Middle East Journal of Agriculture Research
Volume: 11 | Issue: 04| Oct. – Dec.| 2022

EISSN: 2706-7955 ISSN: 2077-4605
DOI: 10.36632/mejar/2022.11.4.84
Journal homepage: www.curresweb.com
Pages: 1241-1264

Spraying with some natural substances and/or soil nitrogen fertilization counteracted the negative effects of delaying seed sowing of cotton and increased the productivity

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Received: 10 Oct. 2022 **Accepted:** 30 Nov. 2022 **Published:**15 Dec. 2022

ABSTRACT

Two field experiments were carried out during 2018 and 2019 seasons at El-Gemmeiza Agricultural Research Station, El-Gharbia Governorate, Egypt to study the effect of spraying marine plants and yeast extracts three times (at the squaring stage, flowering initiation and 15 days later) either alone or in combination with soil nitrogen fertilization on productivity of cotton plant under late sowing. A strip plot design with three replicates was used. Nitrogen recommended dose, foliar application with the combination between the two natural substances at the high level as well as their interactions significantly increased plant pigments, leaves chemical composition as combined analysis between the two seasons (except proline content which decreased and P, Ca and Mo content which did not affect by the interaction) and growth parameters, earliness attributes (except boll shedding% which decreased), seed cotton yield and its components in both seasons, with some exceptions; plant height and lint% increased by the interaction and number of total flowers plant^{-1} increased by N recommended dose in one season. Nitrogen recommended dose (RD) significantly decreased micronaire reading and increased fiber strength in both seasons and uniformity index and fiber length in one season. Foliar application with the combination between the two natural substances at the high level significantly increased fiber length in both seasons and uniformity index in one season The interaction between N recommended dose (RD) and foliar application with the combination between the two natural substances at the high level significantly increased fiber length and strength in one season. Micronaire reading did not follow a definite trend. It could be concluded this interaction to counteract the negative effects of delaying sowing of cotton and to increase its boll retention and productivity under conditions like El-Gemmeiza location.

Keywords: Natural substances, Marine plants, yeast powder, Egyptian cotton.

1. Introduction

During early growth stages of cotton, the requirement for nutrients is much higher because of greater assimilatory and accumulation capacity (Ahmed *et al.,* 2016). Nitrogen is a vital nutrient for cotton, under the optimal N rate the highest cotton biomass and yield were achieved (Stamatiadis *et al.,* 2016). An optimal N rate is conducive to cotton growth for different growing patterns (Rochester *et al.,* 2007). Both N deficiency and excess are not conducive to increasing cotton yield (Gerik *et al.,* 1998). Therefore, optimal applications of N must be determined to increase cotton yield (Dong *et al.,* 2012). Song *et al.* (2020) showed that N rate from 120–180 kg ha^{-1} increased cotton yield, whereas it not affected beyond 180 kg ha^{-1}, or even decreased (9–29%). Hutmacher (2017) reported that N must be available at the correct times and in the proper amounts to produce high cotton yields. Plants can use two forms of soil nitrogen (N): ammonium (NH_4^+) and nitrate (NO_3^-). The NH_4^+ form is held in the soil by negatively charged soil clays or colloids. Because soils have this negative charge, the NO_3^- form (also negatively charged) is repelled by soil particles and is subject to movement with water in the soil profile.

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On the way of clean agriculture in addition to the high prices of mineral N fertilizers in recent years and their dangerous and harmful impacts on environmental pollution, the need to cultivate cotton in an ecological or organic way (Beltrao *et al.,* 2010) have prompted the attention to use natural materials such as marine plants 'Algaefol' extract and yeast extract in farming, where they have many advantages; 1-They are biodegradable, non-toxic, non-polluting and save (Dhargalkar and Pereira, 2005). 2-They are excellent and rich sources of available macro and micronutrients for plant growth and increase activity of all plant process, thus chemical fertilizers application can be reduced or released. 3-They create biologically diverse agriculture. In recent years use of Marine plants is popular due to their use in organic and sustainable agriculture (Russo and Beryln, 1990).

Yeast extract was suggested to participate in a beneficial role during vegetative and reproductive growth through improving flower formation and their set in some plants due to its high auxin and cytokinin content in addition to the enhancement of carbohydrates accumulation (Barnett *et al.,* 1990). It was reported to have stimulatory effects on cell division and enlargement, protein and nucleic acid synthesis and chlorophyll formation (Wanas, 2006). In addition, yeast extract contains sugars, protein and amino acids and several vitamins (Mahmoued, 2001).

There is a need to optimize the N fertilizer under late sowing particularly its use along with natural resources. Therefore, these experiments aimed to investigate the effect of combined application of N fertilizer rates and spraying marine plants 'Algaefol' extract and/or yeast extract as foliar on chemical composition, growth parameters, earliness attributes, yield and quality of cotton growing under late sowing condition.

2. Materials and Methods

Two field experiments were carried out during 2018 and 2019 seasons at El-Gemmiza Agricultural Research Station, El-Gharbia Governorate, Egypt to study the effect of marine plants and yeast extracts either alone or in combination with nitrogen fertilizer on productivity of cotton Super Giza 86 cultivar under late growing conditions. The experiments were laid out in a strip plot design in three replicates with N fertilizer rates as horizontal plots and natural substances as vertical plots.

A- Soil application N fertilizer:

a_1- 50 % of the recommended N rate (15 kg N/fed).
a_2- 75 % of the recommended N rate (22.5 kg N/fed).
a_3- 100 % of the recommended N rate for late sowing (30 kg N/fed), serving as a control.

B- Foliar application of natural substances:

b_1-Without natural substances application (sprayed with tap water), serving as a control.
b_2- Foliar spraying with 5 cm^3 marine plants 'Algaefol' extract/ L.
b_3- Foliar spraying with 10 cm^3 marine plants 'Algaefol' extract/ L.
b_4- Foliar spraying with 3 g yeast powder/L.
b_5- Foliar spraying with 6 g yeast powder/L.
b_6- Foliar spraying with 5 cm^3 marine plants 'Algaefol' extract/L + 3 g yeast powder/L.
b_7- Foliar spraying with 10 cm^3 marine plants 'Algaefol' extract/L + 6 g yeast powder/L.

Spraying natural substances was carried out three times (at the squaring stage, flowering initiation and 15 days later)

Soil samples were collected 10 days before sowing at 0–30 cm depth, cleaned and analyzed according to Jackson (1973). Data are presented in Table, 1.

2.1. Preparation and application of yeast extract:

Yeast extract was prepared from brewer's yeast (*Saccharomyces cerevisiae*), dissolved in water (3 and 6 g/L) followed by adding sugar at a ratio of 1: 1 and kept for 24 hours in a warm place for reproduction according to the method of Morsi *et al.* (2008). Chemical analysis of activated yeast after Mahmoued (2001) and Shafeek *et al.* (2015) is shown in Table, 3.

Preceding crop was sugar beets (*Beta vulgaris,* L.) and Egyptian clover (*Trifolium alexandrinum,* L.) "berseem" in the first and second seasons, respectively.

Table 1: The properties of the experimental soil sites in the two seasons.

Particulars	Season 2018	2019
Mechanical analysis		
Clay%	38.0	44.2
Silt%	38.0	33.0
Sand% (fine +coarse)	24.0	22.8
Texture	Clay loam	Clayey
Chemical analysis		
pH	8.0	8.1
EC ds/m	0.37	0.99
Organic matter %	1.23	1.40
Total N (ppm)	430.5	490
Available P (ppm)	11.9	12.8
Exchangeable K (ppm)	215	310
Available Mg (ppm)	190	230
Available Fe (ppm)	6.0	12.4
Available Mn (ppm)	2.1	3.9
Available Zn (ppm)	0.70	1.12
Available Cu (ppm)	0.9	1.7
Available B (ppm)	0.54	0.50
Available Mo (ppm)	0.07	0.03

Main characteristics of marine plants extract, and yeast powder used in the study are depicted in Tables, 2 and 3.

Table 2: *The main components of marine plants 'Algaefol' used in the study.

Components	Components
Carbohydrates (Mannitol (4.2%), alginic acid (26.7%), poly saccharin (14.4%), laminaric acid (9.2%) and methyl bentosan (7%))	**Amino acids** (Tyrosen, proline, lysine, arginine, glycine, cystine, venyl alanyl, treptovan, alanine lysine, syrine, valine, histidine, methionine, asparatic acid, glutamic acid, therionin, isolysine, orniten and cytrolin)
Mineral elements (K, S, F, B, I, W, P, V, Zn, Co, Sb, Ti, Zr, Mg, Ca, Ba, Al, Li, Au, Fe, Mo, La, Gr, Ag, Ti, Si, Se, Sr, Rb, Ni, Mn and Cu)	**Vitamins** (A, B1, B2, B12, C, D, E, riboflavin-colin oten and banthocin)

*As reported by Chema company.

Table 3: **Chemical analysis of activated yeast**.**

Minerals (mg/100 g dry weight)		Carbohydrates (mg/100 g dry weight)		Amino acids (mg/100 g dry weight)	
Total N	7.23	Carbohydrates	23.2	Arginine	1.99
P_2O_5	51.68	**Vitamins** (mg/100 g dry weight)		Histidine	2.63
K_2O	34.39			Isoleucine	2.31
MgO	5.76	Vit.B1	2.23	leucine	3.09
CaO	3.05	Vit.B2	1.33	Lysine	2.95
SiO_2	1.55	Vit.B6	1.25	Methionine	0.72
SO_2	0.49	Vit B12	0.15	Phenyl alanine	2.01
NaCl	0.30	Insitol	0.26	Threonine	2.09
Fe	0.92	Thimain	2.71	Tryptophan	0.45
Ba	157.6	Riboflavin	4.96	Valine	2.19
Co	67.8	Biotin	0.09	Glutamic acid	2.00
Pd	438.6	Nicotinic acid	39.88	Serine	1.59
Mn	81.3	Panthothenic acid	19.56	Aspartic acid	1.33
Sn	223.9	Cobalamin	153 ug	Proline	1.53
Zn	335.6	Folic acid	4.36	Tyrosine	1.49
		Pyridoxine	2.90	**Enzymes** (mg/100g dry weight)	
		Pamino benzoic acid	9.23	Oxidase	0.350
				Peroxidase	0.290
				Catalase	0.063

** As reported by Mahmoued (2001) and Shafeek *et al.* (2015).

Fertilization was taken place by the tested N rates using urea (46% N) in two equal doses, after thinning before irrigation and after 15 days (at the next irrigation). Calcium super phosphate (15.5% P_2O_5) at the rate of (22.5 kg P_2O_5 /fed) was added during land preparation. Potassium fertilizer in the form of Potassin-P was applied as foliar spraying at a rate of 1 liter/fed three times (at the squaring stage, flowering initiation and 15 days later) The experimental sub-plot area was 17.64 m^2, (4.2 m long x 4.2 m width) including 6 ridges. Ridge to ridge and hill to hill distance were kept 70 cm and 30 cm, respectively. Seeds of the cotton cultivar Super Giza 86 (obtained from Cotton Research Institute, Agricultural Research Center, Egypt) were sown on 10 May on the tribal side of the ridge (14 hills per ridge). Seedlings were hand thinning at first true leaf stage to leave two vigor's seedlings hill^{-1}, providing plant density of 40,000 plants fed^{-1} in both seasons.

