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Applications of Nano Biotechnological Microalgae Product for Improve Wheat Productivity in Semai Aird Areas

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Abstract Wheat is the most important strategic crop cultivated in the arid and semiarid areas in the world and Egypt that is extremely drought tolerant. However, production and quality of wheat are threatened by major stresses such as diseases and environment stress. In this study, we established a digital database for the land resources in new reclaimed soils in Egypt and for optimum management of wheat crop production and then sustainable agriculture could be achieved . So, Remote sensing data , geographic information system (GIS) techniques was used to establish a land resources database of the newly reclaimed areas located in, Egypt by estimating and mapping soil salinity, properties and normalized difference vegetation index (NDVI). Sinai (Sahl El Tena) area is being a good model for conduct and land use planning, so it selected for this study and compare with the Wadi Natrun. Applications of nano biotechnological microalgae product of nano silica Blue-green Cyanobacteria - *Oscillatoria agardhii* improved the wheat resistance to biotic stress as diseases, environment stress, soil ,water irrigation quality , reduce losses and increase yield productivity in some semi-arid region and normal conditions. Blue-green Algae applied treatment increased antioxidant enzymes as catalase (CAT), peroxidase (POD), superoxide dismutase (SOD), as well as grain yield, flour protein and glutamine in most cases- and improved wheat yield quality parameters.

Keywords: Algae, antioxidant enzymes, Blue-green Cyanobacteria– *Oscillatoria agardhii, nanobiotechnological*, Wheat.

Introduction

Arid climate as water shortage and soil salinization has contributed to reduced crops yield production in many reclaimed regions . Climate change is essential pay that led to physiological stresses particularly in semiarid regions that sorely affected crop production (Godfray *et al*., 2010, 2016, Haggag Wafaa *et al*., 2016). Environmental stress as water stress , saltiness and heavy metals is highly variable in its duration and seriousness that significantly reduce the optimal plant productivity that can be accomplished (Saber *et al.,* 2016). Today there is excessive demand for accurate soil information and land use planners over large areas from environmental researchers as well as more strategic traditional agricultural

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users of soil resource inventories as wheat and soil properties directly relevant to their application (Ali and Abdel Kawy, 2007 and Gad and Ali, 2011).

The soil information so produced was explained for various aim like land classification, crop suitability , management and prioritization of watersheds . The fertile soils of the Nile Valley are among the most productive in Egyptian conditions conducive many cereal and horticultural crops. However of its productivity, limited arable land leaves the country dependent on imported food products special wheat crop. Soil information is needed for a wide range of environmental and agricultural applications (Dobos and Montanarella, 2007). Soil information is needed for a wide range of environmental and agricultural applications (Dobos and Montanarella, 2007). In addition, a biotic (fungi, bacteria,..) stress is severely affecting the yield of these crops. Wheat plants is the most important grain crop of the world population and in Egypt. The world production of wheat in 2016 was 749 million tonnes,(United Nations, Food and Agriculture Organization. 8 December 2016). Biotic (Fungi, bacteria,..) and abiotic (including drought, heat, salinity and mineral toxicities) Stresses of wheat are main hazards to wheat growth , production and quality (Haggag Wafaa 2016, Haggag Wafaa *et al*., 2017).

Application of biotechnology products to these crops can contribute efficiently to reduce these problems. The induction of the plant defense response by beneficial microorganisms products as bioelicitor that normally colonize living plants, had received ample attention (Haggag, Wafaa, 2014, Haggag Wafaa and Timmusk, 2007, Haggag, Wafaa *et al.* 2014a, Ghaly *et al*., 2010) . Similarly, Blue-green Algae (cyanobacteria) are a diverse group of organisms that frequently occur in marine environment and play a role in soil fertility , reclamation, protect plants from pathogens, change of microbiological system and can stimulate plant growth that show a great potential for generation of novel agricultural technologies derived benefit and as a source of compounds act as biofertilizer, biopesticides and biofungicides , and others (Khan *et al*., 2009b, Hoballah *et al*. 2012 and Haggag, Wafaa *et al*. 2014a). Blue-green Algae (cyanobacteria) show a great potential for suppressive and inhibit of plant pathologists, *in vitro* by substances produced by various cyanobacteria as *Chaetomium globosum, Cunningha mellablakesleeana,* and *Aspergillus oryzae, Rhizoctonia solani* and *Sclerotinia sclerotiorum (*Haggag, Wafaa *et al*. 2014b). Biochemically and physiologically, algae are similar in many aspects to other plants. Algae possess the same basic biochemical pathways; all possess chlorophyll-*a* and have carbohydrate, protein and products comparable to those of higher plants. Furthermore, algae are the major primary producers of organic compounds and play a central role as the base of the food chain in aquatic systems. These have been reported to be plant growth regulators (PGRs), vitamins, amino acids, polypeptides, antibacterial or antifungal substances that exert phytopathogen biocontrol and polymers, especially exopolysaccharides, that improve soil structure and exoenzyme activity (Shweta *et al*., 2011, Abdel-Raouf *et al*., 2012 and Stadnikand *et al*., 2014). So, algae are important components of arid and semi-arid ecosystems. Resistance against pathogens is one of the key factors for plant varieties used in production systems (Haggag, Wafaa *et al*., 2014a). The most prevalent tools to control plant, pests and enhance soil fertilely are the use of intensive agrochemicals irrespective of their high cost and deleterious impacts on health and environments. Some potential applications to consider for cyanobacteriaare the production of antimicrobial compounds for thepharmaceutical industry and the agricultural sector as both bio-fertilizers and biocontrol agents.

