International Journal of Botany Studies
ISSN: 2455-541X, Impact Factor: RJIF 5.12
www.botanyjournals.com
Volume 1; Issue 4; May 2016; Page No. 01-07

A review on blue green algae as biofertilizer (site characteristics, location and boundaries of Vindhya basin, geology of Rewa, physiography, climatology)

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Abstract

Inoculation of Blue-green algae-alagalization commonly reported as a safe agro ecosystem to contribute in economic feasibility in paddy habitat, minimise cost and energy inputs. Some of additional researches of algalization or BGA with soils carried out in India and, various other countries have shown advantageous effects on productivity. Modern increasing trend of population is the only way to assuse production potential of agriculture adopting through improved agricultural practice and high yielding varieties of crops and use of fertilizers in agro fields with the optimum use of pesticides and other required materials. Algalization is being followed in various states such as Haryana, Karnataka, Andhra Pradesh, Jammu & Kashmir and Maharashtra. Algalization is also being utilized in United States of Soviet Republic, Philippines, Egypt, and China. Biotechnology Department of Govt. of India has introduce four major centers in the growing areas of paddy fields of the country to accelerate and extension of work in the field of algal bio fertilizer in 1990. The programme was launched in Lukhnow (UP), Calcutta (West Bengal), Madurai (Tamil Nadu) and New Delhi under technology development and presentation programmes on Cyanobacterial biofertilizer with the objective of i) to provide low cost locally used technology for large production of BGA, ii) to isolate better and fast growing N_2- fixing strains, iii) to demonstrate the farmers in the field, iv) to develop starter inoculums and v) to study both ecology and economy benefits. The result of study of algal biofertlizer has been reported very useful for the formers of small and marginalised group of India.

Keywords: Inoculation, Blue-green algae, agro ecosystem, algalization, biofertilizer, N_2- fixing, farmers

1. Introduction

Spoehr and Milner (1949) [1] published work on mass culture of algae which may help to fulfill the requirement of global protein. It was reported that algae had fulfill with crude protein content with the 50 percent and the biomass productivity in the order of 25 tons/ha/year. The supply per capita protein is lamentably low in many parts of the world and mass cultivation of algae has shown very casual interest. Nutrient recycling and nitrogen fixation is also emphasize by the United Nations Environmental Programme (UNEP) through a microbiological system (MIRCENS) with the hope of stimulation of micro algal technology as an integrated system for recycling for community of rural areas. Under the International code of Botanical Nomenclature (ICBN) psychologists investigated microalgae and organisms of eukaryotic and prokaryotic both type of cell. The BGA constituted latter category for the largest group. Under provisions of ICBN the prokaryotic nature of BGA and it fairly close relationship with the eubacteria made more appropriate (Geitler, 1932; Rippka, *et al*., 1979; Sneath, 1992; Waterbury, 1992; Greuter, *et al*., 1994) [2, 3, 4, 5, 6].

Cyanobacteria (BGA) are playing a vital role to increase the fertility of various ecological agriculture as they are widely distributed in the world, BGA are able to do this as a free-living organisms and as making association symbiotically with azolla the water-fern, and it is the main principle of so many species that they have nitrogen-fixing ability which subsequently, increase the fertility of soil (Fay, 1983) [7]. The importance of these particular in the organisms for rice culture had made in the review published by Roger and Kulasooriya (1980) [8]. This paper shows that addition of dried inocula increase nitrogen fixation in different ecosystem of rice. However, methods and results are mostly lacked in these recent reviewed documents, on this account published by Roger (1989) [9] describe the significance of research work on the use of Azolla as biofertiliser. The different workers published specific report on use (Lumpkin and Plucknett, 1982) [10].

