The Effect of Spirulina on Growth and Yield of Onion, Tomato and Chili

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Abstract

Spirulina (Blue Green Algae, BGA), harvested from Twin Taung Crater Lake, Myanmar, has been used as a potential biomass fertilizer in the growth and yield of tomato, onion and chili from the seedling to the adult stage. The three vegetable crops studied field crops based on screening tests. In the first seedling stage, on the basis of w/w%, powdered Spirulina and seeds were mixed and were planted in sandy loam soils. The seedling stage took 45 days, in the process, a number of germinated seedlings; average height and weight were monitored, determined and measured with respect to a control. Statistical data based on 't' tests was employed to evaluate the growth and yield factors. In the seedling stage, these crops showed positive factors in growth and yield with respect to the 20%, 50%, 75% and 100% of Spirulina to seeds, on w/w% basis. The crops were transplanted using a similar w/w% fertilizer field study up to the adult stage. Quantitative and qualitative analysis of the seedling of tomato, onion and chili plants were made by Kjeldahl's method, AAS, UV-VIS and Flame photometry. Elemental distribution of N, P, K, Ca and Mg contents of seedling plants were done after treating with Spirulina for 45 days. In the adult stage, the specific three crops were harvested and were measured by weighing in ton/ha after transplantation.

Keywords: Spirulina, Blue Green Algae, vegetable crops, seedling, growth and yield

Introduction

In Myanmar, fertilizers play an important role in maintaining soil fertility for increased crop yields. Thus, biofertilizer seems to be one of the most important alternative inputs for agriculture and replacing the chemical fertilizers and rebuilding the structure of depleted soils. Myanmar Spirulina biomass harvested from Twin Taung is used as biofertilizer on soil and vegetable crops. It is most concerned by using Spirulina in powder form as not only as a growth factor but also as a potential nutrient to the soil the seedling and adult stages of the three crops such as onion, tomato and chili. This investigation has shown that mixing of Spirulina and seeds of the vegetable crops not only enhance the growth factor of the seedling plants but also sustained to do so up to the matured quality stage. Moreover, a breakthrough was found when onion seed could be successfully grown based on seedlings and not by usual common regular method of using onion bulbs as planted in the soil.

Experimental

Mixing of Spirulina with vegetable crop seeds; The ranges of treatment were 20%, 50%, and 100% of Spirulina powder w/w crop seeds. Spirulina powder is mixed with vegetable crop seeds on a weight by weight basis. Immediately after mixing, the seeds are sown on experimental plots. Number of germinated seedlings and average height at seedling stage and final vegetable crops yield after harvesting are measured and compared to control (100%) basis. The composition of the chemical species of Spirulina and vegetable crops (onion, tomato, chili) were analyzed by Kjeldahl's method, AAS, UV-VIS

