Effect of Algal Biofertilizers on Vegetative Growth of *Arachis hypogaea* L. (Groundnut)

Win Mar[1], A Me Zin[2]

Abstract

The present study was conducted to determine the effect of algal biofertilizers on vegetative growth of *Arachis hypogaea* L. (groundnut). The research was carried out at the Department of Botany, Yadanabon University during July to October 2014. Groundnut seeds were grown using *Spirulina* suspension $4gl^{-1}$ and *Nostoc* suspension $4gl^{-1}$ in pot experiment. It was observed that *Nostoc* suspension was the most effective in the enhancement of vegetative growth of groundnut. *Spirulina* suspension was the second most effective. The result concluded that the growth of groundnut treated with *Nostoc* biofertilizer was significantly better than control.

Key words : Biofertilizer, *Arachis hypogaea* L., Groundnut.

Introduction

Groundnut (*Arachis hypogaea* L.) is one of the principal economic crops in the world. It is an important food, fertilizer, oil, fuel and income generating crop. The oil content of groundnut is higher than those of soybean and mustard. It is useful in rotation through its ability to fix free nitrogen into the soil thereby improving soil fertility. It is grown on 35.5 million ha across 82 countries in the world. Groundnut is grown primarily for its high quality edible oil and protein. Groundnut kernels are rich in protein and vitamins A, B, etc and can be eaten raw, roasted, fried, sweetened or boiled. Refined groundnut oil is extensively used in food preparations. The oil can also be used in soap making, manufacture of cosmetics, lubricants, etc (Waele and Swanevelder, 2001). The residual oil cake contains 7-8% N, 1.5% P_2O_5 and 1.2% K_2O and can be used as fertilizer or as a protein supplement in livestock rations. According to Purseglove (1998), groundnut was taken across the pacific to the Philippines by the Spaniards before spreading in Asia.

Nitrogen (N) is the motor of plant growth. In the plant, it combines with compounds produced by carbohydrate metabolism to form amino acids and proteins. Being the essential constituent of proteins, it is involved in all the major process of plant development and yield formation (Richard, 2003). High yield requires correct amount of fertilizers to be applied. The choice of fertilizers and amount to be applied for raising crop production is usually predicted on the fertility status of a soil (Pessarakli, 1994).

Biofertilizer improves soil fertility and enhances nutrient uptake and water uptake in deficient soils, thereby aiding in better establishment of plants. (Smith, 1962). In agriculture, nitrogen-fixing blue-green may be used as organic fertilizers. The nutritional value of *Spirulina* was brought to light only recently after a worldwide interest in new sources of protein. A *Spirulina* farm is an environmentally sound green food machine. Cultivated in shallow ponds, this algae can double its biomass every 2 to 5 days. This productivity breaks, through yields over 20 times more protein than soybeans on the same area, 40 times corn and 400 times beef (Henrikson, 1989).

Nostoc muscorum are important for the nutrient cycling of carbon and nitrogen within the soil ecosystems in which they are found. The process of fixing atmospheric nitrogen contributes plant-available nitrogen to the soil, improving plant growth

[1] Associate professor, Dr, Department of Botany, Mandalay University of Distance Education
[2] Student, Department of Botany, Yadanabon University

(Rogers and Burns, 1994). The chemical analyses were made from *Nostoc muscorum*. It contains the macromolecules such as protein, carbohydrate, lipid, pigments, ash and moisture and other micronutrients (May Kyawt Khaing, 2004).

The aim and objectives of this study are to test the effect of *Spirulina* and *Nostoc* as biofertilizer on vegetative growth of groundnut to find out which one is the best effect for groundnut and to know the suitable dose for improving the growth of groundnut.

