Annals of Plant and Soil Research 25(3): 455-460 (2023)
https://doi.org/10.47815/apsr.2023.10291

Influence of different concentrations of *Spirulina platensis* extract on seed germination and seedling vigor of various crops

B. BASAVARAJA[1]*, NAGARAJ HULLUR[1] AND RADHA, B.N.[2]

[1]AICRP on Seed (Crops), UAS, GKVK, Bangalore-560065

Received: June, 2023; Revised accepted: August, 2023

Abstract

An experiment was conducted to know the influence of different concentrations of Spirulina platensis extract on seed germination and seedling vigor of various crops. The experiment involved eight different crops, and five concentrations of the algal extract were applied. The parameters evaluated included seed germination percentage, seedling vigor index-I and II. The results indicated significant variations in seed germination and seedling vigor among different crops and concentrations of Spirulina platensis extract. Among different concentrations of Spirulina platensissignificantly higher (85.75 %) seed germination was recorded in BGA @100 % concentration in all the crops selected for study. This study provides valuable insights into the potential use of algal extracts for enhancing crop growth and productivity.

Keywords: *Spirulina platensis*, seed germination, seedling vigor, algal extract

INTRODUCTION

Seed germination and seedling vigor are critical determinants of crop establishment and subsequent yield potential. Various approaches have been explored to improve these parameters, and recent research has shown promising results with the application of algal extracts. *Spirulina platensis* is a filamentous cyanobacterium, commonly referred to as Spirulina, and is one of the most well-known and widely consumed species of blue-green algae. It is naturally found in alkaline lakes, ponds, and other water bodies with high pH levels and is known for its exceptional nutritional value and potential health benefits. Algae are an abundant source of minerals, proteins, carbs, and chemical substances, particularly polysaccharides, polyphenols, phlorotannin, plant pigments, unsaturated fatty acids, sterols, and phytohormones. Due to their activity at modest concentrations, algae extract effectively stimulate plant development. Additionally, algae extract enhances the sprouting of seeds, the growth of saplings, the production of photosynthetic pigment, and the ability of plants to withstand external stressors (Manickavelu *et al.,* 2006). *Spirulina platensis*, nutrient-rich blue-green microalgae, is known for its diverse bioactive compounds that can potentially enhance plant growth and development. This study aimed to evaluate the influence of different concentrations of *Spirulina platensis* extract on seed germination and seedling vigor in selected crops.

MATERIALS AND METHODS

About 5 gm of Cyanobacteria, *Spirulina platensis* was homogenized with 50 ml of distilled water and filtered by suction pump. The filtrate was then converted into 25%, 50%, 75% and 100% by using distilled water. These various concentrations were used for seed treatment. The seeds of crops such as Chilli, Tomato, Carrot, Beans, Maize, Paddy and Ragi were collected from local market. The seeds were soaked in the different concentrations (25%, 50%, 75% and 100%) of *Spirulina platensis*extract for the period of 12 hours and the seeds soaked in distilled water acts as control. After presoaking treatment, the seeds were transferred to sterilized petriplates and about 10ml of water was added to each petriplate. Then the observations on seed quality attributes with respect to seed germination and seedling vigour were recorded.

Germination (%):

The germination test was carried out as per ISTA procedure (Anon, 2013). Four hundred seeds from each treatment were taken and the test was carried out in four replications, having 100 seeds each. The seeds were allowed to germinate using top of paper (TP) method at 20 ^{0}C temperature. The first and final count was

Corresponding authour Email:basavaraja.sst@gmail.com, [2]*Department of Seed Science and Technology, UAS, GKVK, Bangalore-560065*

taken on 5th and 10th day of the test, respectively. Germination percentage was calculated using the following formula:

$$\text{Germination (\%)} = \frac{\text{Number of seeds germinated}}{\text{Total number of seeds kept for germination}}$$

Seedling vigour index (SVI)-I:

Seed vigour index-I was calculated as per the formula given by Abdul Baki and Anderson (1973).

$$\text{Seed vigour index} - I = \text{Germination (\%)} \times \text{Mean Seedling length (cm)}$$

Seedling vigour index (SVI)-II:

Seed vigour index II was calculated as per the formula given by Abdul Baki and Anderson (1973).

$$\text{Seed vigour index} - \text{II} == \text{Germination (\%)} \times \text{Mean Seedling dry weight (mg)}$$

Mean values, standard error of the mean (S.Em±), critical difference (CD) at 5% significance level, and coefficient of variation (CV) were calculated and presented.

