ISSN: 0067-2904

Partial replacement of Chemical Fertilizers with Organic and Biofertilizers of *Anabaena circcinalis* and *Oscillatoria lymentica* in rice Fields.

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Abstract

A field experiment was carried out in the province of Najaf - al ashraf using two types of blue-green algae(*Anabaena circinalis and Oscillaoria lymentica*) which have been isolated and diagnosed in the laboratories of the department of plant protection / ministry of agriculture in Iraq with the compost(palm fronds) manufacturer locally and by 1 ml : 10 g of organic matter within one month of cuddling and using a single level of humidity is 1 : 2 (water : organic matter). Randomized complete block design RCBD to see the effect of use it as a single or mix in the productivity of rice crop Yasamin cultivar where it was noted that it is equipped with a dynamic composting of organic matter leads to the analysis of organic material and increasing the nitrogen content to moss 32.76 % with *Anabaena* and 19.72 % with mixture of algae. It was also observed superiority of the treatment (5) *Anabaena* with 25% of the chemical fertilizer, treatment (4) *Anabaena* with 50% of the chemical fertilizer which is not differ with the treatment (2) full recommending fertilizer and treatment (9) compost with 50% of the recommendation fertilizer, which gave seed weight 695 g / m^2 and 694 g / m^2 , respectively, compared with 754.7 g/m^2 and 730 g/m^2 respectively, Weight of 1000 also gave the seed of 27.64 g and 27.58 g, respectively, compared with 754.7 g and 730 g, respectively the length of the deltoid was 25.23 cm and 24.70 cm, respectively, compared with 25.37 cm and 25.30 cm respectively and it was noted an increase in the biological yield gave 15.88 tons / h and 15.84 tons /h, respectively, compared to 16.50 tons/h and 16.13 tons /h. Also it was noted an increase in the length of plant in treatment (4) *Anabaena* with 50% of the fertilizer recommendation which is not differ with the full treatment of recommendation fertilizer and the treatment 9 of compost with 50% of the recommendation as fertilizer gave 110.6 cm compared to 110.9 cm and 110.1cmrespectively, as for the dry weight observed increasing of algae treatments (4) treatment *Anabaena* with 50% of the recommendation fertilizer ,(5) treatment *Anabaena* with 25% of the recommendation fertilizer and (7) treatments (algae mixture with 50% of the fertilizer recommendation) which is not differ from full recommending fertilizer (2) treatment and (9) treatment compost with 50% of the recommendation fertilizer, was given 890 g 893 g, 890 g, respectively, compared to 896 g and 883 g, respectively.

We conclude that the use of the way with bio- organic and algal fertilizer in alone or mixture increase in productivity of growth ,biological yield and reduces the use of chemical fertilizer for a healthy quotient of consumers in food consumption.

Keywords: Biofertelizers, Cyanobacteria, Rice, Compost.

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استبدال جزئي للأسمدة الكيماوية بالاسمدة العضويه المحملة بنوعين من الاسمدة الاحيائية لطحلبي *Oscillatoria lymentica* و*Anabaena circcinalis* في حقول الرز

