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EFFECT OF STOCKING RATIO AND CHEMICAL FERTILIZATION ON POND WATER QUALITY AND GROWTH PERFORMANCE OF SOME WARM WATER FISH SPECIES

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Key words : Nile tilapia, common carp, grass carp, polyculture, stocking rtio, fertilizer.

ABSTRACT

This experiment was carried out in the Central Laboratory for Aquaculture Research from June to October 1997. A total number of 11400 fingerlings were used in this work. Such number included 7200 Nile tilapia, 3600 common carp and 600 grass carp. The fish were divided into six experimental groups. Polyculture system was carried out in the present experiment. Six earthen ponds (20X50m, 1000m^2) were used in this study. Three ponds were fertilized with inorganic fertilization, while the other three ponds were left without inorganic fertilization. At the start of the experiment, each pond was fertilized with 50 kg chicken manure weekly per pond. The chemical composition of chicken manure was 18.5% crude protein, 12.2% crude fiber, 1.5% ether extract and 32.1% ash. The experimental diet was given at a rate of 3% of body weight per day. The ration was contained 15.9% crude protein, 10.6% crude fiber, 4.9% ether extract and 8.6% ash. The first three ponds were weekly fertilized with 2.5 kg urea (46% N) and 5 Kg super-phosphate (15.5 CP) as the chemical fertilizer per pond, while the other three ponds didn't receive any chemical fertilizer. Fish samples were taken randomly biweekly from each pond.

Within each fertilization system and feeding system, the first pond was stocked with 900 Nile tilapia, 900 common carp and 200 grass carp (45, 45 and 10% stocking ratio, respectively; 1:1 tilapia : common carp). The second pond was stocked with 1200 Tilapia, 600 common carp and 200 grass carp (60, 30 and 10%-stocking ratio, respectively; 2:1 tilapia to common carp). The third pond was stocked

with 1500 tilapia, 300 common carp and 200 grass carp (75, 15 and 10% stocking ratio, respectively; 5:1 tilapia to common carp. Water quality of the ponds was measured daily. The obtained results can be summarized as follows:

Phytoplankton and zooplankton increased as affected with chemical fertilization. Stocking ratio 1 tilapia: 1 common carp recorded higher phytoplankton and zooplankton, while the ratio 5 tilapia: 1 common carp recorded lower phytoplankton and zooplankton in each fertilized and non-fertilized pond. Water temperature was not affected with fertilizers or stocking ratio. Concentration of dissolved oxygen in water ponds increased with chemical fertilizer under all stocking ratios. Values of pH, total hardness, total nitrogen and total phosphorus concentration increased with chemical fertilization than those without chemical fertilizers. On the other hand, increasing tilapia density decreased total nitrogen concentration.

Fish body weight increased significantly ($P<0.05$) in chemical fertilization treatments during the whole experiment. Nile tilapia showed the highest responses to chemical fertilization. Fish live body weight, body length or condition factor were not affected significantly with stocking ratio.

INTRODUCTION

Semi-intensive aquaculture occurs in ponds that are intensively fertilized with nutrients (manures, urea or phosphates) to stimulate natural food production or when supplement feed is added. Semi-intensive pond culture of fish depends on factors such as food, temperature, light, age, and species, crowding and established fertilization system to grow up the required natural foods in fishponds.

The economic success of controlled production of fish, mainly, on the cost of feed. Reducing feeding costs could be an essential factor for successful development of fish culture. Green *et al.* (1994) reported that tilapia grow faster in ponds fertilized with organic and inorganic fertilizers. Garg and Bhatnagar (1996) reported that the fertilization of pond with organic and inorganic fertilizers increased the productivity of plankton, which lead to greater production. Nguenga *et al.*(1997) found that the survival rate improved in fishponds fertilized with chemical fertilizer or animal manure. Also the final weight of fish increased significantly.

The objective of the present study was to investigate the effect of fertilization system and stocking ratio on growth performance and feed efficiency of tilapia, common carp and grass carp fish.

MATERIALS AND METHODS

The present study was conducted at the Department of Animal production, Faculty of Agriculture, Zagazig University. The practical work was carried out at Central Laboratory for Aquaculture Research, Abbassa, Sharkia, Egypt. The experiment was carried out from June to October, 1997.

