Research Article

iMedPub Journals
www.imedpub.com

Journal of Aquatic Pollution and Toxicology
ISSN ISSN 2581-804X

2021
Vol.5 No.6:9662

Diagnosis the occurrence of green algae and management in low land paddy fields of Cauvery delta zone, Tamil Nadu

M. Jeya Bharathi*

Department of Agricultural Microbiology, Tamil Nadu Agricultural University, india

***Corresponding author:** M. Jeya Bharathi, Department of Agricultural Microbiology, Tamil Nadu Agricultural University, india, Tel: 9952310224; Email: jbharathi86@gmail.com

Received date: July 23, 2021; **Accepted date:** October 12, 2021**; Published date:** October 22, 2021

Citation: Bharathi LM (2021) Diagnosis the occurrence of green algae and management in low land paddy fields of Cauvery delta zone, Tamil Nadu. J Aquat Pollut Toxicol. Vol: 5 No: 6.

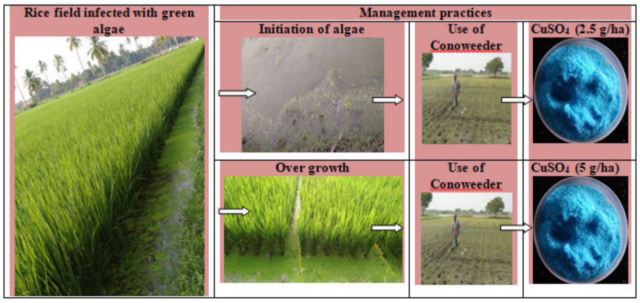
Abstract

Rice is a prime food crop for Asian countries. Wet land rice cultivation contributes maximum grain yield than dry land rice. Cauvery delta is a predominant area for rice cultivation in Tamil Nadu. Green algae growth during Kuruvai (June - August) season is a serious problem in wet land rice. The green algae prevent the root respiration and avoid root standing. Laboratory and field experiments were conducted to find out the remedial measures. The results of soil and water analyses showed that use of bore well water and dumping of phosphatic fertilizers leads to salt accumulation which favours the algal growth. The results of the laboratory experiment revealed that the CuSO4, londox power, propiconazole and hexaconazole showed moderate inhibition on 5th day after treatment. The findings from field experiment indicated that use of conoweeder and CuSO4 drenching at the rate of 2.5 kg/ha when green algae appearance has just noticed or 5.0 kg/ha when severe growth occurred is effective in managing the green algae. Biofertilizers application, crop rotation, green manure trampling to be practised to control the algae growth not rectified by CuSO4 application.

Keywords: Green algae; High pH; Salt concentration; CuSO4; Management

Introduction

Rice (Oryza sativa L.) is a staple food for more than half of the world's population. Globally, rice is grown on 161 million hectares, with an average annual production of 678.7 million tonnes (Bargali et al.,2009; Vibhuti et al., 2015). India is the largest rice growing country, accounting for about one-third of the world acreage under the crop (Bargali et al., 2007 & 2009; Rajkumar, 2013).It is one of the most widely grown crops in Tamil Nadu state of India under million hectares.



Green algae or slime is a perpetual problem in wet land rice cultivation. It is prevalent in the water as a large slab of algae, that covers the surface and smother the emerging rice crop. It thrives well where there is plenty of nutrients in the water and plentiful sunlight encourages photosynthesis (Coptrol, Rural chemicals industries (Australia) private limited, 1957). Green algae (singular: green alga) are a large, informal, grouping of algae consisting of the chlorophyte and charophyte/ Streptophyta, which are now placed in separate divisions, as well as the more basal Mesostigmatophyceae and Chlorokybophyceae. (Sánchez-Baracaldoet al., 2017). Embryophytes or green algae have emerged from the charophytes (Jeffrey et al., 2004). Green algae have chloroplasts that contain chlorophyll a and b giving them a bright colour as well as the accessory pigments beta carotene and xanthophylls in stacked thylakoids (Hoek et al., 1995). The cell walls of green algae usually contain cellulose and they store carbohydrate in the form of starch (Judd et al., 2002). Like land plants, green algae undergo open mitosis without centrioles(Raveenet al., 2005). Algae is commonly present in irrigation water and generally the rate they multiply is balanced by natural degeneration. However,when the balance is upset through increased sunshine or by the introduction of extra nutrients, the rate of growth increases and the algae blooms become a problem in rice growing. Before algae are visually detected a lot of damage has already been done to the crop at its most vulnerable stage of growth (Coptrol, Rural chemicals industries (Australia) private limited, 1957).With this background the current investigation was focused to find out the reason behind the algae growth and to device management practices to control algae growth in wet land rice fields.