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الخلاصه

نفذت تجربة حقلية في محافظة النجف الاشرف باستخدام نوعين من الطحالب الخضراء المزرقه*Anabaena circinalis and Oscillatoria lymentica* والتي تم عزلها وتشخيصها في مختبرات دائرة وقاية المزروعات / وزارة الزراعه / العراق والمحمله على السماد العضوي (سعف النخيل) المصنع محليا في دائرة وقاية المزروعات وبنسبة 1 مل:10 غم من السماد العضوية لمدة شهر واحد من الحضن وباستخدام مستوى واحد من الرطوبة 2:1 (ماء : مادة عضوية)بتصميمالقطاعاتالكاملةالمعشاةRCBD لمعرفةتاثيراستخدامها بصورة مفردة او مع بعضها في نمو و انتاجية محصول الرز صنف ياسمين حيث لوحظ ان السماد الحيوي يؤدي الى تحلل للمادة العضوية وزيادة محتوى النتروجين وبنسبة 32,76%لطحلب *Anabaena*و بنسبة19,72% لخليط الطحالب. كما لوحظ تفوقمعاملة (5)*Anabaena* مع 25% من السماد الكيمياوي ومعاملة (4)*Anabaena* مع 50% من السماد الكيمياوي وبدون فارق معنوي مع معاملة (2) كاملة التوصيه السماديه ومعامله (9) السماد العضوي مع 50% من التوصيه السماديه حيث اعطت وزن البذور695غم|^{2}م و694غم| ^{2}م على التوالي مقارنة مع 754,7 غم|^{2}م و730 غم|^{2}م على التوالي. كما اعطى وزن 1000 بذرة27,64 غم و27,58 غم على التوالي مقارنه مع 754,7 غم و730 غم على التوالي وان طول الداليه كان 25,23 سم و 24,70سم على التوالي مقارنة مع 25,37 سم و 25,30 سم على التواليوكذالك الحاصل البايولوجي حيث اعطت 15,88 طن| هكتار و 15,84 طن|هكتار على التوالي مقارنة 16,50 طن |هكتار و 16,13 طن|هكتار.كما اعطى طول النبات تفوق المعاملة (4)*Anabaena* مع 50% من التوصيه السماديه وبدون فارق معنوي مع معاملة (2) كاملة التوصيه السماديه ومعامله 9 السماد العضوي مع 50% من التوصيه السماديه حيث اعطت 110,6سم مقارنة 110,9 و 110,1 على التوالي. اما بالنسبه للوزن الجاف لوحظ تفوقمعاملات الطحالب وبدون فارق معنوي عن معاملة 2 كاملة التوصيه السماديه ومعامله (9) السماد العضوي مع 50% من التوصيه السماديهفقد اعطت المعاملة الرابعه *Anabaena* مع 50% من التوصيه السماديه ، المعاملة الخامسه *Anabaena* مع 25% من التوصيه السماديه ، المعامله السابعه (خليط الطحالب مع 50% من التوصيه السماديه) 890 غم، 893غم، 890غم على التوالي مقارنة896 غم و883غم على التوالي.ان استخدام الطريقة العضوية مع السماد الحيوي الطحلبي بصورة مفردة او كخليط يساهم في زيادة نمو وانتاجية الحاصل ويقلل من استخدام الاسمدة الكيمياوية من اجل حاصل صحي للمستهلكين في استهلاك الاغذية.

Introduction

Rice (*Oryza sativa L.*) is one of the major crops after wheat in Iraq producing belts of Al-Najaf Al-ashraf receives moderate rainfall with hot and humid climate serving as reservoir of cyanobacterial diversity. *Cyanobacteria* (BGA) are one of the major components of the nitrogen fixing biomass in paddy fields**,**. BGA fix nitrogen under anaerobic conditions in specialized cells called heterocyst which comprises 5 to 10% of cells in a filament [1].

In non heterocystous forms, the oxygenic photosynthesis was found to be separated from nitrogen fixation either temporally or spatially. In temporal separation, nitrogen fixation predominantly occurs during the dark period and photosynthesis during the light; in these forms in terms of energy the anaerobic dark conditions are not very favorable for the process of nitrogen fixation [2].

Cyanobacteria play an important role in maintenance and build-up of soil fertility, consequently increasing rice growth and yield as a natural biofertilizer [3].

Cyanobacteria have been reported to improve aggregate stability through enrichment of soil with organic matter, improvement of biological activity and secretion of exocellular polysaccharides (EPS) [4].[5] reported that rice fields in higher elevations were dominated by members of Oscillatoriaceae while those at lower elevation contained a mixed population of Oscillatoriaceae and Nostocaceae members.

Biofertilizer enhance organic materials availability to plant more than an ordinary organic fertilizer. This in an environmentally friendly biotechnological approach also offers as an alternative to hazardous chemical fertilizers [6].

The algal addition to mature compost material has a positive impact on all studied analyses under the optimum moisture condition [7].