Nanotechnology is a promising approaches of interdisciplinary products and its practical applications into agriculture industry is receiving attention due to the potential benefits (Huang *et al*.2015, Khiyami *et al*., 2014 and Haggag Wafaa 2014). Use of bionanoparticles in plant disease management is a novel approach that may prove very effective potential of application aspects of nanotechnology (Khiyami *et al.*, 2014 and Haggag, Wafaa *et al.*, 2014b). Some of the nano particles that have entered into the arena of controlling plant diseases are nano forms of carbon, silica and silver (Sharma *et al*., 2011 and AbdulHameed 2012).

The objective of this study was thus to innovate technologies for a clean farming system able to produce economically feasible and sustainable wheat production free from agrochemical residues in a better environment, salt stress, water quality and climate change using the potentiality of nanobiotechnological product from blue-green Algae (cyanobacteria) in wheat plants grown in two regions as semi-arid land of Sinai (Sahl El Tena) and compare with normal condition in the Wadi Natrun.

Materials and methods

Characterization of water and soils

Data collate available in a back ground sector of the past and current status of saline soil management in Egypt

Management of available data of saline soils in Egypt was composed and recorded, assessed with special care on this tasks of the project to select the suitable region.

Mapping and estimating the areas of saline soils and properties by using the remote sensing techniques and GIS in Egypt Governorate:

Mapping and estimating the soil salinity area(s) , mapping soil properties, were done using ramote sensing techniques and GIS through satellite images, geo-metric correction, change detection , image improvement and image classification . The aim of this task was using digital and electronic remote sensing technique and GIS operation to detect and estimating the spatial variability map of soil salinity in terms of spectral response of satellite images.

Routine analysis

Water and soil samples were collected, determined for pH values, electrical conductivity in dS/m at 25C^{o} in 1:5 soil water extract, dry solids, volatile solids/organic matter, approximate surface area of soils, soluble cations and anions in 1:5 soil water extracts , exchangeable cations were extracted by ammonium acetate solution, chloride by titration with silver nitrate and soluble carbnate by titration with standardized sulfuric acid, total calcium carbonate using Schiebler's calciminer and calculated as $CaCO_3$, active calcium carbonate , surface area and nutrients contents in wet samples. The chemical properties' of saline water and soils were determined and assessment by their chemical composition.

Soils and water analyses

Representative soils and water samples were collected form the experimental fields following the guidelines detailed by FAO (2006). Samples were analyzed using the soil survey laboratory methods (Soil Survey Staff, 2014).

Algae

Cyanobacteria- *Oscillatoria agardhii* was isolated and characterized by Hoballah *et al*. (2012), cultivated on BG- 11 media at 26^{0}C-28^{0}C. The cultures were kept on a shaker to aid proper aeration and agitation to facilitate growth of the cells. Cyanobacteria- *O. agardhii* extract was prepared from the lysed cells along with methanol solvent. The extracts were prepared according Karticioglu (2006).

Biosynthesis of silicon and titanium nanoparticles

The extracellular synthesis of silicon nano particles (SNPs) from algae was anchored following the methods described by Parial D, Pal R (2015) .The harvested algae biomass (1 gm of wet weight) were resuspended in 100 mL aqueous solution of 10^{-3} M potassium hexafluorosilicate (K_2SiF_6) and kept on a shaker (200 rpm) at 31^{o}C under anaerobic conditions. The reaction products were collected after separating the algae biomass from the reaction medium through centrifugation at 5000 rpm for 10 min. In a control experiment, the harvested algae biomass was resuspended in autoclaved deionized water in the absence of K_2SiF_6 or K_2TiF_6 and the product obtained was characterized for the presence of Si/SiO_2 nanocomposite.