At the inner aspect of the cytoplasmic membrane cyanoglobin was reported to found inside (Hill, *et al*., 1996) [11]. Cyanoglobin partitions appears to be an inner membrane protein, peripherally bound and to the soluble phase during disruption. Absolute requirement of Cyanoglobin is not necessary for nitrogen fixation (Hill, *et al*., 1996) [11]. However, nitrogen and oxygen deplete condition shows the relatively unique under which glnN is expressed, some suggestions would be for relevant function in other Nostocean species and in this organism found which is glbN (Hill *et al*., 1996) [11]. The specific aim of this study is to understand the function of various changes in terms of its relation to nitrogen fixing group of algae. Role of Oxygen relations in nitrogen fixation is one of important considerable biochemical interest, in the BGA especially, which are in a variety of ecosystems and crucial to make the nitrogen balance in the Earth. Study of cyanoglobin may play an additional role regarding information for current model systems.

BGA occupy a unique position and possess metabolic system like bacteria, an autotrophic mode like eukaryotic plant cells. They have chlorophyll ‘a’ for carry out photosynthesis and exhibit great diversity of morphology with their broader spectrum of physiological properties shows their widely distribution and tolerance of environmental stress (Tandeau and Howard, 1993) [12]. The detail studies of BGA in the various geographical part of India reported interesting results (Venkataraman, 1975) [13]. Various reports have already been published on widly distribution of forms like Nostoc, *Oscillatoria, Anabaena, Aphanothece and Phormidium* (Paul and Santra, 1982; Garcia-Pichel and Belnap, 1996) [14, 15]. Some species reported from soil of cuttack and Orissa, those are dominating heterocutous N2 fixing Blue green algae species of *Nostoc, Anabaena, Tolipothrix, Aulosira, Calothrix*, and Cylindrospermum. Distribution of isolated cyanobacteria in the soil of Howrah, Cuttack and Bhuwaneshwar, indicated that heterocytous strains are predominance in the natural habitat (Saxena, *et al*., 2007) [16].

BGA are more common in Tropical and Sub-tropical regions as compare to temperate belts (Vaishampayan, *et al*., 2001) [17]. The research findings concludes a highly favourable environment condition in the water-logged conditions of paddy habitat where habitat enable to provide nitrogen to plants, betterise crop yields by altering the soil productive, vital and fertile. Inoculation of Blue-green algae-alagalization commonly reported as a safe agro ecosystem to contribute in economic feasibility in paddy habitat, minimise cost and energy inputs (Mishra & Pabbi, 2004) [18].

The influence of so many agrochemicals is imperative on these organisms be understood thoroughly. Coastal region of Goa is with humid, hot and tropical climate. The staple food of Goans is *Oryza sativa L.*(paddy) is being cultivated 47,104 hectares of overall area in Rabi(1593ha) and Kharif (31166ha) (Sakshena, 2003) [19]. The aim of my study is to Identify, evaluation of the diversity and density of the BGA in the paddy fields of Sidhi district near to Rewa division, which are influenced by different environmental conditions.

Saadatnia & Riahi (2009) [20] has shown experimental work on germination of rice seeds treated with cyanobacteria compare than control. The more germination was reported with blue-green algae. BGA are uses as a major component for the nitrogen fixation in the paddy fields. In the cultivation of rice the agricultural importance of cyanobateria is related directly with the nitrogen fixing ability and some other positive effect for soil and paddy plants. Nitrogen is the second limiting factor after the water for growth of plants in various fields and deficiency of this element is met by bio fertilizer (Malik, *et al*., 2001) [21].

The use of excessive chemical fertilizer has created various environmental problems including ozone layer depletion, acidification of water and greenhouse effect. These problems may be break down by the regular use of biofertilizer (Choudhury and Kennedy 2005; Rai, 2006) [22, 23].

Microbial inoculants, mycorrhizal fungi and bacteria (Azobacter), including Algae(BGA) are well knowledge as Biofertlizer; these are beneficial and ecological, natural, potent and able to maintain soil structure and provide nutrient for the plants (Board 2004) [24]. BGA are playing a valuable role for the maintenance and increase fertility of soil, increasing rice growth consequently, and yield as a natural algal biofertiliser (Song, *et al*. 2005) [25]. These organisms increase soil pores having with structure like filaments and excretion of substances for growth promoting hormones i.e. auxin and gibberellins and amino acids, vitamins. These organisms also increase water holding capacity of soil through their jelly like structure. After their death and decomposition they increase biomass of soil and subsequently, decrease salinity of soil, prevent weeds growth and, by excretion of organic acids increase phosphate in soil (Wilson, 2006) [26].