All other agronomic practices were kept uniform for all the experimental treatments during both growing seasons as recommended (Cotton Research Institute, Agricultural Research Center, Egypt).

2.2. Studied characters

2.2.1. Leaves chemical composition

In 2018 and 2019 seasons, twenty leaves (fourth upper leaf) were randomly taken from plants of each sub-plot after two weeks from the last spraying of natural substances extracts (108 days old) to determine the following traits as described by A.O.A.C. (2005); Percentages of N, P, K, Ca, Mg and Na as well as Fe, Zn, Mn, Cu, B and Mo concentration in ppm were determined. The photosynthetic pigments (chlorophyll a, b, a+b and carotenoids) and total carbohydrates were also determined and expressed as mg/g dr.wt. Proline was estimated and expressed as ug /g dr.wt. Data was taken as the combined analysis between the two-growing seasons because of the high cost of chemical analysis.

2.2.2. Growth parameters

In both seasons, six guarded plants were taken at random from each sub-plot carefully after 108 days from sowing. Roots of sample plants were removed at the cotyledonary nodes, then the different plant fractions were washed and dried to a constant weight in a forced air oven at 70 °C for 72 hrs then, dry weight was calculated in expression of canopy dry weight (g/plant). Leaf area (dm^2/plant) was determined by using disc method according to Johnson (1967) and leaf area index (LAI) was determined as proposed by Hunt (1978). At harvesting time, ten representative plants from each sub-plot were taken at random to determine final plant height (cm) and its number of fruiting branches.

2.2.3. Earliness attributes

Ten representative plants of each-sub plot were taken at random to determine the following earliness attributes which calculated according to Richmond and Radwan (1962) and Kadapa (1975); 1- Number of total flowers plant^{-1}, 2- Number of total bolls set plant^{-1}, 3- Boll setting percentage, 4- Boll shedding percentage and 5- First picking percentage was calculated from the following formula (Singh, 2004): First picking percentage = (Weight of seed cotton from first pick/ Total seed cotton weight from the two picks) x100.

2.2.4. Seed cotton yield and its components

At harvesting, data were taken from the above ten representative plants to determine the following yield characters; 1- Number of open bolls plant^{-1}, 2- Boll weight (g), 3- seed cotton yield/plant, 4- Lint percentage as percentage of lint cotton to seed cotton after ginning and 5-Seed index **(**weight of 100 cotton seeds in grams**).** The crop was harvested in two manual pickings. The seed cotton yield obtained from both pickings was summed to calculate the whole seed cotton yield from each sub-plot in kilograms and transformed to kentars fed^{-1} (one kentar=157.5 kg seed cotton and one feddan=4200.83 m^2).

2.2.5. Fiber quality

The seed cotton obtained from the above ten representative plants from the two pickings was mixed, weighted, and ginned using a roller-type, hand-fed laboratory gin to obtain cotton seeds and cotton lint. Fiber tests were made at the laboratories of the Cotton Technology Research Division, Cotton Research Institute, Agricultural Research Center, Giza, Egypt. Measurements included (i) Upper half mean length (millimeters) and uniformity index (%) as measured by a digital fibrograph, (ii)

Micronaire reading (a combined measure of fiber fineness and fiber maturity) measured by a micronaire instrument, and (iii) Fiber strength measured by the Pressley instrument and expressed as Pressley index (according to Annual Book of A.S.T.M. Standards, 2012).

2.6. Statistical analysis

All data were subjected to the statistical analysis as prescribed by Le Clerg *et al.* (1966) and the mean values were compared at 0.05 level of probability using LSD (Waller and Duncan, 1969).

Results

3. Chemical composition

3.1. Mineral content

3.1.1. Effect of N rates

Results in Tables, 4 and 5 indicated that mineral leaf nutrients content influenced significantly because of N rates. The highest values of mineral elements evaluated (2.94% N, 0.338% P, 3.40% K, 1.51% Ca, 0.506% Mg, 3.73% Na, 107.39 ppm Fe, 28.66 ppm Zn, 30.87 ppm Mn, 9.49 ppm Cu, 27.99 ppm B and 0.067 ppm Mo) were recorded from fertilized plants with the recommended rate of nitrogen. The lowest values (2.10% N, 0.271% P, 3.28% K, 1.28% Ca, 0.404% Mg, 2.95% Na, 75.63 ppm Fe, 22.91 ppm Zn, 21.74 ppm Mn, 7.14 ppm Cu, 21.45 ppm B and 0.053 ppm Mo) were recorded from 50% of NRD.

Table 4: Effect of marine plants 'Algaefol' extract and/or yeast powder under three N rates as well as their interactions on leaves macronutrients and Na percentage as the combined analysis between the two-growing seasons.

Treatments	Traits	N	P	K	Ca	Mg	Na
					%		
A-Levels of N recommended dose:							
a_1- 50%		2.10	0.271	3.28	1.28	0.404	2.95
a_2- 75%		2.56	0.283	3.31	1.38	0.422	3.11
a_3- 100% (control)		2.94	0.338	3.40	1.51	0.506	3.73
LSD at 5%		**0.05**	**0.004**	**0.01**	**0.04**	**0.003**	**0.09**
B-Levels of natural substances:							
b_1 - Control (without application)		2.00	0.251	3.24	1.12	0.378	2.78
b_2 - 5 cm^3 Marine plants extract/L		2.20	0.266	3.29	1.22	0.401	2.89
b_3 - 10 cm^3 Marine plants extract/L		2.30	0.301	3.33	1.48	0.447	3.25
b_4 - 3 g yeast powder/L		2.65	0.291	3.31	1.38	0.433	3.09
b_5 - 6 g yeast powder/L		2.69	0.307	3.35	1.30	0.454	3.46
b_6 - (b_2+ b_4)		2.89	0.319	3.38	1.57	0.476	3.57
b_7 - (b_3 + b_5)		2.98	0.347	3.42	1.65	0.519	3.81
LSD at 5%		**0.09**	**0.004**	**0.01**	**0.02**	**0.007**	**0.06**
AXB Interactions:							
	b_1	1.71	0.227	3.18	1.00	0.343	2.49
	b_2	1.76	0.230	3.24	1.15	0.350	2.56
	b_3	1.91	0.280	3.28	1.35	0.413	2.89
a_1	b_4	2.26	0.263	3.28	1.30	0.393	2.73
	b_5	2.20	0.287	3.31	1.20	0.423	3.21
	b_6	2.41	0.290	3.34	1.45	0.430	3.29
	b_7	2.44	0.320	3.36	1.50	0.477	3.50
	b_1	1.87	0.227	3.22	1.10	0.343	2.52
	b_2	2.15	0.250	3.26	1.20	0.380	2.65
	b_3	2.25	0.287	3.31	1.50	0.423	3.16
a_2	b_4	2.69	0.280	3.29	1.35	0.413	2.92
	b_5	2.79	0.287	3.32	1.30	0.423	3.26
	b_6	3.04	0.310	3.35	1.55	0.463	3.40
	b_7	3.11	0.340	3.42	1.65	0.507	3.85
	b_1	2.42	0.300	3.34	1.25	0.447	3.34
	b_2	2.68	0.317	3.36	1.30	0.473	3.45
	b_3	2.75	0.337	3.40	1.60	0.503	3.72
a_3	b_4	3.01	0.330	3.38	1.50	0.493	3.64
	b_5	3.08	0.347	3.43	1.40	0.517	3.91
	b_6	3.23	0.357	3.44	1.70	0.533	4.02
	b_7	3.39	0.380	3.47	1.80	0.573	4.07
LSD at 5%		**0.16**	**NS**	**0.02**	**NS**	**0.011**	**0.05**

Middle East J. Agric. Res., 11(4): 1241-1264, 2022
EISSN: 2706-7955 ISSN: 2077-4605 *DOI: 10.36632/mejar/2022.11.4.84*

Table 5: Effect of marine plants 'Algaefol' extract and/or yeast powder under three N rates as well as their interactions on leaves micronutrients concentration as the combined analysis between the two-growing seasons.

Treatments	Traits	Fe	Zn	Mn	Cu	B	Mo
		(ppm)					
A-Levels of N recommended dose:							
a_1- 50%		75.63	22.91	21.74	7.14	21.45	0.053
a_2- 75%		82.16	23.94	23.62	7.51	22.36	0.064
a_3- 100% (control)		107.39	28.66	30.87	9.49	27.99	0.067
LSD at 5%		**2.96**	**0.26**	**0.85**	**0.06**	**0.25**	**0.001**
B-Levels of natural substances:							
b_1 - Control (without application)		71.62	21.42	20.59	6.55	19.50	0.052
b_2 - 5 cm^3 Marine plants extract/L		76.84	22.72	22.09	7.25	21.78	0.057
b_3 - 10 cm^3 Marine plants extract/L		86.68	25.33	24.92	7.80	23.13	0.057
b_4 - 3 g yeast powder/L		85.80	24.53	24.67	7.75	23.00	0.063
b_5 - 6 g yeast powder/L		91.84	25.83	26.41	8.45	25.22	0.062
b_6 - (b_2+ b_4)		96.82	26.93	27.84	8.86	26.40	0.068
b_7 - (b_3 + b_5)		109.14	29.43	31.38	9.66	28.51	0.070
LSD at 5%		**1.63**	**0.33**	**0.47**	**0.07**	**0.30**	**0.003**
AXB Interactions:							
a_1	b_1	63.28	19.52	18.19	5.50	16.15	0.047
	b_2	66.64	19.82	19.16	6.45	19.52	0.050
	b_3	73.36	23.43	21.09	6.91	20.74	0.050
	b_4	70.37	22.23	20.23	6.72	20.25	0.053
	b_5	78.96	24.03	22.70	7.65	23.13	0.050
	b_6	84.56	24.33	24.31	7.95	23.86	0.060
	b_7	92.21	27.03	26.51	8.80	26.50	0.060
a_2	b_1	64.96	19.52	18.68	6.00	17.91	0.050
	b_2	72.61	21.62	20.88	6.69	19.96	0.060
	b_3	75.97	24.03	21.84	7.02	20.98	0.060
	b_4	77.84	23.43	22.38	7.32	21.96	0.067
	b_5	81.20	24.03	23.35	7.70	23.18	0.067
	b_6	87.73	26.13	25.23	8.20	24.60	0.070
	b_7	114.80	28.83	33.01	9.63	27.96	0.073
a_3	b_1	86.61	25.23	24.90	8.14	24.45	0.060
	b_2	91.28	26.73	26.24	8.61	25.85	0.060
	b_3	110.69	28.53	31.82	9.47	27.67	0.060
	b_4	109.20	27.93	31.40	9.21	26.79	0.070
	b_5	115.36	29.43	33.17	10.01	29.36	0.070
	b_6	118.16	30.33	33.97	10.42	30.73	0.073
	b_7	120.40	32.44	34.62	10.56	31.07	0.077
LSD at 5%		**2.27**	**0.65**	**0.65**	**0.09**	**0.60**	**NS**

Similar results were reported by Hamissa *et al.* (2000), who found that the recommended N dose enhanced the leaf N and Ca contents of treated plants. N deficiency leads to decrease the root system which affects N and P uptake (Ebelhar and Ware, 2003). Sui *et al.* (2017) found that leaf N content increased as N rate increased in irrigated plots.