Field experiments

The field trials were performed under aird conditions in of Sinai (Sahl El Tena) and compare with normal condition in the Wadi Natrun., using wheat Gemza variety during 2015/ 2016 and 2016/ 2017 growing seasons. Experimental design was randomized complete block design with 5 replicates and 1-meter row experimental unit. Ten rows of wheat plants were grown in each plot with a density of 300 seeds per square meter using one Fadden. Control plants were fertilized immediately after sowing with ammonium nitrate ($NH4 + -N$) at the rate of 100 $kg·N·ha^{-1}$. Wheat seeds were treated with the algae extract as well as, its nano silicon at concentration of 150 ppm. Fungicide Sumi 8 5% Ec (produced by Kafr El-Zayat chemical Company Limited, Cairo, Egypt) at concentration of 0.5 mL / L were applied for comparison. After 30 days of sowing, plant were sprayed with the same treatments. Two months later, 10 individual-plant-samples from each experimental unit were carefully harvested an adhering soil removed by washing. Fungal infection of roots was evaluated and fresh weight and dry weight (70 ℃ for 72 h) were determined. Liquid extract were especially sprayed on to the wheat leaves at 30 days after sowing. Each treatment consisted of three plots and the experiments were conducted three times. Diseases severity was assessed as the percentage area of leaves infected during growth periods.

- Disease severity (R) was calculated according to the formula, having added the per cent of the affected leaf area of each leaf and having divided the sum by the number of assessed leaves:

$$R = \frac{\Sigma(n \cdot b)}{N}$$

- Where $\Sigma(n \cdot b)$ – sum of product of the number of leaves with the same percent of severity and value of severity, N – number of assessed leaves.
- Disease incidence, i.e. per cent of disease-affected leaves (P) was calculated according to the following formula**:**

$$P = \frac{n}{N} \cdot 100$$

- where n – number of affected leaves, N – number of assessed leaves.

Powdery mildew

Leaves colonization by the fungus was quantified by measuring mildew colonies covering the surface of the leaves. Ten days after inoculation, disease severities were recorded according to the following scales: 0 = 0%; 1 ≤ 5%; 3 = 6%– 15%; 5 = 16%–25%; 7 = 26%–50%; and 9 ≥ 50%.

Chemical analysis

Ten days after spraying, five leaves per plant were separately collected, frozen for 36 h, dried and powdered. Generally, 100 mg dried sample were used for analysis.
Protein determination: The concentration of protein was determined by the method of Bradford (Bradford 1976) using BSA as a standard.

Enzymes extraction and assays

Superoxide dismutase (SOD): SOD activity was estimated by recording the decline in the absorbance of superoxide nitro blue tetrazolium complex by means of the enzyme based on the method of Dhindsa *et al.* (1980). Absorbance was recorded at 560 nm and one unit of enzyme movement was taken as the amount of enzyme.

Catalase (CAT) and peroxidase (POD): Catalase action was precise according to Aebi (1998). As concerning for CAT 3 ml reaction mixture containing 1.5 ml of 100 mmol potassium phosphate buffer (pH = 7.2), 0.5 ml of 75 mmol H_2O_2, 0.05 ml enzyme extraction. The absorbance recorded in decrease at 240 nm for 60 s. The enzyme action was accounted by calculating the quantity of decomposed H_2O_2. Peroxidase (POD) activity was assayed by recording 3 ml reaction mixture. The reaction mixture contained 0.1 mmol EDTA, 1 ml of 0.2 mol/m^3 potassium phosphate buffer with pH = 7.6, 0.1 ml of 2 m mol (NADPH), 0.5 ml of 3 m mol DTNB, 0.1 ml enzyme extract. Reaction initiated by adding of one unit of POD activity. The raise within absorbance at 412 nm was recorded at 25 ℃ in excess of a period of 5 min on a spectrophotometer. Protein extract was quantified using the technique of Bradford .

Determination of growth and yield

All the plants of different treatments were harvested in the same physiological growth stage. Data on wheat total dry biomass, grain and yields, tiller and spike numbers per plant, grain number per spike, and weight of 100 kernels were recorded. Spikes were oven-dried at 70 ℃ for 72 h and their dry weights were determined. Spike weight per plant was recorded.

Grain protein content (GPC) measurement

Mature grains were ground and passed through a 0.5 mm screen. GPC was measured using the Kjeldahl method (1983) with three replications for each sample. Protein content is calculated by duplicating a factor of 5.83 with N content (Mariotti *et al.*, 2008).

Statistical analysis: Disease assessment results were analyzed using an ANOVA of square- root-transformed data. Data were transformed to acquire the normal distribution necessary for statistical analysis to be carried out. Significant differences were assessed by comparison of sample mean differences with the LSD value.