RESULTS AND DISCUSSION

The data on seed germination as influenced by different BGA concentrations in various crops are presented in Table1.Among the different concentrations of BGA, significant differences were observed for seed germination. Significantly higher (85.75 %) seed germination was recorded in BGA @100 % concentration followed by BGA @75 % and BGA @50 % (83.50 and 80.33 %, respectively) and the lower (75.38 %) seed germination was observed in control and followed by BGA @ 25 % concentration. Significant differences were recorded among the different crops when they subjected to various concentrations of BGA for seed germination. Maize showed significantly higher (91.53 %) seed germination and it was on par with Paddy (89.13 %) followed by Ragi and Beans (84.27 and 82.80 %, respectively). The lowest (69.07 %) seed germination was recorded in Carrot. The interaction between the BGA concentrations and crops for seed germination was non-significant.

Table 1: Influence of different concentration of *Spirulina platensis* extract on seed germination of various crops

	Seed Germination (%)					
Crops (C)/ Treatment (T)	Control	BGA extract (25 %)	BGA extract (50 %)	BGA extract (75 %)	BGA extract (100 %)	Mean
Cucumber	74.00	75.33	77.33	81.00	83.00	78.13
Chilli	68.00	70.67	73.00	75.00	78.00	72.93
Tomato	71.00	74.33	76.33	79.00	82.00	76.53
Carrot	64.00	66.33	69.00	72.00	74.00	69.07
Beans	78.00	80.00	82.00	86.00	88.00	82.80
Maize	86.00	88.00	91.00	95.00	97.67	91.53
Paddy	82.00	86.00	90.00	92.67	95.00	89.13
Ragi	80.00	81.67	84.00	87.33	88.33	84.27
Mean	75.38	77.79	80.33	83.50	85.75	
	S.Em±	CD (5%)	CV (%)			
C	0.813	2.288	3.909			
T	0.643	1.809				
C×T	1.818	5.117				

From the results, it has been found that there is positive relationship between concentration of extract and seed germination, it means increase in concentration of the extract of algae resulted as increase in the growth parameters. The positive effect of algal leachate on the growth of seedlings was progressively increased with increase in concentration.

Cyanobacteria or blue green algae (BGA) when applied as biofertilizers, plays a key role in improving growth of many plants. This evidence was clearly appeared in growth of selected crops. The Anabaena culture is able to increase the germination rate in chilli after seed treatment which can be used for increased germination rate. The pigments such as Chlorophyll a and Chlorophyll b can be increased after Anabaena

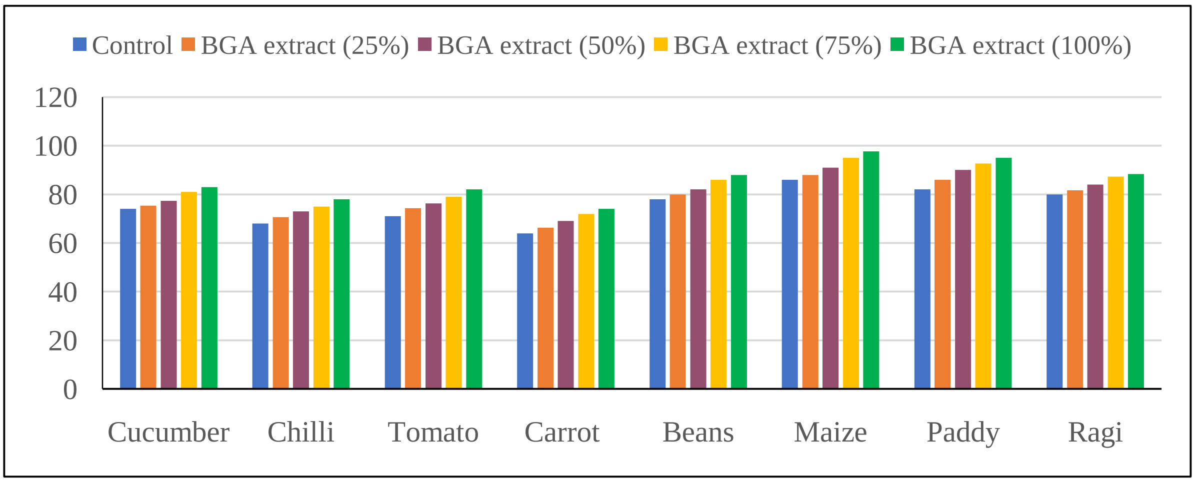

Fig 1: Vaiation in seed germination percentage as influenced by *Spirulina platensis* extract

treatments which are associated with increased photosynthetic rate. Also, the cyanobacterial application increased the organic content and nitrogen content of soil. Anabaena intact culture may not have positive response on protein content. Overall Cyanobacteria can positively affect the chilli plantlets after seed treatment (Jayant *et al.,* 2018).

