ISSN: 2347-5129
IJFAS 2014; 2(3): 45-55

www.fisheriesjournal.com
Received: 11-11-2014
Accepted: 18-12-2014

Assessment of water quality of giant freshwater prawn (*Macrobrachium rosenbergii*) in culture ponds in Zhejiang of China

Nguyen Thanh Hai, Yang Lili, Liu Qigen, Zhao liangjie, Liu Jun, Zhang Hong

Nguyen Thanh Hai
(a) Key Laboratory of Freshwater Fishery Germplasm Resources, Ministry of Agriculture, Shanghai Ocean University, P. R. China.
(b) Vietnam Institute of Fisheries Economics and Planning, Directorate of Fisheries of Vietnam, Ha Noi, Vietnam

Yang Lili
Extension Center of Technology in Fishery of Haiyan district, Zhejiang province, China.

Liu Qigen
Key Laboratory of Freshwater Fishery Germplasm Resources, Ministry of Agriculture, Shanghai Ocean University, P. R. China.

Zhao liangjie
Key Laboratory of Freshwater Fishery Germplasm Resources, Ministry of Agriculture, Shanghai Ocean University, P. R. China.

Liu Jun
Key Laboratory of Freshwater Fishery Germplasm Resources, Ministry of Agriculture, Shanghai Ocean University, P. R. China.

Zhang Hong
Key Laboratory of Freshwater Fishery Germplasm Resources, Ministry of Agriculture, Shanghai Ocean University, P. R. China.

Correspondence
Liu Qigen
Key Laboratory of Freshwater Fishery Germplasm Resources, Ministry of Agriculture, Shanghai Ocean University, P. R. China.

Abstract
Zhejiang province was chosen for assessment on water quality in Giant freshwater prawn (GFP), with 19 ponds in five farms used the different seed sources for culture and different geographical positions which represents for GFP culture status in Zhejiang. In the present study, some physical and bio-chemical parameters such as pH, temperature (T°C), dissolved oxygen (DO), transparency (SD), total phosphorus, total nitrogen, nitrate, nitrite, ammonia-nitrogen, COD and chlorophyll-a contents of 19 ponds have been analyzed for assessment of real situation with respect to ponds water taken as control. Study was undertaken for a period of three months from 2013 July 5 to 2013 September 25 during which the physical and bio-chemical parameters were compared with the water quality optimum for GFP growth from previous researches. T°C values of the GFP aquaculture ponds range between 26.13-34.2 °C as against the value of standard water quality 28-32 °C. Total phosphorus, total nitrogen, nitrate, nitrite, ammonia-nitrogen, SD, COD and chlorophyll-a contents showed variation within different farms. DO values varied from 1.21 to 8.36 mg/l during three months of investigation, most farms have DO value higher than 3.0 mg/l. The Trophic Level Index (TLI) indicated there occurred different eutrophic level from light to severe among 5 farms. Four water parameters such as DO, SD, pH and chlorophyll-a showed high significant differences between each pair farm with $P<0.01$; the Total phosphorus illustrated significant difference between each pair farm with $P<0.05$. Generally, the water of GFP culture ponds were occurred on eutrophic status, thus our need intensifies managing and monitoring of water quality in order to lead the GFP culture industry will be sustainable development.

Keywords: Water quality; *Macrobrachium rosenbergii*; sustainable development; water parameter; Trophic Level Index; Eutrophic.

1. Introduction
Giant freshwater prawn (GFP) is a natural distribution through Sub-tropical to Tropical region. Although it is not natural distribution in China, but after introduced into China the first time in 1976 [1] GFP aquaculture industry was developed step by step and has significant contribution for China aquaculture industry. Spending nearly 4 decades with some different development stages as from 1976 to 1991, GFP aquaculture has been moderate development, average volume production was variation 10.000 tons per year. There was great development in period of 1991 to 2001; the volume of GFP aquaculture production was increasing 20.000 tones annual thus China was became the biggest GFP producer. However, in 2001-2002, the white tail disease was appeared on the GFP and thereafter rapidly approached to some major GFP aquaculture areas to induce many farmers loss of money. At that time many farmers were simultaneous change to culture white leg shrimp as resulting the volume of GFP production was considerable decrease. Fortunately, the disease was controlled in 2003 and then the GFP aquaculture industry was developing again [1], concurrently the cultural technique, diseases treatment methods, nutrition, producing seed et al., also were researched incessantly by scientists. Following FAO statistic 2012, total of volume GFP aquaculture production of China gained the highest over the world and constituted surpass 50% in total of volume GFP production of the world [2].

Although GFP is an exotic species of China, however it was became a one of major freshwater species for aquaculture in China [3]. The development of the GFP aquaculture industry in recently increased the products supply for human demand; concurrently it was also created the jobs for farmers with stable income. Exploiting and using was proper land and water surface for aquaculture, contributed product value for fisheries industry of China.

With the greatly achievement was gained of GFP aquaculture in the past that is the basis for continuously development in future. However, although China is the biggest GFP producer in the world [2] but China also has to face to many problems which may impact directly or indirectly to developing process such as many other countries. Those are global climate change impacted to GFP aquaculture industry; the degenerate genetic source was appeared in many regions that caused by inbreeding and invasive exotic species and consequently, the seed source was produced with low quality. If the farmers used low quality seed to culture it may prolong the period of cultured time, the cost for crop will be trending increase, thus the risks of cultivating would be raised [4].

Especially, the industrialization, civilization situation were expanded quickly on larger scale in years recently, thus the GFP aquaculture areas has been narrow tendentiously in order to resign land for industry development. Besides, GFP aquaculture industry has to face to environmental pollution caused by itself and industrialization, civilization development [1, 5]. Those reasons would be affected to sustainable development of GFP aquaculture industry.

The water quality influences directly to existence and growth of aquaculture animal. However water parameters are very easy variation and depending on many internal and external factors impact to. Thus water management needs to do frequently like as water monitoring, assessment and adjustment for proper with each species in aquaculture [6].

With those reasons, to carry out a research on water quality in GFP aquaculture ponds is really necessary and urgent in order to identify exactly status of water quality and to analyze the relating between some environment factors and GFP growth in ponds based on harvest production at the end of the crop.

We chose Zhejiang province as the research location because Zhejiang is one of 4 provinces with the largest GFP aquaculture industry (Zhejiang, Guangdong, Guangxi and Jiangsu) in China, besides, Zhejiang has multiform of GFP culture model that can representative for GFP aquaculture in China.

2. Locations, materials and methods

2.1. Sampling locations

Water samples were collected from 19 ponds from 5 farms with different scale and named farm 1, farm 2, farm 3 farm 4 and farm 5, respectively (**Table 1**; **Fig. 1**). Each farm has different water source, seed source and to apply the different aquaculture model (**Table 2**).