Results

Characterization of water and soils

General Characterization of regions in Egypt

Egypt’s climate is arid or semi-arid characterized by hot and dry summers; moderate winters of very little rainfall. From the climatological point of view, Egypt could be divided into three zones as shown in Figure (1). The zones represent north, middle and upper of Egypt which are different in their climatic conditions. Through this project, we are going to select some newly reclaimed areas in each zone, to ensure from homogenous distribution of these sites.

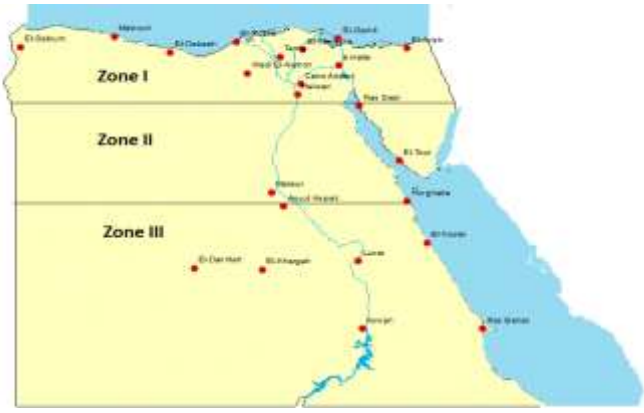

Figure 1. Agro-climatic zone in Egypt

Detecting and mapping the areas of saline soils in Egypt governorate using remote sensing techniques and GIS and Routine analysis

The main objective of the current research is to establish a digital database for the land resources in new reclaimed soils. This database could be used for optimum management of cultivated land and then sustainable agriculture could be achieved. Estimating and mapping soil salinity, mapping soil properties, normalized difference vegetation index (NDVI) were done using remote sensing techniques and GIS through satellite images, geometric correction, image enhancement, image classification and change detection . The data extracted from satellite images; land survey and laboratory analyses were linked with their relevant geographic locations using Arc-GIS 9.2 software. The land use and land cover over the study area is represented in Figure 2 and Table 1.

Table 1. Mapping soil salinity, mapping soil properties using remote sensing techniques and GIS through satellite images.

Zone	Region name	Area (F.)	Salinity level dS/m	OM %	$CaCO_3$ %
1	Sahl El Tena	90,000	12-170	0.2-0.8	0.5-5.4
2	Plain South Port Said	160,000	6-34	0.1-1.2	6.4-24.2
3	North Delta	110,000	3-35	1.1-1.7	0.9-2.5
4	Adco	35,000	10-45	0.7-1.8	1.5-19.6
5	Mariot	220,000	8-45	0.4-1.6	3.0-21.2
6	Wadi Natrun	100,000	4-49	0.2-1.4	5.1-23.0
7	North of Fayoum	105,000	6-35	0.7-1.9	5.5-28.7
8	Rayan Valley	20,000	8-40	0.2-1.1	6.4-31.1
9	Odd	85,000	11-60	0.2-0.6	7.5-31.5
10	Oasis of Siwa	170,000	6-150	0.6-2.6	4.6-40.0
11	Farafra Oasis	190,000	2-30	0.1-2.6	1.8-33.4
12	Abu Munqar	88,000	2-35	0.1-0.8	2.4-38.7
13	The Dakhla Oasis	185,000	6-45	0.2-0.8	3.8-28.6
14	The oases of Kharga	210,000	4-45	0.1-0.7	4.4-36.4
15	The trail of the forty	240,000	6-20	0.1-0.4	1.3-14.6
16	Toshka	380,000	4-35	0.1-0.8	5.2-18.4
17	East of Awainat	420,000	2-20	0.1-0.8	2.6-12.4

Two pilot areas have been selected for this study (Figure 2). The first area is located to the North of the Nile Delta represents the alluvial plain of fine texture . The second pilot area is located to the North of Sinai peninsula represents the Aeolian plain of coarse texture .These areas are irrigated with mixed (1:1) irrigation water characterized by EC of 1.36 dS/m. The ratios of CaCO3 and organic matter (OM) in the marginal land in Egypt were included within the attached Table (1). The ratio of OM give good indicator about the soil fertility, it can be used instead of N, P, K which are not available for all sites specially the desert areas (Table 1). The data collected from field work and lab analyses were stored in the established database and linked with their relevant geographic locations. The results indicate that the main LU/LC over the area includes cultivated land, degraded land, arable land and water logged areas. The main soil properties confirming that the soils are characterized by low quality and low productivity is expected. The area requires more attention in land use planning where the poor soil fertility, various surface elevation and poor drainage should be considered. Sahl El Tena is the good area in salinity which ranged from 12 to 70 dS/m . North of Delta and Sahl El Tena are good in CaCo3 and organic matter.