Soils of paddy fields mostly have a natural population of BGA which make available a potential nitrogen source at economically very low (Mishra and Pabbi, 2004) [18]. For the growth of cyanobacteria the ecosystem of paddy field provides a favorable environment with respect to their necessity of high temperature, water and light and availability of nutrients. This can be one of the specific reason for more abundant growth of BGA in the soil of paddy field comparative than in soil of upland (Roger and Reynaud, 1982, Kondo and Yasuda, 2003) [27, 28].

An attempt has been made to explore the ecological and economic production of algal biofertiliser intensity with respect to different seasons and habitat. Seasonal patterns in cyanobacterial abundance have been studied in different solar radiation, nutrient supply and various temperatures. This has been noted that temperate climate environment promote the growth of cyanobacteria particularly in all season Mihaljevic, *et al*. (2011) [29]. However, Graham, *et al*., (2008) [30] published his results in their study that cyanobacterial populations tend to maximum in spring and summer seasons. One interesting feature published that in low light conditions cyanobacterial growth rates was comparatively greater than that of other aquatic species and this has greater ecological adoptability coupled with higher ecological plasticity allows them to compete with other algae in highly polluted waters (Vincent, *et al*., 2004) [31]. Other research results indicated that high water temperatures leads to an increase in density of cyanobacteria with a maximum growth noted for the temperature above 15°C (Lehman, *et al*.,2008) [32]. Nevertheless, maximum growth rates noted at temperatures above 25°C (Newcombe, *et al*., 2010) [33]. Mass blooms of cyanobacteria are reported generally associated with high nutrient concentrations, especially in phosphorus but their growth and biomass is maximum by availability of phosphate in which algae multiply as suggested by Schreurs, (1992) [34] & Newcombe, *et al*., (2010) [33].

Xie, *et al*., (2011) [35] noted that cyanobacteria maintain a viable population and this is correlated with turbidity of Muskegon Lakes. Based on these dynamism characteristics of cyanobacteria, prefer to utilise high spatial and temporal remote sensing methods for their quantification.

Graham, *et al*., (2008) [30] noted cyanobacteria vary on small time scales. Under light wind conditions cyanobacteria is moved towards the shoreline of area lakes and bays, where they form thickets (Lehman, *et al*., 2005; Graham, et. al., 2008) [37, 30]. In extreme conditions, such clusters may become very thick and even acquire a sticky consistency as reported by Noges, *et al*., (2010) [36]. Cyanobacteria changes rapidly with changing hydrological conditions for example 'circulation patterns or inflow of water' Graham, *et al*. (2008) [30].

Site Characteristics

The site selected for present investigation was situated at the Sidhi district for assessing the natural growth of Cyanobacterial alga and their affect on the various properties which helps for better paddy growth in the water swamp area of the habitat.

Specific site was selected at village Mawai nearby 10 km from Churhat, of Sidhi district Rewa region (M.P.). The paddy field of this site reflect higher fully mass of growth of algal production. The natural algal strains were collected for assessing the diversity of algal diversity of the region. The soil of the region ranges slightly alkaline in nature. Whereas, nitrogen level was noted moderate. The site was characterised with sandy loamy nature of soil. Site and their spots were selected to assess the variety of the BGA algal flora in different spot of the habitat for paddy growth. The site was characterized with huge amounts of algal deposits in the whole paddy area. The site was characterize with sandy loamy texture of soil with moderate to low nitrogen content. The better growth of natural growth of algal strain which betterise the crop productivity of rice in natural habitat. Probably site was best natural habitat with special reference to micro specificity of micro climate of the area enhance the best production and not need to have additional amount of extra input of energy in the form of nitrogen for better productivity of crop.

These algal strain productions in natural habitat extend limitation level and betterise the microclimatic situation of the environment of the habitat.