3.1.2. Effects of natural substances used

Results in Tables, 4 and 5 indicated that mineral leaf nutrients content influenced significantly because of foliar application with marine plants 'Algaefol' extract and yeast extract each alone or with each other. Mineral nutrients content in the cotton leaves increased significantly due to all treatments compared with the control. The highest values of mineral elements evaluated (2.98% N, 0.347% P, 3.42% K, 1.65% Ca, 0.519% Mg, 3.81% Na, 109.14 ppm Fe, 29.43 ppm Zn, 31.38 ppm Mn, 9.66 ppm Cu, 28.51 ppm B and 0.070 ppm Mo) were recorded with foliar feeding with the combination treatment at the high level. The lowest values of these elements (2.00% N, 0.251% P, 3.24% K, 1.12% Ca, 0.378% Mg, 2.78% Na, 71.62 ppm Fe, 21.42 ppm Zn, 20.59 ppm Mn, 6.55 ppm Cu, 19.50 ppm B and 0.052 ppm Mo) were recorded with the control (untreated plants). The positive effect of natural substances used might be due to that yeast extract and marine plants extract contain different nutrients as N, P, K, Mg, Ca, Na, Mn, Zn, Cu, B and Mo (Tables, 2 and 3) which would be reflected on increasing leaves concentrations of these nutrients.

3.1.3. Interaction effect

Tables, 4 and 5 showed that cotton plants fertilized with the recommended N rate and received 10 cm^3/L marine plants 'Algaefol' extract plus 6 g/L yeast powder gave the highest values of mineral elements evaluated (3.39% N, 3.47% K, 0.573% Mg, 4.07% Na, 120.40 ppm Fe, 32.44 ppm Zn, 34.62 ppm Mn, 10.56 ppm Cu and 31.07 ppm B). The lowest values (1.71% N, 3.18% K, 0.343% Mg, 2.49% Na, 63.28 ppm Fe, 19.52 ppm Zn, 18.19 ppm Mn, 5.50 ppm Cu and 16.15 ppm B) were recorded from fertilized plants with 50% NRD and untreated with natural substances used. However, concentrations of P, Ca and Mo did not affect by the interaction.

3.2. Photosynthetic pigments, total carbohydrates, and proline content

3..2.1. Effect of N rates

Nitrogen rates exhibited significant differences in the concentrations of photosynthetic pigments and total carbohydrates in the cotton leaves (Table, 6). The highest values were recorded with cotton plants fertilized with the recommended rate followed by those fertilized with 75% of the recommended rate, while the lowest values recorded from those fertilized with 50% of the recommended rate. The reverse trend was obtained regarding proline content. Application of N fertilizer less than the amount required for optimum growth could lead to early senescence and reduced photosynthetic rate and canopy development (Dong *et al.,* 2012). Carbohydrate limitation is most pronounced when plants are well supplied with nitrogen because it stimulates vegetative growth and increases the demand for photosynthetic products**.**

3.2.2. Effects of natural substances used

Photosynthetic pigments and total carbohydrates in the cotton leaves were significantly increased by increasing the concentration of foliar application with marine plants 'Algaefol' extract and yeast powder each alone or in combination (Table, 6). The highest photosynthetic pigments and total carbohydrates content in cotton leaves was recorded at the combination of marine plants 'Algaefol' extract and yeast powder either at the low or high levels. The control treatment gave the lowest values in this respect. Meanwhile, there was a significant decrease in proline content at the same levels. The positive effect of natural substances used might be due to activation of chlorophyll biosynthesis. It was found that yeast powder contains vitamins, amino acids, carbohydrates and different nutrients as N, P, K, Mg, Ca, Na, Mn, Zn, Cu, B and Mo (Table, 3) which increased the metabolic process's role and its effect in activating photosynthesis process through enhancing the release CO_2 and stimulating photosynthesis which would be reflected on seedlings growth. Similarly, it's high contents of phytohormones (cytokinin, GA3 and IAA), vitamins and amino acids may increase the metabolic processes and levels of endogenous hormones (Sarhan and Abdullah, 2010). Thus, yeast treatment increased metabolic processes such as protein and carbohydrates synthesis parallel with the increased content of phytochromes.

3.2.3. Interaction effects

The interaction treatments gave a significant effect on photosynthetic pigments and total carbohydrates content in the cotton leaves (Table, 6). The plants fertilized with the recommended level of N and received 10 cm^3/L marine plants 'Algaefol' extract plus 6 g/L yeast powder gave the highest values. The lowest values were detected from the plants fertilized with 50% of the recommended level of N fertilizer and without natural substances used treatments. The reverse trend was obtained about proline content.

Table 6: Effect of marine plants 'Algaefol' extract and/or yeast powder under three N rates as well as their interactions on leaves photosynthetic pigments, total carbohydrate, and proline contents as the combined analysis between the two-growing seasons.

Treatments		Chlorophyll a (mg /g dr.wt.)	Chlorophyll b (mg /g dr.wt.)	Chlorophyll Total (mg /g dr.wt.)	Carotenoids (mg /g dr.wt.)	Total carbohydtate (mg /g dr.wt.)	Proline (ug /g dr.wt.)
A-Levels of N recommended dose:							
a_1- 50%		3.516	0.947	4.463	1.151	201.569	656.484
a_2- 75%		3.666	1.027	4.693	1.228	204.110	626.920
a_3- 100% (control)		4.589	1.343	5.932	1.601	215.671	526.526
LSD at 5%		**0.027**	**0.038**	**0.038**	**0.027**	**0.55**	**17.85**
B-Levels of natural substances:							
b_1 - Control (without application)		3.198	0.896	4.094	1.056	195.376	695.634
b_2 - 5 cm^3 Marine plants extract/L		3.569	0.960	4.530	1.178	200.292	663.211
b_3 - 10 cm^3 Marine plants extract/L		3.792	1.083	4.875	1.284	206.526	609.809
b_4 - 3 g yeast powder/L		3.771	1.072	4.843	1.267	205.880	613.904
b_5 - 6 g yeast powder/L		4.134	1.150	5.284	1.340	210.303	562.312
b_6 - (b_2+ b_4)		4.327	1.211	5.538	1.483	212.928	558.314
b_7 - (b_3 + b_5)		4.673	1.367	6.040	1.680	218.511	519.983
LSD at 5%		**0.032**	**0.019**	**0.046**	**0.032**	**0.78**	**11.19**
AXB Interactions:							
a_1	b_1	2.647	0.790	3.437	0.967	188.147	759.687
	b_2	3.200	0.833	4.033	0.993	193.310	733.170
	b_3	3.400	0.917	4.317	1.103	202.740	655.113
	b_4	3.320	0.880	4.200	1.090	202.393	661.720
	b_5	3.790	0.990	4.780	1.137	205.360	602.980
	b_6	3.913	1.060	4.973	1.230	207.807	596.350
	b_7	4.343	1.157	5.500	1.540	211.227	586.367
a_2	b_1	2.937	0.813	3.750	0.943	190.123	734.937
	b_2	3.270	0.907	4.177	1.047	197.450	668.303
	b_3	3.440	0.947	4.387	1.110	204.357	652.503
	b_4	3.600	0.970	4.570	1.120	203.413	652.183
	b_5	3.800	1.020	4.820	1.177	206.657	598.820
	b_6	4.030	1.097	5.127	1.493	208.693	591.147
	b_7	4.583	1.437	6.020	1.703	218.073	490.547
a_3	b_1	4.010	1.083	5.093	1.257	207.857	592.280
	b_2	4.237	1.140	5.377	1.493	210.117	588.160
	b_3	4.537	1.387	5.924	1.640	212.480	521.810
	b_4	4.393	1.367	5.760	1.590	211.833	527.810
	b_5	4.813	1.440	6.253	1.707	218.893	485.137
	b_6	5.037	1.477	6.514	1.727	222.283	487.447
	b_7	5.093	1.507	6.600	1.797	226.233	483.037
LSD at 5%		**0.053**	**0.029**	**0.059**	**0.019**	**1.260**	**14.10**

3.3. Growth parameters

3.3.1. Effect of N rates

Concerning the effect of N fertilizer rate on growth aspects as leaf aera, leaf area index and dry weight plant^{-1}at 108 days old as well as plant height and number of fruiting branches plant^{-1} at harvesting, results in Table, 7 showed that, N fertilizer rate exhibited significant differences during the two seasons on these traits, where 100 % RD of nitrogen gave the highest values of these traits (20.06 dm^2, 1.91, 130.56 g, 16.02 and 167.85 cm; 26.74 dm^2, 2.55, 131.02 g,16.05 and 164.75 cm), while the lowest values (15.30 dm^2, 1.46, 93.36 g, 13.54 and 158.20 cm; 20.40 dm^2, 1.94, 99.97 g, 13.33 and 158.78 cm) resulted from fertilized plants with 50% RD of N in the first and second seasons, respectively. An increase of these traits may be due to the role of N in cotton plant. Addition of nitrogen fertilizer leads to increase the leaf area which increases the amount of solar radiation intercepted thereby increasing days to flowering, physiological maturity, plant height and dry matter accumulation. The presence of N in excess promotes development of the above ground organs, synthesis of proteins and formation of new tissues are stimulated, resulting in vigorous vegetative growth. This increases the days of physiological maturity. In this concern, plant height and sympodial branches were significantly increased by each additional increment of N fertilizer, Munir *et al.* (2015); Rawal *et al.* (2015); Zonta *et al.* (2016) and Emara *et al.* (2018). Rawal *et al.* (2015) observed that application of nitrogen significantly increased the plant height at 100 per cent RD of nitrogen over 75 per cent RD of nitrogen. However, maximum sympodial branches were observed at 125 per cent RD of nitrogen which was significantly higher over 75 per cent RD and was at par with 100 per cent RD and 150 per cent RD of nitrogen, respectively. These results are in line of Zarina *et al.* (2011) who reported that cotton plant height linearly increased with each increment of N from 0 to 150 kg ha^{-1} whereby each higher dose was significantly higher the preceding level. Nitrogen is also an essential constituent of chlorophylls, which is closely associated with photosynthetic process, it is a major part of all proteins, enzymes, amino acids, nitrogenous plant components viz., the nucleic acids and chlorophyll. Also, N is essential for use carbohydrate within plants. Nitrogen related with high photosynthetic activity, dark green color, vigorous growth, leaf production and size enlargement. Nitrogen is necessary for formation of amino acids, the building blocks of protein. Essential for plant cell division, vital for plant growth.