Materials and Methods

The pot experiment was conducted at the Department of Botany, Yadanabon University. The soil was prepared in the earthen pots which is 34 cm in diameter and 24 cm in depth. Before sowing, some seeds of groundnut were soaked in water as control. Other seeds of groundnut were presoaked in *Spirulina* suspension 4 gl^{-1} (T_1) and *Nostoc* suspension 4 gl^{-1} (T_2) for 6 hr. Then, the seeds were sown by hand in pot and prepared 3 hole per pot. Sown 3 seeds per hole with a depth of 3cm according to the different treatments i.e, C (control), T_1 (*Spirulina* suspension) and T_2 (*Nostoc* suspension). Pots were arranged according to the layout of experimental design. The experimental design was Randomized Complete Block Design (RCBD) with five replications 15 pots were used in this experiment **(**Figure 1). Each pot was watered daily with one liter to maintain moisture at field capacity. After 14 DAS, the weak plants were thinned out and left only three strong and healthy plants per pot. The plant height, leaf number and branches number were measured at two weeks interval. At harvest, total leaf area, fresh weight of plant, dry weight of plant, root length, fresh weight of root, dry weight of root, nodule number were measured.

Using the leaf area formular;

Leaf area = K (L × W) (Manian and Balarkishan as cited in Field Crop Production Group-3 1999)

L = length W = width K = adjustment factor (K value of pulses = 0.65)

Figure 1. Materials and Methods used in this study

A. Seeds of *Arachis hypogaea* L.
B. *Spirulina* powder
C. *Nostoc* powder
D. Soaking seeds in *Spirulina* suspension
E. Soaking seeds in *Nostoc* suspension
F. Pot experiment

Results

Pot experiment

Effect of algal biofertilizers on plant height

The highest plant height was found T_2, followed by T_1 and control. It ranged from 27.08 cm to 29.16 cm at 91 days after sowing (Table 1 and Figure 2,9,10).

Table 1. Effect of algal biofertilizers on mean plant height(cm) of *Arachis hypogaea* L.

Control and treatment	Mean plant height (cm) ± sd					
	21 DAS	35 DAS	49 DAS	63 DAS	77 DAS	91 DAS
C	6.49±0.20	9.80±0.24	18.23±0.85	23.10±0.99	24.25±0.86	24.46±0.73
T_1(*Spirulina*)	7.67±0.67	11.20±0.49	21.68±1.04	25.01±1.06	26.60±0.49	27.08±0.19
T_2(*Nostoc*)	**8.75±0.24**	**12.94±0.71**	**24.54±0.39**	**27.10±0.23**	**28.65±0.34**	**29.16±0.27**

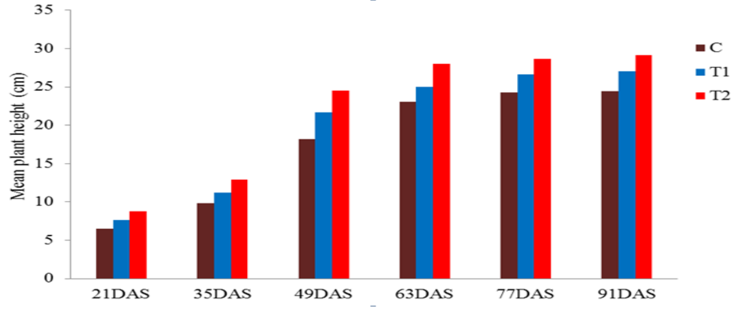

Figure 2. Effect of algal biofertilizers on mean plant height (cm) of *Arachis hypogaea* L.

Effect of algal biofertilizers on mean leaf number per plant

The mean leaf number per plant of groundnut affected by T_2 (63.39) was the best and followed by T_1 (58.06) and control (46.00) at 91 days after sowing. (Table 2 and Figure 3).

Table 2. Effect of algal biofertilizers on mean leaf number of *Arachis hypogaea* L.