Figure 2. Mapping soil salinity, mapping soil properties using remote sensing techniques and GIS through satellite images

Tables 2 and 3 represent some soils and water properties of the experimental fields. The data indicate that the experimental fields are characterized by sandy soil texture. The soil salinity (EC) differs widely from 7 dS/m in Sahl El Tena to 1.72 dS/m in Wadi Natrun experimental field. Soil pH is relatively high and reaches 7.7 in Sahl El Tena and 7.8 in Wadi Natrun. The dominant salts in the soils of experimental field are NaCl and $CaCl_2$. Regarding to the irrigation water the analyses indicate that the water salinity (EC) is high in Sahl El Tena experimental field (8.01 dS/m), while it is low in Wadi Natrun (1.9 dS/m). Values of water pH are 7.5 in Sahl El Tena and 7.7 in Wadi Natrun.

Table 2. Physical and chemical properties of the experimental soil and water irrigation at Sahl El Tena region

Physical properties			*Chemical properties*											**$CaCO_3$ %**
						Cations (meq L^{-1})				Anions (meq L^{-1})				
Sand	Silt and clay	Soil texture	EC dS/m	ppm	pH	Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO_3^{=}$	HCO_3^{-}	Cl^{-}	$SO_4^{=}$	
Soil properties														
96.37	4.33	Sandy	7.0	4002	7.7	7.50	0.81	9.33	0.12	---	1.53	3.36	1.92	0.5
Water irrigation														
			8.01	4206	7.5	13.7	4.27	28.4	0.85	---	5.70	36.7	4.65	

Table 3. Physical and chemical properties of the experimental soil and water irrigation at Wadi Natrun region

Physical properties				*Chemical properties*											**CaCO %**
							Cations (meq L^{-1})				Anions (meq L^{-1})				
Sand	Silt	clay	Soil texture	EC dS/m	ppm	pH	Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO_3^{=}$	HCO_3^{-}	Cl^{-}	$SO_4^{=}$	
Soil properties															
96.6	5.2	1.7	Sandy	1.72	424	7.8	3.50	0.43	2.04	0.14	---	1.1	3.37	1.23	0.75
Water irrigation															
				1.9	323	7.7	9.81	2.07	13.4	0.97	---	2.34	24.7	2.32	

Field experiment

Disease severity

The effects of cyanobacteria- *O.agardhii* extract on controlling wheat diseases were evaluated on plants grown in semi-arid land Sahl El Tena compared normal conditions in Wadi Natrun (Table 5). Powdery mildew, leaf rust , leaf spots and head spots are the most important diseases that cause severe losses of wheat plants under both conditions and seasons. Leave spots are the main diseases in wheat grown in Sahl El Tena and powdery mildew in Wadi Natrun. In general, the diseases incidence were higher in untreated plants and treated with fungicides grown either in semi-arid land or in normal conditions . Analysis of data indicated that application of cyanobacteria- *O. agardhii* significantly reduced diseases severity of wheat in compared to the fungicides and control plants. Nano silicon of *O. agardhii* was more effective in controlling all the diseases include, spot disease, powdery mildew and rust in wheat grown in both regions and seasons.

Enzymes extraction and assays

The effect of nano silicon of *O. agardhii* on the activities of oxidative enzymes is shown in Table (6). The results revealed an increase in Superoxide dismutase (SOD) , Catalase (CAT) and peroxidase (POD) activities in leaves of wheat treated with *O. agardhii* in compared fungicide. The maximum increase in the enzymes activities was observed in the cultivars of wheat treated with nano-silicon of *O. agardhii*.

Based on the results of this study, application of cyanobacteria- *O. agardhii* on wheat was found to be very effective on decreasing foliar diseases and increasing plants yield and its quality (Stadnikand B. Mateus de Freitas, 2014). Cyanobacteria – *O. agardhii* provided an important role in integrated disease management, accelerate biochemical reactions as antioxidant enzymes i.e. Catalase (CAT) and peroxidase (POD) andsuperoxide dismutase (SOD) as well as stimulate growth in general, which will lead for better quality and higher yield. Microalgae are microorganisms of choice in biotechnology thanks to their wide range of potential bio-applications, such as over-expression of pigments, bioremediation, biofuel production and toxicity studies.