Table 7: Effect of marine plants 'Algaefol' extract and/or yeast powder under three N rates as well as their interactions on growth parameters in 2018 and 2019 seasons.

Traits		LA (dm^2 plant^{-1})		LAI		Total dry weight (g plant^{-1})		No. of fruiting branches plant^{-1}		Plant height (cm)	
		Season		Season		Season		Season		Season	
Treatments		**2018**	**2019**	**2018**	**2019**	**2018**	**2019**	**2018**	**2019**	**2018**	**2019**
A-Levels of N recommended dose:											
a_1- 50%		15.30	20.40	1.46	1.94	93.36	99.97	13.54	13.33	158.20	158.78
a_2- 75%		18.42	24.56	1.75	2.34	113.74	120.32	14.53	14.49	165.41	162.51
a_3- 100% (control)		20.06	26.74	1.91	2.55	130.56	131.02	16.02	16.05	167.85	164.75
LSD at 5%		**0.51**	**0.68**	**0.05**	**0.07**	**2.09**	**3.34**	**0.18**	**0.20**	**2.35**	**0.38**
B-Levels of natural substances:											
b_1 - Control (without application)		15.02	20.02	1.43	1.91	89.05	98.11	13.01	12.86	159.93	158.78
b_2 - 5 cm^3 Marine plants extract/L		15.82	21.09	1.51	2.01	97.71	103.34	13.83	13.80	160.59	160.17
b_3 - 10 cm^3 Marine plants extract/L		16.17	21.55	1.54	2.05	102.27	105.62	14.38	14.33	163.70	161.23
b_4 - 3 g yeast powder/L		19.23	25.63	1.83	2.44	117.90	125.62	14.85	14.74	164.36	161.92
b_5 - 6 g yeast powder/L		19.23	25.64	1.83	2.44	119.67	125.64	15.32	15.42	165.39	162.73
b_6 - (b_2+ b_4)		19.91	26.55	1.90	2.53	128.63	130.10	15.65	15.59	165.70	164.04
b_7 - (b_3 + b_5)		20.10	26.80	1.91	2.55	132.65	131.31	15.84	15.62	167.06	165.20
LSD at 5%		**0.66**	**0.88**	**0.06**	**0.09**	**4.06**	**4.33**	**0.23**	**0.15**	**2.48**	**0.25**
AXB Interactions:											
	b_1	13.37	17.82	1.27	1.70	76.22	87.34	11.57	11.40	156.67	156.90
	b_2	12.99	17.32	1.24	1.65	78.37	84.88	12.53	12.47	155.37	157.07
	b_3	13.70	18.26	1.30	1.74	84.77	89.50	13.33	13.00	157.13	158.17
a_1	b_4	16.72	22.30	1.59	2.12	100.52	109.25	13.90	13.67	158.07	159.10
	b_5	16.18	21.56	1.54	2.05	97.95	105.66	14.33	14.33	159.17	159.73
	b_6	16.90	22.54	1.61	2.15	107.04	110.44	14.43	14.30	159.90	160.00
	b_7	17.25	23.00	1.64	2.19	108.66	112.72	14.70	14.17	161.07	160.47
	b_1	14.31	19.09	1.36	1.82	83.41	93.53	13.40	12.90	162.23	158.17
	b_2	15.81	21.07	1.50	2.00	95.43	103.25	13.40	13.33	159.77	160.60
	b_3	16.13	21.50	1.54	2.05	100.00	105.36	13.90	14.03	165.77	162.20
a_2	b_4	19.80	26.40	1.89	2.51	119.58	129.39	14.57	14.47	166.17	162.03
	b_5	20.22	26.95	1.93	2.57	124.25	132.07	15.03	15.20	167.70	162.93
	b_6	21.40	28.53	2.04	2.72	135.12	139.81	15.70	15.70	167.37	165.13
	b_7	21.25	28.34	2.02	2.70	138.37	138.86	15.73	15.77	168.83	166.47
	b_1	17.37	23.16	1.65	2.20	107.51	113.48	14.07	14.27	160.90	161.27
	b_2	18.66	24.87	1.78	2.37	119.32	121.89	15.57	15.60	166.63	162.83
	b_3	18.67	24.89	1.78	2.37	122.05	121.99	15.90	15.97	168.20	163.33
a_3	b_4	21.15	28.20	2.02	2.69	133.60	138.21	16.07	16.07	168.81	164.63
	b_5	21.31	28.40	2.03	2.71	136.80	139.19	16.60	16.73	169.30	165.53
	b_6	21.44	28.58	2.04	2.72	143.73	140.05	16.83	16.77	169.83	167.00
	b_7	21.79	29.05	2.07	2.77	150.92	142.35	17.10	16.93	171.27	168.67
LSD at 5%		**1.17**	**1.55**	**0.11**	**0.15**	**6.96**	**7.61**	**0.32**	**0.35**	**NS**	**0.54**

Directly involved in photosynthesis. Necessary component of vitamins. Aids in production and use of carbohydrates. Affects energy reactions in the plant. Lack of N causes the reduction in chlorophyll production resulting into reduction of photosynthesis. Increased photosynthesis improves the cotton yield, whereas N deficit can impair cotton development and yield-insufficient photosynthesis. Stomatal conductance, an important biological process, reflects the carbon accumulation and transpiration in plants with CO_2 flowing into sites of photosynthesis by the stomata (Sikder *et al.,* 2015). Nitrogen uptake by cotton is proportional to the plant's photosynthetic capacity and dry matter accumulation. Prior to squaring stage, cotton plants have a low N requirement. The majority of N is taken up between early square and peak bloom (Fritschi *et al.,* 2003). Normally N deficiency in cotton does not occur before early square even if there is no N fertilizer applied before planting because residual soil N can be sufficient to meet N requirement of young cotton stands. As the season progresses, especially at peak bloom stage, N deficiency will occur in cotton leaf N content if appropriate amount of N has not been supplied. Direct measurement of total N content of most recent, fully expanded cotton leaves in the upper canopy is one of the most reliable methods to assess N status of cotton plants (Gerik *et al.,* 1998). The highest values of LA due to the high N rate is mainly attributed to an increase in the plant levels of endogenous auxins and gibberellins activity, which encourages cell division and elongation as well as initiate meristematic activity, increases leaves number, produce a sufficient assimilation area for maximum photosynthesis, thereby enhancing plant growth (Mengel and Kirkby, 1987). Phosphorus a constituent of cell nucleus is also essential for cell division and development of meristematic tissue, and hence it would have a stimulating effect on increasing the leaf area. The increase in LA/plant is attributed to the increase in the number of leaves per plant and the average area of leaf. This result may be due to that nitrogen is of extreme importance in plants, where it is a main constituent of protoplasm, nucleic and amino acids, chlorophyll, protein as well as other important substances. Nitrogen deficiency delayed and decreased the magnitude of osmotic potential adjustment and therefore, reduced the capacity of leaves to maintain turgor, N deficit decrease whole plant cumulative leaf area by about 40% through decreased daily production of main stem and branch leaves and decreased final area of individual main stem and branch leaves. The increase in leaf area/plant results from the increase in both leaf number and leaf size. N deficiency generally affect the entire plant and lead to lower total leaf area (reduced leaf expansion) (Ebelhar and Ware, 2003). In this concern, Jia *et al.* (1985) found that, with increasing N rates LAI increased from 1.4 – 1.96 to 3.34 – 3.74 and was positively correlated with the rates. Chhabra and Bishnoi (1993) and Perumal (1999) found that increase in N levels significantly increased biomass production and in particular the above ground biomass and reported that nitrogen mediated integration of growth and development for productivity. El-Beily *et al.* (2001); Shriram and Prasad (2001) and Liang *et al.,* (2003), found that LAI increased with increasing nitrogen. El-Shazly and Darwish (2001) found that the highest value of LAI was obtained from plant receiving the high N level (60 kg N/fed) followed by the medium N level (45 kg N fed), while the lowest value was obtained from the lowest N level (30kg N/fed) and Zhao and Oosterhuis (2001) found that low N decreased leaf area index than the high N treatment. Saleem *et al.* (2008) found that increasing rate of integrated plant nutrition levels significantly enhanced total dry matter production (TDM) over control. El-Shazly (2011) found that LA/plant increased with increasing rates of nitrogen. Niu *et al.* (2021) reported that Nitrogen (N) fertilizer plays a vital role in increasing cotton yield, but its excessive application leads to lower yield, lower nitrogen uses efficiency (NUE), and environmental pollution. The biomass and nitrogen accumulation of four cultivars increased with an increase in N rate, whereas the NUE decreased.

3.3.2. Effects of natural substances used

Results in Table, 7 revealed that foliar application with yeast extract and marine plants 'Algaefol' extract either individually or in mixture significantly increased leaf aera, leaf area index and dry weight plant^{-1} at 108 days old as well as plant height and number of fruiting branches plant^{-1} at harvesting during the two seasons as compared with the control treatment. Significant differences were found among the seven natural substances treatments as for these traits in consideration in both seasons (Table, 7), in favor of foliar spraying with the combination of the high level (10 cm^3 marine plants 'Algaefol' extract + 6 g yeast powder) /L three times and at last untreated plants (control). The respective values of these traits due to these two treatments were (20.10 dm^2, 1.91, 132.65 g, 15.84 and 167.06 cm; 26.80

dm^2, 2.55, 131.31 g, 15.62 and 165.20 cm); (15.02 dm^2, 1.43, 89.05 g, 13.01 and 159.93 cm; 20.02 dm^2, 1.91, 98.11 g, 12.86 and 158.78 cm) in the first and second seasons, respectively.

The positive effect of these natural substances used on these traits in consideration is mainly due to; their effects on promoting vigorous vegetative growth and plenty of chemical constituents (El-Sherbeny *et al*, 2007). The positive effect of yeast on leaf area may be due to its effects on photosynthesis processes activation as well as enhances release of carbon dioxide. Also, yeast naturally increases the promoter hormones as IAA and cytokinins which help in increasing the leaf area (Moor, 1979). Moreover, the stimulatory effect of yeast powder can be attributed to the increased contents of different nutrients as well as the high concentration of protein, vitamin B and natural plant growth regulators such as cytokinins (Fathy and Farid, 1996), in addition to its content of cryoprotective agent *i.e.,* sugars, protein, amino acids and several vitamins (Mahmoued, 2001). The physiological roles of vitamins and amino acids in yeast powder can increase the metabolic processes and levels of endogenous hormones which in turn encourage vegetative growth (Shehata *et al.,* 2012), cell division and enlargement, protein and nucleic acid synthesis and chlorophyll formation (Wanas, 2006), contents of micronutrients in marine plants 'Algaefol' extract especially zinc is required for chloroplast formation and sink limitations (Terashima and Evans, 1988).The presence of adequate amount of nitrogen resulted in better vegetative growth, greater photo assimilate for the production of dry matter. The synergetic effect of mineral N and foliar application with the combination between marine plants ' Algaefol' extract and yeast extract at the high level may be activated. Chlorophyll a and b positively responded to the different foliar applications of yeast extract during the two assigned seasons, and this could be due to activation of chlorophyll biosynthesis, and it had the highest contents of phytohormones (cytokinin, GA3 and IAA). This could be explained on the basis that vitamins and amino acids found in the yeast powder may increase the metabolic processes and levels of endogenous hormones (Sarhan and Abdullah, 2010). In addition, it's content of vitamins, amino acids, carbohydrates and different nutrients as N, P, K, Mg, Ca, Na, Mn, Zn, Cu, B and Mo which increased the metabolic process's role and its effect in activating photosynthesis process through enhancing the release CO_2 and stimulating photosynthesis which would be reflected on seedlings growth. The positive effects caused by the addition of yeast suspension might be due to direct or indirect effect of the yeast throughout its ability in changing the environment of roots or because the development of the yeast after analysis into wide groups of amino acids and vitamins (Glick, 1995). Moreover, yeast as a natural source is also characterized by richness in protein, carbohydrates, nucleic acid, lipids and different minerals and Li in addition to thiamin, riboflavin, pyridoxine, hormones, and other growth regulating substances, biotin, B12 and folic acid (Reed and Nagodawithana, 1991).