Control and treatment	Mean leaf number ± sd					
	21 DAS	35 DAS	49 DAS	63 DAS	77 DAS	91 DAS
C	6.60±0.36	16.00±0.78	33.53±0.56	47.73±1.64	48.73±2.06	46.00±1.68
T_1(*Spirulina*)	7.06±0.43	17.60±0.72	37.00±0.97	56.00±0.53	59.66±1.36	58.06±1.25
T_2(*Nostoc*)	**8.73±0.28**	**19.66±0.47**	**39.06±1.04**	**58.80±0.38**	**64.66±2.28**	**63.39±1.88**

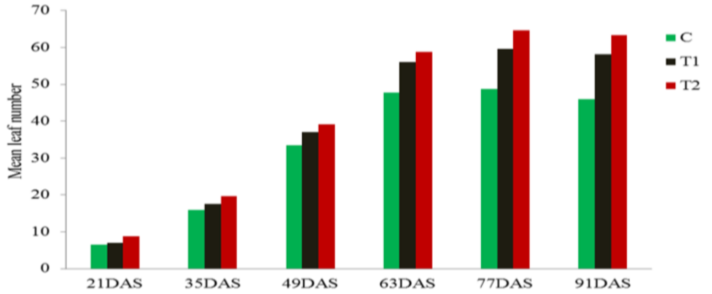

Figure 3. Effect of algal biofertilizers on mean leaf number of *Arachis hypogaea* L.

Effect of algal biofertilizers on mean branches number per plant

The more branches were found in T_2, followed by T_1 and control. It ranged from 5.73 to 7.00 but control was 4.40 at 91 days after sowing (Table 3 and Figure 4).

Table 3. Effect of algal biofertilizers on mean branches number of *Arachis hypogaea* L.

Control and treatment	Mean branches number ± sd					
	21 DAS	35 DAS	49 DAS	63 DAS	77 DAS	91 DAS
C	0.87±0.92	2.93±0.70	3.67±0.49	4.00±0.00	4.40±0.51	4.40±0.51
T_1(*Spirulina*)	1.87±0.52	4.00±0.38	4.40±0.51	5.27±0.59	5.73±0.59	5.73±0.59
T_2(*Nostoc*)	**2.40±0.74**	**4.53±0.52**	**5.26±0.46**	**6.60±0.51**	**7.00±0.54**	**7.00±0.54**

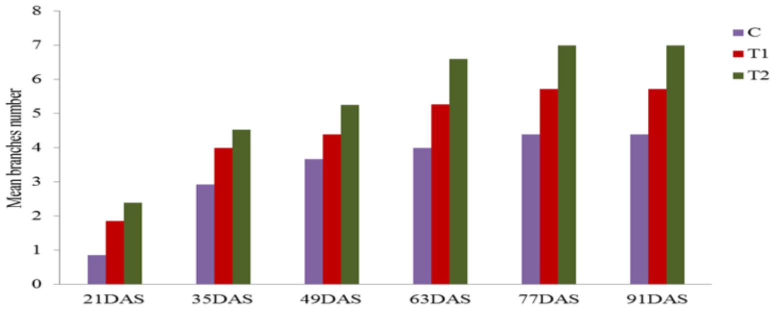

Figure 4. Effect of algal biofertilizers on mean branches number of *Arachis hypogaea* L.

Effect of algal biofertilizers on total leaf area (cm^2) of *Arachis hypogaea* L.

The highest total leaf area per plant in terms of (cm^2) was found in T_2 and followed by T_1 and control. The total leaf area of groundnut in control was 1000 cm^2, 1465.9 cm^2 in T_1 and 1677.1 cm^2 in T_2 (Table 4 and Figure 5).

Table 4. Effect of algal biofertilizers on total leaf area (cm^2) of *Arachis hypogaea* L.

