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EFFECT OF DIFFERENT HUSBANDRY METHODS ON WATER QUALITY AND GROWTH OF SOME FRESHWATER FISHES

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Key words: Fish, tilapia, common carp, silver carp, water quality, growth chemical fertilizer

ABSTRACT

This study was conducted jointly at the Central Laboratory for Aquaculture Research (CLAR) and Faculty of Agriculture, Cairo University. The experiment included six treatments. The first treatment included the application of supplemental diet (17% CP), The second treatment included the application of complete diet (25% CP). Both diets were administrated at a rate of 3% of fish body weight per day. The third treatment included a biweekly application of nitrate and triple super phosphate(ammonium nitrate 33% N and TSP 37% P2O5) at high dose at a rate of 10.61 and 4.72 kg/pond, respectively. The fourth treatment included a biweekly application at a medium dose at a rate of 5.3 and 2.36 kg/pond. The fifth treatment included a biweekly application at a low dose at rate of 2.65 and 1.18 kg/pond. The sixth treatment was considered as a control treatment with no addition of nutritional or fertilizer inputs.

Water temperature in the experimental ponds was below the thermal requirements of fish for optimal growth during winter season and of medium magnitude during fall and spring and close to the optimal thermal range for growth during summer season.

Water in experimental ponds was characterized by high alkalinity (263.11 – 490.0 mg/l), high hardness (180.79 – 339.16 mg/l) and high pH values (8.58 – 9.8) among treatments during the course of the experiment.

Dissolved oxygen under the experiment was within the optimal level for growth of cultivated fishes. The overall average of total ammonia concentration in pond water during the experimental period indicated that high dietary protein treatment had an over abundance of ammonia (1.32 mg/l) followed by the high (0.78 mg/l),medium(0.52 mg/l) and low (0.40 mg/l) fertilizer treatments, respectively. The shallow Secchi disk readings during summer season in the high dietary protein treatment was due to the effect of over abundance of ammonia in water on algae growth enhancement rather than nitrate effect.

Nitrate (NO3-N) content in water increased from 0.14, 0.26 and 0.24 mg/l during fall at the start of the experiment to 0.23, 0.13 and 0.37 mg/l during summer season at the end of the experiment for the control, the low dietary protein and the high dietary protein treatments, respectively. Nitrate contents in water in the low, medium and high fertilizer treatments were 0.65, 0,86 and 1.44 mg/l in summer at the end of the experiment.

Chemically fertilized ponds had higher total phosphorus ($P<0.05$) compared to treatments fed the experimental rations and the control ponds.

The results of the present study indicated a super abundance of algae in all fertilizer treatments over that of the ration and control treatments in all seasons. The control treatment had the lowest algae turbidity compared to that of the ration treatments. In contrast to tilapia and common carp, silver carp grew higher in the higher fertilizer treatment compared to the feed treatments. There was a tendency for silver carp to decrease in harvest size with the decrease in fertilizer dose.

INTRODUCTION

Protein is the most expensive component in most fish feeds and accounts for as much as 40-70% of aquaculture operating costs. Thus, protein utilization has been the main focus of research into the nutrient requirement of fish species. The optimum dietary protein level for young *O. niloticus* was found to be 30% (Siddiqui *et al.*, 1988). De Silva and Perera (1985) found that best growth of tilapia with 28-30% protein level diets (Wang *et al.*,1985) reported that better growth with 30% protein over a diet containing 40% and the maximum growth was obtained with a diet containing 25% protein fed at a rate of 3.5% body weight per day.

A 90 day growth trial was conducted with common carp. *Cyprinus carpio* L.,to test the suitability of mixed feeding using a plant-based low-protein diet (16% -diet A), and fish-meal-based diets of 25% protein (diet B) and 31% protein (diet C). The study supports the view that fish can be fed alternately with animal-and plant-protein-based diets of varied protein levels. This practice would help to reduce protein input, and would contribute to the efficient utilization of low-quality, plant-protein-based diets (Nandeesha *et al.*, 1995).