Chemical *components and* physiological characteristics of wheat

*C*hemical components and physiological characteristics of wheat include N, P, K, K/N , proline, Soluble carbohydrates , Chl. a+b , and Carotenoids are highly significantly influenced by grown in different types of soils that great decreased in saline soil of Sahl El Tena (Tables 7 and 8). The results indicated cyanobacteria *O. agardhii* show significant difference over the fungicide and control treatment in improving wheat plant components either grown in semi-arid land (Sahl El Tena) or in normal conditions (Wadi Natrun). In general, the results showed that wheat treated with nano silicon of *O. agardhii* has significant effect on plant components in semi-arid land (Sahl El Tena) than in normal conditions (Wadi Natrun) .

Grain yield

Grain yield as grain index , grain yield of spike and crude protein% of wheat cultivar are highly significantly influenced by grown in different types of soils that great decreased in saline soil of Sahl El Tena (Table 9). The results of data analysis showed that wheat plants treated with cyanobacteria *O. agardhii* show significant difference over the fungicide and control treatment in improving wheat yield either grown in semi-arid land (Sahl El Tena) or in normal conditions (Wadi Natrun) (Table 9). The results showed that application nano silicon of *O. agardhii* has significant effect on yield in semi-arid land (Sahl El Tena) or in normal conditions (Wadi Natrun).

The same results were also obtained in yields grain quality and components of wheat as glutamine, flour yield, flour protein and N% (grains) are highly significantly influenced by grown in different types of soils that great decreased in saline soil of Sahl El Tena (Table 10). In addition, application of *O. agardhii* extract has significantly contribute to the formation and improved of grain yield and yields quality of wheat grown in semi-arid land (Sinai) or in normal conditions (Wadi Natrun) The results showed that application nano silicon of *O. agardhii* has significant increased yield grain quality and components in semi-arid land (Sahl El Tena) or in normal conditions (Wadi Natrun).

Table 5. Diseases severity (%) of wheat plants cv Gemaza 10 treaded with nano silicon product of *O. agardhii* , grown under saline soil in Sahl El Tena and compared in Wadi Natrun.

Treatment	Location	Powdery mildew		Leaf rust		Leaf Spots		Head spot	
		2015/2016	**2016/2017**	***2015/2016***	**2016/2017**	***2015/2016***	**2016/2017**	***2015/2016***	**2016/2017**
Control	**Sahl El Tena**	25.7	24.3	10.8	11.4	33.5	35.6	11.2	12.4
Fungicide		11.3	10.6	5.4	6.8	8.6	7.7	3.3	4.4
O. agardhii		3.4	3.7	2.3	3.3	4.8	3.7	1.4	1.5
NSi *O. agardhii*		1.4	2.2	0.8	1.2	1.2	1.4	0.8	0.9
Control	**Wadi Natrun**	22.3	21.3	21.3	22.3	28.7	30.7	17.8	18.6
Fungicide		10.6	11.3	7.8	9.8	7.6	6.7	4.7	5.6
O. agardhii		2.4	2.5	2.4	3.1	3.8	3.2	1.9	1.8
NSi *O. agardhii*		0.7	0.7	0.7	1.1	1.3	1.4	0.8	0.9
LSD		2.5	2.4	1.3	1.2	2.3	2.4	1.4	1.5

Table 6. Oxidative enzymes in wheat plants cv Gemaza 10 treaded with nano silicon product of *O. agardhii* , grown under saline soil in Sahl El Tena and compared in Wadi Natru

Treatment	Location	***Superoxide dismutase (SOD)*** *unit/mg protein*		***Catalase (CAT)*** *unit/mg protein*		***Peroxidase (unit)***	
		2015/2016	**2016/2017**	***2015/2016***	**016/2017**	***2015/2016***	**2016/2017**
Control	Sahl El Tena	4.2	4.4	2.9	2.7	19.8	19.8
Fungicide		4.6	4.7	4.5	4.7	20.7	20.7
O. agardhii		10.6	9.9	7.7	7.8	24.7	22.8
NSi *O. agardhii*		12.6	11.9	9.7	11.8	26.8	25.7
Control	Wadi Natrun	3.7	3.6	2.6	2.6	16.8	17.7
Fungicide		4.1	4.2	4.3	4.7	18.8	18.9
O. agardhii		8.5	8.6	7.6	7.7	22.8	21.7
NSi *O. agardhii*		11.7	11.8	9.7	10.7	23.7	23.8

Table 7 . Chemical components and physiological characteristics of wheat plants cv Gemaza 10 treaded with nano silicon product of *O. agardhii* , grown under saline soil in Sahl El Tena and compared in Wadi Natrun.