Location and Boundaries of Vindhya Basin

Rewa, headquarter situated on the national highway number 7 between Jabalpur and Varanasi is a commissionary town of North East Madhya Pradesh. It lies at latitude of 24°32' N and longitude of 81°18'E. Its heights above sea level is 318.7mtrs. The area of Rewa District is 6315 Sq.K.m. approximately 1054 Sq.kms is under forest cover, which is about 16.99% of total geographical area. Vindhya region includes 13 District namely, Rewa, Satna, Sidhi, Singrauli, Shahdol, Katni, Anuppur, Umaria, Damoh, Panna, Chhaturpur, Tikamgarh, & Datia and two Divisions i.e. Rewa & Shahdol Division with diverse specific climatic situation met on the different type of habitat. The one site of Sidhi district was taken for collection of algal species. Diverse situation & specific microclimatic condition of the habitat enable the algae to develop adoptability through morphological & physiological change.

Geology of Rewa

Rewa plateau is a part of Vindhya basin formed from vast hilly tract of Central India. Vindhya basin is divided into two divisions – (a) Upper Vindhya System and (b) Lower Vindhya System. The lower Vindhya system is composed of marine calcareous sand stones and undulated shales of argillaceous nature. The upper Vindhya system comprises stratification of hard and soft bands of sand stones, lime stones and shales which are of shallow water origin. The recent upper Vindhya system is deposited over the lower Vindhya system.

The Vindhya System has been given the status of super group with four groups Semri, Kaimore, Rewa and Bhander. Two important formations that are exposed in the area are the lower Gourgarh Shale followed by the Bhander lime stone formation. (Singh and Dubey 1990, 1998) [38]. Tiwari & Dubey (2007) [39] reported the stratigeorgraphy of the area and specific soil formation in the different spots of Vindhya region.

Physiography

Rewa region has saucer shaped structure. The flat central part is made up of sedimentary rocks originated from the denuded material of the surrounding hills. The sloping margin of saucer comprises older rocks which contrastingly occupies a higher level than the younger sedimentary rocks of the central flat zone. The saucer was once formed in sea which sediments from the coastal hills deposited during the Precambrian period. Decapitation of the surrounding hills exposed the older rocks at the coast line of the original synclinal tathys. Owing to the synclinal shape of this area, the drainage system is of centripetal type. This clearly reflects the vegetation pattern of habitat. The rivers mostly originated from south and flows towards North. Regional structure, earth surface and geodynamic process such as silting and erosion, consequently, extend to form specific complex microclimatic of the habitat. The saucer, shaped structure of this area clearly reflects for the scanty vegetation except a few situationary spots. Owing to its centripetal drainage pattern of the area is reported to accelerating quick and continuous erosion of soil.

Climatology

Climate of any region is mostly determined by certain meteorological parameters such as relative humidity of air, temperature, wind pressure and rainfall.

Climate

The physical state of atmosphere is composed of various constituents of climate. Climate of region is mostly determined by certain meterological parameters such as relative humidity, temperature and rainfall. Which influences the vegetation pattern of habitat. Climo-edaphic factors characterised by specific pattern of vegetation of the region. Keeping view in mind the various related climatic data have been taken in the present investigation.

(a) Temperature

Temperature greatly affect the vegetative growth of the various BGA species. The effects of temperature on the algal growth of area can be studied best by recording seasonal variation and diurnal fluctuations of temperature. Seasonal data reflect marked seasonal extreme and fluctuations in the recorded temperature values.

Table 1. shows the monthly distribution of temperature of Rewa region for the years 2010 to 2013, based on the recorded data.The average temperature was recorded 26.85°C for the year 2010, 24.45°C for the year 2011, 24.85°C for the year 2012 & 21.4°C for the year 2013 which shows that year 2010 was average hot year in the these years. The lowest temperature was recorded in the month of January 2013, i.e. 3.3°C while January was the lowest average temperature month i.e. 12.8°C in the year 2013. Monthly mean temperature of January 2012 was 15.0°C from February-2012 onwards the temperature started rising, reaching its maximum in the month of June 2012 i.e. 33.2°C. The average monthly mean temperature of February 2012 to June 2012 were 16.1°C, 28.5°C, 28.5°C, 32.7°C and 33.2°C alternatelively. July-2012 also experienced the extreme temperature towards higher scale but the upward movement of mercury was checked by coming monsoon. In July 2012 the average monthly mean temperature was 27.5°C. In Aug.-2012 it was 26.5°C, In Sep.-2012 27.2°C, In October-2012 i.e. 25.4 °C, November-2012 i.e. 20.5°C and in December-2012 it was

