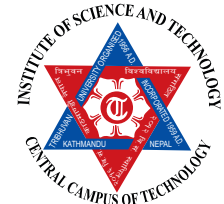




Original Research Article



Occurrence of Red-Bloom in Fish Pond in Chitwan District, Nepal

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Abstract

Red-bloom in fish pond has become a common problem in Nepal. In order to assess causative agents and seasonal variations of red bloom in fish pond, a study was conducted in the eastern, western and southern sites of Chitwan district from September, 2013 to June 2014. Preliminary data on occurrence and effect of red bloom were collected by visual observation and household survey of 30 randomly selected households using semi-structured questionnaire. Water quality and phytoplankton population were monitored in those ponds for four seasons, viz., autumn, winter, spring and summer. Among phytoplanktons, *E. Sanguinea* was abundant in the pond water indicating the reason of red color in the pond. *E. Sanguinea* exhibited seasonal variation corresponding with the occurrence of red bloom in the pond. Highest density of *E. Sanguinea* was in summer (1628.4±70.4 number/L) which can be attributed to higher temperature and total nitrogen content of the water. Greater red bloom was observed in the southern site compared to eastern and western sites, where water was more stagnant, un-drainable and came from under-ground source.

Key words: red-bloom, seasonal variation *Euglena sanguine*

Introduction

Red-bloom in fish ponds is a common occurrence in Chitwan, Nepal. Red bloom fish ponds are frequently covered with brick-red colored thin film of fine dust. However, red-bloom does not occur forever in fish ponds, it keeps changing diurnally and seasonally and its dynamism is still unknown. Red bloom appears in the late morning and disappears in the evening. Scum over the surface of water is red during bright sunshine and the scum becomes green whenever sunshine ceases (Kol, 1929; Heidt, 1934; Johnson, 1939). The red blooms are mostly seen in the marshy land and in ponds with high organic load. In

fish ponds, eutrophication due to sedimentation of nutrients from feed and fertilizers is said to induce phytoplankton bloom including euglenophytes which causes red blooming in pond water (Ohio EPA, 2013). Red bloom gives unpleasant look, shades the lower waters, inhibits photosynthesis and causes water quality problems such as depletion of dissolved oxygen (Zimba et al., 2004; Zimba et al., 2010). This problem has been raised many times from farmers and extension officials, and has received wide attention.

Materials and Methods

The study was carried out in three sites of Chitwan, viz., eastern, western and southern. The eastern site included Kathar, Bhandara and Piple Village Development Committee (VDC), western site included Saradanagar, Jagatpur, Gunjnagar VDC and southern site included Ayodhyapuri, Madi-Kalayanpur and Baghauda VDC. The study included field observation, household survey and laboratory analysis of water quality and phytoplankton. For household survey, a semi-structured questionnaire was developed for interview of 30 randomly selected households with 10 in each site of the district to gather preliminary data on pond status, occurrence and effect of red bloom. Water quality and phytoplankton were monitored in 9 ponds, with 3 ponds in each site. Water samples

were collected seasonally from red ponds by using water column sampler and phytoplankton by using plankton net from September 2013 to June 2014 in the morning (7:00 to 8:00 am). Water quality parameters such as dissolved oxygen (DO), pH, and temperature were recorded in situ whereas total phosphorus, total nitrogen and chlorophyll-a were analyzed at laboratory of Aquaculture and Fisheries Department of Agriculture and Forestry University by using standard methods (APHA, 1985). For phytoplankton sampling, five liters of pond water (up to 50 cm depth) was collected using graduated bucket and filtered with plankton net (mesh size 5 µm) and then preserved in 5% formaldehyde solution. Phytoplanktons were identified following Prescott (1951) and

Table 2. Continued . . .

