While control treatment recorded the lowest values of root dry weight in both seasons (3.06 g and 3.08 g) respectively.

These results are in a harmony with those found by **Migahed and El-Kased (1998)** on dill plants, they concluded that using urea at the rates of 150 and 300 kg/fed. increased root dry weight.

Also, **Taha *et al.* (2016)** investigated the effect of spraying neem plants with dry yeast (*Saccharomyces cerevisiae*) extract at various concentrations (0, 5, 10, 15 and 20%) on growth. Results showed that yeast extract at 15% significantly increased growth parameters (plant height, stem and root fresh and dry weights).

Oil Yield

Oil yield per plant

Results presented in Table 3 show that interaction between nitrogen fertilization and dry yeast, significantly increased lavender oil yield per plant compared to control. Moreover, addition of urea at 150 kg.fed^{-1} (N) with dry yeast as foliar spray at 30% recorded the highest values of oil yield per plant in the two seasons (420.00 ml and 352.77 ml/plant) respectively. In the other hands, control treatment recorded the lowest values of oil yield/plant in the two seasons (102.71 ml and 103.23 ml/plant, respectively.

These results are in a harmony with those found by **Sakr *et al.* (2015)** on lavender plants**,** they mentioned that, the highest essential oil production can be attributed to apply sheep manure at the rate of 15 m^3 /fed + 6 g/l active dry yeast, in addition to 300 kg/fed calcium super phosphate, 100 kg/ fed potassium sulphate and ammonium sulphate at the rate of 150 kg/fed.

Oil yield per fed

As shown in Table 3 it is clear that interaction between N fertilization and dry yeast significantly increased lavender oil yield per fed. compared to control. Furthermore, addition of urea at 150 kg.fed^{-1} + dry yeast as foliar spray at 30% recorded the highest values of oil yield per fed in the two seasons (3528.02 L and 2954.31 l/fed, respectively. In contrast, control treatment recorded the lowest values of oil yield/fed in the two seasons (862.76 l and 867.13 l/fed respectively.

These results are in accordance with those found by **Sakr *et al.* (2015)** on lavender plants mentioned that, For the highest essential oil production it can be recommended to apply sheep manure at the rate of 15 m^3 /fed + 6 g/L active dry yeast, in addition to 300 kg/fed calcium super phosphate, 100 kg/ fed potassium sulphate and ammonium sulphate at the rate of 150 kg/fed.

Chemical Constituents

Nitrogen percentage

Results in Table 4 show that interaction between N fertilization and dry yeast significantly increased lavender nitrogen percentage compared to control. Results cleared that addition of urea at 150 kg.fed^{-1} (N) with dry yeast as foliar spray at 30% recorded the highest values of nitrogen (%) in the two seasons (5.01% and 5.85%,

Table (3): Effect of interaction between N fertilization and dry yeast foliar spry treatments on oil yield of lavender during two seasons (2013/2014 and 2015/2016).

Treatment / Parameters		Oil yield per plant (ml)	Oil yield per fed (L)
N kg. fed^{-1}	Dry Yeast (%)		
First season (2013 - 2014)			
o.o	0.0	102.71 l	862.76 l
	10%	110.60 k	929.04 k
	20%	126.92 ij	1066.16 ij
	30%	256.40 e	2153.76 e
50	0.0	123.99 j	1041.59 j
	10%	138.38 i	1162.40 i
	20%	187.56 h	1575.54 h
	30%	215.49 g	1810.12 g
100	0.0	175.63 h	1475.326 h
	10%	249.72 e	2097.67 e
	20%	260.54 e	2188.56 e
	30%	294.05 d	2470.06 d
150	0.0	235.78 f	1980.60 f
	10%	316.01 c	2654.55 c
	20%	357.76 b	3005.24 b
	30%	420.00 a	3528.02 a
Second season (2014 – 2015)			
0.0	0.0	103.23 k	867.13 k
	10%	106.03 j	890.46 j
	20%	108.87 j	914.57 j
	30%	213.20 e	1790.96 e
50	0.0	99.23 j	833.54 j
	10%	144.20 j	1211.28 j
	20%	150.01 i	1260.09 i
	30%	173.34 h	1456.13 h
100	0.0	142.45 i	1196.65 i
	10%	197.63 fg	1660.12 fg
	20%	208.33 ef	1749.98 ef
	30%	236.39 d	1985.83 d
150	0.0	190.14 g	1597.19 g
	10%	256.77 c	2156.89 c
	20%	293.06 b	2461.74 b
	30%	352.77 a	2963.26 a

Means having the same letter (S) within the same column are not significantly different according to Duncan's multiple range test at 5% level of probability.

Table (4): Effect of interaction between N fertilization and dry yeast foliar spry treatments on chemical constituents lavender during two seasons (2013/2014 and 2014/2015).