Treatment	Location	N		P		K		K/N ratio	
		2015/2016	2016/2017	*2015/2016*	016/2017	*2015/2016*	2016/2017	*2015/2016*	2016/2017
Control	**Sahl El Tena**	0.23	0.24	0.17	0.18	0.28	0.19	1.17	1.15
Fungicide		0.29	0.28	0.21	0.22	0.41	0.32	1.20	1.19
O. agardhii		0.35	0.37	0.28	0.29	0.46	0.43	1.25	1.25
NSi *O. agardhii*		0.41	0.44	0.33	0.31	0.52	0.51	1.29	1.28
Control	**Wadi Natrun**	0.32	0.23	0.22	0.23	0.24	0.25	1.19	1.14
Fungicide		0.39	0.41	0.25	0.27	0.29	0.28	1.24	1.20
O. agardhii		0.44	0.55	0.31	0.33	0.36	0.47	1.28	1.27
NSi *O. agardhii*		0.54	0.65	0.34	0.36	0.49	0.56	1.30	1.30
LSD		0.12	0.13	0.11	0.12	0.21	0.32	0.31	0.3

Table 8. Chemical components and physiological characteristics of wheat plants cv Gemaza 10 treaded with nano silicon product of *O. agardhii* grown under saline soil in Sahl El Tena and compared in Wadi Natrun.

Treatment	Location	Proline (umol/g fresh weight)		Soluble carbohydrates %		Chl. a+b (mg/g fresh weight)		Carotenoids (mg/g fresh weight)	
		2015/2016	2016/2017	*2015/2016*	2016/2017	*2015/2016*	016/2017	*2015/2016*	2016/2017
Control	**Sahl El Tena**	129.8	130.7	10.9	10.4	3.09	3.12	0.59	0.61
Fungicide		130.7	144.8	11.8	11.7	3.36	3.39	0.62	0.64
O.agardhii		152.8	164.7	12.8	12.7	3.88	3.88	0.87	0.89
NSi *O. agardhii*		161.7	175.7	13.7	13.6	4.01	4.12	0.91	0.97
Control	**Wadi Natrun**	102.7	109.8	11.8	11.9	3.32	3.25	0.62	0.63
Fungicide		121.8	124.8	11.96	11.9	3.56	3.66	0.68	0.69
O.agardhii		132.7	139.6	12.98	13.3	3.98	3.99	0.85	0.78
NSi *O. agardhii*		156.8	154.7	13.6	13.9	4.32	4.23	0.95	0.91
LSD		5.3	5.7	0.6	0.5	0.07	0.08	0.12	0.16

Table 9 . Wheat yield cv Gemmiza 10 treaded with nano silicon product of *O. agardhii* , grown under saline soil in Sahl El Tena and compared in Wadi Natr

Treatment	**Location**	**Grain index (g)**		**Grain Yield of spike(g)**		**Ton acre^{-1}**		**Crude protein%**	
		2015/2016	**2016/2017**	***2015/2016***	**16/2017**	***2015/2016***	**2016/2017**	***2015/2016***	**2016/2017**
Control	**Sahl El Tena**	3.8	3.9	11.8	12.7	1.70	1.81	8.9	9.0
Fungicide		5.5	5.8	15.4	15.6	2.40	2.56	10.6	10.8
O. agardhii		6.9	7.1	18.7	22.1	3.65	3.78	12.8	12.7
NSi *O. agardhii*		7.9	7.9	19.7	24.7	3.76	3.98	13.7	13.1
Control	**Wadi Natrun**	4.6	4.9	15.8	13.7	1.98	1.97	9.8	10.2
Fungicide		6.6	6.8	19.8	18.5	2.98	2.96	11.7	11.9
O. agardhii		7.5	7.1	24.8	25.8	3.89	3.61	12.6	13.0
NSi *O. agardhii*		7.9	8.5	26.7	27.8	3.98	3.97	13.6	13.6
LSD		0.8	0.86	1.2	1.3	0.5	1.54	0.98	1.1

Table 10 . Chemical components and physiological characteristics of wheat grain cv Gemmiza 10 treaded with nano silicon product of *O. agardhii* , grown under saline soil in Sahl El Tena and compared in Wadi Natrun.

Treatment	**Location**	**Glutamine**		**Flour yield**		**Flour protein content**		**N% (grains)**	
		2015/2016	**2016/2017**	***2015/2016***	**2016/2017**	***2015/2016***	**2016/2017**	***2015/2016***	**2016/2017**
Control	**Sahl El Tena**	161.7	172.5	43.6	42.7	9.8	9.8	1.56	1.65
Fungicide		197.6	201.2	57.4	55.7	11.6	11.8	2.09	2.12
O.agardhii		226.8	231.2	61.7	60.1	15.8	15.5	2.77	2.57
NSi *O. agardhii*		231.7	243.7	69.6	64.7	18.7	18.6	2.98	2.89
Control	**Wadi Natrun**	180.2	189.7	49.2	49.7	10.8	11.7	1.98	2.01
Fungicide		203.5	213.6	59.1	58.4	12.5	14.6	2.32	2.43
O.agardhii		243.8	251.7	64.3	65.1	16.9	16.6	2.58	2.67
NSi *O. agardhii*		251.6	262.7	78.8	75.7	20.8	19.7	2.97	2.97
LSD		6.8	7.5	3.5	3.6	0.9	0.96	0.65	0.75