Southern Chitwan				
Temperature (°C)	30.7±0.2 ^b	21.7±0.1 ^d	23.9±0.1 ^c	36.1±0.1 ^a
pH	7.4	7.7	7.8	8.4
DO (mg/L)	5.4±0.1 ^b	6.2±0.1 ^{ab}	7.2±0.2 ^a	6.6±0.4 ^a
Chlorophyll-a (mg/L)	50.75±12.3 ^a	48.45±9.9 ^a	47.15±6.7 ^a	43.55±6.3 ^a
Total alkalinity (mg/L)	112.25±16.2 ^a	116.90±18.0 ^a	118.0±15.4 ^a	121.70±15.0 ^a
Total phosphorus (mg/L)	0.26±0.7 ^a	0.28±0.02 ^a	0.26±0.02 ^a	0.25±0.02 ^a
Total nitrogen (mg/L)	2.5±0.5 ^a	3.4±0.5 ^a	2.2±0.1 ^a	3.4±0.1 ^a
Combined mean				
Temperature (°C)	30.7±0.1 ^b	21.0±0.2 ^d	24.3±0.2 ^c	35.3±0.3 ^a
pH	6.8	7.2	7.9	8.1
DO (mg/L)	5.8±0.2 ^b	6.5±0.2 ^{ab}	7.0±0.2 ^a	6.4±0.2 ^{ab}
Chlorophyll-a (mg/L)	69.6±17.1 ^a	67.1±15.5 ^a	65.2±14.1 ^a	61.7±13.2 ^a
Total alkalinity (mg/L)	94.1±5.8 ^a	102.1±19.1 ^a	110.0±8.8 ^a	116.4±5.6 ^a
Total phosphorus (mg/L)	0.28±0.5 ^a	0.29±0.03 ^a	0.28±0.03 ^a	0.27±0.03 ^a
Total nitrogen (mg/L)	2.5±0.2 ^b	3.1±0.1 ^{ab}	2.4±0.2 ^b	3.3±0.09 ^a

Phytoplankton analysis showed that *Euglena sanguine* was dominant among phytoplanktons (Table 3). Except *Euglena*, density of other phytoplanktons did not differ significantly ($P>0.05$) in different seasons. Density of *E. sanguine* was higher in summer than in spring in three sampling sites. Density of *E. proxima* was higher in summer than in spring in the eastern site, while it was on par with autumn and winter. In the southern site, density of *E. proxima* was higher in summer and winter than in autumn but was not different than that of spring. Combined density of *E. sanguine* was highest in summer, lowest in spring and intermediate in autumn and that of winter was on par with summer and autumn. Combined density of *E. proxima* was higher in summer than in autumn, winter and spring.

Red surface scum in fish ponds was probably due to *sanguine* because its population density was higher than other phytoplanktons. *E. sanguine* are red coloured algae. They contain haematochrome, a red coloured pigment (Gerber and Hader, 1994). Although the actual causes of red-blooming is not clearly understood, red pond water was found to be dominated by *Euglena* species such as *E. sanguine* (Benham, 1913; Dendy, 1913; Lind, 1938; Pringsheim, 1956; ICLARM, 1995) and *E. shafiqii* (Rehman, 1998). According to Pringsheim (1956) *Euglena* sp. are typically found in hypereutrophic of total nitrogen and total phosphorous. Present finding agrees fairly well with finding of Mishra and Saksena (1993) and Hosmani (1988) who reported that the percentage

of euglenophytes (*Euglena* species) was greater in red ponds compared to other planktons due to nutrient richness of water bodies (Costa and Garrido, 2004; Lopez *et al.*, 2008; Costa, 2014).

Population of *E. sanguine* varied seasonally along with temperature and total nitrogen. High temperature and total nitrogen might have favored growth and multiplication of *sanguine*. Its density was higher in summer and lower in spring which did not correspond with findings of household survey. Household survey revealed that occurrence of red bloom was greater in winter followed by autumn, spring and summer. The differences could be attributed to human error to memorize and express the event of red bloom. Questionnaire interview of farmers was based on their past experience and might be difficult for them to recall. On the other hand, red bloom might not be critical to them as per survey findings majority of farmers (52%) did not experience reduced fish production due to red bloom.

Although red-blooms in fish ponds are reported to be harmful but no such effect was reported by farmers in the present study. However, surface gulping by fish had been observed by farmers probably due to low dissolved oxygen caused by phytoplankton bloom mainly in summer. Prolonged low DO might cause mass fish mortality. Zimba *et al.* (2004) and Rodgers (2008) reported that *Euglena* sp. produce ichthyotoxin which is fatal to fish.