Materials and methods

Laboratory experiment

Laboratory experiments were carried out at Tamil Nadu Rice Research Institute, Aduthurai. Green algae were collected from infected rice fields. Ten gram of algae was placed in the Petri dish. Fungicides, weedicides and algicides were added at the rate of 2ml/plate each separately, closed with lid and left for 7 days. The observations were recorded every day after incubation.

Preliminary field experiment

A field experiment was conducted at Tamil Nadu Rice Research Institute, Aduthurai during June to August 2015 (Kuruvai season) to determine green algae management practices under wet land rice ecosystem. Experiments were laid out in a randomized block design with 11 treatments and 3 replications. Fertilizers were applied at the rate of 150: 50: 50 kg NPK/ha. N was applied 50% as basal and two top dressings of 25% each at the time of active tillering and panicle initiation stages. The size of the experimental plot adopted with 3 x 4m and 2 seedlings / hill. Soil sample (50g) was drawn at 30, 60 and 90 days after planting (DAP) for enumeration of bacteria (Allen, 1953), fungi (Martin, 1950) and actinomycetes (Allen, 1953).The survival of Azospirillum (Okonet al., 1977) and Phosphobacteria(Sperber, 1958) in the rhizosphere of ADT 43 was estimated by MPN and standard plate count method (Parkinson, 1971) respectively.The Pseudomonas population was estimated using King's B (Kings et al., 1954) medium. Available N, P and K were estimated by alkaline permanganate method (Subbian and Asija, 1956), Olsen's method (Olson et al., 1954) and flame photometer method (Standford and English, 1949) respectively. The grain yield was recorded at the time of harvest.

Table1: The physicochemical and microbiological populations of the experimental field soil.

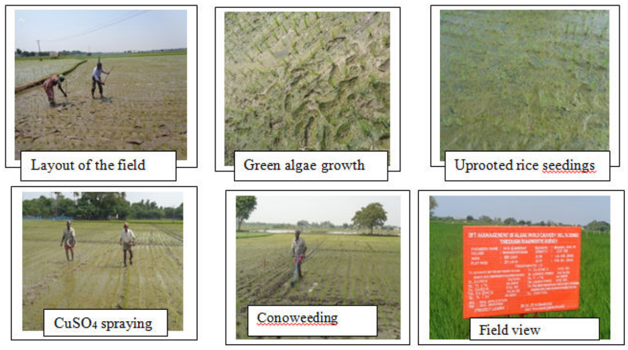
Soil properties	Mean ± SE
Soil type	Clay loam
pH	7.8± 0.09
EC (dSm-1)	0.04± 0.15
Organic carbon (%)	0.50 ± 0.01
Available N (%)	162± 2.88
Available P (%)	35± 0.57
Available K (%)	250± 1.45
Total bacteria (cfu x 105 /g drwt of soil)a	46 ± 1.15
Fungi (cfu x 103 /g drwt of soil)b	2 ± 0.16
Diazotrophs (cfu x 104 /g drwt of soil)c	21 ± 1.15

- Total bacteria were enumerated by serial dilution plating method on soil extract agar medium (James, 1958).
- Total culturable fungi were enumerated by serial dilution plating method as described by Parkinson et al. (1971)
- Total diazotrophs were enumerated by the procedure as described by Rennie (1981).

Confirmatory field experiment

Field experiments were conducted during Kuruvai season in two places viz., Aduthurai and Maharajapuram village located at Thanjavur district during June to August 2016. Fertilizers were applied as in the case of preliminary field experiment. The experiments were laid out in a randomized block design with 12 treatments and 3 replications. The plot size was 4m x 3m with 20 x 15 cm spacing having 2 seedlings / hill. ADT 45 variety was used in this experiment

Figure2: Overview of the field experiment.