In this regard, yeast is natural source of cytokinins and has stimulatory effects on bean plants (Amer, 2004). Mady (2009) found that foliar application with yeast extract increased many growth aspects as number of leaves per plant, dry weights of both stems and leaves and total leaf area, also increased photosynthetic pigments, total sugars, free amino acids, and crude protein content in leaves.

3.3.3. Interaction effects

The interaction between rates of N fertilizer and natural substances used treatments had a significant effect on plant height in the second season and number of fruiting branches $plant^{-1}$ at harvesting, dry weight $plant^{-1}$, leaf area/plant as well as leaf area index at 108 days old in both seasons (Table, 7), in favor of the recommended N fertilized plants which received the combination of marine plants 'Algaefol' extract and yeast extract as foliar spraying at the high level (10 cm^3 marine plants ' Algaefol' extract + 6 g yeast powder) /L, followed in ranking by the low level (5 cm^3 marine plants 'Algaefol' extract + 3 g yeast powder) /L and at last 50% recommended N fertilized plants and untreated with natural substances used.

3.4.-Earliness parameters

3.4.1. Effect of N rates

Significant differences among N fertilization rates on number of total flowers $plant^{-1}$ in the second season and on number of total bolls set $plant^{-1}$, percentages of boll setting, and earliness were found in both seasons (Table, 8). The highest values of these traits in consideration were recorded with 100% RD of N. However, the highest values of boll shedding% in both seasons were recorded with N deficiency. The poor and excessive nitrogen supply contributes to enhanced rate of shedding by slowing photosynthesis rate. The insufficient application produced stunted plants bearing small leaves, fewer nodes and fruiting branches and slows down photosynthesis process and over supply leads to rank growth and reduce light penetration to lower canopy.

Table 8: Effect of marine plants 'Algaefol' extract and/or yeast powder under three N rates as well as their interactions on earliness attributes in 2018 and 2019 seasons.

Treatments	Traits	No. of total flowers plant^{-1}		No. of total bolls plant^{-1}		Boll setting %		Boll shedding %		Earliness %	
		Season		Season		Season		Season		Season	
		2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
A-Levels of N recommended dose:											
a_1- 50%		22.80	25.88	11.47	12.03	50.29	46.44	49.71	53.56	36.20	46.68
a_2- 75%		22.88	26.93	13.85	14.22	60.47	52.60	39.53	47.40	43.13	56.19
a_3- 100% (control)		22.83	27.56	15.17	15.82	66.45	57.24	33.55	42.76	46.56	61.18
LSD at 5%		NS	0.85	0.39	0.39	1.26	0.70	1.26	0.70	1.19	1.56
B-Levels of natural substances:											
b_1 - Control (without application)		22.53	25.41	11.19	11.70	49.58	45.98	50.42	54.02	39.91	45.81
b_2 - 5 cm^3 Marine plants extract/L		22.99	25.74	11.93	12.52	51.88	48.60	48.12	51.40	39.08	48.25
b_3 - 10 cm^3 Marine plants extract/L		22.81	25.98	12.13	12.82	53.21	49.28	46.79	50.72	41.98	49.32
b_4 - 3 g yeast powder/L		22.69	26.66	14.46	14.49	63.60	54.28	36.40	45.72	42.98	58.65
b_5 - 6 g yeast powder/L		22.85	28.03	14.47	14.90	63.45	52.92	36.55	47.08	42.64	58.67
b_6 - (b_2+ b_4)		22.95	27.42	15.02	15.67	65.47	56.99	34.53	43.01	43.22	60.75
b_7 - (b_3 + b_5)		23.04	28.30	15.28	16.06	66.29	56.61	33.71	43.39	43.95	61.31
LSD at 5%		**0.23**	**0.81**	**0.50**	**0.31**	**2.17**	**1.94**	**2.17**	**1.94**	**1.55**	**2.02**
AXB Interactions:											
a_1	b_1	22.13	24.92	9.80	10.80	44.28	43.34	55.72	56.66	36.39	40.78
	b_2	22.96	25.30	9.91	11.17	43.16	44.15	56.84	55.85	33.87	39.63
	b_3	22.81	25.33	10.25	11.25	44.93	44.41	55.07	55.59	34.86	41.79
	b_4	22.35	25.79	12.55	12.58	56.17	48.78	43.83	51.22	37.94	51.01
	b_5	23.33	26.24	12.13	12.01	52.01	45.77	47.99	54.23	35.91	49.34
	b_6	23.04	26.40	12.70	13.10	55.10	49.62	44.9	50.38	36.88	51.57
	b_7	22.97	27.16	12.96	13.32	56.41	49.04	43.59	50.96	37.58	52.63
a_2	b_1	22.70	25.09	10.72	11.32	47.20	45.12	52.8	54.88	38.51	43.67
	b_2	22.94	25.74	11.85	12.27	51.68	47.67	48.32	52.33	38.06	48.21
	b_3	22.99	26.40	12.10	12.77	52.67	48.37	47.33	51.63	44.80	49.20
	b_4	23.09	27.45	14.91	15.33	64.25	55.85	35.75	44.15	44.56	60.42
	b_5	22.72	27.33	15.22	15.33	66.97	56.09	33.03	43.91	45.23	61.67
	b_6	22.70	27.48	16.12	16.27	71.01	59.21	28.99	40.79	45.48	65.29
	b_7	23.04	29.03	16.01	16.23	69.48	55.91	30.52	44.09	45.30	64.84
a_3	b_1	22.77	26.21	13.04	12.97	57.27	49.48	42.73	50.52	44.83	52.99
	b_2	23.07	26.17	14.03	14.13	60.81	53.99	39.19	46.01	45.30	56.92
	b_3	22.63	26.21	14.04	14.43	62.04	55.06	37.96	44.94	46.29	56.96
	b_4	22.63	26.75	15.93	15.57	70.39	58.21	29.61	41.79	46.43	64.53
	b_5	22.49	30.52	16.05	17.37	71.37	56.91	28.63	43.09	46.78	65.00
	b_6	23.10	28.37	16.24	17.63	70.30	62.14	29.70	37.86	47.31	65.40
	b_7	23.12	28.71	16.87	18.63	72.97	64.89	27.03	35.11	48.96	66.47
LSD at 5%		**0.42**	**1.59**	**0.89**	**0.45**	**4.19**	**3.38**	**4.19**	**3.38**	**2.72**	**3.55**

Therefore, the shedding mediated by poor carbohydrates supply can be prevented by judicious use of nitrogen (Tariq *et al.,* 2017). In this respect, increasing mineral N level significantly reduced boll shedding percentage (El-Shahawy *et al.,* 1997 and El-Gabiery and Abd El-Razek, 2012). Higher earliness index was noted where no N was applied (Munir, 2014). Nitrogen has many roles in plants that affect growth and development. Nitrogen occurs in nucleic acids, all enzymes, most coenzymes, chlorophyll, auxins, cytokinins, and membrane proteins. The essential functions of N about earliness attributes are: 1-N deficiency may mask the promotion of boll abscission because, so few flowers are produced. A statement of percentage of bolls shed has little meaning unless accompanied by a statement of number of flowers produced (Guinn, 1985), 2-N deficiency can stimulate abscission (Addicott and Lynch, 1955; Addicott and Lyon 1973). N is a component of IAA, which inhibits abscission, and of cytokinins, which mobilize nutrients to developing bolls and thereby help prevent senescence. N deficiency may increase the ABA content of leaves (Goldbach *et al.,* 1975). Radin and Ackerson (1981) found that N deficiency increased ABA and caused the stomata of greenhouse-grown cotton leaves to close at a higher leaf water potential (before stress became severe) than that required to cause stomatal closure in N-sufficient plants. If the same effect occurs in field-grown cotton, deficiencies of N and water could interact 3-N deficiency could limit photosynthesis, in part, by inducing stomatal closure sooner during a dry period. This would conserve water, but would also limit photosynthesis, growth, and fruiting. Possible effects of N deficiency on ABA content of squares and bolls have not been determined and should be investigated and 4-A deficiency of N limits both the rate and the duration of flowering (Tucker and Tucker 1968; Hearn, 1975) and may be a major factor in cutout of cotton. Soil N is depleted as the season progresses. Crowther (1934) obtained evidence that N uptake ceased when the plants set a load of bolls even though the soil still contained N. He suggested that root growth stopped because of competition by bolls for carbohydrates and that the cessation of root growth stopped N uptake. Whether the cessation of apical growth is caused by a N deficiency, a carbohydrate deficiency, a hormonal signal from developing bolls, or a combination of factors has not been established with certainty. It should be noted that, with high fertilization, boll shedding was decreased, while a reversible trend was shown in the squares shedding. This may be due to competition on nutrients, where heavy boll load may cause increased abscission, as well as bolls are stronger sinks than squares and young bolls, therefore are better able to compete for available nutrients (Matthews, 1979). Severe deficiency causes stunting and restricts the growth of all plant organs, where nitrogen deficient plants always remain small and early flowering and fruiting takes place which mean the plant goes early in the reproductive phase. Deficiency of N at early growth stage increases ethylene production in cotton which promotes shedding of fruiting organs and induces premature senescence (Legé *et al.,* 1997). Cotton can shed up to 70 % of all initiated fruiting structures from sympodial branches during reproductive stage of development (Peoples and Mathews, 1981) According to Heitholt and Schmidt, (1994), whole plant boll retention i.e., total bolls per total flowers are an imperative process affecting lint yield. A dense and lavish growth causes abnormal shedding of young fruiting bodies like buds, flowers and bolls, delayed maturity, boll rot (due to shading), decreased defoliation and reduced yield. Thus, the plant must have a balance between vegetative and reproductive growth, where there is enough vegetative growth to provide adequate carbohydrate supply for fruit development, but not excessive vegetative growth that inhibits fruit development (Kerby *et al.,* 1997). Application of optimal N rates has been reported to benefit cotton yield by producing larger bolls at a greater number of fruiting sites (Boquet *et al.,* 1994). Thus, N nutrition is known to be the major pivotal facets of cotton production (Iren and Aminu, 2017a & b).