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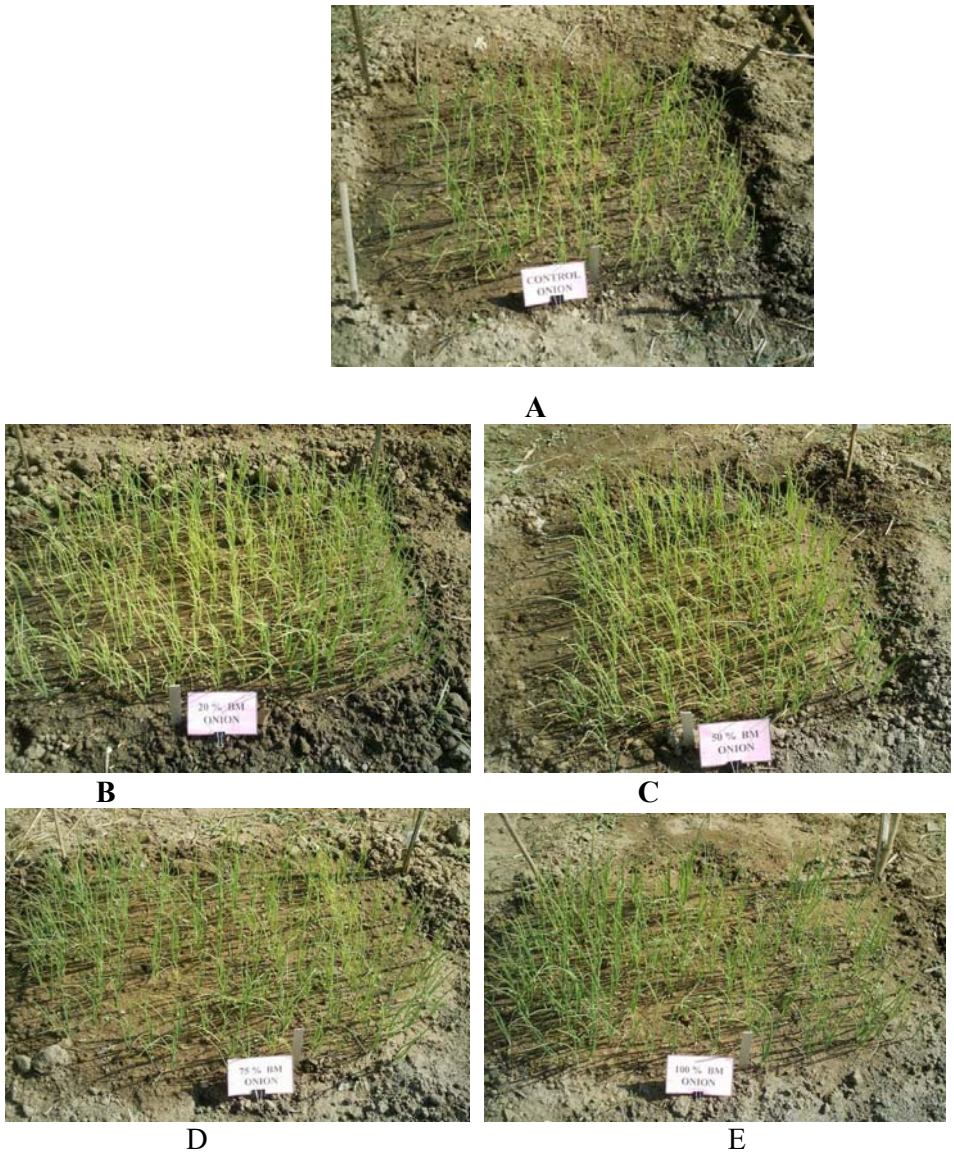
and Flame photometry. The field works were carried out at MSF and Land Used and Seed Division, Ministry of Agriculture and Irrigation.

Results and Discussion

In the screening experiments, chili, onion and tomato showed positive effects on number of seedlings and average height of 45 days old seedlings. The ranges of treatment were 20%, 50%, and 100% of Spirulina powder w/w crop seeds. Table 1 and Figure 1,2,3,4 represent that selected vegetable crops such as onion, tomato and chili, treatment with Spirulina biomass showed significant increase in number of seedlings, average height per plant at seedling stage. Paired sample "t" tests on height of 45 days old seedlings also showed significant differences at 99% and 95% levels.



A B C D E

Figure (1). Seedling of onion with respect to the different (%) amount of Spirulina treatment in field plots after 45 days.

Treatment plots

A Control
B 20% of Spirulina treatment (w/w) crop seeds
C 50% of Spirulina treatment (w/w) crop seeds
D 75% of Spirulina treatment (w/w) crop seeds
E 100% of Spirulina treatment (w/w) crop seeds