A total number of 11400 fingerlings were used in this experiment. Such number included 7200 Nile tilapia, 3600 common carp and 600 grass carp. The fish were divided into 6 experimental groups. Polyculture system was carried out in the present experiment. Six earthen ponds (20X50m, 1000m2) were used in the present study. Three ponds were fertilized with inorganic fertilization, while the other three ponds were left without inorganic fertilization. At the start of the experiment, each pond was fertilized with 50kg chicken manure weekly per pond. The chemical composition of chicken manure was 18.5% crude protein, 12.2% crude fiber, 1.5% ether extract and 32.1% ash. The experimental diet was given at a rate of 3% of body weight per day. The ration contained 15.9% crude protein, 10.6% crude fiber, 4.9% ether extract and 8.6% ash. The first three ponds were weekly fertilized with 2.5 kg urea (46%N) and 5 kg super-phosphate (15.5 CP) as chemical fertilization per pond, while the other three ponds didn't receive any chemical fertilization. Within each fertilization and feeding system, the first pond was stocked with 900 fish Nile tilapia and 900 common carp and 200 grass carp (45, 45 and 10%-stocking ratio respectively; 1:1 Nile tilapia to common carp). The second pond was stocked with 1200 Nile tilapia, 600 common carp and 200 grass carp (60, 30 and 10% stocking ratio, respectively, 2:1 Nile tilapia to common carp. The third pond was stocked with 1500 Nile tilapia, 300 common carp and 200 grass carp (75, 15 and 10% of stocking ratio respectively; 5:1 Nile tilapia to common carp).

The fingerlings of Nile tilapia, *Oreochromis niloticus*, common carp, *Cyprinus carpio*, and grass carp, *Ctenopharyngodon idella*, were obtained from Abbassa hatchery. Fish sample (30 fish per species) was taken randomly biweekly from each pond and the

individual body weight and body length was recorded. Water temperature and dissolved oxygen were recorded daily. Water pH was tested weekly. Nitrite, nitrate, total alkalinity, total hardness, organic phosphate, phytoplankton and zooplankton were determined in pond water monthly. Transparency of water was measured directly by using Secchi disk. Total hardness and total alkalinity were measured according to APHA (1985).

Live body weight recorded to the nearest gram, while body length recorded to the nearest cm. Daily body gain = (W1-W0)/ period (days), where W1 = final body weight and W0 = initial body weight. Daily body gain per 100 g live body weight was calculated according to the following equation (Ayyat, 1991):

$$\text{Daily gain per 100 g body weight} = \frac{W1-W0}{\frac{1}{2}(W1+W0)} \times 100/\text{period (days)}$$

Body weight, body measurements were statistically analyzed by two way analysis of variance as described by Snedecor and Cochran (1982) according to the following model:
Xilk = M + Fi + Sj + Fsij + eijk, where M = general mean, Fi – effect of ith fertilization (I = 1.2), Sj = effect of jth stocking ratio (j = 1.3), Fsij = interaction effect between ith fertilization and jth stocking ratio and eijk = random error.

RESULTS AND DISCUSSION

Natural food

Natural food included small plants (phytoplankton) and small animals (zooplankton) and bacteria. The natural food in the ponds increased with using the inorganic fertilizers. Also, increasing the density of tilapia than common carp decreased the count of natural food in pond (Table 1). The highest phytoplankton count was recorded during August and September months, while the lowest values was recorded in June and July in fertilized and non-fertilized ponds. This may be due to the water temperature, the increasing of water temperature in June and July decreased the values of phytoplankton.

Phytoplankton increased as affected with chemical fertilization when compared with the non-fertilized ponds. Stocking ratio 1 tilapia:1 common carp recorded higher phytoplankton, while the ratio 5:1 recorded lower phytoplankton in each fertilized and non-

fertilized ponds (Table 1). Knud-Hansen *et al.* (1993) reported that the chemical fertilizers stimulate the natural food productivity through photosynthesis.

Zooplankton increased with chemical fertilization when compared with the non- fertilized ponds. Stocking ratio 1 tilapia: 2 common carp recorded higher zooplankton concentration, while the ratio 5:1 recorded lower zooplankton in fertilized and non-fertilized ponds. Garg and Bhatnagar (1996) reported that the fertilization of fishponds with organic and inorganic fertilizers increased the productivity of plankton, which leads to greater fish production.

Ponds water quality

The collected data for water quality during the study were summarized in Table 2. The water temperatures were not affected with fertilizers or stocking ratio of tilapia to common carp. Dissolved oxygen concentrations in pond water ranged between 3.7 and 5.3 mg/l in all treatments. Concentration of dissolved oxygen increased in ponds treated with chemical fertilizer under all stocking ratios. Values of pH in tested water pond slightly increased with chemical fertilizers than those without chemical fertilization. Higher pH value was obtained at stocking ratio 1:1, while the lower value was observed in 5:1 stocking ratio in each treatment. Total alkalinity increased with chemical fertilizer and with increasing tilapia density and lower common carp density (Table 2). Total hardness of pond water slightly increased with chemical fertilizer and increasing tilapia density in ponds. Total nitrogen concentration increased in chemical fertilizer treatments compared those without fertilization. On the other hand, increasing tilapia fish density decreased the total nitrogen. Boyd (1979) reported that total nitrogen is usually not a primary limiting nutrient to productivity in chemical fertilization of ponds. The total phosphorus concentration increased by using chemical fertilization. The ratio of 1 tilapia:1 common carp recorded the higher total phosphorus concentration in pond water than the ratios 2:1 and 5:1 (Table 2). The same trend was obtained in orthophosphate concentration. In this regard Boyd (1990) showed that phosphorus fertilizers resulted in a great increase in the phosphorus concentration in pond water.