Control and treatment	Total leaf area (cm^2) ±sd
C	1000.0 ± 71.55
T_1(*Spirulina*)	1465.9 ± 100.9
T_2(*Nostoc*)	**1677.1 ± 47.12**

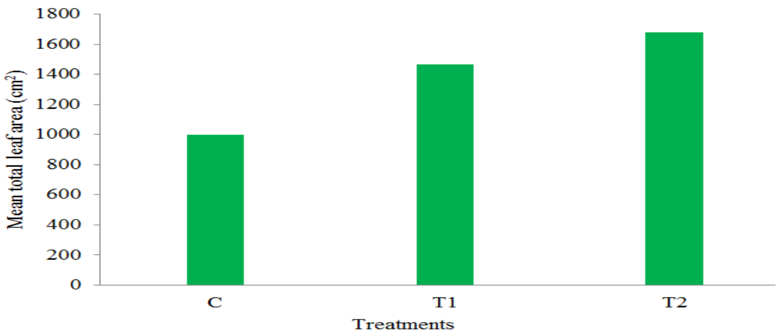

Figure 5. Effect of algal biofertilizers on total leaf area (cm^2) of *Arachis hypogaea* L.

Effect of algal biofertilizers on root length (cm), fresh root weight (g), dry root weight (g) and root nodule number at harvest

Root Length

At harvest, study in root length indicated that T_2 was attained the longest root length and followed by T_1 and control. (Table 5, Figure 6).

Nodule number

The greatest number of nodules was observed in T_2 followed by T_1 and control at harvest. (Table 5, Figure 8).

Fresh weight of root

The highest fresh weight of root was found in T_2 and followed by T_1 and control. (Table 5, Figure 7).

Dry weight of root

The maximum dry weight of root was obtained in T_2 and followed by T_1 and control. (Table 5, Figure 7).

Table 5. Effect of algal biofertilizers on root length (cm), fresh root weight (g), dry root weight (g) and root nodule number of *Arachis hypogaea* L.

Control and treatment	Mean±sd			
	Root length(cm)	Fresh weight of root (g)	Dry weight of root (g)	Root nodule number
C	15.07±1.78	2.52±0.18	0.74±0.13	251.60±21.66
T_1(*Spirulina*)	19.44±0.74	4.31±0.19	1.41±0.06	349.86±12.88
T_2(*Nostoc*)	**21.66±1.48**	**6.30±0.28**	**1.91±0.03**	**431.93±20.94**

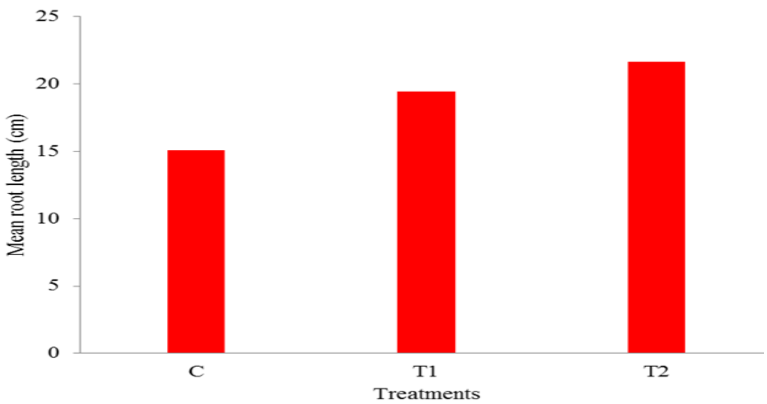

Figure 6. Effect of algal biofertilizers on root length (cm) of *Arachis hypogaea* L.

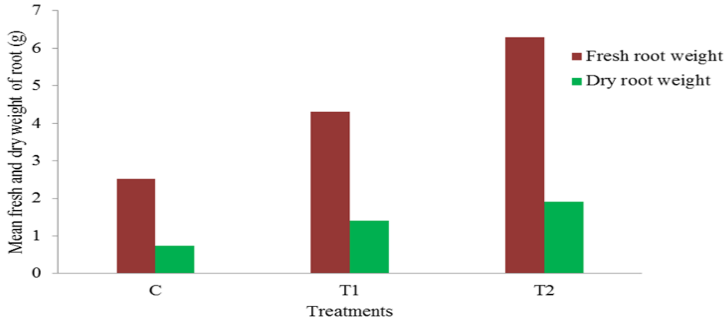

Figure7. Effect of algal biofertilizers on fresh and dry root weight (g) of *Arachis hypogaea* L.