Table 1: The sampling locations

Farm	Number of pond	Position
Farm 1	1 - 4	30º30’25.87” N 120º54’50.30”E
Farm 2	5 - 6	30º30’32.54” N 120º53’28.49”E
Farm 3	7 - 9	30º33’33.32” N 120º48’52.78”E
Farm 4	10 - 13	30º34’30.15” N 120º55’37.00”E
Farm 5	14 - 19	30º36’11.36” N 120º54’57.09”E

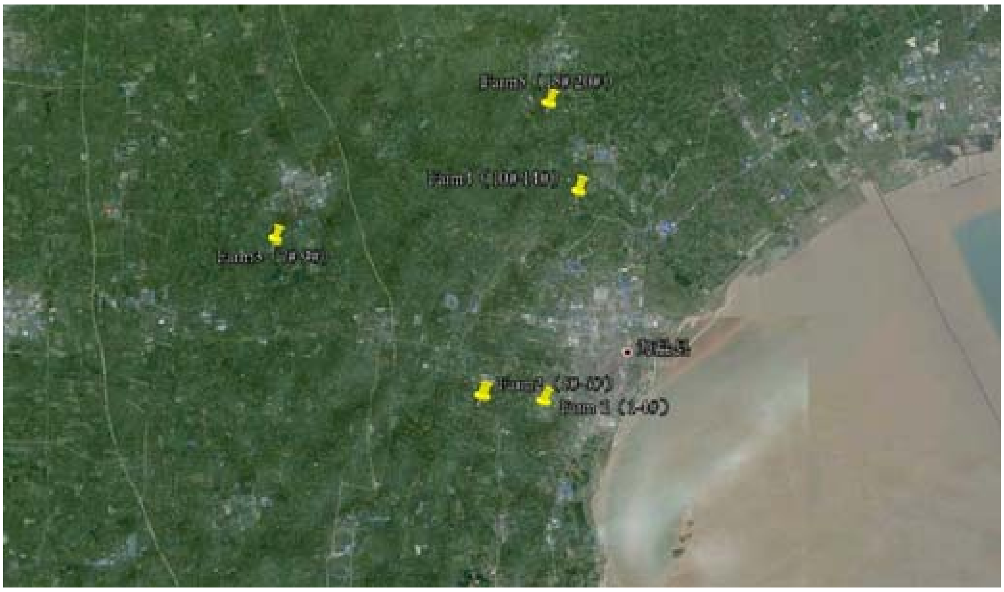


Fig 1: The map sampling sites

Table 2: The detailed information of 19 GFP culture ponds

Farmers	Pond number	Area of pond (ha)	Seed source	The density of seed (inds/m^2)	Cultured Timing (days)	Production (kg/ha)
Farm1	1	3.7	Shanghai Huzhou	75	130	2,625
	2	3.7	Shanghai Huzhou	75	130	2,625
	3	3.7	Shanghai Huzhou	75	130	2,625
	4	3.7	Shanghai Huzhou	75	130	2,625
Farm2	5	2.7	Huzhou	113	130	2,250
	6	2.7	Huzhou	113	130	2,250
Farm3	7	4.5	Haiyan	75	125	4,500
	8	4.5	Haiyan	75	125	4,500
	9	4.5	Haiyan	75	125	4,500
Farm4	10	4.3	Haiyan	150	130	3,375
	11	4.3	Haiyan	150	130	3,375
	12	4.3	Haiyan	150	130	3,375
	13	4.3	Haiyan	150	130	3,375
Farm5	14	2.0	Shanghai	75	63	6,000
	15	2.0	Shanghai	75	63	6,000
	16	2.0	Shanghai	75	63	6,000
	17	2.0	Shanghai	75	63	6,000
	18	2.0	Shanghai	75	63	6,000
	19	1.7	Shanghai	75	63	6,000

(*Source: surveyed*)

2.2. Determination of physicochemical properties of water

We collected samples at the beginning and middle of a month, from 2013/7/5 to 2013/9/25 (total five times). Some parameters were measured in the field such as dissolved oxygen (DO); pH; temperature (T^{o}C) and transparence (SD). DO and T^{o}C of water layers were measured with a DO meter (*YSI-58, Yellow Springs Instrument Co., Yellow Springs, Ohio*). pH index was detected with a pH meter (*PHB-2, Sanxin Instrument Factory*, *Shanghai*, *China*). SD was measured by Secchi disk. The mixture water samples of 19 stations were taken to the laboratory for chemical analysis. Total phosphorus (TP) and total nitrogen (TN) were detected with the national standards for surface water quality monitoring system. TN was determined by alkaline potassium per-sulfate digestion ultraviolet spectrophotometric method (GB/11894-89) [7]; TP determination using ammonium phosphomolybdate colorimetric method (GB/11893-89) [8]; nitrate nitrogen (NO_3^-) using the phenol disulfonic acid spectral light degree method (GB/T7480-87) [9]; nitrite nitrogen (NO_2^-) using naphthalene ethylenediamine spectrophotometry (GB/T7493-87) [10]; ammonia nitrogen (NH_3-N) were measured by nessler's reagent colorimetric method (GB/T7479-87) [11]; chemical oxygen demand (COD_{Mn}) was specified by acidic potassium permanganate method of permanganate index (GB/T11892-89) [12]; Chlorophyll-a was used method according to Method of State Environmental Protection Administration of China [13] (China Environmental Science Press, 2002). All sample measurements will be done within 2 days after sampling [14]. Using the trophic level index (TLI) to estimate the eutrophic level of water in GFP culture ponds [15]. Using nonparametric test (Friedman test-P and Kendall W test-P) to test variance analysis of water parameters among 5 farms [16, 17, 18].

3. Results

3.1. The variation of parameters in water of GFP culture ponds

The water of 19 ponds in this study was impacted by many internal and external factors so the indicators of them were being changed following the culture times which were shown in **Fig 2** and **Table 3**. The average temperature of water in GFP pond of 5 farms varied from 26.13 to 34.2 ^{o}C in period July 05 to September 25. The disparity of water temperature among five farms was not too much. All of them were sharp decline from August 05 to September 25. The highest of water temperature occurred at Farm3 on August 05 (34.2 ^{o}C) and the lowest occurred at Farm1 on September 25 (26.13 ^{o}C) (**Fig 2-A**). The Dissolved Oxygen (DO) in water of GFP ponds had relatively high among five farms and they also varied largely high following the culture time (**Fig 2-B**). The lowest of DO defined at Farm1 on July 05 (1.21 mg/l) and the highest was measured at Farm3 on August 05 (8.36 mg/l). The highest variation of DO in water was Farm3, especially in two periods from July 05 to August 05 and from August 05 to September 25. The pH index among five farms all were rapidly decreased on July 19 but thereafter it was raised again and steadily around 7.63-8.07 (**Fig 2-C**). The SD index in most farms had slight decrease in period of culture time in all of farms; except, Farm2 varied the highest of SD that was suddenly increased on July 19, then decreased quickly again on August 05 (**Fig 2-D**). The ammonium-nitrogen (NH_3-N) in water of five farms all have trending raised over time (**Fig 2-E**). The lowest of NH_3-N concentration showed in Farm 2 on July 05 (0.33 mg/l) and the highest among five farms occurred in Farm2 and Farm3 on September 25 (2.42 mg/l). The nitrate content has generally trending increase in period cultured time, except Farm1 has decreased rapidly from August 05 (1.74 mg/l) to September 25 (0.74 mg/l). The nitrite content (NO_2^-) was high variation in Farm1, Farm4 and Farm5. NO_2^- content had trending increased in Farm2 and Farm3 in over time. The NO_2^- concentration was monitored the lowest at Farm2 on July 05 (0.002 mg/l) and the highest in Farm4 on August 05 (0,396 mg/l) (**Fig 2-G**). Total nitrogen had decreased in the second time (July 19); thereafter the parameter was increased in all farms all time. The highest value is 9.30 mg/little at Fam3 on September 25 and the lowest value is 2.21 mg/l at Farm1 on July 19 (**Fig 2-H**). The total phosphorus in 5 farms had trending decreased in over the cultured time, except Farm3 (**Fig 2-I**). Farm2 had the highest TP value among 5 farms on July 5 (1.00 mg/l); the farm3 had the lowest TP value on July 5 (0.25 mg/l). The Chlorophyll-a value was varied relatively high among 5 farms, especially in Farm1, 4 and 5, Chllo-a content was sharp decline in period cultured time (**Fig 2-K**). Chllo-a content was the highest value at Farm 1 on July 5 (222.26 mg/l) and the lowest at Farm2 on September 25 (28.26 mg/l). The COD_{Mn} index generally had varied smoothly in 5 farms and gradually decrease from 7.43 (Farm3 on July 5) to 10.01 mg/l (Farm4 on July 5) (**Fig 2-L**).