Growth performance

Fish body weight increased significantly ($P<0.001$ or 0.05) with chemical fertilization during the whole experimental periods except at the second month (Tables 3 & 4). Nile tilapia body weight

increased as by chemical fertilization when compared with ponds without chemical fertilization. The same trend was observed for common carp and grass carp. The average daily gain at the whole experimental period increased by chemical fertilization (Table 5). The average daily gain of tilapia, common carp and grass carp increased in fertilized ponds than those reared in ponds without chemical fertilization. Nile tilapia showed the highest growth rate responses for chemical fertilization than the other species studied. These results are in agreement with the findings of Green *et al.* (1994) who reported that tilapia grew faster in ponds fertilized with organic and inorganic fertilizers. Average daily body gain per 100 grams of live body weight of Nile tilapia fish increased when reared in ponds fertilized with chemical fertilization (1.13g per day per 100g live weight) than fish reared in ponds without chemical fertilization (1.09g) during the whole experimental period (Table 6). On the other hand, growth performance of common carp and grass carp did not effected (Table 6). In this respect, Colman and Edward (1987) reported that inorganic fertilizers has been promoted the growth rate of fish due to its lower loading rates; due to higher nutrient contents and lower oxygen demand.

Nile tilapia body length slightly increased with chemical fertilization, while common carp and grass carp did not affected (Tables 7 & 8).

Condition factor of fish did not show any significant differences as affected with chemical fertilization during the whole experimental periods (Table 9). At five months condition factor of Nile tilapia decreased, while that of common carp and grass carp increased.

Fish live body weight was affected significantly ($P<0.1$ or $P<0.001$) with stocking density during the experimental period (Tables 3 & 4). Increasing Nile tilapia density in ponds (associated with decreasing common carp density) decreased the live body weight, 5 tilapia to 1 common carp ratio recorded the lower tilapia fish weight. Increasing the tilapia fish density (the ratios 2:1 or 5:1) decreased the live body weight with 11.5 and 17.5%, respectively, when compared with the ratio 1:1.

Live body weight of common carp fish under the stocking ratios 2:1 and 5:1 increased with 64.2 and 188.2%, respectively, when compared with the ratio 1:1. At the ratios 2:1 or 5:1, grass carp weight decreased than the ratio 1:1. Live body weight of grass carp fish under stocking ratios 2:1 and 5:1 decreased with 3.1 and 13.1%,

respectively, when compared with the ratio 1:1. The obtained results are in agreement with those obtained by Karplus *et al.*(1996).

Fish body length or condition factor was not affected significantly with stocking density at all the experimental periods.

Fish live body weight was not affected significantly with the interaction between chemical fertilization and stocking ratio at all the experimental periods, except at first month (Tables 3 & 4). The obtained results indicated that the body weight increased in fish reared in fertilized ponds and under any stocking ratio. Within Nile tilapia species, fish group with the stocking ratio 1:1 and reared in fertilized ponds recorded higher body weight than the other group. The same trend was observed at 2:1 ratio with chemical fertilization. Within common carp species, contrary results were obtained with stocking ratio 5:1 and reared in fertilized ponds. Within grass carp species, fish group with the stocking ratios 1:1 and 2:1 and reared in fertilized ponds recorded higher body weight than the other group.

Within the fertilization system, increasing the density of tilapia fish in ponds (5:1 ratio) decreased the live body weight of tilapia and increased the body weight of common carp. On the other hand, within the stocking density ratio, using the chemical fertilization increased the live body weight of all fish species.

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Table 1. Natural food production in fish's ponds as affected by fertilization and stocking ratio at different experimental periods.

Ponds	June	July	August	September	October
Phytoplankton (cells/ml):					
Without fertilization					
1 : 1[a]	4070	9420	16756	17832	10574
2 : 1	4460	9194	16036	16744	9830
5 : 1	4090	8910	15346	16109	9012
Chemical fertilization:					
1 : 1	5410	10356	19730	18645	11780
2 : 1	4900	9826	18230	17869	10728
5 : 1	4600	9592	17550	16764	10024
Zooplankton (cells/ml)					
Without fertilization:					
1 : 1	113	422	624	544	378
2 : 1	73	359	492	467	297
5 : 1	58	304	415	398	222
Chemical fertilization:					
1 : 1	144	470	769	612	480
2 : 1	123	410	674	553	383
5 : 1	89	364	528	492	326

a The ratio = tilapia fish numbers : common carp numbers.

Table 2. Water quality as affected by fertilization and stocking ratio.