Discussion

The growing demand for food consumption in developing countries alone is predicted to increase by around 1.3% per annum until 2020 (World food situation: FAO cereal supply and demand brief" 2016). Egypt, the most populous country in the Arab World, is also by far the largest importer of wheat globally (Haggag Wafaa *et al.,* 2016). The increase in imports in the coming marketing year is expected in response to the increased local crushing capacity with the objectives of producing affordable, high quality of-protein for the food industry.

In recent years thematic mapping has undergone a revolution as the result of advances in geographic information science and remote sensing (Ali and Abdel Kawy, 2007 and Gad and Ali, 2011). The results of this work are of great importance as they represent the soil productivity constraints of all over the region. The digital database allows policy makers, planners and experts to overcome some of the shortfalls of data availability. It also facilitates the integration of the data in internal and external network, this can realize by a systematic manner of the digital database (Gad *et al* ., 2005 , Ali and Abdel Kawy, 2007 , Gad and Ali, 2011 and Haggag Wafaa *et al*., 2016 & 2017). The incorporation of the obtained data from different resources can be achieved to fulfill the sustainable development requirements.

The microorganisms in bio-fertilizers restore the soil's natural nutrient cycle and build soil organic matter. Therefore, they are extremely advantageous in enriching soil fertility and fulfilling plant nutrient requirements by supplying the organic nutrients through microorganism and their byproducts. Hence, bio-fertilizers do not contain any chemicals which are harmful to the living soil (Vessey, 2003). Bio-fertilizers provide "eco-friendly" organic agro-input. Bio-fertilizers such as Rhizobium, blue green algae (BGA) have been in use a long time (Haggag Wafaa *et al*., 2014a).

Many studies have been conducted to determine the using of algae as biofertlizer modes of action for a list of benefits, including; early seed germination and establishment, improved crop performance and yield, elevated resistance to biotic and abiotic stress, and enhanced postharvest shelf-life of perishable products (El-Sayed *et al*.,2011 and Haggag Wafaa *et al*., 2014). Furthermore, algae are the major primary producers of organic compounds; and play a central role as the base of the food chain in aquatic systems. In the last decades, different researchers have studied the replacement of chemical pesticides by natural components of different plant and microalgal sources of fungicidal agents (Volk and Furkert, 2006 , Abdel-Raouf *et al.,* 2014 and Haggag Wafaa *et al*., 2014b). These natural materials in addition to their lethal activities on pathogens, preserves the environment of pollution and maintain the equal distribution of fauna.

Nanotechnology would provide green and efficient alternatives for the management of plant diseases (Haggag, Wafaa, 2014). The broad range of nanotechnology applications in agriculture includes nanopesticides (NPs) for the control of crop pests and diseases (Abdul Hameed 2012 & Haggag, Wafaa 2014). Soil microorganisms and plants (extracts) are important bioagents and possess great potential and scope in the synthesis of nanoparticles. In natural biological systems, scientists developed an alternative strategy for nanoparticles synthesis using microorganisms (Malhotra *et al*, 2013). Development of efficient and eco-friendly processes of synthesis of nanoparticles is an important aspect of bionanotechnology (Khan *et al*., 2009). Numerous microorganisms have been found to produce nanoparticles in the substrate (El-Rafie *et al*., 2012). Singh *et al*. (2013) found that nanoforms of 15 micronutrients were most effective in controlling rust disease of peas plants. Si has been involved in several many diseases resistance responses, including resistance to anthracnose *(Colletotricum graminicolum)* of sorghum (Narwal, 1973), barley resistance to powdery mildew disease (Kunoh Leusch and Buchenauer, 1989). Silicon (Si) is known to be absorbed into plants to increase growth of plants, disease resistance and stress resistance . Si know to promotes the physiological activity via induces compounds such as chitinase, peroxidase, polyphenol-oxidase, salicylic acid, phenolic, and phenylalanine ammonia-lyase that result in diseases suppress (Currie and Perry, 2007).

Application of nano silicon product of *O. agardhii* act as biocontrol agents , biofertilizers that reduce plant pathogens, improve of plant resistance to diseases, environment stress and increase plant growth, yield productivity, and could increase the quality and quantity of the wheat products.

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