Soil and water physical

Parameter analysis

Soil and water sample were collected from algae noticed fields for analysing the reason behind the over algae growth. Available N, P and K were estimated as described earlier. Micronutrients viz. HCO3, S, Cl, Ca, Mg, Na and K were estimated using Atomic Adsorption Spectrophotometer (AAS) method and expressed in ppm. The electrical conductivity (EC) and pH were estimated using EC and pH meter respectively.

Result and discussion

Effect of fungicides, weedicides and algicides on algae growth under laboratory and field conditions

The laboratory experiments revealed that the application of propiconazole, hexaconazole, CuSO4 and londox power showed moderate inhibition on algae growth at 5th day of incubation. The algae became shrunken and black in colour. Other chemicals don't have negative impact on the algae growth as given below (Table 2).Field experiment results revealed that CuSO4application inhibitedalgal growth 100%, whereas,londox power exhibited 50% inhibition of algal growth (Table 2) while, other chemicals don't have inhibition on algal growth.Chemicals réaction on algae under invitro and invivo conditions were significantly different. Eventhough CuSO4 inhibit algae growth under field conditions, it was not observed in labortory conditions. This might bé due to the change in the soil pH due to CuSO4application.

Table2: Effect of weedicides, fungicides and algicides application on algae growth under laboratory/field conditions.

Treatments	Recommended dose /ha	Laboratory conditions (dosage: 2ml/ plate)	Field conditions
T1-Bispyriphos sodium	20 g	No inhibition	No inhibition
T2 – Almix	20 g	No inhibition	No inhibition
T3 – Pyrosulfuran	200 g	No inhibition	No inhibition
T4 - Londox power	10 Kg	Moderate inhibition	Moderate inhibition
T5 -CuSO4	2.5 Kg	Moderate inhibition	Inhibition
T6 –CaO	25 Kg	No inhibition	No inhibition
T7 -CuSO4 + CaO	2.5 kg + 25 Kg	Moderate inhibition	Moderate inhibition
T8 –Butachlor	2.5 lit	No inhibition	No inhibition
T9 – Propiconazole	250 ml	Moderate inhibition	No inhibition
T10 - Hexaconazole	250 ml	Moderate inhibition	No inhibition
T11– control	-	No inhibition	No inhibition

Effect of fungicide, weedicide and algicide application on nutrient availability and microbial population under field conditions

Bispyriphos sodium and butachlor application increased soil available N content at the rate of 831.25 and 650 kg/ha respectively. On the other hand, butachlor and CuSO4 + CaOapplication increased soil available P (142 kg/ha). Bispyriphos sodium and propiconazole application increased soil available K (775 kg/ha) at 90 DAT as given in the Table 2. This might be due to the changes in soil acidic and alkali status by the application of the chemicals. There is no sufficient data related to the effect of this fungicide, weedicide and algicides on soil nutrient availability, hence it needs to be studied.

Table3: Effect of weedicides, fungicides and algicidesapplication on available N, P and K contentof the soil infected with green algae under wet land rice (ADT 43) ecosystem.

Treatments	Available N (kg/ha)	Available P (kg/ha)	Available K (kg/ha)
T1–Bispyriphossodium	831.25	75	775.0
T2 – Almix	385.0	58	462.5
T3 – Pyrosulfuran	317.5	117	287.5
T4 - Londox power	332.5	95	400.0
T5 -CuSO4	280.0	64	437.5
T6 –CaO	202.5	104	262.5
T7 -CuSO4 + CaO	177.5	142	350.0
T8 –Butachlor	650.0	181	237.5
T9 – Propiconazole	332.5	72	512.5
T10 – Hexaconazole	280.0	83	225.0
T11 –control	260.0	34	400.0
SEd	26.13	6.25	25.69
CD(P =0.05)	54.89	13.15	53.97

The results revealed that the application of all the chemicals significantly reduced the beneficial soil microbe's viz., bacteria, fungi, actinomycetes, phosphobacteria, Azospirillum and Pseudomonas. This might be due to the inhibitory effect of chemicals on soil microbes (Table 4 and 5).