Application of composted organic fertilizer provoked a significant improvement in growth and biochemical parameters of both plants as compared to plants treated with uncomposted organic fertilizers. This was due to the addition of organic content of soil in the form of composted organic fertilizer. The biodegradation of such materials to simple sugars provides energy sources for heterotrophic microorganisms such as P-solubilizing and nitrogen fixing bacteria. The main inoculants are bacteria, fungi, and cyanobacteria (blue-green algae [6].

The aim was to investigate the effecting of the cyanobacterial isolated alone or in combination as biofertilizers strains for rice cultivar along with screening of potential isolates serving as natural source of biofertilizers to be used in algalization to increase the yield.

Materials and methods

The study was carried out in plant protection directorate / ministry of Iraqi agriculture. Soil samples were collected at 2-month intervals between July 2012 and November 2013. Sites were selected in two parts of Iraq : Rice station in Alnagaf-Alashraf and from canal in Baghdad University (Al-jadria). In each sampling site, soils were collected in five samples at 0– 15 cm from the surface with four replications, then kept in an ice-box prior to purification and identification. Colony-forming characteristics of each cyanobacterial isolate were observed on cultured nitrate free BG11 medium [8]. The mature compost were collected from residue of date palm for nine treatments , Algal biomass of *A. circinalis* and *O. lymentica* were applied to the tested compost in 10 % v/w. Each of treatment was exposed to one level moisture liquid: solid 1:2 ratio. Determined total nitrogen compound using kejldal method [9].

At the end of 21 days incubation [7].The experiment consisted of nine treatments with three replicates for Yasamin cultivar in randomized block design 162m²in individual plot size of 3m × 2 m. The recommended rate of fertilizers for rice crop - 120:80:60 NPK kg. ha^{-1}, Then mature compost carried blue- green algae is mixed with the soil prepared for cultivation. Ten plants were randomly taken at the end of growth from each plot and the following data were achieved:

Plant height/cm, number of branches/ plant, deltoid length/ cm, weight of grains /m^2,dry weight plant (shoot and root) g/m^2, weight of 1000 grains/g, and biological yield t/ ha**.**

Table 1- Different treatments parameters studied.

Treatment No.	Treatment
T1	(Control) without addition
T2	(Control) NPK
T3	*Anabaena circcinalis*
T4	*Anabaena circcinalis* + 50% NPK
T5	*Anabaena circcinalis* + 25% NPK
T6	(*Anabaena circcinalis* + *Oscilatoria lymentica*)
T7	*(Anabaena circcinalis* + *Oscilatoria lymentica*) + 50%NPK
T8	*(Anabaena circcinalis* + *Oscilatoria lymentica*) + 25% NPK
T9	Compost + 50% NPK

Statistical analysis

The data were analyzed using analysis of variance (ANOVA), random complete block design (R.C.B.D.) with three replicate. The least significant differences test was used 0.05 to compare the averages of treatments [10].

Results and Discussion

The current work suggested that the algal addition to mature compost material has a positive impact on all studied analyses under the optimum moisture condition [7].

Table 2- The percentage of total Nitrogen content in mature compost

Treatments	Inoculums size (ml)	Total Nitrogen%
Control	-	1.047
Anabaena circcinalis	10 ml	1.390
Anabaena circcinalis + *Oscilatoria lymentica*	10 ml	1.243
LSD at 5%		0.091

Data in Table-2 showed that after addition of either one or two *cyanobacteria* species to compost materials, significant difference between the treatments was observed in availability of compost nitrogen. Significant increasing with *A. circinalis* in (10 ml) level content 1.390% increased 32.76% which not differs significantly from mix of *cyanobacteria* level (10 ml) 1.243% increased 19.72% (T12) over control 1.047% after three weeks of incubation under the same conditions at liquid: solid ratio of 1:2.

The current work suggested that the algal addition to mature compost material has a positive impact on all studied analyses under the optimum moisture condition [11].

the addition of organic fertilizers alone does not give a significant result compared with algal addition where the decomposition of compost takes a long time to start supplying the plant nutrients, Organic matter improves soil structure, slowly releases nutrients, and increases beneficial microbial activity. agreed with [12].