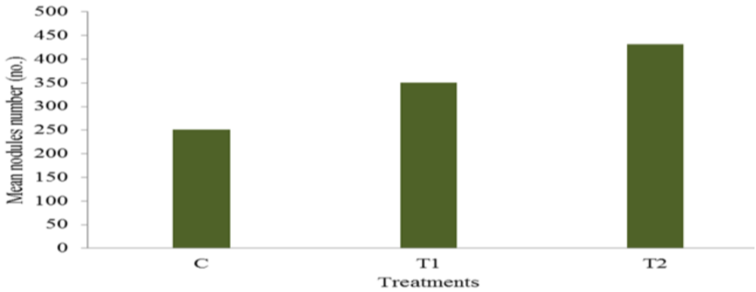

Figure 8. Effect of algal biofertilizers on root nodules number of *Arachis hypogaea* L.

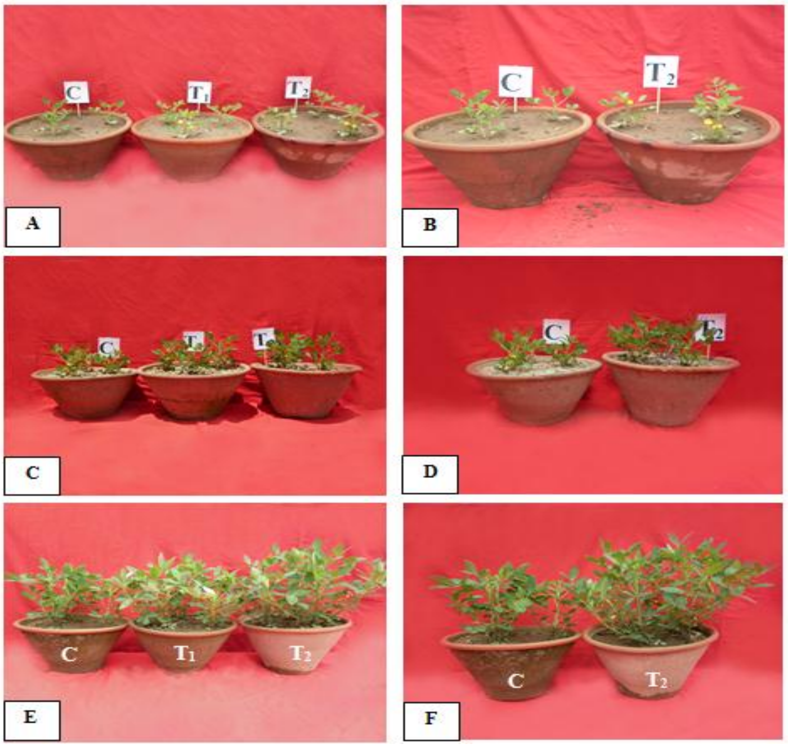

Figure 9. Effect of algal biofertilizers on *Arachis hypogaea* L. (21, 35 and 49 DAS)