Ponnuswamy et al. (1997) reported that the application of various weedicides in soybean affected the bacterial population in soil. All the plots treated with weedicides gave depressing fungal population in first few days of application and regained its population after long period. Similar observations were recorded by Anonymous (1971) and Mukhopadhyay (1980).

Fungicides are used extensively in modern agriculture for the control of fungal pathogens. The chemicals alter the number and activity of microorganism and thus affect biochemical processes and fertility of the soil (Wainwright, 1978). Majority of biochemical transformation in soil results from microbial activity. Fungicides treated soil harboured less population of fungi in comparison to control. This is in conformity with earlier reports of several authors (Colinas et al., 1994; Suklaet al., 1987).

Investigations were carried out on the effects of Cu and other heavy metals on soil microorganisms, invariably indicated the adverse effects of these elements on the soil microbial activity, number and population as reported earlier by various workers (Olson and Thornton, 1982; Duxbury and Bicknell, 1983; Maliszewskaet al., 1985; Hiroki, 1992; Chander and Brookes, 1991, 1993; Hattori, 1992; Huysmanet al., 1994; Doelman and Haanstra, 1984; Aoyama and Nagumo, 1996; 1997). For example excessive heavy metal concentration in the soil has been reported to cause a decrease in microbial population (Hicks et al., 1990; McGrath et al., 1995), changes in populations structure (Chaudriet al., 1993; Bardgettet al., 1994; Huysmanet al., 1994) and physiological activity (Bitton and Dutka, 1986; Cotrufoet al., 1995; Valsecchi et al., 1995).

Copper is known to be very toxic to microorganisms in the free ionic form especially Cu2+ and CuOH+ (Zevenhuizenet al., 1979). The addition of copper to soil was reported to significantly decrease the amount of microbial biomass and exert a pronounce toxic effect on the size of biomass compared to certain metals such as Pb and As when compared on a molarity basis (Aoyama and Nagumo, 1997).

Table4: Effect of weedicides, fungicides and algicidesapplication on microbial population in the rhizosphere of soil cropped with rice (ADT 43) under wet land rice ecosystem.

Treatments	Bacteria (x 104 cfu/g)			Fungi (x 103 cfu/g)			Actinomycetes (x 102 cfu/g)		
	30 DAP	60 DAP	90 DAP	30 DAP	60 DAP	90 DAP	30 DAP	60 DAP	90 DAP
T1 - Bispyriphos sodium	27	15	8	5	3	0	24	15	7
T2 – Almix	34	28	20	20	12	5	18	12	5
T3 – Pyrosulfuran	30	24	12	12	8	3	13	9	4
T4 - Londoxpower	32	27	20	22	15	7	10	7	5
T5 - $CuSO_4$	40	32	15	27	17	11	27	19	8
T6 – CaO	32	25	17	25	15	8	25	15	6
T7 - $CuSO_4$ + CaO	35	28	22	18	12	4	27	18	12
T8 - Butachlor	34	26	15	25	16	9	23	14	11
T9 – Propiconaole	28	1 7	8	22	14	6	21	11	7
T10 - Hexaconazole	32	23	11	20	12	7	19	8	6
SEd	1.93	1.49	0.93	1.23	0.79	0.41	1.20	0.75	0.44
CD (P=0.05)	4.06	3.13	1.97	2.59	1.66	0.85	2.53	1.59	0.92

Table5: Effect of weedicides, fungicides and algicides on beneficial microbial population in the rhizosphere of soil cropped with rice(ADT 43) under wet land rice ecosystem.

Treatments	Phosphobacteria (x 104 cfu/g)			Azospirillum (x105 MPN/g)			Pseudomonas (x104cfu/g)		
	30 DAP	60 DAP	90 DAP	30 DAP	60 DAP	90 DAP	30 DAP	60 DAP	90 DAP
T1 – Bispyriphos sodium	15	10	4	1.2	0.9	1.0	18	7	5
T2– Almix	25	18	10	1.4	0.8	0.1	25	20	18
T3 – Pyrosulfuran	18	12	6	2.5	1.4	0.5	25	20	12
T4 - Londoxpower	26	20	10	2.5	1.8	0.6	23	18	11
T5 - $CuSO_4$	30	25	12	2.8	1.8	0.9	40	32	22
T6 – CaO	28	20	12	2.2	1.5	0.1	30	25	16
T7 - $CuSO_4$ + CaO	27	20	12	1.4	0.8	0.1	36	30	22
T8 - Butachlor	20	14	7	2.5	1.6	0.6	35	28	15
T9 – Propic	17	12	6	1.8	1.5	1.0	24	22	11

ona ole									
T10 - Hexaconazole	12	6	2	1.4	0.8	0.5	20	15	8
SEd	1.35	1.02	0.52	0.12	0.08	0.042	1.66	1.33	0.86
CD (P=0.05)	2.84	2.14	1.11	0.26	0.017	0.087	3.49	2.80	1.81