Items	Without chemical fertilization			Chemical fertilization		
	1 : 1	2 : 1	5 : 1	1 : 1	2 : 1	5 : 1
Temper (°C)	29.12	29.00	29.10	29.12	28.90	29.20
D. oxygen (mg/l)	4.20	3.90	3.70	5.30	5.06	4.70
pH	8.70	8.60	8.60	9.08	8.90	8.70
T. alkalinity (mg/l)	0.40	0.47	0.53	0.48	0.59	0.67
T. H (mg/l)	290.80	293.30	294.80	319.30	320.60	321.00
E.C. (mhos/cm)	0.73	0.75	0.74	0.93	0.94	0.92
Salinity (g/l)	0.25	0.25	0.24	0.32	0.33	0.32
T N (mg/l)	1.13	0.94	0.78	1.40	1.20	1.08
T P	0.93	0.85	0.74	1.07	1.03	0.92
O P	0.43	0.26	0.33	0.54	0.45	0.39
S D	13.00	13.50	14.20	11.10	11.50	11.80

Table 3. Average fish body weight (g) at different experimental periods as affected with fertilization and stocking ratio and their interactions

Item	Body weight at M0	M1	M2	M3	M4	M5
Fertilization						
Inorganic fertilization:						
Tilapia	14.1±0.09	33.0±0.36	60.0±0.71	98.8±0.04	136.0±0.92	171.5±1.50
Common carp	2.0±0.01	20.5±0.82	87.7±2.05	160.3±6.50	247.6±10.7	299.7±12.7
Grass carp	2.95±0.01	32.7±0.72	88.7±1.40	229.5±1.70	357.7±4.14	415.5±4.12
Without inorganic fertilization:						
Tilapia	14.3±0.10	30.7±0.32	57.2±0.57	85.2±0.85	117.9±1.40	143.5±1.65
Common carp	2.0±0.01	17.7±0.61	67.0±2.64	157.2±6.51	239.2±11.7	290.2±13.8
Grass carp	3.0±0.02	21.9±0.73	89.6±1.05	210.2±1.90	295.3±2.30	372.1±2.70
Stocking ratio:						
1:1						
Tilapia	14.2±0.11	30.9±0.40^{c}	59.8±0.74^{c}	96.8±0.70^{c}	135.5±1.21^{c}	174.5±1.12^{c}
Common carp	1.9±0.02	14.2±0.21^{c}	43.1±0.70^{c}	102.9±1.32^{c}	138.4±1.11^{c}	160.0±1.40^{c}
Grass carp	2.9±0.02	26.3±0.73^{c}	91.8±0.90^{c}	230.6±1.70^{c}	351.4±4.51^{c}	417.6±3.52^{c}
2:1						
Tilapia	14.2±0.11	32.5±0.44^{b}	58.3±0.90^{b}	91.6±1.11^{b}	125.9±1.70^{b}	154.5±2.22^{b}
Common carp	2.0±0.02	14.8±0.15^{b}	63.1±0.50^{b}	130.7±1.52^{b}	204.0±1.91^{b}	262.8±1.43^{b}
Grass carp	2.9±0.02	31.4±0.65^{b}	95.1±1.01^{b}	227.2±2.42^{b}	332.9±7.05^{b}	404.9±4.71^{b}
5:1						
Tilapia	14.2±0.13	32.3±0.41^{a}	59.7±0.92^{a}	87.5±1.41^{a}	116.4±1.52^{a}	143.5±1.93^{a}
Common carp	2.0±0.02	28.2±0.55^{a}	95.9±0.80^{a}	242.7±1.21^{a}	387.8±1.59^{a}	461.4±1.78^{a}
Grass carp	2.9±0.02	34.8±1.04^{a}	80.5±1.21^{a}	201.7±1.63^{a}	295.3±1.59^{a}	363.3±1.92^{a}
Interaction between fertilization and stocking ratio:						
Inorganic fertilization:						
1:1						
Tilapia	14.1±0.15	30.7±0.55^{f}	54.3±0.92	100.1±0.69	137.3±0.72	187.5±1.80
Common carp	2.0±0.03	15.2±0.21^{e}	46.9±0.71	111.6±0.83	145.4±0.59	170.5±0.52
Grass carp	2.9±0.03	28.6±0.21^{d}	95.5±0.55	239.7±0.95	385.0±1.40	452.9±1.32
2:1						
Tilapia	14.0±0.10	33.7±0.52^{b}	61.2±1.21	99.1±0.69	137.3±0.68	170.1±0.11
Common carp	2.0±0.03	15.4±0.21^{e}	63.5±0.73	123.0±1.51	212.5±1.90	268.9±1.64
Grass carp	2.9±0.02	28.3±0.31^{d}	95.6±0.51	240.0±1.31	384.6±1.20	440.1±1.40
5:1						
Tilapia	14.1±0.21	34.5±0.60^{a}	64.6±0.81	97.1±0.65	126.0±0.54	156.8±0.82
Common carp	2.0±0.03	30.9±0.71^{a}	92.7±0.90	246.3±1.81	365.0±2.79	459.7±1.63
Grass carp	2.9±0.03	41.3±0.10^{a}	75.0±1.30	208.8±1.71	303.6±1.74	360.4±2.80