The nitrogenase as well as nitrate reductase activities of the alga associated with the surface of plants are responsible for these increases in seedling vigour Adam (1999); or the amino acids and peptides produced in the algal filtrate and or other compounds that stimulate growth of crop plants. Moreover, Jagannath *et al.* (2002) in his study BGA was found to enhance all the morphological characters and biomass of the chickpea. The growth promoting activity of Cyanobacteria as inoculants of wheat was also observe by Nanjappan *et al.* (2007) and Basavaraja (2019).

Table 2: Influence of different concentration of *Spirulina platensis* extract on seedling vigour index (SVI)-I of various crops

	Seedling Vigour Index (SVI)-I					
Crops (C)/ Treatment (T)	Control	BGA extract (25 %)	BGA extract (50 %)	BGA extract (75 %)	BGA extract (100 %)	Mean
Cucumber	785.2	999.9	1086.8	1153.6	1173.0	1039.7
Chilli	853.7	1243.7	1373.9	1406.4	1467.8	1269.1
Tomato	979.5	1520.5	1660.8	1723.0	1785.5	1533.9
Carrot	637.6	967.8	1090.9	1139.7	1162.7	999.7
Beans	1600.6	1954.9	2136.4	2260.5	2284.1	2047.3
Maize	3001.3	3451.8	3837.6	4024.1	4101.5	3683.3
Paddy	1325.6	2078.9	2340.5	2411.0	2474.5	2126.1
Ragi	781.7	1072.8	1159.4	1228.2	1229.4	1094.3
Mean	1245.7	1661.3	1835.8	1918.3	1959.8	
	S.Em±	CD (5%)	CV (%)			
C	24.576	69.166	5.520			
T	19.429	54.680				
C×T	54.953	154.660				

The data on seedling viogur as influenced by different BGA concentrations in various crops are presented in Table 2&3. Among the different concentrations of BGA significant differences were observed for SVI-I. Significantly higher (1959.8) SVI-I was recorded in BGA @100 % concentration followed by BGA @75 % concentration (1918.3) and the lower (1245.7) SVI-I was observed in control. Seedling vigour index (SVI)-I differed significantly among the crops when they subjected for various concentrations of BGA. Considerably higher (3683.3) SVI-I was observed in Maize followed by Paddy (2126.1). Meanwhile, lower (1039.7) B.

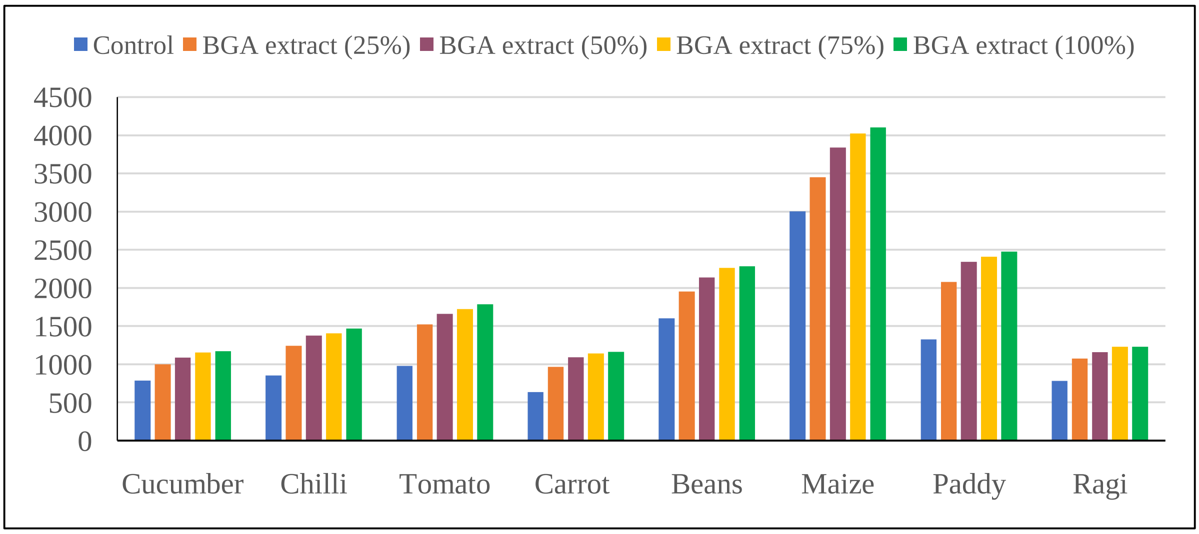

Fig 2: Vaiation in SVI-I as influenced by *Spirulina platensis* extract

SVI-I was recorded in Cucumber. The interaction between the BGA concentrations and crops for SVI-I was significant.