16.00 °C. (Table 1). Whereas Monthly mean temperature of January–2013 was 12.8°C from February-2013 onwards the temperature started rising, reaching its maximum in the month of June 2013 i.e. 30.4°C. The average monthly mean temperature of February 2013 to Jun-2013 were 16.2°C, 22.8°C, 27.2°C, 33.2°C and 30.4°C alternatelively. July 2013 also experienced the extreme temperature towards higher scale but the upward movement of mercury was checked by coming monsoon. In July 2013 the average monthly mean temperature was 28.5°C. In August 2013 it was 27.8°C, In September 2013 28.7°C, In October 2013 24.8°C, November 2013, 18.6°C and in December 2013 16.2°C. (Table 1)

(b) Rainfall

Rainfall of any habitat is indices for vegetational pattern exist on the area. Availability of water is mostly depending on the type of soil, presence of organic matter & amount of humus. The yearly rainfall, distribution greatly influences the growth of natural vegetation of the habitat. The number of rainy days plays crucial role in determining the vegetation pattern of different spots of region.

Table 2 represents the amount of rainfall per month from 2010 to 2013. It is evident from the noted data that average rainfall in the month of July 2012 was maximum i.e. 549.0mm, followed by 541.2 mm in August 2013, 469.8mm in August 2012, & 430.2 mm in August 2011, whereas May-2012 and May 2013 proved to be dried months with no precipitation or too little precipitation. Average rainfall of winter months specially for November-2013 to December-2013 was 0.00 mm, while in Nov.-2012 & Jan.-2013 was 0.0mm, and Dec., 2012 was 7.4mm (Table 2).

Relative Humidity

Relative humidity represents the ratio between the actual humidity present and the saturation of humidity possible at exiting temperature. The relative humidity plays an important role in germination of seed as well as growth and establishment of plant, regulate the loss of water by plant community. It varies from season to season. Any increase in temperature extends the capacity of atmosphere for holding water vapour. If the temperature is lowered, capacity of air for holding water vapour consequently, decreases. Table 3 shows humidity condition of the region for the year 2010 to 2013. The average humidity was recorded maximum i.e. 68.5 in the year 2011, and 62.4 in the year 2012, 61.9 in the year 2010 and 61.8 in the year 2013 separately.

Monthly average humidity conditions were also noted. The monthly average humidity was maximum 78.2 in Aug. 2011, 74.3 in Oct. 2011, 73.7 in July 2012 & 73.3 in Sep. 2011 while minimum average humidity was noted 34.9 in the month of May 2013 & 44.5 in June 2010. On observing the data maximum humidity was recorded 89.7 in Aug. 2013 and 89.1 in the month of July 2013 &, 87.4 in Jul. 2012, 87.6 in Aug.2011, 87 in Jan. 2010 separately while minimum humidity was recorded 23.7 in Jan. 2012 & 29 in May 2010, 32.4 in April 2012, 33 in June 2010, 33.4 in May 2013 separately. (Table 3).

Table 1: Monthly Distribution of Temperature of Rewa Region (Year 2010 To 2013)