Table 3. Continued

Items	Body weight at M0	M1	M2	M3	M4	M5
Without inorganic fertilization:						
1:1						
Tilapia	14.3±0.20	31.0±0.60^{e}	61.3±0.90	93.4±0.81	132.3±1.10	161.6±1.21
Common carp	2.0±0.03	13.2±0.21^{e}	39.3±0.63	94.2±1.30	131.3±0.95	150.9±0.83
Grass carp	2.9±0.04	24.1±1.32^{e}	88.2±1.60	221.5±2.20	317.7±1.90	395.4±3.90
2:1						
Tilapia	14.4±0.20	31.2±0.61^{c}	55.5±0.92	84.2±0.95	114.3±1.50	138.9±1.70
Common carp	2.0±0.03	14.1±0.20^{c}	62.8±0.82	138.4±1.70	195.6±2.41	256.7±1.80
Grass carp	3.0±0.03	34.5±0.94^{c}	94.6±2.01	214.4±2.20	281.2±3.80	369.9±2.50
5:1						
Tilapia	14.3±0.15	30.0±0.13^{b}	54.9±0.80	78.0±1.00	106.9±1.50	130.1±1.61
Common carp	2.1±0.03	25.5±0.50^{b}	99.0±1.04	239.1±1.40	390.6±1.70	463.0±3.15
Grass carp	3.0±0.03	28.1±0.66^{b}	86.0±1.40	194.7±2.20	267.0±1.81	366.1±2.40

Table 4. Analysis of variance of live body weight as affected with fertilization and stocking ratio and their interactions.

SOV	df	Mean squares of M0	M1	M2	M3	M4	M5
Inorganic fertilization (F)	1	1.35	1184.29***	96.01	19296.26*	118726.01***	31672.0*
Stocking ratio (R)	2	0.02	2968.57***	9417.18***	58438.20***	169069.78***	241500.45**
F X R	2	0.04	844.24***	386.18	447.81	16012.42	12445.42
Error	534	31.33	55.34	348.23	3929.57	10421.17	14388.22

M = Month.
* P< 0.05, ** P< 0.01 and *** P< 0.001.

Table 5. Average fish daily body gain weight (g/d) as affected with fertilization and stocking ratio and their interactions.

Items	Daily body gain weight at M0-1	M1-2	M2-3	M3-4	M4-5	M0-5
Fertilization						
Inorganic fertilization:						
Tilapia	0.65	0.91	1.29	1.24	1.18	1.04
Common carp	0.61	1.57	3.08	2.91	1.73	1.98
Grass carp	0.99	1.86	4.69	4.27	1.86	2.73
Without inorganic fertilization:						
Tilapia	0.54	0.90	0.93	1.09	0.85	0.86
Common carp	0.52	1.64	3.00	2.70	1.70	1.92
Grass carp	0.86	2.02	4.02	2.83	2.72	2.49
Stocking ratio						
1:1						
Tilapia	0.55	0.89	1.29	1.39	1.20	1.06
Common carp	0.41	0.96	1.99	1.18	0.72	1.05
Grass carp	0.78	2.18	4.62	4.02	2.20	2.76
2:1						
Tilapia	0.61	0.86	1.11	1.14	0.95	0.93
Common carp	0.42	1.61	2.25	2.44	1.96	1.73
Grass carp	0.95	2.12	4.40	3.52	2.40	2.68
5:1						
Tilapia	0.60	0.91	0.92	0.96	0.90	0.86
Common carp	0.87	2.25	4.89	4.83	2.45	3.06
Grass carp	1.05	1.52	4.04	3.12	2.26	2.40
Interaction between fertilization and stocking ratio:						
Inorganic fertilization:						
1:1						
Tilapia	0.55	0.78	1.52	1.48	1.42	1.15
Common carp	0.44	1.05	2.15	1.12	0.83	1.12
Grass carp	0.85	2.23	4.80	4.84	1.83	2.90
2:1						
Tilapia	0.65	0.91	1.26	1.27	1.09	1.04
Common carp	0.44	1.60	1.98	2.98	1.88	1.77
Grass carp	0.84	2.24	4.81	4.82	1.85	2.91
5:1						
Tilapia	0.68	1.00	1.08	0.96	1.02	0.95
Common carp	0.96	2.06	5.12	4.60	2.49	3.05
Grass carp	1.28	1.12	4.46	3.16	1.89	2.38

Table 5. Continued.