Table 3: The value of parameters in 19 ponds by each time (on July 5)

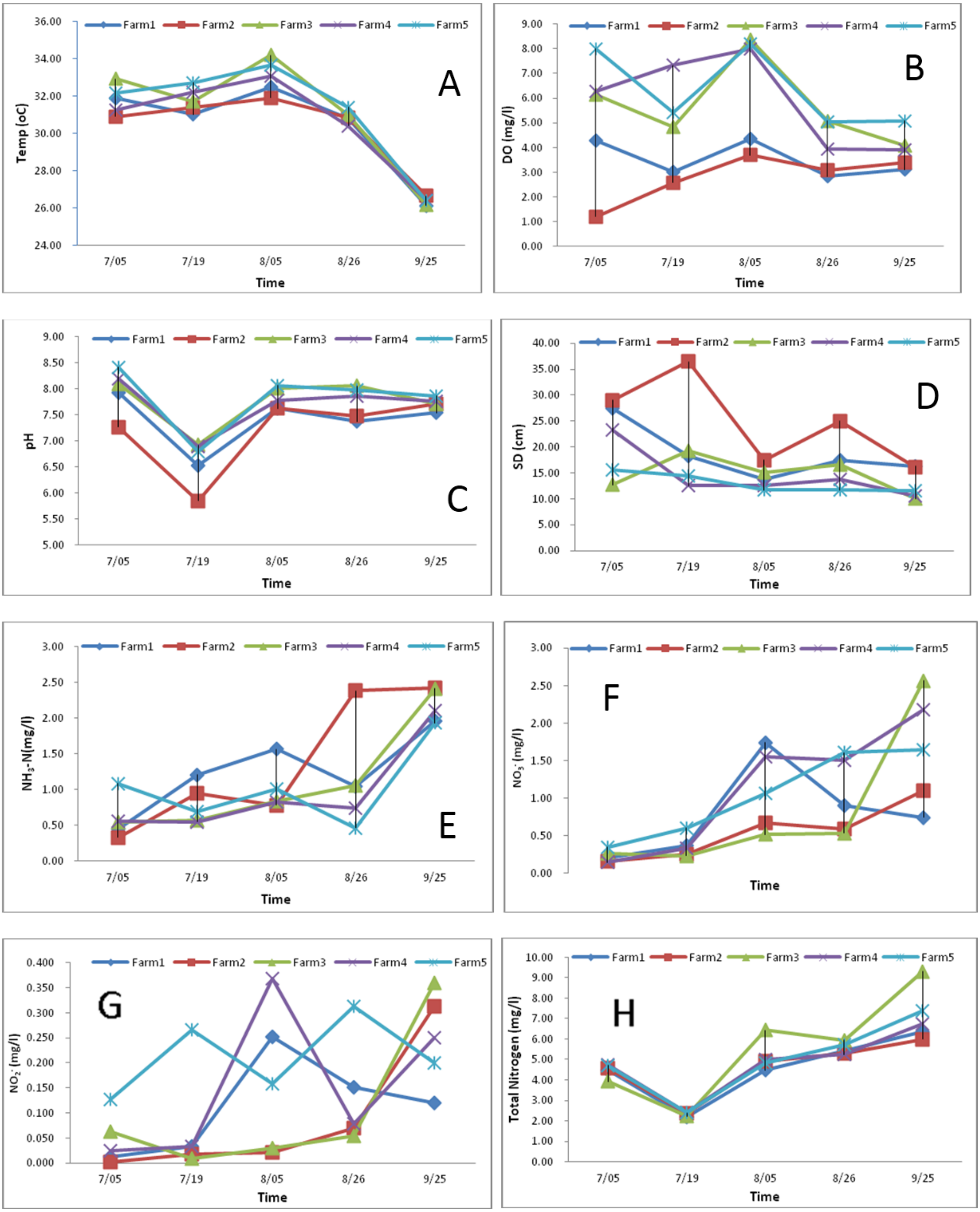
No of Pond	T°C	DO (mg/l)	pH	SD (cm)	NH_3 (mg/l)	NO_3 (mg/l)	NO_2 (mg/l)	Total Nitrogen (mg/l)	Total Phophorous (mg/l)	Chllo A (mg/l)	COD_{Mn} (mg/l)
1	31.6	3.5	7.90	25	0.8323	0.2766	0.0330	4.4557	0.4087	262.88	9.92
2	31.4	4.5	8.09	30	0.4527	0.1796	0.0040	4.7219	0.9692	309.73	10.40
3	32.1	4.67	8.06	25	0.2723	0.1867	0.0065	4.4675	0.3593	146.05	9.37
4	32.4	4.53	7.64	30	0.2383	0.1748	0.0087	4.3199	1.2117	170.40	9.50
5	30.7	6.11	7.51	28	0.1927	0.1366	0.0019	4.6988	0.3920	45.82	8.20
6	31.1	1.21	7.03	30	0.4594	0.1738	0.0028	4.4840	1.6078	49.12	8.30
7	32.7	6.5	8.29	12	0.6764	0.3564	0.0975	4.2755	0.3000	135.82	7.10
8	33.2	4.43	7.75	20	0.4812	0.2477	0.0364	3.6398	0.1923	65.67	7.20
9	32.9	7.46	8.24	18	0.4800	0.1788	0.0554	3.8585	0.2663	68.54	8.00
10	31.6	4.65	8.07	20	1.0855	0.0628	0.0714	4.3738	0.7990	207.30	10.00
11	31.2	7.86	8.71	23	0.5639	0.1099	0.0040	4.7846	0.5779	197.49	10.87
12	31.1	6.11	7.80	20	0.2981	0.2441	0.0231	4.7513	0.4250	145.58	9.27
13	31.1	6.54	8.20	30	0.2598	0.1628	0.0020	4.9844	0.7388	179.75	9.89
14	32.1	9.35	8.90	15	0.3064	0.2095	0.0306	4.5285	0.7616	170.22	9.84
15	32.2	10.8	9.05	17	0.2700	0.3083	0.0810	4.7867	0.4162	172.69	10.20
16	32.3	4.49	7.60	14	1.7859	0.3965	0.1375	4.6070	1.3404	99.55	9.42
17	32.3	5.19	7.83	15	2.8249	0.5492	0.3966	4.3994	0.7352	126.06	9.22
18	32.2	7.52	8.47	17	0.8612	0.3056	0.0608	4.8141	0.6666	340.69	9.85
19	31.9	10.6	8.64	15	0.4793	0.3197	0.0574	5.1941	0.7056	345.92	10.30