A

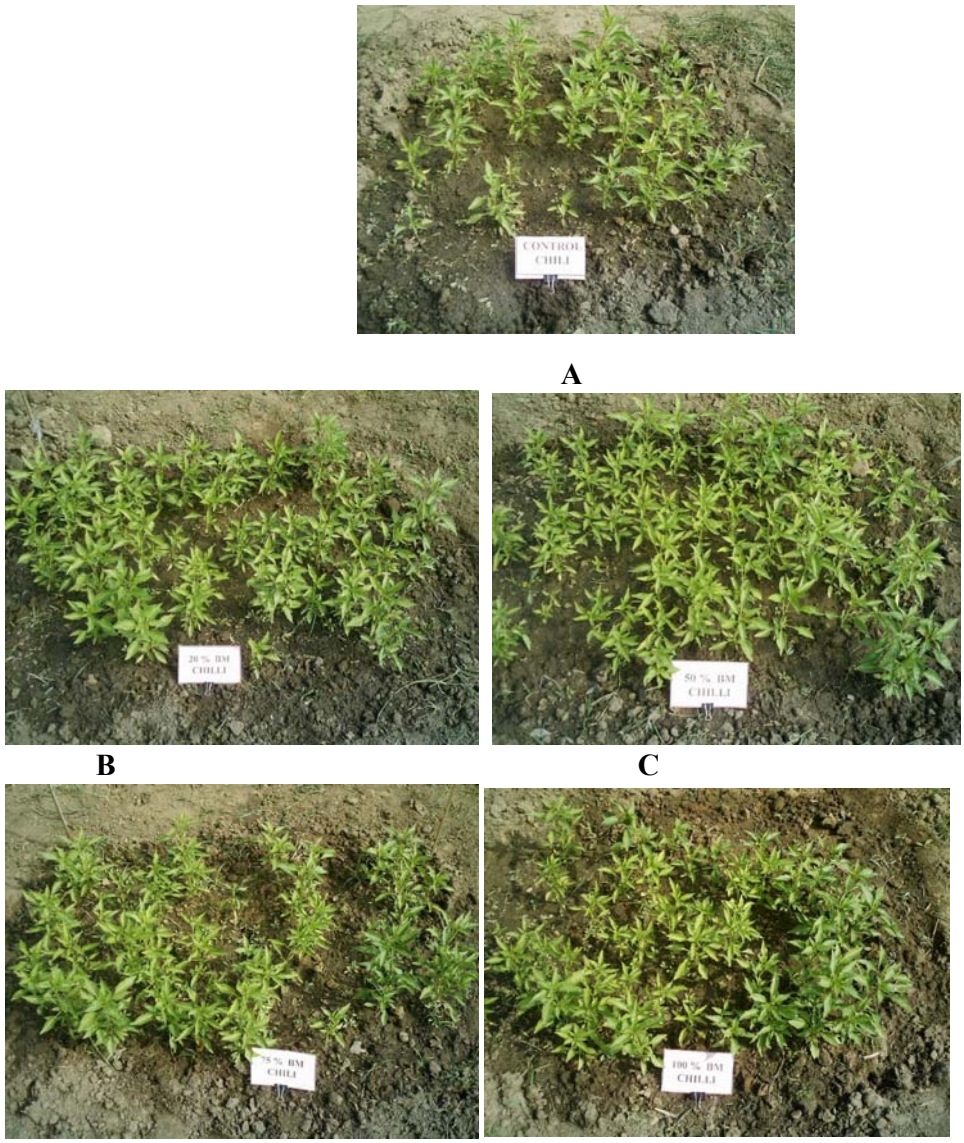
B **C**

D E

Figure (2). Seedling of tomato with respect to the different (%) amount of Spirulina treatment in field plots after 45 days.

Treatment plots

A Control
B 20% of Spirulina treatment (w/w) crop seeds
C 50% of Spirulina treatment (w/w) crop seeds
D 75% of Spirulina treatment (w/w) crop seeds
E 100% of Spirulina treatment (w/w) crop seeds



A **B** **C** **D** **E**

Figure (3). Seedling of chili with respect to the different (%) amount of Spirulina treatment in field plots after 45 days.

Treatment plots

A Control
B 20% of Spirulina treatment (w/w) crop seeds
C 50% of Spirulina treatment (w/w) crop seeds
D 75% of Spirulina treatment (w/w) crop seeds
E 100% of Spirulina treatment (w/w) crop seeds

A

B

C

Figure (4). Seedlings of tomato, onion and chili with respect to the different (%) amount of Spirulina treatments after 45 days

A Onion (Con, 20%, 50%, 75%, 100% of Spirulina treatments (w/w) crop seeds)
B Tomato (Con, 20%, 50%, 75%, 100% of Spirulina treatments (w/w) crop seeds)
C Chili (Con, 20%, 50%, 75%, 100% of Spirulina treatments (w/w) crop seeds)