3.4.2. Effects of natural substances used

The differences in total flowers number plant^{-1}, total bolls number plant^{-1}, boll setting percentage and earliness percentage at various natural substances were significant in both seasons (Table, 8). Foliar application with yeast powder and marine plants ‘Algaefol’ extract either individually or in mixture significantly increased these traits in consideration as compared to the control (without application). However, the reverse trend was obtained regarding boll shedding% in both seasons. These results might be due to; beneficial effects of natural substances used during vegetative and reproductive growths through improving flower formation and their set due to its high auxin and cytokinins content and enhancement carbohydrates accumulation (Barnett *et al.,* 1990). The high concentrations of nutrients in marine plants ‘Algaefol’ extract and effects of N deficiency on ABA content of squares and bolls have not been determined and should be investigated and a deficiency of N limits both the rate and the duration of flowering (Tucker and Tucker, 1968; Hearn, 1975) and may be a major factor in cutout of cotton. Soil N is depleted as the season progresses. in addition to their promote effect on macro and micronutrients contents in cotton leaves (Tables, 4 and 5) are directly linked to increase boll retention, either by themselves or as activators for many basic physiological processes in cotton plants. Yeast is natural source of cytokinins and has stimulatory effects on plants (Amer, 2004). It has stimulatory effects on cell division and enlargement, protein and nucleic acid synthesis and chlorophyll formation (Wanas, 2006). In addition to its content of cryoprotective agent *i.e.,* sugars, protein, amino acids and several vitamins (Mahmoued, 2001). Micronutrients in yeast powder especially zinc have major effects upon flower formation (Gerendas and Sattelmatcher, 1990) and required for chloroplast formation and sink limitations (Terashima and Evans, 1988). The favourable effect of the two treatments in this regard is mainly attributed to their positive action on increasing leaf area and plant dry weight which stimulating growth and assimilates accumulation, which surely reflected on increasing boll set.

3.4.3. Interaction effects

Total flowers number plant^{-1}, total bolls number plant^{-1}, boll setting percentage and earliness percentage were significantly affected by the interaction in both seasons (Table, 8), where the superiority was found in favor of plants fertilized with 100% RD of N and received the combination of marine plants 'Algaefol' extract and yeast extract as foliar spraying at the high level (10 cm^3 marine plants 'Algaefol' extract + 6 g yeast powder) /L. While the lowest values resulted from fertilized plants with 50% RD of N and untreated with natural substances. The reverse trend was obtained regarding boll shedding% in both seasons.

3.5. Seed cotton yield and its components

3.5.1. Effect of N rates

Concerning the effect of N fertilizer rate on number of open bolls plant^{-1}, boll weight and seed cotton yield plant^{-1}, results in Tables, 9 and 10 show that, N fertilizer rate exhibited significant differences in these traits in consideration in both seasons. The highest seed cotton yield plant^{-1} (34.30 and 37.24 g) with the higher number of open bolls plant^{-1} (14.77 and 15.63) and heavier bolls (2.32 and 2.37 g) resulted from fertilized cotton plants with 100% RD of N, while fertilized plants with 50% RD of N had the lightest bolls (2.17 and 2.18 g), the lowest number of open bolls plant^{-1} (11.28 and 11.95) and the lowest seed cotton yield plant^{-1} (24.51 and 26.12 g) in both seasons.

Lint% and seed index (g) were significantly affected by various nitrogen rates in both seasons. Highest lint% and seed index were obtained at nitrogen rate of 30 kg N/fed followed by N rate of 22.5 kg N/fed and at last by fertilized plants with 15 kg N/fed, the respective values due to these treatments in the same order were (39.65, 39.08 and 38.21%; 10.53, 9.94 and 9.20 g) in the first season and were (39.84, 38.89 and 37.58%; 10.90, 10.59 and 10.06 g) in the second season.

Nitrogen fertilizer rate exhibited significant differences in seed cotton yield feddan^{-1} in both seasons (Tables, 9 and 10). The recommended rate of N significantly increased seed cotton yield feddan^{-1} by 14.82% and 39.80; 14.84% and 30.75 than 75% RD of N and 50% RD of N application in the first and second seasons, respectively. Also, 75% RD of N significantly increased seed cotton yield feddan^{-1} by 21.75 and 13.85% than 50% RD of N fertilization in both seasons.

The significant increase in number of open bolls plant^{-1} which resulted from100% RD of N fertilizer as compared with 75% RD of N fertilizer rate (22.5 kg N/fed) and 50% RD of N fertilizer rate (15 kg N/fed) is mainly due to significant increase of boll setting percentage (Table, 8), where it may cause low leaching of fertilizers and help to face plant requirement. Therefore, it enhanced the retention of bolls and decreased boll shedding. Nitrogen uptake contributes to the size of cotton boll and this resulted in lint yield as the boll becomes larger at every additional dose of nitrogen applied. It is clear that serious reduction in seed cotton yield/fed as a result of N deficiency. These results may be due to; The positive effect of N fertilizer on the expense of fruiting parameters, where it increased the amounts of metabolites synthesized which caused more production of flowers and decreased small bolls shedding of plants through supply cotton plants with its requirement through the different stages of growth. Nitrogen gave the highest leaves number and weight, and leaf area/plant which increase photosynthetic activity and accumulation of metabolites with direct impact on seed index which reflected on enhancing the quality and seed development. Moreover, nitrogen increased number of fruiting branches/plant, plant height, number of open bolls plant^{-1}, boll weight, seed cotton yield plant^{-1}, seed index and lint% and consequently increased yield. Cotton yield declines with each decrement of nitrogen rate due to those late sowing plants in May had the shorter time available to initiate and mature an adequate number of bolls, bore more flowers plant^{-1} because of the corresponding increase in monopodial and sympodial branches plant^{-1}. Those plants eventually offered a fruitful base for additional square bolls (fruit of cotton) on the micronutrient-fed plants improved plant height, monopodial and sympodial branches plant^{-1}, flowers and bolls plant^{-1}, chlorophyll content, and ultimately seed-cotton yield due to meeting sufficient levels of these nutrients in cotton leaves and petioles. Meeting enough of these nutrients stimulated enzymatic activities (Oosterhuis and Weir, 2010), leading to an improvement in biochemical processes like photosynthesis, respiration, and protein. The improved concentration of N in leaves might be involved in cell wall properties related to

Middle East J. Agric. Res., 11(4): 1241-1264, 2022
EISSN: 2706-7955 ISSN: 2077-4605 *DOI: 10.36632/mejar/2022.11.4.84*

cell enlargement thus leading to longer stems loaded with more branches and flowers plant^{-1}. The availability of N, P and K to plants directly correlated with the affected stomatal morphology, conductance, and transpiration. Therefore, inadequate level of these nutrients particularly of N in leaves might be the right explanation for lower plant growth and seed-cotton yield in the control plots that had only the application of soil PK fertilizers. Accordingly, adequate absorption and utilization of these nutrients is essential to accelerate plant growth and get a higher yield of seed-cotton, as was inadequate or imbalanced use of NPK is one of the foremost factors that bring the potential of high yielding cotton cultivars down. For that reason, soil N fertilizer at the recommended rate is highly advisable for cotton production.

In this regard, increasing N fertilizer levels significantly increased number of open bolls/plant, seed cotton yield/plant as well as per feddan and boll weight (Ali *et al.,* 2011; Seilsepour and Rashidi, 2011; Zarina *et al.,* 2011; Abd El-Aal, 2014; Munir *et al.,* 2015; Tuppad, 2015 and Elhamamsey *et al.,* 2016). Each increment in nitrogen fertilizer significantly (P<0.01) produced higher seed index (Ali *et al.,* 2011). On the other hand, seed index and lint percentage insignificantly affected by all nitrogen levels (Abd El-Aal, 2014). Further increased level of nitrogen from 150 to 200 kg ha^{-1} reduced the seed cotton yield (Sagar *et al.,* 2014). Pabuayon *et al.* (2021) studied five N fertilizer treatments (0 kg ha^{-1}(control), 45 kg ha^{-1} (N-45), 90 kg ha^{-1} (N-90), 135 kg ha^{-1} (N-135), 180 kg ha^{-1} (N-180)) from 2018 to 2020. Additional N fertilizer on top of the control treatment did not increase the lint yield of cotton.

Table 9: Effect of marine plants 'Algaefol' extract and/or yeast powder under three N rates as well as their interactions on seed cotton yield and its components in 2018 season.

Treatments / Traits		No. of open bolls/plant	Boll weight (g)	Seed cotton yield/plant (g)	Lint %	Seed Index (g)	Seed cotton yield/feddan (kentar)
A-Levels of N recommended dose:							
a_1- 50%		11.28	2.17	24.51	38.21	9.20	5.93
a_2- 75%		13.51	2.20	29.76	39.08	9.94	7.22
a_3- 100% (control)		14.77	2.32	34.30	39.65	10.53	8.29
LSD at 5%		**0.38**	**0.04**	**0.79**	**0.27**	**0.09**	**0.13**
B-Levels of natural substances:							
b_1 - Control (without application)		11.00	2.11	23.21	36.68	9.53	5.65
b_2 - 5 cm^3 Marine plants extract/L		11.73	2.20	25.84	38.60	9.76	6.20
b_3 - 10 cm^3 Marine plants extract/L		11.86	2.25	26.75	39.32	9.94	6.49
b_4 - 3 g yeast powder/L		14.10	2.18	30.87	38.43	9.78	7.49
b_5 - 6 g yeast powder/L		14.10	2.22	31.28	39.37	9.93	7.60
b_6 - (b_2+ b_4)		14.70	2.30	33.86	39.97	10.08	8.17
b_7 - (b_3 + b_5)		14.81	2.35	34.84	40.47	10.19	8.42
LSD at 5%		**0.49**	**0.03**	**0.92**	**0.31**	**0.09**	**0.26**
AXB Interactions:							
a_1	b_1	9.80	2.01	19.70	35.85	8.87	4.84
	b_2	9.91	2.15	21.31	37.81	9.15	4.98
	b_3	10.05	2.21	22.21	38.81	9.25	5.38
	b_4	12.26	2.15	26.36	37.60	9.14	6.38
	b_5	11.86	2.16	25.62	38.41	9.18	6.22
	b_6	12.40	2.26	28.02	39.39	9.35	6.80
	b_7	12.65	2.24	28.34	39.57	9.47	6.90
a_2	b_1	10.50	2.08	21.84	36.87	9.66	5.30
	b_2	11.59	2.16	25.03	38.79	9.80	6.06
	b_3	11.83	2.21	26.14	39.26	9.92	6.35
	b_4	14.52	2.16	31.36	38.42	9.79	7.59
	b_5	14.82	2.19	32.46	39.76	9.97	7.89
	b_6	15.69	2.25	35.30	40.01	10.14	8.58
	b_7	15.59	2.32	36.17	40.43	10.25	8.79
a_3	b_1	12.71	2.21	28.09	37.33	10.06	6.83
	b_2	13.68	2.28	31.19	39.20	10.33	7.58
	b_3	13.69	2.33	31.90	39.88	10.66	7.75
	b_4	15.51	2.25	34.90	39.28	10.41	8.48
	b_5	15.62	2.29	35.77	39.93	10.64	8.69
	b_6	16.00	2.39	38.24	40.51	10.76	9.13
	b_7	16.20	2.47	40.01	41.40	10.85	9.58
LSD at 5%		**0.85**	**0.01**	**1.10**	**NS**	**0.09**	**0.44**

Table 10: Effect of marine plants 'Algaefol' extract and/or yeast powder under three N rates as well as their interactions on seed cotton yield and its components in 2019 season.