A study of the effects of slurry inorganic and organic fertilizers on the production of phyto-and zooplankton in earthen ponds was conducted in Central Scotland, UK over a period of one year. For the inorganic fertilization, replicate ponds were treated with low and high phosphorus, high phosphorus and nitrogen, while the organic fertilization replicate treatments were low and high chicken manure and combination of high and cow manure. Each of fertilization programs had 2 untreated controls, without fertilizer.All the inorganic treatments produced significantly more Bacillariophyceae (diatoms), Chlorophyceae (green algae) and Cyanophyceae (blue –green algae) than the untreated controls, but high phosphorus and nitrogen produced vastly more algae than the others (Wade & Stirling, 1999).The specific growth rate of the common carp fish was significantly increased by increases in the level of natural food. The data also indicate that some fish drive a high proportion of their food from plankton organisms, rather from supplement feed. These fish maintain rapid growth even though they compete poorly for supplement (Wahlam & Shephard, 1988).

The present study aimed at testing the effect of different fertilizer doses on natural food production and fish growth under low stocking density of fish.

MATERIALS AND METHODS

This study was conducted in six experimental earthen ponds (3500 m2) at the Central Laboratory for Aquaculture Research (CLAR), Abbassa, Sharkia, Agriculture Research Center. The duration of the experiment was 319 days from 15 August 1998 to 1st

July 1999 inclusive of Fall (wk1 to wk14), Winter (wk15 to wk28), Spring (wk29 to wk40) and Summer season (wk41 to wk46).

Three fish species were cultivated in a polyculture system, namely common carp, *Cyprinus carpio*, silver carp, *Hypophthalmichthys molitrix*, and tilapia, *Oreochromis niloticus*.

The ponds were of the same surface area (3500 m2), with an average depth of 1 m. the experiment included six treatments (Table 1). The first treatment included the application of supplemental diet (17% CP). The second treatment included the application of complete diet (25% CP).Both diets were administered at the rate of 3% of fish body weight per day (Table 2). The third treatment included a biweekly application of nitrate and triple super phosphate (ammonium nitrate 33% N and triple super phosphate TSP 37% P2O5) at high dose at a rate of 10.61 and 4.72 kg/pond, respectively. The fourth treatment included a biweekly application of N and TSP at a medium dose5.3 and 2.36 kg/pond, respectively. The fifth treatment included a biweekly application at low dose of 2.65 and 1.18 kg/pond, respectively. The sixth treatment was considered as a control treatment with no addition of nutritional or fertilizer inputs.

Each treatment received a stocking density of one unit/ m2 divided among three fish species, silver carp (0.1 unit/ m2) with a mean stocking weight of 6.0 g/fish, common carp (o.3 unit/m2) with a mean stocking weight of 3.0 g/fish and tilapia (0.6 unit/m2) with a mean stocking of 17.5 g/fish. The overall stocking density was 3500 units/pond.

Water from each pond was tested once a week for temperature, dissolved oxygen (DO),secchi disk visibility(SD), pH, total ammonia, total alkalinity, total hardness (TH), total phosphorus (TP), nitrate nitrogen (NO3-N) and electric conductivity (E.C) according to the Standard Methods, American Public Health Association (APHA) (1993) and Boyd (1990).

Fish samples (20 fish per species) were collected every month from each pond . Growth performance data were calculated according to the following formulas:

Body weight (Wt) (g) was measured at the end of each interval.

Statistical analysis was performed using the analysis of variance and Duncan's range test to determine differences among treatment means at a significance of 0.05. Means (X) and standard deviations (S.D) and coefficient of variability (C.V.) were calculated using SAS (1996 – 2000).

RESULTS AND DISCUSSION

Water quality

The average water temperature for all treatments ranged from 19.75 - 20.43°C during fall, 14.41 - 14.84°C during winter, 20.59 - 21.71°C during spring and 24.06 - 24.6 °C during summer seasons, respectively. Water temperature in experimental ponds was below the thermal requirements of fish for optimal growth during winter season, of medium magnitude during fall and spring and close to optimal thermal range for growth during summer season (Fig. 1). Warm water species which are native to temperate climates grow best at temperatures between 20 and 28 °C (Boyd, 1990).