Among the different concentrations of BGA significant differences were observed for SVI-II. Significantly higher (1932.4) SVI-II was recorded in BGA @100 % concentration followed by BGA @75 % concentration (1835.9) and the lower (1361.5) SVI-II was observed in control. Seedling vigour index (SVI)-II differed significantly among the crops when they subjected for various concentrations of BGA. Significantly higher (5846.1) SVI-II was observed in Maize followed by Beans (4134.3). However, lower (294.2) SVI-II was recorded in Carrot. The interaction between the BGA concentrations and crops for SVI-II was significant.

Table 3: Influence of different concentration of *Spirulina platensis* extract on seedling vigour index (SVI)-II of various crops

Crops (C)/ Treatment (T)	Seedling Vigour Index (SVI)-II					Mean
	Control	BGA extract (25%)	BGA extract (50%)	BGA extract (75 %)	BGA extract (100 %)	
Cucumber	693.0	811.4	855.4	934.5	981.5	855.2
Chilli	236.1	423.1	451.1	478.3	515.3	420.8
Tomato	276.6	537.7	568.1	608.5	651.9	528.5
Carrot	137.4	295.3	320.9	348.6	369.0	294.2
Beans	3607.5	3856.0	4063.1	4465.8	4679.3	4134.3
Maize	5093.8	5449.9	5776.1	6283.2	6627.4	5846.1
Paddy	466.3	834.7	913.6	967.9	1020.1	840.5
Ragi	381.6	524.7	554.3	600.5	614.6	535.1
Mean	1361.5	1591.6	1687.8	1835.9	1932.4	
	S.Em±	CD (5%)	CV (%)			
C	33.71	94.87	7.76			
T	26.65	75.00				
C×T	75.37	212.13				

A worthy content of growth hormones in BGA solution could influence the vigour of the produced seedlings in terms of seedling length as compared to the control. In this study, the increment in seedling vigour is due to increase in seedling growth and seedling dry weight resulting from different cyanobacteria treatments was significant among crops and also between concentrations. The results are in accordance with Maiti & Pramanik (2013), used different priming techniques improved seedling vigor, growth and yield of tomato, cucumber, chilli, cabbage and watermelon crops; although the cultivars showed variation in germination