Table (1). The Effect of different % amount of Spirulina applications on onion, tomato and chili; number of seedling, average height of 45 days old seedlings

Treatments	Yield of onion seedling emergence after 45 days				Yield of tomato seedling emergence after 45 days				Yield of chill seedling emergence after 45 days			
	No of seedling		Average height		No of seedling		Average height		No of seedling		Average height	
Control	170	100%	15.13cm	100%	230	100%	21.71cm	100%	41	100%	15.35cm	100%
20% BM	335	189%	20.78cm	123%	325	145%	27.50cm	123%	62	151%	22.03cm	117%
50% BM	278	156%	22.26cm	132%	485	225%	35.46cm	158%	104	279%	24.77cm	120%
75% BM	273	153%	21.96cm	131%	471	215%	38.82cm	177%	77	185%	25.98cm	118%
100% BM	305	170%	25.96cm	145%	462	210%	38.20cm	180%	87	230%	21.56cm	115%

At adult stage, Tables 2,3 and Figures 5,6 are shown in weight of fresh market fruits and bulbs. In the case of onion, an experiment was carried out to see the effect of second treatment after seedling transplantation. The results obtained, Table 2 and 3 show only a slight increase in yield, which does not indicate economic feasibility for the second treatment.

Table (2). Yield per hectare and percent yield of harvested onion bulbs, tomato and chili fruits (age of transplanted crop=110 days)

Treatments*	Onion		Tomato		Chill	
	Yield (ton/ha)	Yield %**	Yield (ton/ha)	Yield %**	Yield (ton/ha)	Yield %**
Control	10.30	100	52.46	100	1.35	100
20% BM	15.29	148	100.42	191	1.50	111
50% BM	18.57	166	83.64	159	1.75	130
75% BM	23.77	230	87.87	167	1.75	130
100% BM	14.72	143	60.70	145	2.44	181

*completed at first seedling stage
** based on 100% control

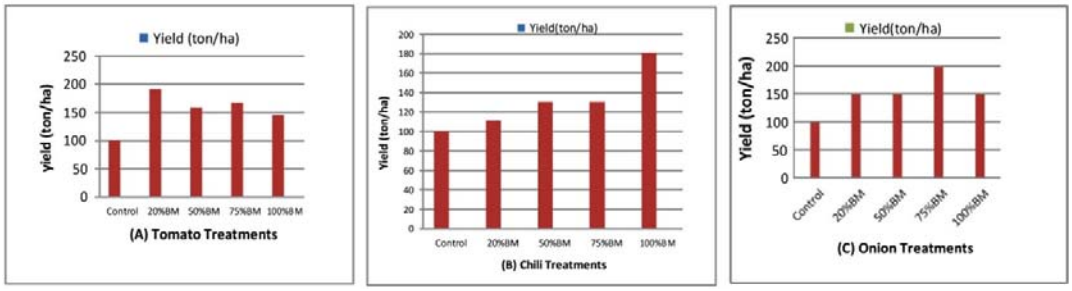


Figure (5).Yield (ton/ha) and percent yield of harvested tomato, chili fruits and onion bulbs with respect to Spirulina treatment completed as first stage of seedling

Table (3). Yield ton per hectare and percent yield harvested onion bulbs with respect to Spirulina treatment at the second stage of transplantation (age of transplanted crop= 110 days)

Treatments*	Yield (ton/ha)	Yield %**
Control	10.73	100
1 kg/acre	17.62	164
2 kg/acre	17.13	160
3 kg/acre	25.78	240
4 kg/acre	16.50	154
5 kg/acre	16.12	150

*completed at second treatment kg/acre

**based on 100% control

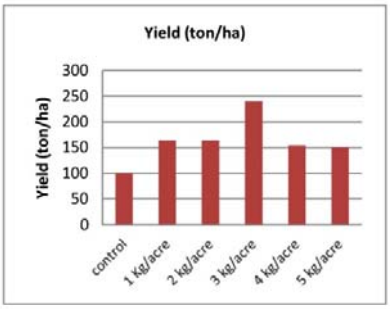


Figure (6). Yield (ton/ha) and percent yield of harvested onion bulbs with respect to Spirulina treatment completed as second stage of transplantation.