No of Pond	T°C	DO (mg/l)	pH	SD (cm)	NH_3 (mg/l)	NO_3 (mg/l)	NO_2 (mg/l)	Total Nitrogen (mg/l)	Total Phophorous (mg/l)	Chllo A (mg/l)	COD_{Mn} (mg/l)
1	31.5	3.7	6.69	19	1.3599	0.6923	0.0436	2.2477	0.6517	203.15	9.87
2	30.5	2.85	6.81	20	1.0912	0.3061	0.0604	2.1480	0.5023	253.65	9.30
3	31.3	2.79	6.29	20	0.8992	0.2843	0.0202	2.4364	0.5731	140.22	9.14
4	30.8	2.67	6.34	14	1.4834	0.1948	0.0090	2.0096	1.4341	164.55	9.16
5	31.5	2.60	5.80	35	0.9199	0.2056	0.0065	2.4649	0.2822	31.36	8.60
6	31.3	2.57	5.90	38	0.9800	0.2873	0.0300	2.2615	1.7121	40.11	8.09
7	32.1	5.16	6.92	18	0.4480	0.2018	0.0027	2.3002	0.2262	107.47	8.09
8	31.6	3.82	6.50	23	0.5606	0.2412	0.0191	2.2792	0.1465	51.86	7.29
9	31.5	5.49	7.34	17	0.6984	0.2500	0.0046	2.1395	0.2745	68.60	8.46
10	32.4	8.35	7.10	12	0.5087	0.3529	0.0646	2.5162	0.9357	196.29	9.52
11	31.7	7.65	6.85	10	0.6650	0.2284	0.0024	2.3648	0.8158	236.94	9.10
12	32.3	7.45	6.71	15	0.5095	0.5418	0.0646	2.2757	0.3856	217.54	8.00
13	32.5	5.89	6.89	13	0.5114	0.1893	0.0030	2.4727	0.8815	179.51	8.87
14	32.0	4.59	6.85	14	0.5226	0.3652	0.2622	2.4698	0.3543	210.28	8.52
15	32.1	4.51	6.51	12	0.6324	0.3382	0.3878	2.2916	0.3585	165.75	9.05
16	33.1	4.32	6.39	11	1.0532	0.7577	0.3252	2.3886	0.4826	99.52	9.10
17	33.2	5.92	6.99	17	0.5165	1.5682	0.2386	2.3670	0.4597	126.25	8.66
18	33.5	7.95	7.11	11	0.5834	0.3429	0.2723	2.3228	0.7922	265.62	8.89
19	32.5	5.26	6.95	21	0.8541	0.2550	0.1108	2.4815	1.1405	256.35	8.04

No of Pond	T°C	DO (mg/l)	pH	SD (cm)	NH_3 (mg/l)	NO_3 (mg/l)	NO_2 (mg/l)	Total Nitrogen (mg/l)	Total Phophorous (mg/l)	Chllo A (mg/l)	COD_{Mn} (mg/l)
1	32.3	3.86	7.56	10	1.3051	0.6783	0.4611	5.0303	1.7623	104.52	8.74
2	32.4	3.76	7.56	20	2.5422	1.0100	0.0106	3.6486	0.3474	90.96	9.12
3	32.6	4.43	7.56	10	0.6715	3.4782	0.1992	5.3230	0.5244	96.27	9.30
4	32.7	5.38	7.82	15	1.7457	1.7915	0.3341	3.9238	0.7943	84.77	9.60
5	31.8	2.6	7.64	20	0.8086	0.7892	0.0275	4.3599	0.1983	9.19	9.17
6	32.0	3.7	7.63	15	0.7472	0.5383	0.0131	5.4605	1.4204	9.68	7.92
7	33.4	7.83	7.99	15	0.1968	0.6172	0.0019	4.6691	0.2608	59.60	9.32
8	34.7	8.51	7.98	15	1.7205	0.5044	0.0498	9.0990	0.2620	29.83	9.56
9	34.5	8.75	8.07	15	0.5927	0.4323	0.0362	5.5246	0.4399	70.27	9.05
10	33.2	6.18	7.18	10	1.2048	2.4511	0.0300	3.9182	0.6373	61.78	9.18
11	32.8	9.05	8.22	10	0.4827	1.0937	0.7764	4.2811	0.5478	235.06	9.47
12	33.5	9.42	7.67	15	0.6162	2.0684	0.1959	7.7212	0.3668	123.36	8.08
13	32.8	7.34	8.03	15	1.0162	0.5767	0.4725	4.1537	0.7870	187.47	8.32
14	33.2	7.3	7.93	10	0.6391	0.7989	0.4918	5.0087	0.6322	129.59	8.48
15	33.1	6.08	7.83	10	1.8489	1.3330	0.0357	3.8243	0.4186	89.84	8.00
16	34	6.6	7.84	15	0.3788	1.6781	0.0155	5.6472	0.4311	99.26	8.82
17	34.6	9.62	8.15	10	1.2755	0.5410	0.0186	4.4307	0.6050	67.71	8.24
18	34.2	13.61	8.73	15	0.7808	1.0237	0.1604	4.4808	0.5567	149.58	9.60
19	33.0	6.00	7.91	10	1.0969	0.9983	0.2230	5.5992	0.8039	100.83	8.99

No of Pond	T°C	DO (mg/l)	pH	SD (cm)	NH_3 (mg/l)	NO_3 (mg/l)	NO_2 (mg/l)	Total Nitrogen (mg/l)	Total Phophorous (mg/l)	Chllo A (mg/l)	COD_{Mn} (mg/l)
1	30.5	3.54	7.14	15	0.6586	0.7222	0.1036	6.0462	0.5612	134.84	8.79
2	30.9	2.25	7.48	20	2.1707	0.5513	0.2361	4.9403	0.4248	180.91	9.85
3	30.9	2.97	7.35	20	0.7598	1.6915	0.2468	5.8412	0.5059	89.30	8.49
4	30.9	2.61	7.53	15	0.5955	0.6218	0.0222	4.8808	0.8397	253.05	6.18
5	31.0	2.32	7.63	30	2.2876	0.6604	0.0551	3.9920	0.2455	42.05	6.25
6	30.7	3.07	7.34	20	2.4795	0.5057	0.0836	6.5684	0.7826	55.39	9.83
7	31.2	7.75	8.38	15	0.4911	0.4252	0.1163	4.6766	0.2801	202.21	7.76
8	31.1	4.64	8.14	20	1.5114	0.4680	0.0089	6.7605	0.2439	88.92	9.25
9	30.6	2.86	7.65	15	1.1705	0.7066	0.0356	6.3718	0.3478	97.76	10.06
10	30.4	3.95	7.76	15	0.9102	1.8260	0.0407	4.1219	0.4941	60.26	8.24
11	30.4	3.92	7.80	10	0.5608	1.8266	0.0548	4.9949	0.3032	214.55	8.30
12	30.5	4.02	7.93	15	0.5626	1.5963	0.1781	6.9843	0.3004	182.01	10.53
13	30.3	3.94	7.95	15	0.9141	0.7598	0.0434	4.8344	0.6491	181.05	8.63
14	31.6	3.28	8.29	10	0.2298	2.9339	0.2755	6.0486	0.4014	74.87	8.32
15	31.0	3.98	7.80	10	0.2558	2.6003	0.0774	5.0616	0.4001	116.56	8.39
16	31.4	7.76	8.22	15	0.3920	0.9789	0.0142	6.7390	0.3583	173.41	10.30
17	31.7	4.30	7.99	15	0.3780	1.2112	0.6393	5.4448	0.4934	67.68	9.50
18	31.5	7.31	8.11	10	0.5511	1.0252	0.3922	4.1102	0.4376	118.08	8.39
19	31.3	3.52	7.49	10	0.9782	0.8991	0.4754	6.9569	0.9024	82.15	8.39