Conclusions

Red-bloom in fish ponds is probably due to *E. sanguine*, which is versatile in shape and covers the whole pond, leading to a low DO and hence fish mortality. Although farmers are not pretty much sure on its effect, detail study is needed on dynamics of red bloom and its effect on fish production. Present study identified the causative agents of red bloom and its

seasonal variation but it could not clear the cause of *Euglena sanguine* bloom. Increased temperature and total nitrogen accompanied with higher *E. sanguine* density during summer indicate that the temperature and total nitrogen could be responsible for *E. sanguine* bloom.

Table 1. Findings of household survey of fish ponds in three different sites of Chitwan district

Particular	Respondents (%)			
	Eastern	Western	Southern	
Water source				
River	70	15	20	35
Ground recharge	5	70	70	48
Boring	25	15	10	17
Pond water color				
Green	40	30	30	33
Slightly red	25	30	15	23
Red	35	40	55	43
Occurrence of red bloom				
New pond (< than three years pond)	10	10	10	10
Old pond (> than three years pond)	30	20	20	23
Drainable pond	5	5	0	3
Un-drainable pond	30	30	30	30
Organic fertilizing pond	20	30	25	25
In-organic fertilizing pond	5	5	15	8
Problems in red pond				
Surface gulping of fish	30	25	20	25
Low fish production	20	25	20	22
High fish production	5	0	0	2
No change in fish production	45	50	60	52
Season of red - bloom				
Autumn (Sept- Nov,)	10	30	20	20
Winter (Dec.- Feb.)	40	40	25	35
Spring (March- May)	20	20	10	17
Summer (Jun- Aug.)	30	0	0	10
All Season	0	10	45	18

Table 2. Season wise water quality parameters (mean±S.E.) in the eastern, western and southern sites of Chitwan districts

Region/Parameter	Autumn	Winter	Spring	Summer
Eastern Chitwan				
Temperature (°C)	30.4±0.8 ^b	20.1±0.8 ^d	25.0±0.1 ^c	34.4±0.6 ^a
pH	5.6	6.4	7.7	7.7
DO (mg/L)	5.2±0.1 ^b	6.1±0.0 ^a	7.35±0.8 ^a	6.3±0.2 ^a
Chlorophyll-a (mg/L)	45.85±1.7 ^a	46.35±0.8 ^a	46.55±0.02 ^a	45.15±0.31 ^a
Total alkalinity (mg/L)	85.65±2.3 ^b	88.15±0.37 ^b	82.25±3.0 ^b	101.2±1.4 ^a
Total phosphorus (mg/L)	0.18±0.0 ^b	0.23 ±0.0 ^a	0.20±0.0 ^b	0.19±0.01 ^b
Total nitrogen (mg/L)	2.7±0.2 ^a	2.8±0.1 ^a	2.7±0.1 ^a	3.1±0.2 ^a
Western Chitwan				
Temperature (°C)	31.1±0.5 ^b	21.2±0.1 ^d	23.8±0.1 ^c	35.4±0.2 ^a
pH	7.5	7.6	8.3	8.1
DO (mg/L)	6.8±0.1 ^a	6.7±0.0 ^a	7.2±0.1 ^a	6.7±0.5 ^a
Chlorophyll-a (mg/L)	112.25±44.7 ^a	106.35±40.7 ^a	101.80±36.9 ^a	96.45±34.2 ^a
Total alkalinity (mg/L)	84.60±8.9 ^a	101.40±12.9 ^a	129.85±26.5 ^a	126.30±19.4 ^a
Total phosphorus (mg/L)	0.40±0.1 ^a	0.38±0.08 ^a	0.38±0.09 ^a	0.37±0.08 ^a
Total nitrogen (mg/L)	2.4±0.2 ^{ab}	3.0±0.1 ^{ab}	2.3±0.3 ^b	3.3±0.1 ^a

Table 3. Seasonal abundance of Phytoplankton (number/L) in red-bloom fish pond of the eastern, western and southern sites of Chitwan district.