The result in Table-3 show that the significantly increase of Yasamin cultivar in plant height for T2 (chemical fertilizer) 110.9cm which not differ significantly from T4(*Anabaena circcinalis* + 50% NPK)110.6 cm and T9 (Compost + 50% NPK) 110.1 cm while it differs significantly with T1 (Control) without addition) 97.1 cm. The percentage over control was increased: 14.21% for T2, 13.90% for T4 and13.38% for T9 respectively.

In number of branches/plant as indicated in Table-3 significant increase in T2 (chemical fertilizer) 20.20 branches/plant and T9 (Compost + 50% NPK) 17.10 branches which differ significantly from

other treatments and the lowest value withT1 (Control) without addition12.10 branches .The percentage over control was increased: 66.94% for T2 and41.32 % for T9.The cyanobacterial contained a special set of biologically active compounds including growth regulators. Many actual and putative biofertilizing PGPR (plant growth promoting rhizobacteria) produce phytohormones such as auxin substances, cytokinins which are known to promote cell division, cell enlargement and tissue expansion in certain plant parts [13],Gibberellins [14],that are believed to be related to their ability to stimulate plant height and productivity.

Significant increase in dry weight shoot and root(straw) of Yasamin cultivar observed in Table-3 for all treatment except T1 (control) which is the lowest value. The percentage over control was increased for T2(chemical fertilizer), T3 *Anabaena circcinalis*, T4 *Anabaena circcinalis* + 50% NPK. T5 *Anabaena circcinalis* + 25% NPK, T6(*Anabaena circcinalis* + *Oscilatoria lymentica*), T7*(Anabaena circcinalis* + *Oscilatoria lymentica*) + 50%NPK, T8*(Anabaena circcinalis* + *Oscilatoria lymentica*) + 25% NPK and T9 Compost + 50% NPK25.14%, 9.78%, 24.30%,24.72%,15.29%, 24.30%, 18.16%and 23.32% respectively. significant increasing in the dry weight of shoot and root with biofertilizer addition its impact on the nutrient availability and growth especially the early stages where the stem, root and leaves grow and that may related to the favorite of some environmental factors in the stages of plant growth, that agree with [15-17].

The result of deltoid length for Yasamin cultivar showed significantly increase in T2 (chemical fertilizer) 25.37cm in Table-3 which was not differ significantly with T9 (compost + 50% NPK*)*25.30 cm, T4(*A.circinalis*+50%NPK) 25.23cm, T7 *(Anabaena circcinalis* + *Oscilatoria lymentica*) + 50%NPK) 24.80cm, T5 (*Anabaena circcinalis* + 25%NPK)24.70cmand T8 (*(Anabaena circcinalis* + *Oscilatoria lymentica* + 25% NPK)24.53cm compared withT1 (control) 22.40cm. The percentage over control was increased: 13.26%, 12.94% and 12.63%,10.71 and 9.50%respectively.

The increase in growth production of a variety of organic acids by the tested parameters of broad bean could be due to the action cyanobacteria, with decrease in the soil pH leading toof one or more of the growth promoting chemicals conversion of the non-available Phosphor (p) into the available P. secreted by cyanobacteria especially auxins [14, 18] concluded that soil inoculation with cytokinins [19] and gibberellins [14].

In weight of 1000 grains for Yasamin cultivar showed significantly increase in T2 (chemical fertilizer) 27.72g, T9 (compost + 50% NPK*)*27.66g T5 (*Anabaena circcinalis* + 25%NPK) 27.64g and T4(*A.circinalis* +50%NPK) 27.58gm compared withT1 (control) 26.51g. The percentage over control was increased: 4.56% 4.33% 4.26% and4.03% respectively.

In weight of yeild grains /m^2 for Yasamin cultivar showed significantly increase in T2 (chemical fertilizer) 754gm T9 (compost + 50% NPK*)*, 730gm, T5 *Anabaena circcinalis* + 25% NPK695gm and T4(*A.circinalis*+ 50%NPK) 694 gm comparedwithT1 (control) 585g. The percentage over control was increased:28.88%,24.78%,18.80% and18.63%,respectively.