No of Pond	T°C	DO (mg/l)	pH	SD (cm)	NH_3 (mg/l)	NO_3 (mg/l)	NO_2 (mg/l)	Total Nitrogen (mg/l)	Total Phophorous (mg/l)	Chllo A (mg/l)	COD_{Mn} (mg/l)
1	26.3	3.60	7.76	20	2.7829	1.2637	0.2347	7.6254	0.7973	27.09	9.83
2	26.0	2.70	7.05	15	3.0480	0.4726	0.0923	5.1492	0.2916	50.50	8.40
3	26.1	3.28	7.68	13	0.6513	0.6751	0.1280	7.2304	0.5327	57.42	8.94
4	26.1	2.86	7.69	17	1.3530	0.5478	0.0246	5.4464	0.6107	83.90	8.86
5	26.9	4.72	7.92	22	0.1199	0.6175	0.1944	3.3178	0.1680	36.33	8.94
6	26.4	3.38	7.52	10	4.7257	1.5812	0.4300	8.6596	0.6363	20.18	7.92
7	25.9	3.87	7.68	12	1.2088	0.5247	0.1739	5.0799	0.3293	47.69	8.94
8	26.1	3.58	7.69	10	4.0830	4.4695	0.5219	13.9189	0.7258	67.67	7.36
9	26.5	4.78	7.75	8	1.9552	2.6947	0.3842	8.9096	0.3326	31.00	8.84
10	26.8	2.62	7.69	9	0.8403	1.4241	0.4235	3.9202	0.2250	16.09	9.11
11	26.3	5.35	7.89	11	1.8125	0.8617	0.2553	5.2183	0.3118	51.42	7.77
12	26.5	3.58	7.73	10	4.4316	5.7803	0.0153	13.1668	0.4188	25.29	6.98
13	26.3	4.05	7.72	12	1.3579	0.6475	0.3098	4.6600	0.2585	28.63	8.08
14	26.5	4.86	7.88	12	1.3439	1.7710	0.4513	7.5475	0.3759	31.71	7.46
15	26.4	5.52	7.89	10	0.9436	1.1410	0.0157	5.3571	0.4131	24.76	8.16
16	26.2	4.24	7.79	15	4.9480	0.5744	0.0842	8.9058	0.2824	18.21	8.83
17	26.3	5.06	7.82	10	0.8910	2.8140	0.0311	6.4943	0.2881	43.36	8.24
18	26.2	6.45	7.98	10	1.5837	1.3522	0.2753	7.1901	0.5842	47.72	8.65
19	26.7	4.38	7.83	12	1.8902	2.1900	0.3421	8.7168	0.5618	41.30	6.26


A
Temp (oC)
Farm1
Farm2
Farm3
Farm4
Farm5
36.00
34.00
32.00
30.00
28.00
26.00
24.00
7/05
7/19
8/05
8/26
9/25
Time
B
DO (mg/l)
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
C
pH
9.00
8.50
8.00
7.50
7.00
6.50
6.00
5.50
5.00
D
SD (cm)
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
E
NH_3-N(mg/l)
3.00
2.50
2.00
1.50
1.00
0.50
0.00
F
NO_3^- (mg/l)
G
NO_2^- (mg/l)
0.400
0.350
0.300
0.250
0.200
0.150
0.100
0.050
0.000
H
Total Nitrogen (mg/l)
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00