Effect of fungicide, weedicide and algicide application on plant growth parameters under field conditions

Application of CuSO4 significantly increases the root length (22 cm/plant), shoot length (108 cm/plant) and grain yield (4962.5 kg/ha) than the other treatments (Table 6). Horii et al. (2007) reported that the germination percent of fungicide treated seeds got increased with increase in concentration of fungicide. Various other studies also found that seed germination was stimulated by thiamethoxam in soybean, pea and corn (Cataneo et al., 2010).The shoot length was increased with increase in concentration of fungicide. Windham & Windham (2004) reported that systemic fungicides, which are based on sterol biosynthesis inhibitor, are closely related to plant growth regulators, the use of which at higher than labeled rates shorten the internodes which may lead to slow shoot growth. Vigor index of fungicide treated seedlings got increased with increase in concentration of fungicide. The increase in vigor index was significant at almost all the concentration of fungicide as compared to control. These present findings supports Doyle et al. (2001) proved that seedlings treated with thiamethoxam had a particular advantage of improved seedling vigor. Csinos (2004) revealed that mefenoxam improved vigor index of tobacco. All herbicidal treatments significantly increased yield and yield components like seed yield, test weight, pod dry weight, number of pods / plant, number of seeds / plant, harvest index (Amarogouda et al., 2013).

Copper is one of the essential micronutrients for plant growth and involved in numerous physiological functions as a component of several enzymes, mainly those which participate in electron flow, catalyze redox reactions in mitochondria and chloroplasts (Lolkema and Vooijs, 1986; Harrison et al., 1999; Hansch and Mendel, 2009). However, in large amount copper becomes toxic as it interferes with photosynthetic and respiratory processes, protein synthesis and development of plant organelles (Agarwala et al., 1995; Upadhyay and Panda, 2009). Specifically, excess copper can cause chlorosis, inhibition of root growth and damage to plasma membrane permeability, leading to ion leakage (Ouzounidouet al., 1992; Berglund et al., 2002; Bouaziziet al., 2010).

Pankaj Giriet al. (2014) findings suggest that Cu fluxes affect the growth and yield of wheat plants. Application of Cu in low amount may promote growth, pigments synthesis, protein and sugar contents while in excess amount it adversely affects the yield and other growth parameters

Table6: Effect of thefungicides, weedicides and algicidesapplication on root length, shoot length and grain yield of rice (ADT 43) under wet land rice ecosystem.

Treatments	Root length (cm/plant)			Shoot length (cm/plant)	Yield (Kg/ha)		
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	
T1 - Bispyriphos sodium	11.0	19	9.0	53.5	73.5	93.5	3568.0
T2– Almix	12.5	17.0	8.0	54.0	74.0	94.0	3913.0
T3 – Pyrosulfuran	14.0	18.0	10	52.5	72.5	92.5	4887.5
T4 - Londox power	12.0	16.0	8.0	53.5	73.5	93.5	3762.5
T5 - CuSO4	18.0	22.0	14	68.0	88.0	108.0	4962.5
T6 – CaO	15.0	19.5	11	52.5	72.5	92.5	4837.5
T7 - CuSO4 + CaO	16.5	21.0	11	61.5	81.5	101.5	4487.5
T8 - Butachlor	14.0	17.0	8.0	60.5	80.5	100.5	4775.0
T9 - Propiconazole	13.0	18.0	9.0	57.5	77.5	97.5	3468.0
T10 - Hexaconazole	11.0	16.0	8.0	48.5	68.5	92.5	4712.5
SEd	0.81	1.08	0.57	3.35	4.54	5.75	3.807
CD (P =0.05)	1.71	2.27	1.21	7.05	9.54	12.089	7.999