In biological yield for Yasamin cultivar showed highly increase in T4 *Anabaena circcinalis* + 50% NPK15.84 t/ha and T5*(Anabaena circcinalis* + 25%NPK) 15.88 t/ha Biofertilizers leads to soil enrichment and the quality of the soil improves with time , convert complex organic material into simple compounds, so that the plant can easily take up the nutrients ,fixed atmospheric nitrogen and make it directly available to the plants ,They increase the phosphorous content of the soil by solubilising and releasing unavailable phosphorous, Biofertilizers improve root proliferation due to the release of growth promoting hormones and they help in increasing the crop yield while the biological yield in T2 (chemical fertilizer)16.5 t/ha, the effects of chemical fertilizer may be negative in oftentimes, lack of rainfall caused chemicals to accumulate in the soil, which lead to low productivity because of the high salinity of the soil due to add fertilizer, while high rainfall caused the descent of chemicals into the groundwater. So due to the fluctuation and irregular rains fall, the use of fertilizers have many risks [20].

Table 3- Effect of algal biofertilizers treatments on growth and yield components of Yasamin cultivar.

Treatments	Plant height/cm	branches/ plant	deltoid length/ cm	wt. of 1000 grains/gm	wt. of grains gm / m^2	Dry weight gm /m^2	biological yeild/ t ha^{-1}
T1	97.1	12.10	22.40	26.51	585.0	716	1301
T2	110.9 *	20.20	25.37 *	27.72	754.7	896	16.50
T3	98.1	12.50	23.0	26.58	667.0 *	786	1453
T4	110.6 *	15.60	25.23 *	27.58 *	694.2 *	890	15.84
T5	103.1	15.0	24.70 *	27.64 *	695.4 *	893	15.88
T6	97.6	12.90	23.53	26.66	575.6	830	14.05
T7	101.2	12.50 *	24.80 *	26.66 *	624.0 *	890	15.14
T8	101.0	15.40 *	24.53 *	27.51 *	671.7 *	846	15.17
T9	110.1 *	17.10	25.30 *	27.66	730.0 *	883	16.13
L.S.D. at 0.05%	9.41	4.116	1.457	1.112	73.69	44.22	

This work revealed that the use of algae biofertilizers make possible that the growth and the yield of rice plant is increased. This algae biofertilizer increases the fertility, productivity and water holding capacity of soil and also provide some growth regulators also like auxin, abscisic acid, gibberellins and vitamin B12 also which is very necessary for plant growth and development. It also reduce the effect of insect in root system and there is also no side-effect in plant of biofertilizers. Biofertilizer is very helpful to remove alkalinity of soil, because it can separate sodium salt from soil and convert alkaline soil into fertility of soil. Thus, for the maintenance of soil fertility, quick replacement of the organic matter and mineral nutrient removed from the soil becomes necessary. Organic matter is produced in the nature after decaying and death of organisms. Biofertilizers obtained from organism which increases nutrients availability to crop plants, it is not essential for maintaining soil structure, aeration and hydration. In this category, those microbes have been included which increase the soil fertility by increasing the content of plant nutrients [21].

Conclusion

In conclusion, cyanobacteria species were recommended to be used as biofertilizers instead of utilizing the expensive industrial chemical fertilizers. This was because of the increased cost of chemical fertilizers that cause soil and water pollution. In comparison, cyanobacteria are a cheap source of N, which does not cause pollution the application of cyanobacteria inoculation combined with compost improved organic matter content and the available nutrients in soil. As well as, the improve of macronutrients uptake (N, P and K) in rice cropping system, which in is reflected on the yield and its components. In general the results of this study have indicated that application of the fresh cyanobacteria strain as biofertilizer with compost increase growth performance for Yasamin cultivar thus could enhanced growth and yield of rice without using the costly chemical fertilizers. It's become major factor in improved agriculture and increased production due to constant use of land there is loss of its important element which is essential for plant.

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