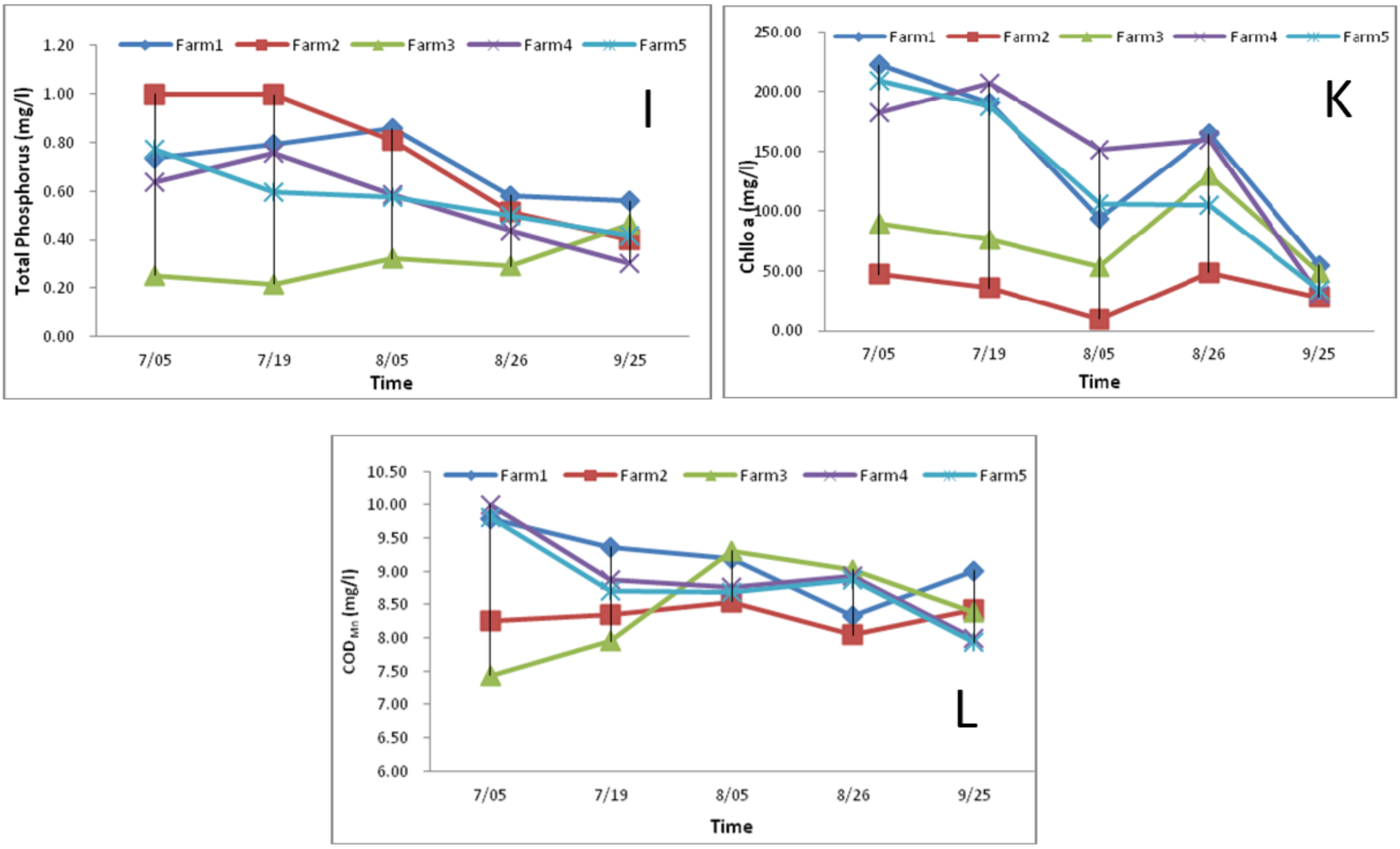


Fig 2: Variation of water parameters in 19 GFP culture ponds in five times

3.2. The water quality of GFP culture ponds based on Trophic Level Index

We used the Trophic Level Index (TLI) to assess the water quality of ponds. Trophic level is a concept used to determine water condition in pond based on water quality parameters such as nutrients (total phosphorus, total nitrogen), clarity (Secchi depth) and algal content (chlorophyll a) [19]. In this study, the nutritional status of water in Farm1 - Farm5 were performed at 5 times as shown in **Fig 3**, until September 25, Farm1 - Farm5 GFP aquaculture ponds nutritional status fell slightly. Average TLI value of Farm1 - Farm5 were shown in **Fig 4**, the highest Farm1 TLI, up to 80.4, in severely eutrophic condition; the lowest is 49.4 in Farm2; Farm3 and Farm4 the TLI value varied 64.9 and 71.5 respectively, in moderate eutrophication condition; The TLI is 60 in Farm5, it indicated that the lightly eutrophic [20, 21].

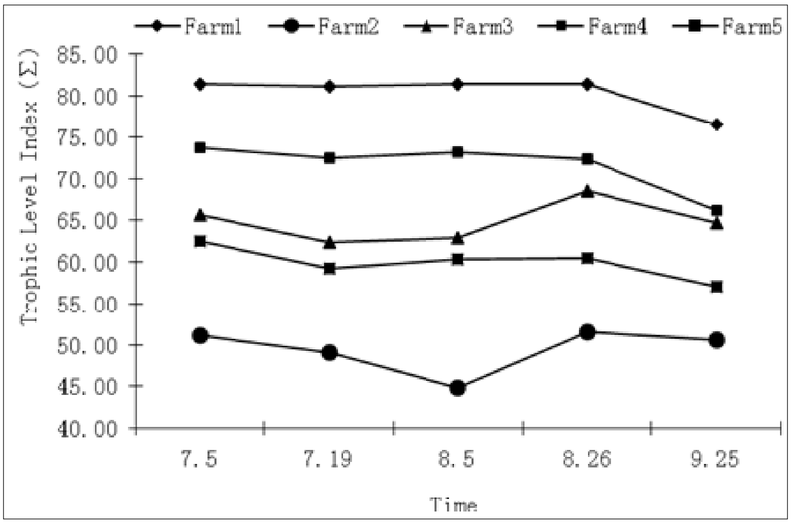


Fig 3: The trophic level index of 5 farms in 5 times

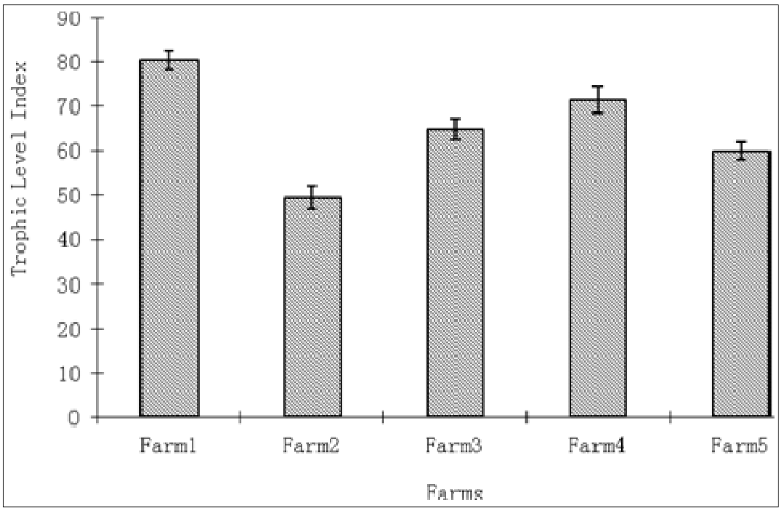


Fig 4: The average of trophic level index of 5 farms

3.3. The comparison of water parameters among five farms.

With Friedman test-P and Kendall W test-P each pair of water quality factor variance analysis among 5 farms, the results are shown in **Table 4**. Four water parameters are DO, SD, pH and chlorophyll-a (Chll-a) which showed high significant differences between each pair farm with P<0.01; the total phosphorus (TP) displayed significant difference between each pair farm with P<0.05; the remainders showed no significant difference among 5 farms.

Table 4: Different parameters of water in aquaculture pond nonparametric test-P

	Mean ranking					Friedman test-P	Kendall W test-P	Kendall W[a]
	Farm1	Farm2	Farm3	Farm4	Farm5			
T	1.8	2.4	3.8	2.8	4.2	0.098	0.098	0.392
DO	1.8	1.4	4	3.4	4.4	0.007**	0.007	0.712
pH	1.4	1.8	3.8	3.6	4.4	0.008**	0.008	0.696
SD	3.8	4.8	2.8	2	1.6	0.008**	0.008	0.688
NH_4-N	3.6	3.4	2	3	3	0.551	0.551	0.152
NO_3-N	3.2	2	2.4	3.2	4.2	0.218	0.218	0.288
NO_2-N	2.8	2	2.6	3.6	4	0.275	0.275	0.256
TN	1.8	2.4	3.6	3.6	3.6	0.218	0.218	0.288
TP	4.4	4	1.6	2.2	2.8	0.024*	0.024	0.560
Chll-a	4.4	1	2.6	3.8	3.2	0.009**	0.009	0.680
COD_{Mn}	3.8	2	3	3.6	2.6	0.364	0.364	0.216