Treatments / Traits		No. of open bolls/plant	Boll weight (g)	Seed cotton yield/plant (g)	Lint %	Seed index (g)	Seed cotton yield/fed (kentar)
A-Levels of N recommended dose:							
a_1- 50%		11.95	2.18	26.12	37.58	10.06	6.57
a_2- 75%		14.05	2.21	31.17	38.89	10.59	7.48
a_3- 100% (control)		15.63	2.37	37.24	39.84	10.90	8.59
LSD at 5%		**0.39**	**0.04**	**0.80**	**0.05**	**0.16**	**0.06**
B-Levels of natural substances:							
b_1 - Control (without application)		11.61	2.10	24.49	37.69	10.09	5.97
b_2 - 5 cm^3 Marine plants extract/L		12.41	2.22	27.66	38.55	10.16	6.73
b_3 - 10 cm^3 Marine plants extract/L		12.70	2.26	28.80	38.97	10.32	7.19
b_4 - 3 g yeast powder/L		14.34	2.24	32.12	38.56	10.46	7.68
b_5 - 6 g yeast powder/L		14.78	2.26	33.50	38.83	10.59	7.97
b_6 - (b_2+ b_4)		15.48	2.30	35.77	39.16	10.91	8.47
b_7 - (b_3 + b_5)		15.82	2.40	38.24	39.63	11.08	8.81
LSD at 5%		**0.27**	**0.05**	**0.88**	**0.16**	**0.26**	**0.16**
AXB Interactions:							
a_1	b_1	10.80	2.02	21.78	36.72	9.15	5.23
	b_2	11.13	2.15	23.92	37.38	9.64	6.07
	b_3	11.17	2.21	24.68	37.80	10.14	6.57
	b_4	12.50	2.22	27.75	37.47	10.28	6.53
	b_5	11.93	2.22	26.45	37.80	10.35	6.93
	b_6	13.00	2.21	28.73	37.86	10.47	7.20
	b_7	13.13	2.25	29.54	38.01	10.41	7.46
a_2	b_1	11.17	2.09	23.38	38.08	10.48	5.48
	b_2	12.10	2.20	26.62	38.70	10.28	6.23
	b_3	12.60	2.21	27.84	39.14	10.28	6.89
	b_4	15.13	2.20	33.23	38.71	10.43	7.93
	b_5	15.17	2.22	33.67	38.95	10.69	7.97
	b_6	16.10	2.24	36.12	39.26	10.92	8.78
	b_7	16.10	2.32	37.35	39.43	11.02	9.05
a_3	b_1	12.87	2.20	28.31	38.27	10.64	7.20
	b_2	14.00	2.32	32.43	39.58	10.56	7.89
	b_3	14.33	2.36	33.88	39.98	10.55	8.12
	b_4	15.40	2.30	35.37	39.50	10.67	8.57
	b_5	17.23	2.34	40.38	39.76	10.74	9.02
	b_6	17.33	2.45	42.47	40.35	11.35	9.42
	b_7	18.23	2.62	47.83	41.47	11.80	9.92
LSD at 5%		**0.43**	**0.05**	**0.89**	**0.29**	**0.38**	**0.29**

For each year, both control and N-45 treatments resulted in the greatest revenue above variable costs (RAVC) values for all cultivars. The improved N partitioning efficiency in newer cultivars and the high levels of residual soil NO_3^-N allowed sustained plant growth and yield even with reduced N application. Overall, the results show the advantage of reducing N inputs in residual N-rich soils to maintain yield and increase profits. These findings are important in promoting more sustainable agricultural systems through reduced chemical inputs and maintained soil health.

Deficiency of cotton in nitrogen from emergence to early blooming could lead to inadequate vegetative growth, resulting in decreased fruiting (Sattar *et al.,* 2017). N deficiency causes premature senescence of the plants and reduces their yields (Dong *et al.,* 2012). Read *et al.* (2006) support evidence that N stress indirectly affects cotton growth, as N deficiency decreased fiber length, strength and micronaire primarily in flowering groups with large percentage of bolls. Nitrogen deficiency decreased yield through early termination of reproductive growth. Nitrogen (N) is an important constituent of chlorophyll and so, if applied adequately stimulates photosynthesis in plants. Thus, at higher N levels, there would have been more photosynthetic activity in plant. It enters the structure of chlorophyll, amino acids, amides, alkaloids, protein and protoplasm of the plant parts, such as leaves and seeds. Thus, increased amount of nitrogen is an essential for increasing the growth and finally the yield of crop. Therefore, under adequate N supply there would have been greater translocation of photosynthates from leaves via stem to sink site *i.e.,* seeds, bolls. Deficiency of N at early growth stage increases ethylene production in cotton which promotes shedding of fruiting organs and induces premature senescence (Legé *et al.,* 1997) and the plant-yield and quality affect negatively.

Omadewu *et al.,* (2019) studied four nitrogen (N) rates (0, 120, 150, 200 kg ha^{-1}) and they found that nitrogen rates at all levels significantly ($p < 0.05$) increased the seed and lint yield of cotton when compared with control. However, the differences in yield between 150 kg N ha^{-1} and 200 kg N ha^{-1} rate was not significant making nitrogen rate of 150 kg N ha^{-1} more economical and optimum for cotton seed yield. Abd El-Aal (2014) showed that increasing mineral N level reduced boll shedding percentage.

The availability of N, P and K to plants directly correlated with the affected stomatal morphology, conductance, and transpiration. Therefore, inadequate level of N in leaves might be the right explanation for lower plant growth and seed-cotton yield in the control plots that had only the application of soil PK fertilizers. Accordingly, adequate absorption and utilization of these nutrients is essential to accelerate plant growth and get a higher yield of seed-cotton, as was inadequate or imbalanced use of NPK is one of the foremost factors that bring the potential of high yielding cotton cultivars down. For that reason, soil N fertilizer at the recommended rate is highly advisable for cotton production. Excess nitrogen can cause excessive vegetative growth, delay maturity, create difficulty in defoliation, increase pest problems, and ultimately reduce the crop yield and fiber quality.

3.5.2. Effects of natural substances used

Significant differences were detected as a result of natural substances used on number of open bolls $plant^{-1}$, boll weight and seed cotton yield $plant^{-1}$ in both seasons (Tables, 9 and 10), in favor of foliar spraying with the combination of the high level (10 cm^3 marine plants 'Algaefol' extract + 6 g yeast powder) /L three times followed in ranking by foliar spraying with the combination of the low level (5 cm^3 marine plants 'Algaefol' extract + 3 g yeast powder) /L three times and at last untreated plants (control). The respective values due to these treatments in the first season were (14.81, 14.70 and 11.00 boll; 2.35, 2.30 and 2.11 g; 34.84, 33.86 and 23.21 g). In the second season, the respective values were (15.82, 15.48 and 11.61 boll; 2.40, 2.30 and 2.10 g; 38.24, 35.77 and 24.49 g).

The tested natural substances treatments exhibited significant differences in lint% and seed index (g) in both seasons (Tables, 9 and 10). Highest lint% (40.47 and 39.63%) and seed index (10.19 and 11.08 g) were obtained from marine plants 'Algaefol' extract and yeast extract as foliar spraying at the high level (10 cm^3 marine plants 'Algaefol' extract + 6 g yeast powder) /L three times (at the squaring stage, flowering initiation and 15 days later) and the lowest lint% (36.68 and 37.69%) and seed index (9.53 and 10.09 g) resulted from the control treatment (Tables, 9 and 10).

The positive effect due to these two combinations is due primarily to the increase in number of fruiting branches/plant, seed index and lint percentage which lead to the significant increase in boll weight in both seasons. The lower lint yield is produced in nitrogen deficit plants due to high shedding (Cetin *et al.,* 2015). The same tables showed that foliar spraying with the combination of the high level (10 cm^3 marine plants 'Algaefol' extract + 6 g yeast powder)/L three times significantly increased seed cotton yield per feddan by 49.03 and 47.57% than control in the first and second seasons, respectively. Also, the same tables showed that foliar spraying with the combination of the low level (5 cm^3 marine plants 'Algaefol' extract + 3 g yeast powder) /L three times significantly increased seed cotton yield per feddan by 44.60 and 41.88% than control in the first and second seasons, respectively.

The positive effect due to this combination on seed cotton yield fed^{-1} is mainly due to their promoting effects on increasing yield components *e.g.*, numbers of total and open bolls, boll weight, seed index and lint percentage. The positive effect on photosynthetic pigments (Table, 6) which reflects in significant increase in production of assimilates by the leaves (source) due to an increase in CO_2 assimilation and photosynthetic rate which increased mineral uptake by the plant may be detected. The stimulatory effect may also be due to increase permeability of plant membranes and enhance uptake of nutrients (Tables, 4 and 5). The positive effect on cell membrane functions by promoting nutrient uptake, respiration, biosynthesis of nucleic acid, ion absorption, enzyme and hormone-like substances. Marine plants 'Algaefol' extract and yeast extract improves the supply of essential nutrients such as potassium, manganese, copper, zinc, iron, calcium, nitrogen, and phosphorus etc. that enhance the resistance to adverse conditions. The high leaves nitrogen content due to this combination (Table, 4) makes these plants utilized of the absorbed light energy in electron transport and tolerant to photo-oxidative damage under high intensity light and consequently increases photosynthesis capacity. Enhanced the chlorophyll content reflecting from their role in enhancing leaf nutritional status (Table,

6) especially, N as an important part of chlorophyll molecule. This result could be explained on the basis that experimental soil being low in organic matter and available nitrogen (Table, 1) and the supplied of marine plants 'Algaefol' extract and yeast extract increased leaves NPK content (Table, 4) and the ingredients contained in these two extracts used provided plants with their requirements of macronutrient (Ca, Mg, K, N and P) and micronutrients (Fe, Mn, Zn, Cu, B and Mo). Retaining more bolls and reducing boll shedding % (Table, 8). Thus, foliar spraying with the combination of the high level (10 cm^3 marine plants 'Algaefol' extract + 6 g yeast powder)/L three times (at the squaring stage, flowering initiation and 15 days later) could be considered as the proper treatment for Super Giza 86 cotton cultivar under the environmental conditions and soil of El-Gemmeiza region under delaying planting date, where the yield fed^{-1} was very close from this combination.