A. Control and treatments (21 DAS) D. Control and T_2 (35 DAS)

B. Control and T_2 (21 DAS) E. Control and treatments (49 DAS)

C. Control and treatments (35 DAS) F. Control and T_2 (49 DAS)

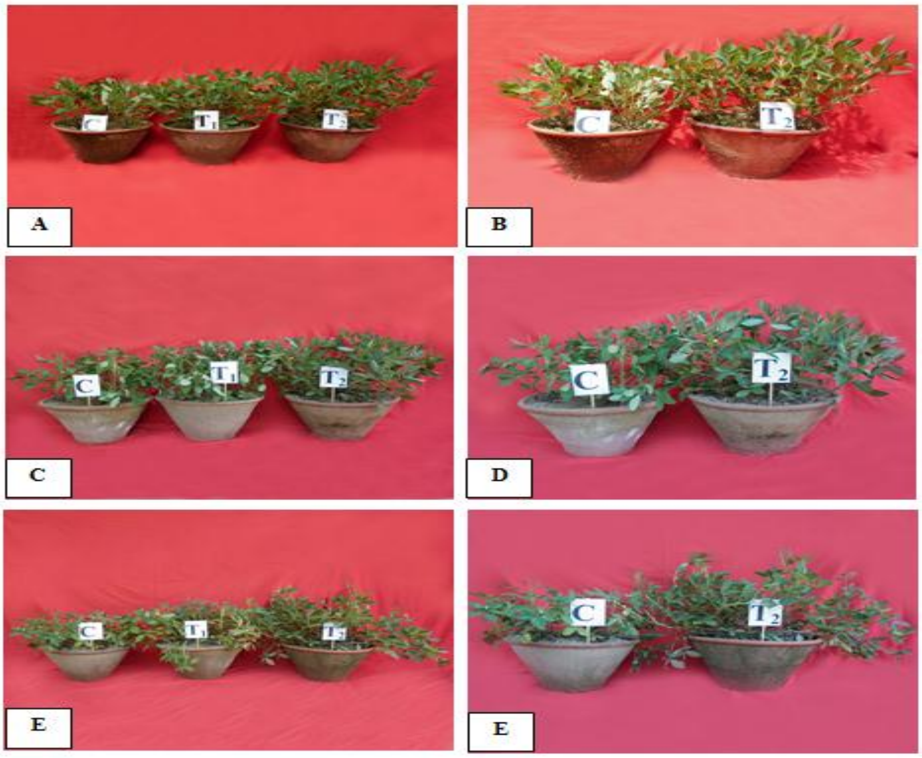

Figure 10. Effect of algal biofertilizers on *Arachis hypogaea* L. (63, 77 and 91 DAS)

A. Control and treatments (63 DAS) D. Control and T_2 (77 DAS)

B. Control and T_2 (63 DAS) E. Control and treatments (91 DAS)

C. Control and treatments (77 DAS) F. Control and T_2 (91 DAS)

Discussion and Conclusion

In this study, the effect of *Spirulina* suspension and *Nostoc* suspension on vegetative growth of *Arachis hypogaea* L. was investigated in pot experiment. It was found that the plant height, leaf number and branches number in *Nostoc* suspension were 19.21%, 37.81% and 59.09% higher than the control respectively, those of *Spirulina* suspension were 10.69%, 26.23% and 30.22% higher than the control. Tun Chun (1982) studied the relative efficiency of 10 blue green algae promoting the growth and yield of rice. It was found that the plant height of rice in treatment was increased to 14.07% higher than the control.

As a result of the stimulation of the root length, fresh weight of root, dry weight of root, and root nodule number of *Nostoc* suspension were increased to 43.69%, 149.6%, 159.56% and 71.67% higher than the control. However, those of *Spirulina* suspension were 28.96%, 70.69%, 90.90% and 39.05% higher than the control. Similar results on germination of rice seeds treated with Cyanobacteria were found by Sadaatina and Riahi (2010). The effect of cyanobacterial treatments were 53% (plant height), 66% (root length), 58% (fresh leaf and stem weight), 80% (fresh root weight) and 125% (dry leaf and stem weight) higher than the control.