** (P < 0.01); * (P<0.05).

4. Discussion

4.1. Impacted of water quality on the GFP production and eutrophication status in five farms

At the parameters of water in five farms such as water temperature, total phosphorus and chlorophyll a slow decline trend over time, ammonia-nitrogen, nitrate-nitrogen and nitrite-nitrogen were rising over time. Our results have some differences on rule of parameters variation with the results by Liu *et al.* (2011 in Chinese). That study showed the ammonia nitrogen in August to reach a maximum of 0.82 mg/l and decrease in September of 0.48 mg/l. In this study, the ammonia nitrogen have not reached the maximum value in August, it reached a peak in September, a value of 1.93 to 2.42 mg/l, this may be related to feed and dissolution of nitrogen in the prawn waste mainly in the form of organic nitrogen [22, 23]. When prawns are cultured intensively and fed protein-rich feeds they can produce high concentrations of ammonia in the water. If feed is uneaten, then more ammonia is present than if it is consumed by prawns. For every kilogram of feed fed, about 30 grams of ammonia will be excreted by prawns into the pond. Un-ionized ammonia is very toxic to prawn and causes gill damage and reduced growth at low concentrations [6]. In ponds, the equilibrium between NH_3 and NH_4^+ is affected by temperature and pH index. At any given pH, more toxic ammonia is present in warmer water than in cooler water; un-ionized ammonia is the toxic form and predominates when pH is high [24, 25]. The organic nitrogen will gradual accumulation in water following time and not immediately decomposed by microbial decomposition; when accumulated extension with large amount, heterotrophic bacteria multiply in the water will also increase about amount for decomposition, thus ammonia-nitrogen content in water peak appeared [26]. In this study, ammonia nitrogen content concentrated relatively high in water compared to water quality requirements for freshwater prawn grow - out facilities, but there were not occurred the dead prawn symptoms, it may be influence on mortality rate and growth of GFP culture, which have been relating directly to the GFP production of the farms [6]. Phosphorous is a limiting nutrient needed for the growth of all plants- aquatic plants and algae. In GFP aquaculture ponds, phosphorus is found in the form of inorganic and organic phosphates (PO_4). With a concentration less than 0.010 mg/l is considered as oligotrophic; concentrations between 0.010 and 0.020 mg/l indicated of mesotrophy, and exceeding 0.020 mg/l is already considered eutrophic [27]. Generally, phosphates are not toxic to animals, unless they are present in very high levels. In current study, the total phosphorus concentration in water slightly down in September, may be because the phosphorus element is important to the growth of microbes and GFP, phosphorus was supplied mainly from feed, natural phosphorus often cannot meet the needs of the primary producers, so that if phosphorus was not supplied enough it may impact to GFP culture production [28], the water temperature was sharp decline in September, accordingly the level digested food of prawns trending decreased so farmers fed less food quantity, resulting a total phosphorus concentration was also decrease in water.

4.2. Water quality parameters affected to GFP growth

Nitrogen is the major factor that affects to growth of algae in water body and it also plays an important role for GFP growth [29]. Some previous studies have pointed out that GFP culture in intensive model that nutrients needed for the prawn growth in almost whole depending on artificial compound feed feeding, natural environment provides nutrients portions of the very few [30, 31, 32, 33]. The demand of nitrogen in nutrients portions for GFP culture will be decreased gradually following period culture time. For harvested shrimp the N and P content in food were 29.46%-40.46% of total nitrogen and 12.64%-17.41% respectively, while post larvae demands nutrients of N and P in food were 91.76%-93.68% and 94.55%-96.97% respectively [33]. Comparative on production among five farms the results showed that Farm1 and Farm2 have production low, this indicated "the hardened prawn" symptoms, Farm3 and Farm4 production medium, indicated symptoms, "slight hardened prawn" Farm5 has the highest yield, but the variance analysis (**Table 4**) of total nitrogen, nitrate nitrogen and nitrite nitrogen showed no significant difference among 5 farms. Total nitrogen, nitrate nitrogen and nitrite nitrogen content in water after July were raised gradually and responding enough for GFP growth [33]. Some parameters in this study such as DO, SD, pH value and chlorophyll-a (Chll-a) displayed very significant differences ($P<0.01$); TP performed the significant differences ($P < 0.05$) among 5 farms. This results may be associated with sampling time, Farm1 was collected samples at 9 o'clock in the morning all the times, Farm2 at 10 o'clock, Farm3 at 11 o'clock, Farm5 12 o'clock and Farm4 was collected around 2 o'clock. Daily variation of DO displays approximate a sine curve and within one peak and one bottom in the sunny afternoon before dawn respectively [34]. Liu *et al*. (2005) was testing on water of shrimp ponds, the results showed that DO was the highest and the lowest in afternoon around 14:00 pm and around 4:00 am respectively, this change is mainly affected by the plant photosynthesis in water, since early in the morning the DO concentration is low, with the rising of the sun the photosynthesis of phytoplankton operated thus increase the dissolved oxygen in water, until reached its peak in the afternoon, sunny days even when saturated and produce oxygen "surplus" [35]. Besides, excess feeding can result in an increase in organic material, a decrease in DO due to oxidation by bacteria and an increase in metabolic wastes [36, 37]. The amount of DO in water is largely dependent upon the water temperature; colder water can carry more dissolved oxygen that warmer water [6]. The pH of a solution is the concentration of hydrogen ions, expressed as a negative logarithm; lower pH levels indicate increasing acidity, while pH levels higher than 7 indicate increasingly alkaline solutions. In aquaculture ponds decrease in pH after feeding rates were increased was reported for channel catfish ponds [37]. Chlorophyll-a concentration and DO are closely relationship, such as Qian *et al*. (2013) illustrated that chlorophyll-a summer was positively correlated with total phosphorus and dissolved oxygen, whereas it was negative correlation with total nitrogen and nitrate nitrogen [34]. Chll-a and DO among five farms showed significant difference mainly relating to sampling time and they may impacted on the growth of GFP. While the optimum temperature range for freshwater prawn production is 25-32 ºC [38, 39], the average temperature of the present study was around 28 ºC, with the highest values up to 33.07 ºC recorded in August, thus the water temperature was proper for GFP growth. In this study, 5 farms cultured with different seed sources (**Table 2**), that may a caused to different production among 5 farms. The quality of seed has especial important role in grow-out of GFP. The results of study by Li *et al*. (2004) [40] showed that the cultured population has lower genetic diversity level than wild population. The degenerated genetics of brood stock related closely to seed quality [4], thus in this study the difference of seed sources among 5 farms conclusively influence to GFP growth in culture ponds.

5. Conclusions

This study assessed relatively completion about water quality in 5 farms which represents for GFP aquaculture status in Zhejiang province, China. Generally, the water parameters were a warning level, especially, TLI of five farms all indicated a different eutrophic from lightly to severely level. This situation may be caused by water resources, managements and lack of facilities and technique for GFP culture, thus the effective in producing was considerable decreased. Besides, the seed sources may not so good which makes the GFP cultured in low growth, productivity and production. Correspondingly, to intensify environment management in GFP culture, frequent monitoring, applied an advanced technique for culture, concurrently seed quality improvement in order to lead the GFP culture industry of China will be sustainable and stable development in future.

6. Acknowledgements

We are grateful to the Key Laboratory of Freshwater Fishery Germplasm Resources that offered facilities and technical assistance to conduct my experiments and we would also like to thank Mrs Tang Yuying from Extension Center of Technology in Fishery of Haiyan district, Zhejiang province, China for her help to collect the water samples in Zhejiang.