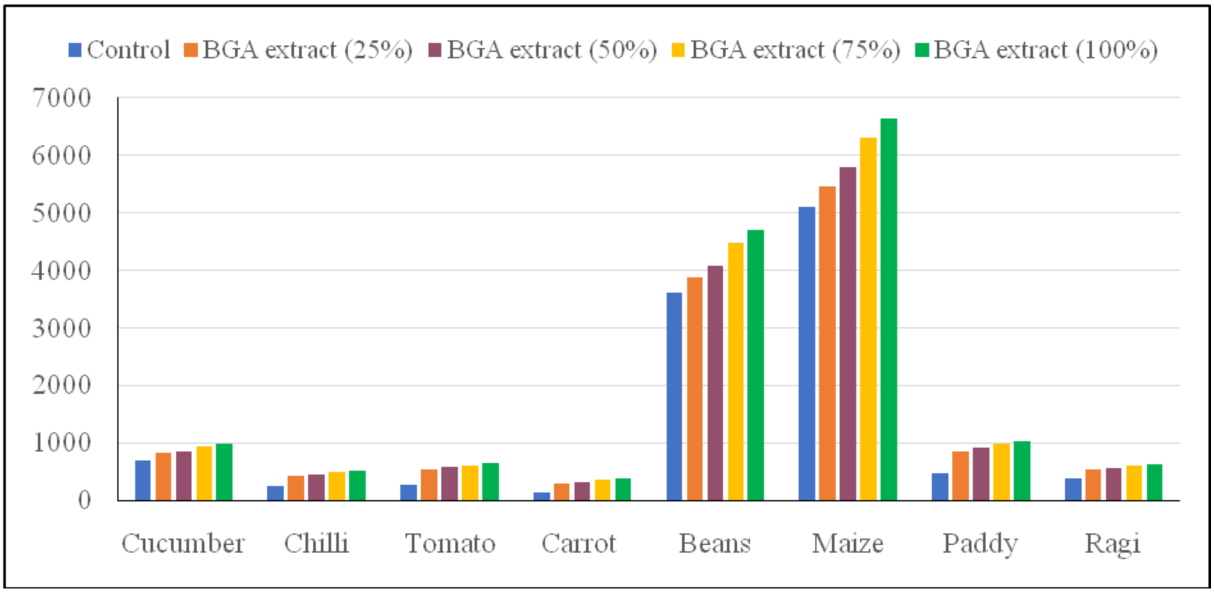

Fig 3: Vaiation in SVI-II as influenced by *Spirulina platensis* extract

percentage in responses to different treatments. In this respect, different cyanobacterial isolates showed a significant increase in percentage of germination, seedling length, seedling dry weight and other viogur parameters of maize plant (Mohan *et al.,* 2015; Gupta *et al.,* 2020).

The findings suggest that the application of *Spirulina platensis* extract had a positive influence on seed germination and seedling vigor. The increase in germination percentage and vigor indices indicates the potential of algal extracts in enhancing early-stage plant growth. The variations observed among different crops and concentrations emphasize the importance of considering crop-specific responses and optimal concentrations for maximum benefit. The bioactive compounds present in *Spirulina platensis* may have stimulated physiological processes, nutrient absorption, and hormone regulation, leading to improved seedling performance.

CONCLUSION

The results of this study demonstrate the positive impact of *Spirulina platensis* extract on seed germination and seedling vigor in selected crops. The findings highlight the potential of algal extracts as natural and sustainable alternatives for enhancing crop productivity. Further research is warranted to elucidate the underlying mechanisms and optimize application methods and concentrations for different crops. The utilization of *Spirulina platensis* extract holds promise for sustainable agriculture practices, reducing reliance on synthetic inputs, and promoting eco-friendly approaches to crop production.

REFERENCES

Abdul-baki, A. A. and J. D. Anderson. 1973. Vigor Determination in Soybean Seed by Multiple Criteria. *Crop Sci*, **13**: 630-633.

Adam, M.S., 1999. The promotive effect of the cyanobacterium Nostoc muscorum on the growth of some crop plants. *Acta Microbiologica Polonica*, **48**(**2**): 163-171.

Anonymus, 2013. International rules for seed testing, *Seed Sci. Technol*., **27**(1): 25-30.

Basavaraja, B., Naik, T. and Nagaraj Hullur. 2019. Variations in Algal Floristic and Major Nutrients in Soils of Hassan District. *International Journal of Current*

Microbiology and Applied Sciences. 8. 2110-2115.

Gupta, G., Dhar, S., Dass, A., Sharma, V.K., Shukla, L., Singh, R., Kumar, A., Kumar, A., Jinger, D., Kumar, D. and Sannagoudar, M.S., 2020. Assessment of bio-inoculants-mediated nutrient management in terms of productivity, profitability and nutrient harvest index of pigeon pea–wheat cropping system in India. *Journal of Plant Nutrition*, ***43***(19):2911-2928

Jagannath, S.B.A, Umapati-Dengi and Eshwarlal S. 2002. Algalization studies on chickpea (*Cicer arietinum* L). *Biotechnology of microbes and sustainable utilization*, **6:** 145-150.

Jayant, P. R., Swapnil, I. L., Darasing R. R. and Rajendra M. G. 2018. Cyanobacterial Culture Acts as Good Organic Biostimulant on Anethum graveolens. *Int J Curr Microbiol App Sci*, **7**(**12**): 787-793

.

Maiti, R. and Pramanik, K. 2013. Vegetable seed priming: A low cost, simple and powerful techniques for farmers' livelihood. *International Journal of Bio-resource and Stress Management,* **4(4)**: 475-481.

Manickavelu, A.; N. Nadarajan; S.K. Ganesh; R. Ramalingam; S. Raguraman and R.P. Gnanamalar (2006). Organogenesis induction in rice callus by cyanobacterial extracellular product. *African J. of Biotech*., 5(5): 437-439.

Mohan, A. and Kumar, B. 2015. Cyanobacterial consortium in the improvement of maize crop. *International Journal of Current Microbiology and Applied Sciences,* **4(3)**: 264-274.

Nanjappan, K., Radha-Prasanna, Latanain and Kaushik, B.D. 2007. Evaluating the potential of plant growth promoting cyanobacteria as inoculants for wheat. *EuropeanJournal-of-Soil-Biology,* **43(1)**: 23-30.