Items	Daily body gain weight at M0-1	M1-2	M2-3	M3-4	M4-5	M0-5
Without inorganic fertilization:						
1:1						
Tilapia	0.55	1.01	1.07	1.29	0.97	0.98
Common carp	0.37	0.86	1.83	1.23	0.65	0.99
Grass carp	0.70	2.13	4.44	3.20	2.59	2.61
2:1						
Tilapia	0.56	0.81	0.95	1.01	0.81	0.83
Common carp	0.40	1.62	2.52	1.90	2.03	1.69
Grass carp	1.05	2.60	3.99	2.22	2.95	2.44
5:1						
Tilapia	0.52	0.83	0.77	0.96	0.77	0.77
Common carp	0.78	2.45	4.67	5.05	2.41	3.08
Grass carp	0.83	1.93	3.62	3.07	2.63	2.42

M = Month.

Table 6. Average fish daily body gain weight (g) per 100 g from live body weight as affected with fertilization and stocking ratio and their interactions

Items	Daily body gain weight / 100 g body weight at: M0-1	M1-2	M2-3	M3-4	M4-5	M0-5
Fertilization						
Inorganic fertilization:						
Tilapia	2.67	1.93	1.62	1.05	0.75	1.13
Common carp	5.48	3.56	2.70	1.29	0.63	1.31
Grass carp	5.58	3.07	2.46	1.45	0.48	1.33
Without inorganic fertilization:						
Tilapia	2.42	2.00	1.31	1.07	0.65	1.09
Common carp	5.31	3.88	2.68	1.37	0.64	1.31
Grass carp	5.42	3.41	2.68	1.12	0.60	1.31
Stocking ratio:						
1:1						
Tilapia	2.47	2.02	[illegible]	[illegible]	[illegible]	[illegible]
Common carp	5.14	3.40	2.75	[illegible]	[illegible]	1.33
Grass carp	5.34	3.70	2.67	1.38	0.57	1.31
2:1						
Tilapia	2.61	1.90	1.48	1.05	0.67	1.10
Common carp	5.00	4.10	2.30	1.46	0.83	1.31
Grass carp	5.50	3.30	2.70	1.25	0.65	1.31
5:1						
Tilapia	2.60	1.90	1.20	0.94	0.69	1.09
Common carp	4.76	3.60	2.80	1.50	0.57	1.32
Grass carp	5.65	2.60	2.86	1.20	0.68	1.30
Interaction between fertilization and stocking ratio:						
Inorganic fertilization:						
1:1						
Tilapia	2.30	1.80	1.97	1.20	0.85	1.14
Common carp	5.18	3.40	2.72	0.87	0.63	1.30
Grass carp	5.31	3.56	2.86	1.54	1.63	1.31
2:1						
Tilapia	2.75	1.93	1.57	1.07	1.09	1.13
Common carp	5.13	4.06	2.12	1.77	0.78	1.31
Grass carp	5.40	3.62	2.86	1.54	0.44	1.31
5:1						
Tilapia	2.79	2.02	1.33	0.86	0.70	1.11
Common carp	5.70	3.30	2.72	1.46	0.58	1.32
Grass carp	5.79	1.90	3.14	1.23	0.57	1.31

Table 6. Continued

Items	Daily body gain weight / 100 g body weight at: M0-1	M1-2	M2-3	M3-4	M4-5	M0-5
Without inorganic fertilization:						
1:1						
Tilapia	2.46	2.18	1.38	1.14	0.66	1.11
Common carp	4.95	3.29	2.74	1.09	0.46	1.29
Grass carp	5.23	3.80	2.87	1.18	0.72	1.31
2:1						
Tilapia	2.45	1.87	1.37	1.01	0.63	1.08
Common carp	5.02	4.22	2.50	1.14	0.90	1.31
Grass carp	5.61	3.10	2.58	0.89	0.90	1.31
5:1						
Tilapia	2.36	1.95	1.15	1.04	0.65	1.06
Common carp	5.65	3.93	2.76	1.60	0.56	1.32
Grass carp	5.40	3.35	2.58	1.27	0.80	1.31

M = Month.

Table 7 Average fish body length (cm) as affected with fertilization and stocking ratio and their interactions