Effect of CuSO4 application on green algae growth at Aduthurai

The results of the confirmatory field experiment at Aduthurairevealed that by simple physical management practices like alternate wetting and drying, manual trampling of algae and use of conoweeder reduces the green algae growth (Table 6).Repeated stagnation of bore well water increases the phosphorus content in soil leads to the stimulation of algae spore. When stimulation of algae spores observed, water was completely drained, CuSO4 drenching at the rate of 2.5 kg/ha was done. But during tremendous algae growth, CuSO4 drenching at the rate of 5.0 kg/ha was done. In most cases action to eradicate green algae is taken only when filaments are present in huge numbers and the treatments available are limited. Generally Australian farmers use water control, bluestone (CuSO4) and coptrol (2. 5 lit/ha), both of which are drastic answers to a problem where a lot of damage has already been done (Hrudeyet al., 1999, Jones and Burch, 1997; Jones and Orr, 1994 and http//www.affa.gov.au/nra/welcome.html accessed January 2002)

PAK™27 (BioSafe Systems, 2008 and Hazardous Substances Data Bank, 2009) is a granular product that attacks planktonic and filamentous algae on contact. The active ingredient is sodium carbonate peroxyhydrate and creates a powerful oxidation reaction that destroys algal cell membranes and chlorophyll providing immediate control of algae. Fast acting within 60 seconds of application and leaves behind no harmful residues and adds 13% bio-available oxygen to the water.

Table7: Effect of CuSO4 application on algae growth under field conditions.

Treatments	Dosage/ha	Aduthuraifield condition	Maharajapuram field condition
T1 -Alternate wetting and thawing the algal growth with conoweeder if algal growth occurred	-	Inhibition	Moderate inhibition
T2 - CuSO4	Soil application– 1 Kg	Inhibition	Moderate inhibition
T3 - T1 + T2	As indicated Above	Inhibition	Moderate inhibition
T4 - CuSO4	Soil drenching-0.5%	Moderate inhibition	Moderate inhibition
T5 -Cu(OH)2	Soil application – 1 Kg	Moderate inhibition	No inhibition
T6 -T1 + T5	As indicated Above	Inhibition	No inhibition
T7 -Cu(OH)2	Soil Drencing-0.5%	Moderate inhibition	No inhibition
T8 -Londox power	Soil application – 1 Kg	Moderate inhibition	No inhibition
T9 -T1 + T8	As indicated Above	Inhibition	No inhibition
T10 -Londox power	Soil drenching -0.5%	Moderate inhibition	No inhibition
T11 -Soil extract with cell free extract containing Rhamnolipids from Pseudomonas chlororamphis	10%	No inhibition	No inhibition
T12 –Control	-	No inhibition	No inhibition

Effect of CuSO4 application at Maharajapuram rice field

The results of confirmatory field experiment at Maharajapuram showed that the algae growth was not completely arrested even after 3rd day of CuSO4 application. Hence, the soil and water sample were collected from the Maharajapuram field to know the physical parameters of the soil.Maharajapuram soil and water consists of alkaline pH (8.2) and more HCO3ions (5.2). This is the main cause of overgrowth of green algaewhich was not controlled by recommended quantity ofCuSO4 (5 kg/ha) application. This was supported by the following findings. In culture media, the optimal pH for the growth of cyanobacteria ranges from 7.5 – 10, with a lower limit of 6.5 – 7.0. However, in soilculture experiments, soils having slightly alkaline reaction were more favourable, while in natural environments cyanobacteria prefer neutral to alkaline pH (De, 1939 and Roger and Reynaud, 1979).

In this regard pH is one of most important factor which affects the presence of BGA in a habitat. Saline and Sodic (alkali) nature of soils significantly reduce the value and productivity of affected lands. Salt affected soil are divided into three groups depending on the total soluble salts (measured in the terms of Electrical Conductivity E. C.), soil pH and Exchangeable Na %. Usar soils are grouped into two divisions Saline (Solanchak) and Alkalines(Solonetz). (Pandey et al., 2005)

Table8: Physical parameters of the soil sample atMaharajapuram field.

