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The stimulant effect of the Spirulina Algae under Low Levels of Nitrogen Fertilization on Wheat plants Grown in Sandy Soils

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Abstract: A field successive experiment was carried out employing sandy soil to clarify the spirulina algae(blue green micro-algae water extract) and varied levels of N fertilization on growth, yield and nutrients indices of wheat (*Triticum aestivum L.*) plants. The experiment was carried out to evaluate the effect of three level of spirulina algae (25, 50 and 100 ml L^{-1}) as combined with two levels of nitrogen fertilization (80 and 100 kg N/fed).Increasing the level of spirulina algae from 25 to100 under the low levels of nitrogen fertilization led to the increase of both growth and yield of wheat and not influenced by decreasing nitrogen fertilization rate. The lowest Nutrient Balance Index (NBI) was recorded from combination treatments 100 kg N fed^{-1} + 100 ml spirulina algae per litter and 100 kg N fed^{-1} + 50 ml spirulina algae per litter , were attained 12.02 and 12.64 , respectively; this treatments achieved high grain yield which were 2.82 and 2.81 ton fed^{-1}, respectively.
Key word: Wheat (*Triticum aestivum L.*), spirulina algae, N fertilization, growth, yield, Nutrient Balance Index.

Introduction

Wheat covers more of the earth's surface than any other cereal crop. However, although it takes more land space than other cereals, based on a three year average it is only the third-largest cereal crop, behind maize and rice. Wheat's domestication produced larger grains and a more productive crop, which could not have survived in the wild and required continued intervention of farmers intentionally planting it.

Spirulina platensis is a planktonic blue - green algae found in warm water and alkaline volcanic lakes. It could be cultivated on marginal, unusable and unfertile soils. Wild Spirulinasu stains hunger flocks of filamentous in the alkaline East African lakes. Spirulina biomass consists of about62% amino acids and it contains also the whole spectrum of natural mixed carotene and Xanthophyl phytopigments which is considered as the richest natural source of vitaminB-12 [1].

The role of spirulina as a biofertilizer has been limited to its relevance and utilization in rice crops [2].Also, Yanni and Abd El-Rahman[3]stated that rice performance (as assessed by plant height, productive tillers, grain and straw yields and their N-contents and fertilizer N-use efficiency) was enhanced by inoculation with cyanobacteria along with urea fertilizer at 36 or 72kg N ha^{-1} rather than 108 kg N ha^{-1} without inoculation. Ali and Mostafa[4]showed that increasing grain and straw yield, plant height, number of capsule/ plant, number of branches/ plant, seed weight/ plant and 1000 seed weight of sesame plants when spirulina algae was used as bio-organic fertilizer.

The objective of this work aimed to study the effects of spirulina algae under low levels of nitrogen fertilization is recommended on growth, yield and nutrient indices of wheat (*Triticum aestivum L.*) plants. In order to clarify the importance of using spirulina algae as stimulating for growth as well as reduce the use of nitrogen fertilizer and thus reduce the hazard effect of pollution.

Materials and Methods

A field trial was successively conducted on a loamy sand soil at Ismailia Agricultural Research Station cultivated with wheat (*Triticum aestivum L.*, cvSakha 69) at winter 2013. Some chemical properties of the cultivated soil were evaluated in samples taken before wheat planting according to standard procedures reported by Cotteine[5]to be presented in (Table, 1).

Table (1): Some chemical properties of soil before wheat cultivation.

Soluble ions (mmol L^{-1})								EC	pH	$CaCO_3$	OM
Mg^{++}	Ca^{++}	K^+	Na^+	$SO_4^=$	HCO_3^-	$CO_3^=$	Cl^-	dS/m	1:2.5 suspension	%	
5.60	6.34	0.52	1.54	9.94	2.1	nd.*	1.96	1.2	8.0	1.5	0.25

* nd= not detection

The bluegreen micro-algae (*Spirulina sp.*) was produced at the Algae Production Station of the National Research Centre (NRC, Dokki, Cairo)

Three levels of spirulina algae (25, 50 and 100 mlL^{-1}, respectively) as combined with two rates of nitrogen fertilization. Spirulina has been sprayed on the plants after 30 day from germination, was repeated three times spraying. Table (2 and 3) shown the chemical analysis and amino acids of spirulina algae

Table (2): Chemical analysis of spirulina algae.

	N	P	K	Fe	Zn	Mn
Spirulina algae	%			ppm		
	5.90	2.35	1.35	10.99	6.50	8.5

Table (3): Amino acids composition of spirulina algae.

Amino acids	Total (%)
Isoleucine	6.0
Leucine	9.5
Lysine	6.4
Methionine	1.3
Phenylalanine	4.5
Threonine	5.3
Tryptophane	1.5
Valine	7.0
Alanine	7.6
Arginine	6.9
Aspartic acid	9.8
Cystine	2.0
Glutamic acid	11.1
Glycine	5.2
Hstidine	3.7
Proline	3.3
Serine	4.9
Tyrosine	4.0

Fertilizer nitrogen (in the form of NH_4 $(SO_4)_2$) was added in two levels 80 and 100 kg N/fed. These two levels below the recommended doses of nitrogen fertilization (120kg N/fed) by33%and 16.5%, respectively. All previous treatments compared to the control treatment, which was 120 kg N/fed without adding spirulina algae.

Plant samples were dried at 65C° for 48 hrs, ground and wet digested using H_2SO_4: H_2O_2method[5]. The digests samples were then subjected to measurement of N using Micro-Kjeldahle method; P was assayed using molybdenum blue method and determined by spectrophotometer and K was determined by Flame Photometer[6]. Amino acids were determined by HPLC method by Frave *et al.*[7].Thenitrogenandphosphorusandpotassium indices calculated using the equations of Diagnosis and Recommendation Integrated System (DRIS) method[8].