Items	Body length at M0	M1	M2	M3	M4	M5
Fertilization						
Inorganic fertilization:						
Tilapia	10.1±0.21	13.9±0.26	16.2±0.30	18.0±0.40	21.0±0.17	23.0±0.34
Common carp	3.8±0.08	8.5±0.17	12.0±0.73	15.8±0.67	19.4±0.35	23.5±0.34
Grass carp	6.5±0.11	12.8±0.26	15.4±0.30	22.6±0.83	28.3±0.65	33.6±1.18
Without inorganic fertilization:						
Tilapia	10.6±0.15	14.2±0.3	15.7±0.14	17.8±0.29	20.1±0.26	21.9±0.27
Common carp	3.7±0.08	8.6±0.32	11.7±0.47	17.7±0.49	20.6±0.73	23.6±0.74
Grass carp	6.9±0.08	12.6±0.23	15.7±0.26	22.1±0.33	26.4±0.30	34.6±0.37
Stocking ratio:						
1:1						
Tilapia	10.3±0.21	[illegible]	15.6±0.20	18.6±0.23	21.1±0.15	23.3±0.40
Common carp	3.9±0.08	[illegible]	10.4±0.15	13.3±0.96	19.0±0.60	22.0±0.34
Grass carp	6.6±0.15	[illegible]	15.8±0.28	25.3±0.83	27.1±0.30	35.2±0.42
2:1						
Tilapia	10.2±0.21	14.7±0.10	16.4±0.35	18.6±0.17	20.6±0.35	22.5±0.28
Common carp	3.8±0.11	8.2±0.10	11.1±0.30	16.5±0.48	20.3±0.27	23.5±0.28
Grass carp	6.6±0.16	13.0±0.18	15.6±0.28	23.4±0.87	28.8±0.94	32.9±1.71
5:1						
Tilapia	10.5±0.31	13.7±0.35	15.8±0.24	17.2±0.55	20.1±0.36	21.6±0.35
Common carp	3.6±0.10	9.4±0.23	14.2±0.38	17.8±0.66	21.5±0.77	25.2±0.64
Grass carp	6.7±0.10	13.2±0.30	15.3±0.49	21.9±0.41	26.3±0.42	34.2±0.49
Interaction between fertilization and stocking ratio:						
Inorganic fertilization:						
1:1						
Tilapia	10.2±0.33	13.2±0.16	15.3±0.33	18.5±0.28	21.2±0.16	24.0±0.57
Common carp	4.0±0.01	8.3±0.16	10.5±0.28	13.8±0.44	19.7±1.01	22.5±0.50
Grass carp	6.3±0.01	12.0±0.28	16.0±0.50	20.3±1.16	27.5±0.28	35.2±0.60
2:1						
Tilapia	10.0±0.28	14.5±0.02	16.8±0.60	18.3±0.15	21.2±0.44	23.0±0.28
Common carp	3.8±0.16	8.1±0.13	10.7±0.44	15.5±0.28	20.0±0.28	24.0±0.28
Grass carp	6.5±0.28	13.0±0.28	15.7±0.44	24.8±1.30	30.5±1.04	31.7±1.60
5:1						
Tilapia	10.2±0.60	14.2±0.60	16.3±0.16	17.3±1.20	20.8±0.33	22.2±0.44
Common carp	3.5±0.06	9.2±0.20	14.8±0.44	18.2±0.60	20.2±0.60	24.0±0.57
Grass carp	6.7±0.16	13.5±0.28	14.5±0.28	22.7±0.44	27.0±0.57	33.8±0.60

Table 7. Continued

Items	Body length at M0	M1	M2	M3	M4	M5
Without inorganic fertilization:						
1:1						
Tilapia	10.5±0.30	14.5±0.28	15.8±0.16	18.7±0.44	21.0±0.28	22.7±0.16
Common carp	3.8±0.16	7.7±0.16	10.3±0.16	17.5±1.04	18.3±0.60	21.5±0.28
Grass carp	6.8±0.16	12.0±0.28	15.5±0.28	21.0±0.57	26.7±0.44	35.1±0.72
2:1						
Tilapia	10.5±0.28	14.8±0.16	16.0±0.28	17.7±0.16	20.0±0.28	22.0±0.28
Common carp	3.7±0.16	8.3±0.16	11.5±0.28	17.5±0.28	20.7±0.44	23.0±0.28
Grass carp	6.8±0.16	13.0±0.28	15.5±0.29	22.0±0.28	27.0±0.57	34.2±0.44
5:1						
Tilapia	10.8±0.16	13.2±0.16	15.3±0.18	17.0±0.28	19.4±0.23	21.0±0.28
Common carp	3.7±0.16	9.7±0.44	13.5±0.28	17.5±1.22	22.8±0.92	26.3±0.60
Grass carp	6.8±0.16	12.8±0.44	16.0±0.76	21.2±0.33	25.7±0.33	34.5±0.86

M = Month.

Table 8. Analysis of variance of body length as affected with fertilization and stocking ratio and their interactions.