In the screening experiments with three vegetable crops, it was observed that different vegetable crops might prefer different levels of Spirulina biomass to be added for improved seedlings. In the experiments with onion, tomato and chili, all treatments with Spirulina powder showed significant improvements in seedlings and final vegetable crops yield compared to control. For instance specifically onion, an increase of 189% (20%BM) in seed germination 145% (100%BM) in seedling height, and final cop yield of 230% (75%BM) was observed compared to control (100%) showing economic feasibility of using Spirulina biomass to raise onion seedlings. However, no direct relations were observed between seedlings and vegetable crops yield indicating some other factors involved and need for further trials. Table 4 shows the composition of mineral elements N, P, K, Ca and Mg in the dried seedlings onion, tomato and chili. It can be observed that the values of N, P, K, Ca and Mg are higher than values of control (no Spirulina) with respect to the different treatments of Spirulina. Thus,the application of Spirulina as biofertilizer revealed highest values of total uptake mineral elements (kg/ha).

Table (4). The Elemental composition of N, P, K, Ca and Mg in onion, tomato and chili at seedling stage

Treatments	Dry wt of onion plant (kg/ha)					Dry wt of tomato plant (kg/ha)					Dry wt of chili plant (kg/ha)				
	N	P	K	Ca	Mg	N	P	K	Ca	Mg	N	P	K	Ca	Mg
Control	6.62	0.48	10.4	1.34	0.67	31.3	6.26	131	9.1	9.19	2.3	0.31	6.98	1.42	0.6
20% BM	20.8	1.51	27.7	5.04	2.04	67.4	11.5	211	12.8	15.1	6.1	0.79	17.1	3.26	1.49
50% BM	19.8	1.39	28.6	3.41	1.87	117	22.6	397	22.4	26.8	9.2	1.15	24.2	4.87	2.26
75% BM	20.4	1.39	31.9	3.43	2.06	101	20.2	393	24.5	27.7	11.1	1.54	29.6	5.06	2.69
100% BM	20.1	1.42	30.5	4.15	2.62	133	18.9	356	19.6	27.9	11.6	1.2	24.2	4.1	2.16

Conclusion

In this research work, Spirulina (Blue Green Algae) is a biofertilizer for seedling of three vegetable crops. However in this work focus is on the seedling stage and adult stage of onion, tomato and chili. Increase in number of seeds germinated with Spirulina treatments compared to control (100%) basis were 153% to 189% for onion, 145% to 225% for tomato

and 151% to 279% for chili respectively. Particularly the germination of onion plants, on the basis of seedling stage right to the maturing stage can be considered as a new finding. Conventionally, onions are cultivated from the small bulbs stage and not from seeds. The cause of positive effect of Spirulina biomass on seedlings may be due to the presence of growth promoting substance and anti-viral activity of Spirulina, as many plant viruses are known to attack young seedlings.

In weight of tomato fruit, chili fruit and onion bulb better significant results were observed with all percentages of treatments compared to control. Average weight of tomato fruit, chili fruit and onion bulb with spirulina treatment, compared to control (100%) basis were 145% to 191% for tomato and 111% to 181% for chili and 143% to 230% for onion respectively. At the transplantation stage, onion plants were subjected to second Spirulina treatment in terms of kilogram per acre (0,1, 2, 3, 4 and 5 kg/acre) with respect to control. The optimal amount of 240% yield was observed corresponding to the 3 kg/ per acre of Spirulina applied at the transplantation stage. Yield of 240% was the best result compare to other treatments. The assay of the soil is sandy loam. It improves the soil physical condition and aggregates the soil particle. This study has proved that the present of macronutrients N, P, K, Ca and Mg together with micronutrient like Fe, Na, Cu, Zn, Min, Cl and Mo within the macro and micronutrients level were able to promote growth and yield of vegetable crop. It can be concluded that Spirulina is a potential biomass fertilizer for the vegetable crops. (especially onion, tomato and chili).

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