In this study, *Nostoc* suspension produced most significant increase total leaf area, fresh weight of plant and dry weight of plant than the control but *Spirulina* suspension was the second most significant increase. *Nostoc muscorum* has heterocysts, which are specialized nitrogen-fixation cells. Heterocysts, (5-10% of cells) appear when *N. muscorum* is transferred to nitrogen free media. (Allison *et al*., 1937). *Spirulina platensis* can easily be recognized as blue-green spiral and unbranched trichome or filaments. Under the microscope, reproduction by fragmentation only and there is no heterocysts (as cited in Toe Aung 1987). The addition of *Spirulina* biomass and of a derived aqueous extract led to an at least 10-fold increase in growth rate of the *lactobacilli* compared to the control (Pulz and Gross 2004). The presence of *Spirulina* extract or biomass in the fermentation media produced higher bacterial growth. *Spirulina* increased *lactobacillus* by five times over control group (Moe Moe Kyaw, 2001).

The increase of the photosynthetic capacity with increase in nitrogen fixation may be due to the utilization of the photosynthetic intermediates for amino acid and protein synthesis. The synthesis of the new enzymes for the two processes will be dependent on nitrogen fixation process. (Than Tun, 1959). These results recommended that *Nostoc muscorum* which could be used as benefit biofertilizer for growth of groundnut. It can be concluded that the application of *Nostoc muscorum* was the most effective than *Spirulina platensis* in stimulating the growth of the shoot system, root system.

References

Allison, F.E., S.R.Hoover, and H.J. Morris, 1937. **Physiological Studies with the Nitrogen-Fixing Alga, *Nostoc muscorum*.** Botanical Gazette. Volume 98, No. 3. p. 433-463.

Field Crop Production Group 3. 1999. **Leaf area determination method of pigeon pea, green grain, cotton and sesame.** Department of Agronomy. Yezin Agricultural University.

Henrikson, R. 1989. **"Earth Food of *Spirulina*".** Kenwood, California. USA.

May Kyawt Khaing, 2004. **A study of The Edible Cyanobacteria (Blue-Green Alagae) *Nostoc* Species in Upper Myanmar,** PhD Dissertation Department of Botany, University of Mandalay.

Moe Moe Kyaw, 2001. **Effect of *Spirulina platensis* and its extract on *Lactobacillus* sp.** MSc. (Thesis). Department of Zoology. University of Taunggyi.

Pessarakli, M. 1994. **Handbook of plant and Crop Physiology**. Maruzen C,Ltd, Japan. pp. 52-78.

Pulz, O. and W. Gross, 2004. **Valuable products from biotechnology of microalgae.** Institute for Biologic. Freie University. Berlin. Germany.

Purseglove, J.W. 1998. **Tropical crops-Dicotyledon**. Longman pp. 225-235.

Richard, J.S. 2003. **The agricultural note book.** University of Plymouth UK.

Rogers, S.L. and R.G. Burns, 1994. **Changes in aggregate stability, nutrient status, indigenous microbial populations, and seedling emergence, following inoculation of soil with *Nostoc muscorum*.** Volume 18, No. 3. p. 209-215. Biology and Fertility of Soils.

Sadaatina, H. and H. Riahi, 2010. **Cyanobacteria in paddy fields in iron as a biofertilizer in rice fields.** Plant Soil Environment. 31: 701-704.

Smith, A.M. 1962. **Manures and fertilizer.** Thomas Nelson and Sons Ltd.

Than Tun, 1959. **Studies on the inter-relationships between photosynthesis and nitrogen fixation in a blue-green alga.** PhD Dissertation, University of London.

Toe Aung, 1987. **Processing and harvesting of *Spirulina*.** M.Sc. Thesis. University of Mawlamying, Consulation organization.

Tun Chun, 1982. **Relative efficiency of 10-blue green algae in promoting the growth and yield of rice.** M.Sc (Thesis), Department of Botany, University of Mandalay.

Waele, D. and C.J. Swanevelder, 2000. **Crop production in tropical Africa**. Goikink Graphic nv. Belgium. pp. 747-753.