Phytoplankton	Autumn	Winter	Spring	Summer
Eastern site				
<i>Euglena sanguinea</i>	1113.3±114.6 ^a	1243.3±113.5 ^a	600.7±32.3 ^b	1412±103.7 ^a
<i>Euglena proxima</i>	168.7±5.0 ^{ab}	154.3±32.8 ^{ab}	96.7±12 ^b	263.7±38 ^a
<i>Glenoidinumquadridens</i>	115.0±5.3	120.0±2.2	118.0±0.2	75.0±1.2
<i>Chroococcus</i>	110.0±1.6	112.0±1.3	25.0±0.4	30.0±1.1
<i>Ankistrodemusfalcatatus</i>	60.0±0.5	75.0±1.2	60.0±1.1	65.0±1.2
<i>Crucigeneatetrapedia</i>	20.0±0.1	18.0±0.1	15.0±0.1	10.0±0.1
<i>Oscillatoriasps.</i>	18.0±0.2	12.0±0.1	155.0±0.2	5.0±0.01
<i>Pandorinamorum</i>	25.0±0.1	126.0±1.2	6.0±0.0	110.0±0.8
Western site				
<i>Euglena sanguinea</i>	1320±43.6 ^{ab}	1452±63.5 ^a	1046±127.3 ^b	1645.7±72.1 ^a
<i>Euglena proxima</i>	175±18.9 ^a	150±43 ^a	215.3±3.4 ^a	243.3±49 ^a
<i>Euglena rostrifera</i>	28.0±3.2	111.0±1.2	45.0±0.5	23.0±3.2
<i>Glenoidinumquadridens</i>	77.0±3.1	50.0±1.2	14.0±.6	12.0±.3
<i>Desmodesmids</i>	85.0±.6	90.0±0.4	10.0±0.1	14.0±0.3
<i>Crucigeneatetrapedia</i>	17.0±1.1	18.0±0.2	12.0±0.1	9.0±0.1
<i>Oscillatoriasps.</i>	28.0±0.2	15.0±0.1	145.0±3.6	43.0±2.4
<i>Naviculasp.</i>	90.0±1.8	43.0±1.2	12.0±0.2	11.0±0.2
<i>Sencillaestrella</i>	12.0±0.1	15.0±1.1	20.0±0.1	43.0±1.3
<i>Scenedesmusdimorphus</i>	29.0±0.8	40.0±1.2	15.0±0.2	80.0±3.3
<i>Merisopedia glance</i>	34.0±0.5	14.0±0.2	19.0±0.3	21.0±0.1
<i>Chlamydomonussps.</i>	12.0±0.2	13.0±0.1	10.0±0.1	7.0±0.1
Southern site				
<i>Euglena sanguinea</i>	1436.7±89.5 ^{ab}	1669.4±78.0 ^{ab}	1238.7±68.1 ^b	1926.7±17.6 ^a
<i>Euglena proxima</i>	215.7±3.4 ^b	222.3±1.0 ^a	240±40.4 ^{ab}	233±6.6 ^a
<i>Glenoidinumquadridens</i>	130.0±1.0	124.0±0.6	128.0±0.8	80.0±0.2
<i>Chroococcus</i>	67.0±0.4	60.0±0.6	45.0±0.2	15.0±0.1
<i>Ankistrodemusfacatus</i>	12.0±0.1	18.0±0.2	20.0±0.1	12.0±0.1
<i>Desmodesmids</i>	22.0±0.1	15.0±0.1	18.0±0.1	30.0±0.2
<i>Crucigeneatetrapedia</i>	32.0±0.2	32.0±0.6	22.0±0.2	11.0±0.01
<i>Oscillatoriasps.</i>	-	11.0±0.02	67.0±0.6	12.0±0.02
<i>Selenastrumgracile</i>	12.0±0.1	23.0±0.2	12.0±0.1	55.0±0.8
<i>Sencillaestrella</i>	34.0±1.1	12.0±0.2	13.0±0.1	40.0±0.3
<i>Scenedesmusdimorphus</i>	60.0±1.2	40.0±0.1	34.0±0.2	21.0±0.2
<i>Coelastrum</i>	80.0±0.2	16.0±0.1	40.0±0.1	12.0±0.1
Combined mean of <i>Euglena</i>				
<i>Euglena sanguinea</i>	1290.0±64.4 ^b	1454.9±75.5 ^{ab}	962.0 ±1.03 ^c	1628.4±70.4 ^a
<i>Euglena proxima</i>	186.4±9.3 ^b	209.1±32.3 ^b	184.0±25.2 ^b	280.0±22.5 ^a

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