7. References

1. Guoliang Y, Mike F, Xuefeng C, Junyi W, Guo H, Qiang G. Current status of the giant freshwater prawn (*Macrobrachium rosenbergii*) industry in China, with special reference to live transportation. Aquaculture Research 2012; 43:1049-1055.
2. FAO. The state of world fisheries and aquaculture 2012. Rome, Italy, 2012.
3. Yang GL. New technique for induced breeding and culture of giant freshwater prawn (part one). Scientific Fish Farming 2008; 10:12–13.
4. Weimin M, Xianping G. Freshwater prawn culture in China: An overview. Aquaculture Asia 2002, 9-12.
5. UNEP. Planning of water quality monitoring systems.

UNEP/ GEMS Water 2012, 132.
6. Andrew L. Grow out Pond and Water Quality Management. University of Maryland 2007, 6-17.
7. Ministry of Environmental Protection of the People's Republish of China. Water quality-Determination of total nitrogen-Alkaline potassium persulfate digestion UV spectrophotometric method 2012, GB 11894-89.
8. Ministry of Environmental Protection of the People's Republish of China. Water quality -Determination of permanganate index 1989, GB/T11892-89.
9. Ministry of Environmental Protection of the People's Republish of China. Water quality-Determination of nitrate-Spectrophotometric method with phenol disulfonic acid 1987, GB 7480-1987.
10. Ministry of Environmental Protection of the People's Republish of China. Water quality-Determination of nitrogen (nitrite)-Spectrophotometric method 1987, GB 7493-87.
11. Ministry of Environmental Protection of the People's Republish of China. Water quality-Determination of ammonium-Nesster's reagent colorimetric method 1987, GB 7479-87.
12. Ministry of Environmental Protection of the People's Republish of China. Water quality-Determination of total phosphorus-Ammonium molybdate spectrophotometric method 1989, GB 11893-89.
13. The Editorial Committee of "Monitoring and Analytical Methods of Water and Wastewater" of China SEPA. *Monitoring and Analytical Methods of Water and Wastewater (Fourth Ed.).* China Environmental Science Press, Beijing, 2002.
14. Jing XC, Liu HL, Tu QY et al. Chinese lake eutrophication [M]. Beijing: Chinese Environmental Science Press 1990, 82-85.
15. Cengiz A, Betul Y, Erkan K. Trophic level determination of Ac Lake, Meke Lake and Sugla Lake. World Journal of Fish and Marine Sciences 2009; 1(3):243-247.
16. Kendall MG, Babington SB. The Problem of m Rankings. The Annals of Mathematical Statistics 1939; 10(3):275-287.
17. Conover WJ. Practical nonparametric statistics, 3rd edition. New York: John Wiley & Sons, 1999.
18. Corder GW, Foreman DI. Nonparametric Statistics for Non-Statisticians: A Step-by-Step Approach Wiley, 2009.
19. Caroll JH, Nolen SL, Peterson LV. Water quality changes, from 1987 to 1991 in Broken Bow Lake. Oklahoma Proc Okla Acad Sci 1996; 76:35-38.
20. Weiming H, Shuijing H, Wei J, Jin L, Junlei L, Jin W. Investigation and protection countermeasures of water environmental quality in Qian Dao Lake. Journal of lake sciences 1996; 8(4):337-344.
21. Jingan M, Hongqing L. Preliminary discussion on eutrophication status of lakes, reservoirs and rivers in china and overseas. Resources and environment in the Yangtze basin 2002; 11(6):575-578.
22. Tucker L, Boyd CE, McCoy EW. Effects of feeding rate on water quality, production of channel catfish, and economic returns. Trans Am Fish Soc 1979; 108: 389-396.
23. Cole BA, Boyd CE. Feeding rate, water quality, and channel catfish production in ponds. Prog Fish-Cult 1986; 48:25-29.
24. John A, Hargreaves, Craig ST. Managing Ammonia in Fish Ponds. SRAC 2004, 4603.
25. Yunfa Z, Ming L, Wenzhong D, Jianbo C, Xiaoze G, Yong T *et al.* Analysis of Influencing Factors on Water Quality Determination of Total Nitrogen by GB 11894-89. Hubei Agricultural Sciences 2009; 48 (5):1232-1234.
26. Michele A, Burford KC, Williams. The fate of nitrogenous waste from shrimp feeding [J]. Aquaculture 2001; 198(1-2):79283.
27. Mueller, David K, Helsel DR. Nutrients in the Nation's Waters-Too Much of a Good Thing? U.S. Geological Survey Circular 1136. National Water-Quality Assessment Program, 1999. http://water.usgs.gov/nawqa/circ-1136.html.
28. Haichun L, Zhiguo L, Xuehong D. Research on changing rule of water quality in *Macrobrachium rosenbergii* aquaculture pond. Jiangsu Agricultural Science 2011; 39(6):397-399.
29. John A, Hargreaves. Review Nitrogen biogeochemistry of aquaculture ponds. Aquaculture 1998; 166:181-212.
30. Mali B, Paiboon V, Virojana S. Shrimp nutrition in Japan a study tour report. FAO/UNDP/THA/75/012; 1980; THA:75:008:80/WP/21.
31. Michael BN. The diet of prawns. FAO/UNDP/THA/75/008; 1980; THA:75:008/80/WP/12.
32. Gopa M, Mukhopadhyay PK, Chattopadhyay DN. Nutrition and feeding in freshwater prawn (*Macrobrachium rosenbergii*) farming. Aqua Feeds Formulation & Beyond 2005; 2:17-19.
33. Jinliang L, Xuefen C, Qiuming L, Chunyu L, Jinling C, Shuye S. Study on nitrogen and phosphorus budgets and production performance in higher place pond of *Litopenaeus vannamei*. South China Fisheries Science 2010; 6(5):13-20.
34. Haiying L, Keming QU, Shaosai MA. Survey of both the variation and the absorption and consumption budget of dissolved oxygen in culture ponds. MARINE FISHERIES RESEARCH 2005; 26(2):80-84.
35. Haozhong Q, Qiaohua Z, Peidong Q, Xiaotao Q, Wanli L, Hongbo C. Spatial-temporal characteristic and influential factors of the chlorophyll-a concentration of Taihu Lake. ENVIRONMENTAL CHEMISTRY 2013; 32(5):789-796.
36. Millamena OM. Organic pollution resulting from excess feed and metabolic build-up: Effect on *Penaeus monodon* postlarvae. Aquacult Eng 1990; 9:143-150.
37. Boyd CE. Water Quality in Ponds for Aquaculture. Alabama Agricultural Experimental Station, Auburn University, Auburn, AL, 1990, 482.
38. Boyd C, Zimmermann S. Grow-out systems- water quality and soil management. In: Freshwater Prawn Culture, the Farming of *Macrobrachium rosenbergii* (ed. By M.B. New &W.C. Valenti), Blackwell Science, Oxford, UK 2000, 221-238.
39. New MB. Farming freshwater prawns: a manual for the culture of the giant river prawn (*Macrobrachium rosenbergii*). FAO Fisheries Technical Paper 2002, 428, FAO, Rome, Italy.
40. Mingyun L, Haiqi Z, Junjie Z, Yong W, Fuyong H, Zhongyang H *et al.* Genetic variation between cultured population from Zhejiang Province and Natural population from Burma of *Macrobrachium rosenbergii* revealed by RAPD method. Journal of Fisheries of China 2004; 28(4):25-28.