Year	Tempe-rature 0°C	Months												Average
		Jan.	Feb.	Mar.	Apr.	May	Jun.	July.	Aug.	Sep.	Oct.	Nov.	Dec.	
2010	Max.	22.3	27.0	35.5	42.0	43.8	43.0	34.5	33.5	32.2	32.1	30.4	24.1	33.4
	Min.	4.7	8.7	16.7	22.5	26.1	28.0	34.1	26.8	25.3	21.0	17.9	6.3	20.3
	Average	13.5	17.8	26.1	32.4	34.9	35.5	34.3	30.1	28.7	26.5	24.1	15.2	26.85
2011	Max.	23.5	29.0	34.0	39.7	42.6	35.7	32.5	31.0	31.1	32.2	30.3	24.3	32.1
	Min.	4.4	9.0	13.5	17.6	23.4	24.2	26.5	24.7	24.9	17.5	11.0	5.7	16.8
	Average	13.9	19.0	23.7	28.6	33.0	29.9	29.5	27.8	28.0	24.8	20.6	15.0	24.45
2012	Max.	22.7	24.4	31.6	38.3	42.2	41.4	31.3	30.2	31.7	32.5	29.0	24.7	32.6
	Min.	7.2	7.8	15.5	18.6	23.2	25.0	23.8	23.4	22.8	18.2	12.1	7.2	17.1
	Average	15.0	16.1	28.5	28.5	32.7	33.2	27.5	26.5	27.2	25.4	20.5	16.0	24.85
2013	Max.	22.2	25.0	32.9	38.4	44.2	36.9	33.2	31.2	32.8	29.3	25.9	24.2	31.3
	Min.	3.3	7.5	12.7	16.0	22.3	23.9	23.9	24.4	24.7	20.4	11.4	8.2	11.5
	Average	12.8	16.2	22.8	27.2	33.2	30.4	28.5	27.8	28.7	24.8	18.6	16.2	21.4

Table 2: Monthly Distribution of Rainfall of Rewa Region (Year 2010 To 2013)

YEAR	Months Rainfall (mm)												Yearly Rainfall (mm)
	Jan.	Feb.	Mar.	Apr.	May	Jun.	July.	Aug.	Sep.	Oct.	Nov.	Dec.	
2010	0	6.6	0	0	11.6	0	187.6	195.8	200.9	18.6	42.2	0	663.3
2011	0	0	0	0	13.6	296.8	238.0	430.2	181.2	0	0	0	1159.8
2012	32.4	0	17.8	0	0	4.9	549.0	469.8	237.6	21.2	0	7.4	1340.1
2013	0	71.2	41.0	5.6	0	138.8	429.2	541.2	112.2	142.2	0	0	1481.4

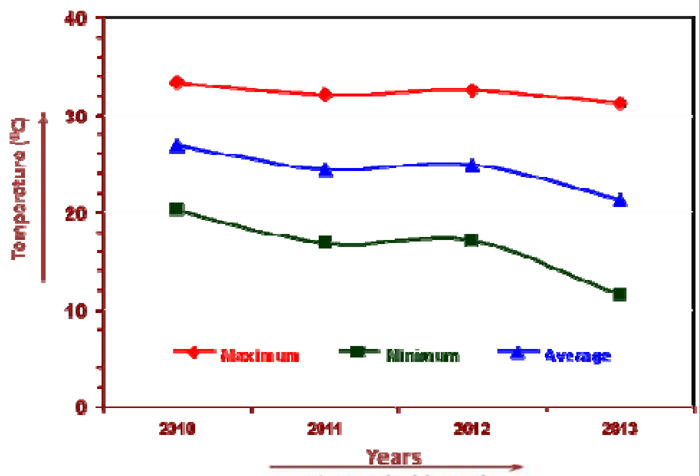
Table 3: Monthly Distribution of Humidity of Rewa Region (Year 2010 To 2013)

YEAR	Humidity	Jan.	Feb.	Mar.	Apr.	May	Jun.	July.	Aug.	Sep.	Oct.	Nov.	Dec.	Average
2010	Max.	87	86	82	78	78	56	71	74	70	70	72	78.2	75.2
	Min.	59	54	41	37	29	33	53	59	52	50	59	57	48.6
	Average	73	70	61.5	57.5	53.5	44.5	62	66.5	61.0	60.0	65.5	67.6	61.9
2011	Max.	82.4	79.6	82.9	72.1	81.2	86.3	86.8	87.6	86.7	85.8	79.7	79.8	82.6