SOV	df	Mean squares of					
		M0	M1	M2	M3	M4	M5
Inorganic fertilization (F)	1	0.85	0.01	0.72	1.07	6.8	0.01
Stocking ratio (R)	2	0.02	5.41	6.24	1.97	3.26	2.22
F X R	2	0.01	0.52	0.07	12.12	1.94	2.26
Error	48	8.37	6.64	5.06	8.95	14.12	34.52

M = Month

Table 9. Condition factor of fish as affected with fertilization and stocking ratio and their interactions

Items	Condition factor at					
	M0	M1	M2	M3	M4	M5
Fertilization						
Inorganic fertilization:						
Tilapia	1.33±0.06	1.24±0.03	1.51±0.02	1.71±0.14	1.49±0.03	1.41±0.03
Common carp	3.71±0.22	3.21±0.24	4.18±0.37	3.22±0.32	3.09±0.15	3.12±0.07
Grass carp	1.06±0.05	1.62±0.08	2.47±0.09	2.16±0.26	1.24±0.07	1.09±0.19
Without Inorganic fertilization:						
Tilapia	1.24±0.03	1.14±0.05	1.45±0.02	1.66±0.06	1.60±0.04	1.45±0.04
Common carp	3.98±0.27	2.63±0.07	3.82±0.07	2.50±0.23	2.80±0.28	2.07±0.16
Grass carp	0.94±0.03	1.43±0.03	2.35±0.07	2.21±0.11	1.57±0.06	0.91±0.03
Stocking ratio:						
1:1						
Tilapia	1.29±0.06	1.20±0.06	1.51±0.01	1.51±0.04	1.45±0.02	1.37±0.02
Common carp	3.38±0.25	2.65±0.07	3.91±0.15	3.21±0.51	3.52±0.30	2.45±0.10
Grass carp	1.06±0.07	1.54±0.03	2.39±0.09	1.43±0.32	1.41±0.06	0.88±0.02
2:1						
Tilapia	1.35±0.05	1.03±0.02	1.45±0.03	1.63±0.02	1.56±0.06	1.40±0.04
Common carp	3.85±0.31	2.71±0.03	4.00±0.37	2.89±0.16	2.78±0.03	2.04±0.05
Grass carp	0.95±0.03	1.40±0.05	2.44±0.08	1.89±0.20	1.24±0.13	1.20±0.29
5:1						
Tilapia	1.19±0.06	1.28±0.03	1.50±0.01	1.91±0.19	1.63±0.06	1.53±0.04
Common carp	4.23±0.23	3.40±0.35	3.44±0.23	2.47±0.32	2.63±0.26	1.80±0.15
Grass carp	0.98±0.04	1.63±0.12	2.40±0.14	2.42±0.14	1.56±0.07	0.93±0.04
Interaction between fertilization and stocking ratio:						
Inorganic fertilization:						
1:1						
Tilapia	1.35±0.01	1.33±0.02	1.51±0.03	1.55±0.04	1.46±0.03	1.37±0.05
Common carp	3.12±0.03	2.62±0.05	4.16±0.19	4.27±0.31	3.25±0.47	2.32±0.12
Grass carp	1.19±0.09	1.60±0.03	2.41±0.20	2.96±0.47	1.29±0.06	0.85±0.05
2:1						
Tilapia	1.42±0.09	1.15±0.01	1.52±0.09	1.59±0.04	1.48±0.05	1.39±0.04
Common carp	3.61±0.41	2.86±0.10	5.39±0.43	3.19±0.20	2.90±0.06	1.95±0.06
Grass carp	0.97±0.04	1.36±0.05	2.36±0.15	1.52±0.24	0.99±0.10	1.48±0.58
5:1						
Tilapia	1.21±0.14	1.23±0.06	1.50±0.02	1.98±0.42	1.55±0.07	1.47±0.06
Common carp	4.40±0.02	4.15±0.10	2.99±0.24	2.19±0.18	3.12±0.20	2.10±0.12
Grass carp	1.01±0.07	1.89±0.09	2.65±0.10	2.00±0.11	1.43±0.09	0.95±0.03

Table 9. Continued

Items	Condition factor at					
	M0	M1	M2	M3	M4	M5
Without Inorganic fertilization:						
1:1						
Tilapia	1.23±0.14	1.06±0.04	1.51±0.01	1.48±0.08	1.45±0.04	1.37±0.01
Common carp	3.63±0.51	2.67±0.16	3.66±0.11	2.16±0.35	3.78±0.35	2.59±0.13
Grass carp	0.94±0.07	1.48±0.03	2.37±0.05	1.91±0.13	1.52±0.08	0.90±0.05
2:1						
Tilapia	1.34±0.05	1.03±0.01	1.35±0.01	1.67±0.03	1.63±0.06	1.40±0.07
Common carp	4.15±0.051	2.56±0.06	3.94±0.10	2.59±0.08	2.67±0.15	2.13±0.05
Grass carp	0.94±0.07	1.44±0.09	2.51±0.07	2.25±0.07	1.49±0.11	0.91±0.04
5:1						
Tilapia	1.16±0.04	1.33±0.02	1.49±0.01	1.84±0.08	1.72±0.06	1.59±0.07
Common carp	4.15±0.51	2.65±0.25	3.88±0.14	2.76±0.64	2.15±0.25	1.50±0.06
Grass carp	0.94±0.07	1.36±0.04	2.15±0.17	2.48±0.20	1.70±0.06	0.90±0.07

M = Month.