3.5.3. Interaction effects

The interaction between rates of N fertilizer and natural substances treatments had a significant effect on number of open bolls $plant^{-1}$, boll weight, seed cotton yield $plant^{-1}$, seed index and seed cotton yield fed^{-1} in both seasons and lint % in the second season (Tables, 9 and 10), in favor of 100% RD of N fertilized plants which received the combination of marine plants 'Algaefol' extract and yeast extract as foliar spraying at the high level (10 cm^3 marine plants 'Algaefol' extract + 6 g yeast powder) /L, followed in ranking by 100% RD of N fertilized plants which received the combination of marine plants 'Algaefol' extract and yeast extract as foliar spraying at the low level (5 cm^3 marine plants 'Algaefol' extract + 3 g yeast powder) /L and at last fertilized plants with 50% RD of N and untreated with natural substances used. 100% RD of N fertilized plants which received the combination of marine plants 'Algaefol' extract and yeast powder as foliar spraying at the high level (10 cm^3 marine plants 'Algaefol' extract + 6 g yeast powder) /L gave the highest seed cotton yield $plant^{-1}$ (40.01 and 47.83 g) with high number of open bolls (16.20 and 18.23 boll) and heavier bolls (2.47 and 2.62 g). Also, this interaction treatment significantly increased seed index and gave the highest values (10.85 and 11.80 g) in both seasons and lint% (41.47%) in the second season than 50% RD of N fertilized plants without natural substances used. However, the later interaction treatment gave the lowest seed cotton yield $plant^{-1}$ (19.70 and 21.78 g) accompanied with the low number of open bolls (9.80 and 10.80 boll) and light bolls (2.01 and 2.02 g), in the first and second seasons, respectively.

The interaction exhibited significant differences in seed cotton yield $feddan^{-1}$ in both seasons (Tables, 9 and 10). Maximum seed cotton yield fed^{-1} (9.58 and 9.92 kentar) could be achieved with the interaction of 100% RD of N in combination with marine plants 'Algaefol' extract and yeast extract as foliar spraying at the high level (10 cm^3 marine plants 'Algaefol' extract + 6 g yeast powder)/L three times (at the squaring stage, flowering initiation and 15 days later) and the lowest yield (4.84 and 5.23 kentar) resulted from fertilized plants with 50% RD of N and untreated with natural substances used in the first and second seasons, respectively.

3.6. Fiber quality traits

3.6.1. Effect of N rates

Rates of N fertilization significantly affected micronaire reading and fiber strength in both seasons, uniformity index and fiber length in the first and second seasons, respectively (Table11), where the highest values of fiber strength (10.51 and 10.22 Pressley units), uniformity index (86.09%) and fiber length (33.72 mm) were obtained from plants fertilized with 30 kg N/fed (the recommended dose for late sowing), followed by the medium rate of N (22.5 kg N/fed).

However, the lowest values of these traits in consideration were recorded by fertilized plants with the low rate (15 kg N/fed). Micronaire reading shows a reverse trend in both seasons.

Poor quality of fiber was observed for plants grown under 50% RD of N fertilization and the high quality of fiber at the recommended N rate (30 kg N/fed). In this concern, Fritschi *et al.,* (2003) at clay loam location found a positive linear relationship between fiber strength, fiber length and N fertility level. Sawan *et al.* (2006) revealed that the mean values of 2.5 and 50.0% span length, micronaire, and strength (flat bundle) were significantly increased by the use of the higher N rate, Gormus and El Sabagh (2016) found a positive effect due to application of 60 to 120 kg N/ha compared to the treatment without N on the fiber length (2.7 to 3.4% increase) and strength, while applications of nitrogen above this rate did not provide an additional increase. Molin and Hugie (2010) found that micronaire decreased, and strength and length increased in response to increasing nitrogen, but again the changes were not large enough to invoke discounts. Uniformity was not affected by increasing nitrogen rate. Kappes *et al.,* (2016) stated that cotton lint yield was positively affected by N fertilizer application, whereas high N rates reduced fiber resistance. While fiber parameters (upper half mean length, fiber strength and micronaire reading) did not affect by nitrogen fertilizer rates (Mahdi, 2007; Munir, 2014 and Emara *et al.,* 2018). However, Echer *et al.* (2019) found a reduction in micronaire values when the level of fertility increased. This was related to the lower number of fruiting points observed when the plants received only 50% of the recommended NPK dose. Sui *et al.* (2017) found that leaf N content increased as N rate increased in irrigated plots, With the increase of leaf N, fiber length increased in irrigated cotton micronaire with zero N rate was higher than that with rest of the N rates and the micronaire decreased as N rate increased.

Table 11: Effect of marine plants 'Algaefol' extract and/or yeast powder under three N rates as well as their interactions on fiber quality traits in 2018 and 2019 seasons.

Traits		Micronaire reading		Pressley index		Upper half mean length (mm)		Uniformity index (%)	
		Season		Season		Season		Season	
Treatments		2018	2019	2018	2019	2018	2019	2018	2019
A-Levels of N recommended dose:									
a_1- 50%		4.70	4.74	10.12	10.01	33.24	33.26	84.83	86.65
a_2- 75%		4.53	4.78	10.45	10.13	33.38	33.47	85.44	86.56
a_3- 100% (control)		4.53	4.71	10.51	10.22	33.37	33.72	86.09	86.77
LSD at 5%		**0.09**	**0.02**	**0.09**	**0.07**	**NS**	**0.17**	**0.52**	**NS**
B-Levels of natural substances:									
b_1 - Control (without application)		4.53	4.77	10.46	10.08	32.66	33.19	84.50	86.76
b_2 - 5 cm^3 Marine plants extract/L		4.63	4.76	10.27	10.13	33.38	33.51	85.33	86.37
b_3 - 10 cm^3 Marine plants extract/L		4.64	4.66	10.16	10.11	33.55	33.30	85.65	86.61
b_4 - 3 g yeast powder/L		4.62	4.72	10.28	10.08	33.61	33.26	85.39	86.88
b_5 - 6 g yeast powder/L		4.60	4.78	10.32	10.11	33.14	33.64	85.79	86.59
b_6 - (b_2+ b_4)		4.57	4.72	10.44	10.08	33.33	33.79	85.67	86.66
b_7 - (b_3 + b_5)		4.51	4.79	10.59	10.27	33.62	33.69	85.82	86.76
LSD at 5%		**NS**	**NS**	**NS**	**NS**	**0.51**	**0.30**	**0.48**	**NS**
AXB Interactions:									
a_1	b_1	4.70	4.90	10.13	9.83	31.90	32.63	83.70	86.70
	b_2	4.73	4.90	10.03	9.85	33.37	33.50	84.57	86.27
	b_3	4.73	4.47	10.00	10.17	33.63	32.80	84.80	86.63
	b_4	4.70	4.63	10.07	10.03	33.87	33.23	84.73	86.93
	b_5	4.71	4.83	10.00	9.97	33.40	33.83	85.53	86.77
	b_6	4.63	4.70	10.30	10.00	33.00	33.33	85.07	86.57
	b_7	4.67	4.77	10.33	10.23	33.50	33.50	85.40	86.67
a_2	b_1	4.43	4.83	10.53	10.13	33.13	33.47	84.90	86.73
	b_2	4.70	4.70	10.07	10.39	33.37	33.33	85.80	86.20
	b_3	4.53	4.77	10.40	10.07	33.33	33.47	85.53	86.50
	b_4	4.53	4.60	10.43	10.20	33.33	33.27	85.57	86.80
	b_5	4.50	4.90	10.53	10.00	33.33	33.30	85.40	86.30
	b_6	4.53	4.80	10.53	10.03	33.27	33.87	85.40	86.67
	b_7	4.47	4.83	10.63	10.10	33.87	33.57	85.47	86.70
a_3	b_1	4.47	4.57	10.70	10.27	32.93	33.47	84.90	86.83
	b_2	4.47	4.67	10.70	10.15	33.40	33.70	85.63	86.63
	b_3	4.67	4.73	10.07	10.10	33.70	33.63	86.63	86.70
	b_4	4.63	4.93	10.33	10.00	33.63	33.27	85.87	86.90
	b_5	4.57	4.60	10.43	10.37	32.70	33.80	86.43	86.70
	b_6	4.53	4.67	10.50	10.20	33.73	34.17	86.53	86.73
	b_7	4.40	4.77	10.80	10.47	33.50	34.00	86.60	86.90
LSD at 5%		**NS**	**0.20**	**NS**	**0.22**	**NS**	**0.40**	**NS**	**NS**

3.5.2. Effects of natural substances used

The tested natural substances gave significant effect on fiber length in both seasons and uniformity ratio in the first season only (Table, 11). The combination of marine plants 'Algaefol' extract and yeast extract as foliar spraying at the high level (10 cm^3 marine plants 'Algaefol' extract + 6 g yeast powder) /L three times significantly increased uniformity index in the first season only (Table 11), where this treatment recorded the high value (85.82%) as compared with the control which recorded the lowest value (84.50%). Fiber length was significantly affected by the tested treatments in both seasons, where the longest fibers (33.62 mm) were obtained from marine plants 'Algaefol' extract and yeast extract as foliar spraying at the high level (10 cm^3 marine plants 'Algaefol' extract + 6 g yeast powder)/L in the first season. In the second season the longest fibers (33.69 and 33.79 mm) were obtained from marine plants' Algaefol' extract and yeast extract as foliar spraying at the high level (10 cm^3 marine plants 'Algaefol' extract + 6 g yeast powder) /L or at the low level (5 cm^3 marine plants 'Algaefol' extract + 3 g yeast powder) /L three times (at the squaring stage, flowering initiation and 15 days later), However, the shortest fibers (32.66 and 33.19 mm) resulted from untreated plants (the control treatment) in both seasons. Micronaire reading and fiber strength did not affect by natural substances application.

3.5.3. Interaction effects

The interaction gave significant effect on fiber length, fiber strength and micronaire reading in the second season only (Table,11). The longest fibers (34.17 and 34.00 mm) were obtained from marine plants 'Algaefol' extract and yeast extract as foliar spraying at the low level (5 cm^3 marine plants 'Algaefol' extract + 3 g yeast powder) /L or at the high level (10 cm^3 marine plants 'Algaefol' extract + 6 g yeast powder) /L three times when combined with the recommended rate of N fertilization, respectively. But the shortest fibers (32.63 mm) were obtained from control treatment (no natural substances used application) when combined with 50% RD of N fertilization. Micronaire reading affected significantly by the interaction in the second season only, but it did not follow a definite trend. Regarding Pressley index the highest value (10.47 Pressley units) throw the interactions was recorded by 100% RD of N fertilization interacted with marine plants 'Algaefol' extract and yeast powder combination as foliar spraying at the high level. However, the lowest values (9.83 Pressley units) resulted from fertilized plants with 50% RD of N combined with control treatment (no natural substances used application).

4. Conclusion

It could be concluded that under late sowing of cotton plant, it is better to increase efficiency of mineral N fertilizer added to the soil by applying marine plants extract and yeast extract as foliar spraying at the high level three times (at the squaring stage, flowering initiation and 15 days later) to achieve the maximum quantity and quality of cotton production with minimum environmental pollution under similar conditions to those of El-Gemmeiza region.

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