	Min.	60.6	51.9	36.6	40.6	43.2	46.1	58.7	63.8	59.9	62.8	62.9	56.2	53.6
	Average	71.5	65.7	59.7	58.8	62.2	66.2	72.7	78.2	73.3	74.3	71.3	68.0	68.5
2012	Max.	76.9	71.8	77.6	77.6	80.6	76.3	87.4	86.9	85.8	85.9	81.8	80.5	80.8
	Min.	23.7	36.7	44.6	32.4	33.8	33.1	60.1	58.3	53.9	49.9	50.9	52.4	44.2
	Average	50.3	54.2	61.1	55.0	57.2	54.7	73.7	72.6	69.8	67.9	66.3	66.4	62.4
2013	Max.	79.9	77.8	77.4	76.3	36.4	65.2	89.1	89.7	83.4	78.1	74.3	76.9	75.4
	Min.	56.4	57.4	49.4	38.6	33.4	35.6	51.1	53.5	44.1	59.6	53.2	59.7	49.3
	Average	62.1	67.6	63.4	57.4	34.9	50.4	70.1	71.6	63.7	68.8	63.7	68.3	61.8

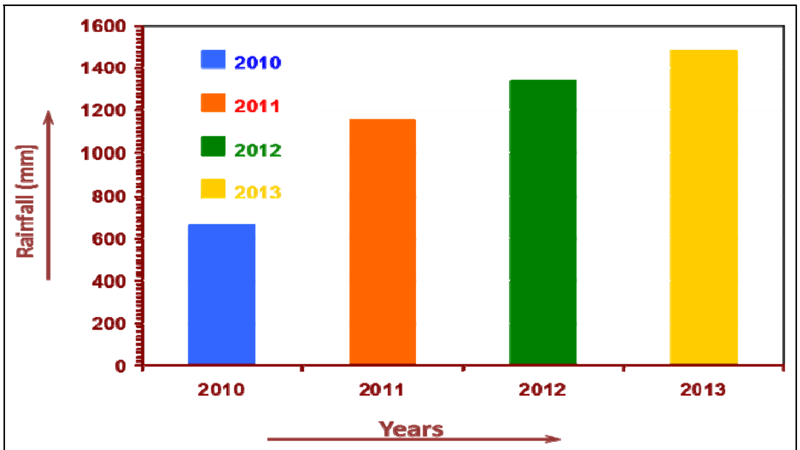
View of various of BGA in different pots

Another view of various species of BGA in Different Pots



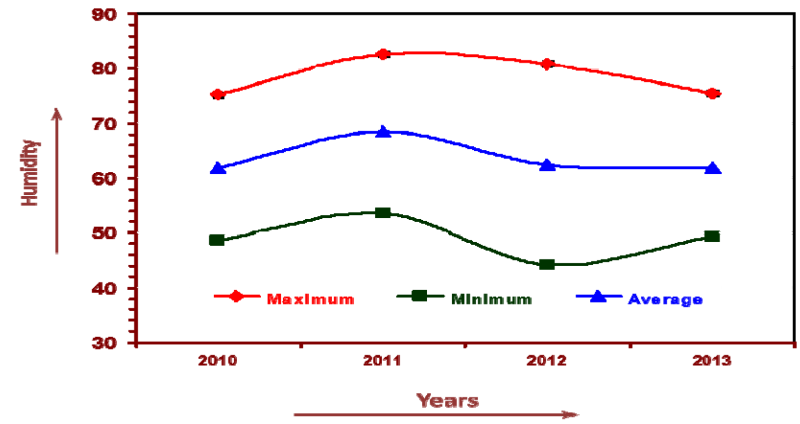
Fig–1.1 (Table-1.1)

Line diagram of average temperature of Rewa region



Fig– 1.2(Table-1.2)

Bar diagram of distribution of Rainfall (mm)of Rewa region



Fig–1.3 (Table-1.3)

Line diagram of Average Humidity of Rewa region

Conclusion

Extensive research on different fundamental and applied aspects of algae have been published that algal biomass can be used for variety of application such as soil improver and sustainable production. In many cases application of whole algal biomass contain large quantity of certain valuable constituents such as vitamins, metabolites, enzymes, minerals and specific organic substances extracted from the body cells of algae. A number of indigenous and improved processes have been developing for greater need of these compounds for various purposes.

Acknowledgement

We thank Dr A. P. Singh and A.P.S. University, Rewa, M.P. India for providing technical support and guidance.

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