Parameters / Treatment		Nitrogen content (%)	Phosphorus content (%)	Potassium content (%)
N kg. fed^{-1}	Dry Yeast (%)			
First season (2013 - 2014)				
o.o	0.0	2.40 m	0.30 k	2.36 l
	10%	2.60 l	0.45 j	2.41 k
	20%	2.65 kl	0.46 j	2.43 k
	30%	2.70 k	0.50 i	2.46 j
50	0.0	2.70 k	0.50 i	2.53 i
	10%	2.90 j	0.52 h	2.55 i
	20%	2.95 ij	0.55 g	2.60 h
	30%	3.00 hi	0.56 fg	2.65 g
100	0.0	3.05 h	0.57 ef	2.67 fg
	10%	3.45 g	0.57 ef	2.70 f
	20%	3.95 f	0.58 e	2.74 e
	30%	4.35 e	0.61 d	2.80 d
150	0.0	4.45 d	0.63 c	2.83 c
	10%	4.75 c	0.72 b	2.86 b
	20%	4.85 b	0.72 a	2.90 b
	30%	5.01 a	0.80 a	2.97 a
Second season (2014 – 2015)				
0.0	0.0	3.25 p	0.83 l	2.20 n
	10%	3.35 o	0.86 k	2.27 m
	20%	4.30 n	0.86 k	2.35 l
	30%	4.35 n	0.86 k	2.40 k
50	0.0	4.65 m	0.89 j	2.46 j
	10%	4.85 l	0.92 i	2.53 i
	20%	5.10 k	0.95 h	2.58 h
	30%	5.25 j	0.98 g	2.63 g
100	0.0	5.30 i	0.99 g	2.69 f
	10%	5.35 h	1.00 f	2.72 f
	20%	5.45 g	1.00 f	2.76 e
	30%	5.55 f	1.01 e	2.82 d
150	0.0	5.65 c	1.02 d	2.86 c
	10%	5.70 c	1.03 c	2.90 b
	20%	5.75 b	1.05 b	2.93 b
	30%	5.85 a	1.07 a	2.89 a

Means having the same letter (S) within the same column are not significantly different according to Duncan's multiple range test at 5% level of probability.

respectively). Moreover, control treatment recorded the lowest values of N% in the two seasons (2.40% and 3.25% respectively).

These results are in accordance with those found by **Taha *et al.* (2016)** on neem plant, studied the effect of foliar spraying plants with dry yeast (*Saccharomyces cerevisiae*) extract at. various concentrations (0, 5, 10, 15 and 20%) on nitrogen content. They added that nitrogen content was produced at the highest value (3.55%) in plants treated with dry yeast extract at 10%.The foliar application of yeast extract at 10, 15 and 20% resulted the highest values of total soluble phenols (72.48, 72.27 and 73.46 mg/g D.W., respectively). The highest flavonoids leave content (3.23 and 3.14 mg CE/g dry yeast) were obtained when the dry yeast extract was used at 15 and 20%, respectively.

Phosphorus percentage

Results tabulated in Table 4 show that interaction between nitrogen fertilization and dry yeast, significantly increased lavender phosphorus percentage compared to control. However, addition of urea at 150 kg.fed^{-1} + dry yeast as foliar spray at 30% recorded the highest values of phosphorus percentage in the two seasons (0.80% and 1.07%) respectively.

While, control treatment recorded the lowest values of phosphorus percentage in the two seasons (0.30 % and 0.83%) respectively.These results are in a aggrement with those found by **Rao *et al.* (1997)** on davana plants they recorded that, effects of N (0, 80 or 160 kg/ha.) and farm yard manure (0, 15 or 30 t/ha.) significantly enhanced N, P and K uptake.

Potassium percentage

Results presented in Table 4 show that interaction between nitrogen fertilization and dry yeast significantly increased lavender potassium content compared to control. Also, addition of urea at 150 kg.fed^{-1} (N) with dry yeast as foliar spray at 30% recorded the highest values of potassium % in the two seasons (2.97 % and 2.98 %, respectively). While control treatment recorded the lowest values of K (%) in the two seasons (2.20 % and 2.36 %, respectively).

These results are in similar with those found by **Subramanian and Vijayakumar (2001)** on coriander plants, they reported that, the highest level each of N (1.22%), P (0.11%) and K (1.46%) in the plant tissue was noticed in 100% N(20 kg/ha) combined with *Azospirillum* seed and soil application. Also, **Fawzy *et al.* (2012)** studied the response of two varieties of onion plant "Giza 20 and Super X" to foliar spraying of EM" Effective microorganisms" amino acids and yeast on chemical composition. They found that Giza 20 cv. gave the highest amount of TSS, N, P and K% as well as some trace elements compared with Super X cv.

With regard to foliar application treatments, the results indicated that, using EM, amino acids and yeast had positive promoting effects by providing supplemental doses of these components on growth, yield and its quality as well as all chemical composition compared with control plants.

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المُلخص العربى

تأثير التسميد النيتروجينى الكيماوى والرش بالخميرة على إنتاجية نبات اللافندر تحت ظروف شمال سيناء

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تهدف هذه الدراسة الى تحسين انتاجية نبات اللافندر والزيت الطيار باستخدام التسميد النيتروجيني والخميرة الجافة النشطة فى التجربة الحقلية خلال المواسم ٢٠١٣-٢٠١٤ و٢٠١٤-٢٠١٥، تم إضافة النيتروجين بالمستويات (صفر، ٥٠، ١٠٠، ١٥٠ وحدة نيتروجين) فى صورة يوريا (٤٦% نيتروجين)، بالاشتراك مع أربع تركيزات من الخميرة الجافة (صفر%، ١٠%، ٢٠%، ٣٠%)، وسجلت البيانات أن النمو الخضري، ارتفاع النبات، الوزن الطازج والجاف، المجموع الجذري، الوزن الطازج والجاف للجذور، محصول الزيت للنبات وللفدان وبعض المكونات الكيميائية (النسبة المئوية لكل من النيتروجين والفسفور والبوتاسيوم)، وبشكل عام تم الحصول على أعلى قيم للنمو الخضري ومحتوى الزيت باستخدام اليوريا عند المستوى (١٥٠ وحدة نيتروجين) بالإضافة إلى رش اوراق النباتات بالخميرة الجافة بتركيز٣٠% تحت ظروف شمال سيناء.

الكلمات الإسترشادية: تأثير التسميد النيتروجينى، الرش بالخميرة، الإنتاجية، نبات اللافندر، ظروف شمال سيناء.