Date of sampling	EC (dSm-1)	pH	N (Kg/ha)	P (Kg/ha)	K (Kg/ha)
16.10.15	0.63	8.2	63.0	25	90
05.11.15	0.16	8. 1	32.2	50	75
25.11.15	0.14	8.0	46.2	38	155

Table9: Physical parameters of the water sample atMaharajapuram field.

Date of sampling	pH	EC (dSm-1)	HCO3 (ppm)	S (ppm)	Cl (ppm)	Ca (ppm)	Mg (ppm)	Na (ppm)	K (ppm)
16.10.15	8.2	1.40	5.2	0.138	7.4	3.4	4.5	5.2	0.1
05.11.15	8.0	1.38	4.8	0.125	7.1	3.1	4.2	5.4	0.1
25.11.15	7.9	1.11	4.4	0.63	4.7	2.9	2.8	5.0	0.1

Conclusion

It is concluded that soil is consider as a buffer that can tolerate the pH change. Even though continuous dumping of DAP and other chemical fertilizers changes the soil pH, innate capacity and fix more amount of the salt in the soil, which indeed difficult by reclamation practices (CuSO4). In this situation continuous treatments like gypsum (bring the pH in

2021
Vol.5 No.6:9662

acidic), infiltration with water (leach excess ions viz. Na, HCO3), biofertilizers treatment (to move the accumulated P) and periodical soil and water sample analysis are important. It is always advisable to prevent the excess algae growth by fertilizer and water management practices rather than control, since chemicals are toxic to soil microorganisms. However, when situation warrants, application of 2.5 kg of CuSO4/ha when the growth of algae is mild and 5.0 kg/ha when severe algae growth is noticed is the best management practices.

References

1. Agarwala SC, Nautiyal BD, Chatterjee C and Nautiyal N. Variations in copper and zinc supply influence growth and activities of some enzymes in maize. Soil Science and Plant Nutrtion,41: 329-335, 1995.
2. Allen DN. Experiments in Soil bacteriology (IIed.) Burgees Publ. Co., Indian Journal of Microbiology, 32: 469 -472,1953.
3. Amaregouda A, Jitendra Jadhav, Chetti MB and Nawalagatti. Effect of weedicide on Physiological parameters, Growth, yield and yield components of soybean (Glycine max. L) and weed growth. Journal of Agriculture and Allied Sciences, 4(2) : 12 -15, 2013.
4. Anonymous.Report of biological nitrogen fixation scheme. Mahatma Phpule Krishi Vidyapeeth, Rahuri (AGRISCO). 1971
5. Aoyama M and Nagumo T. Factors affecting microbial biomass and dehydrogenase activity in apple orchard soils with heavy metal accumulation. Soil Science and Plant Nutrition, 42: 821-831. 1996.
6. Aoyama M and Nagumo T. Comparison of the effects of Cu, Pb and As on plant residue decomposition, microbial biomass and soil respiration. Soil Science and Plant Nutrition,43: 613-622, 1997.
7. Bardgett RD, Speir TW, Ross DJ, Yeates GW and Kettles HA. Impact of pasture contamination by copper, chromium and arsenic timber preservative on soil microbial properties and nematodes. Journal of Biology and Fertility of Soils, 18: 71-79, 1994.
8. Bargali, SS., Bargali, K., Singh, L., Ghosh, L. and Lakhera,M.L. Acacia niloticabased traditional agroforestry system: effect on paddy crop and management. Curent Science. 96(4): 581-587, 2009.
9. Bargali, SS., Singh, SP., Shrivastava, SK. and Kolhe, SS. Forestry plantations on rice bunds: Farmers' perceptions and technology adoption. International Rice Research Notes 32(2): 40-41, 2007.
10. Berglund AH, Mike F, Quartacci MF, Calucci LC, Navari-Izzo F, Pinzino C. and Liljenberg C. Alterations of wheat root plasma membrane lipid composition induced by copper stress result in changed physicochemical properties of plasma membrane lipid vesicles. Biochimica et Biophysica Acta, 1564 : 466-472, 2002.
11. Biosafe Systems. Green Clean Pro: Granular Algaecide/Fungicide. Specimen Label. BioSafe Systems, LLC, Connecticut. 2008.