Results and Discussion

Data presented in table(2) show the effect of spirulina algae and fertilization rates on yield and growth of wheat plants. Increasing the level of spirulina algae from 25 to100under the low levels of nitrogen fertilization, whether low by 16.5% or33% for nitrogen fertilization is recommended to wheat plants(control) led to the increase of both growth and yield of wheat and not influenced by decreasing nitrogen fertilization rate, which means that' spirulina algae offset shortages in nitrogen fertilization rates in order to contain the algae on the percentage of nitrogen, as well as containing on amino acids. Fresh water green microalgae extracts appeared to be promising natural fertilizers. They contain high macro and micronutrients concentrations in addition to the natural enzymes and hormones [9].Ali and Mostafa[4]examined the effect of foliar spray or soil application methods of potassium-humate and Spirulina platens is algae (individually or combined) as bio-organic fertilizer on sesame yield and its attributes. They found that combined foliar application recorded the highest values of plant height, number of capsule/ plant, number of branches/ plant, seed weight/ plant and 1000 seed weight. While, combined soil application gave the highest values of seed and straw yield. Gholve *et al.*[10]indicated that the yield (in rice-wheat cropping system) obtained due to application of 75% recommended dose (RD) of N+20 kgblue green algal (BGA) /ha was statistically equal to that of 100% RD of N thereby indicating the efficient role of BGA for substitution of nitrogen N up to 25%. This was also confirmed by the assessment of the system in terms of monetary returns. In addition, Nanjappan-Karthikeyan *et al.*[11] indicated that the cyanobacterial isolates applied along with 1/3 N+P+K gave statistically equivalent results as compared to application of full dose of chemical fertilizers in terms of wheat grain yields.

Table (3): Effect of N fertilization and Spirulina algae levels on yield and growth of wheat plants..

Treatments		Yield ton fed^{-1}		Plant height	Photosynthetic capacity *	Grain index
N fertilization rate (kg fed^{-1})	Spirulina algae Levels ml L^{-1}	Grain	Straw	cm	g/cm^2	g
80	25	2.72	5.75	79.8	3.52	38.5
	50	2.75	5.84	80.5	3.74	40.1
	100	2.78	5.85	81.4	4.18	40.5
100	25	2.79	5.83	80.1	4.40	39.4
	50	2.81	5.96	81.5	4.54	40.3
	100	2.82	6.02	81.5	4.65	41.0
Control		2.88	6.10	81.6	4.94	41.5

*Photosynthetic capacity = flag leaf weight (g)/flag area (cm^2)

A nutrient index is a mean of the deviation from the optimum or norms values. The negative index values indicate that the nutrient levels are

below the optimum. Consequently, the more negative index, the more deficient the nutrient, similarly a positive index indicates that the nutrient

levels are above the optimum, and the more positive index the more excessive the nutrient that is relative to normal, and the DRIS index is equal to zero indicating that the nutrient is at optimum levels. However, some authors did not consider a nutrient deficiency or excessive when the DRIS indices are negative or positives and near to zero[12]. The combination effect between differentrates of spirulina algae and nitrogen fertilization on nutrient indices and NBI in leaves and grain yield of wheat plants are presented in Table (4).

Table (4):Effect of different rates of spirulina algae and nitrogen fertilization on nutrient indices, NBI in leaves and grain yield of wheat plants.

Treatments		Nutrient indices			NBI*	Grain yield ton fed^{-1}
N fertilization rate (kg fed^{-1})	Spirulina algae Levels ml L^{-1}	N	P	K		
80	25	-3.89	11.4	-7.51	22.80	2.72
	50	-3.00	9.61	-6.61	19.22	2.75
	100	-2.69	9.56	-6.87	19.12	2.78
100	25	-2.10	7.83	-5.73	15.66	2.79
	50	-0.94	6.32	-5.38	12.64	2.81
	100	-0.89	6.01	-5.12	12.02	2.82
Control		0.56	4.71	-5.27	10.54	2.88

* NBI = Nutrient Balance Index

Data revealed that the lowest Nutrient Balance Index (NBI) was recorded from combination treatments 100 kg N fed^{-1} + 100 ml spirulina algae per litter and 100 kg N fed^{-1} + 50 ml spirulina algae per litter , were attained 12.02 and 12.64 , respectively; these treatments achieved high grain yield which were 2.82 and 2.81 ton fed^{-1}, respectively. Selection of these treatments shows that these treatments are given the highest yield, which is approaching a lot of control treatment which had been added nitrogen fertilizer full amount, and therefore it is clear that adding spirulina algae to low rate of nitrogen fertilization which lower than the recommended dose by 16% (100 kg N fed^{-1}) could lead to increase wheat crop and not influenced own the amount of fertilizer nitrogen added. That the decline in the amount of nitrogen fertilization, without much reduced crop leads to lower the cost of using nitrogen fertilizer and thus increase profit and also reduce pollution resulting from the use of nitrogen fertilizer.

Ali and Esawy[13] showed that the simultaneous stimulation of *spirulina* solution could be attributed to its contents of nutrients which easily absorbed by plant leaves during the plant growth compared to the other treatment which were add as soil fertilizer. Considering that DRIS uses the nutritional balancing concept (relationship among nutrients), it is postulated that this method might be more precise than the others in the detection of nutritional deficiencies or/and excesses[14].The DRIS approach reflects the nutrient balance, identifies the order in which nutrients is responsible for limiting the fruit yield, and its ability to make diagnosis at any stage of crop development. These merits impart DRIS the ability to identify nutrient constraints early in the crop growth and allow sufficient time for remediation of identified problem right in the same season of crop[15].

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