Water in experimental ponds were characterized by high alkalinity (263.11 - 490.0 mg/l), high hardness (180.79- 339.16 mg/l) and high pH values (8.58 - 9.8) among treatments during the course of the experiment (Figs.2,3 & 4). This along with high phytoplankton turbidity indicated by shallow Secchi disk expressed an intense photosynthesis especially in high fertilizer and high dietary protein treatments. Anderson (1993) reported that excessive fertilization may cause elevated pH and toxic concentrations of unionized ammonia.

During most of the experiment, both total alkalinity and pH values in all treatments were within the range that permits bicarbonate as a single ion to dominate the carbonate-bicarbonate system with negligible carbonate ion.

The high calcium carbonate content of water in the experimental ponds during the growing season may be due to either the nature of the bed-rock surrounding experimental ponds or the natural calcium carbonate content in water coming from Ismailia canal. Alkalinity values were higher by a range of 23.36 - 82.93 % over that of the hardness values in water in experimental ponds. This could be due to the presence of monovalent ions such as sodium and potassium in combination with carbonate, which adds to total alkalinity. It can be concluded that the experiment was conducted in a hyper alkalinity habitat which was caused by the natural composition of bed-rock mineralogy in the region.

Oxygen levels in all treatments ranged (4.7 - 8.0 mg/l) during the experiment. Dissolved oxygen under the present study was within the optimal level for growth of cultivated fishes (Fig. 5). In this respect, Boyd (1990) mentioned that to sustain a fish population, the dissolved oxygen may be less than 5 mg/l for a period, of not more than 8 hr out of any24 hr period, but at no time shall the concentration be lower than 2 mg/l.

Nitrogen salts were measured in the forms of total ammonia and nitrate. The rate of ammonia production in fertilizer treatments increased with increasing fertilizer dose and there was a tendency to accumulate ammonia salts in these ponds over time (Figs. 6 & 7). The overall average of total ammonia in pond water during the experimental period indicated that high dietary protein treatment had an over abundance of ammonia (1.32 mg/l) followed by the high (0.78 mg/l),medium(0.52mg/l)and low(0.40 mg/l)fertilizer treatments, respectively. The control and low dietary protein treatments were equal in terms of ammonia production during the experimental period having nearly an equal ammonia concentration (0.32 and 0.32 mg/l, respectively). Normally 60 –90% of waste nitrogen of fish is excreted branchically as ammonia (Foster & Goldstein, 1969). Consequently, the high protein diet released more ammonia than the low protein diet especially under high water temperature and high ration inputs late in the growing season.

The shallow Secchi disk readings during summer season in the high dietary protein treatment was due to the effect of over abundance of ammonia in water on algal growth enhancement rather than nitrate effect.

Nitrate ($NO3-N$) content in water increased from 0.14, 0.26 and 0.24 mg/l during fall at the start of the experiment to 0.23, 0.31 and 0.37 mg/l during summer season at the end of the experiment for the control, the low dietary protein and the high dietary protein treatments, respectively. At the start of the experiment, nitrate content in water was0. 29, 0.35 and 0.47 mg/l in low, medium and high fertilizer treatments, respectively. This was sharply increased to 0.65, 0.86 and 1.44 mg/l in summer at the end of the experiment due to the gradual accumulation of surplus of this salt over time in chemically fertilized ponds.

Chemically fertilized ponds had higher total phosphorus ($P<0.05$) compared to the rations and the control ponds (Fig. 8). The sources of total phosphorus in ration ponds were primarily as a product of dietary phosphorus metabolism. The surplus phosphorus accumulated in water in ration ponds over time resulted in a slight increase in total phosphorus content from the beginning of the experiment (0.1–0.15 mg/l) during fall season to the end of the experiment (0.22 – 0.27 mg/l) during summer season. The total phosphorus content in the control treatment increased from 0.04 mg/l during fall season to 0.23 mg/l during summer season at the end of the experiment. The total phosphorus content during fall in the low, medium and high fertilizer treatments averaged 0.19, 0.22 and 0.29 mg/l respectively, and increased gradually to o.59, 0.81 and 1.0 mg/l respectively, by the end of the experiment during summer season. Chemically fertilized ponds had higher total phosphorus ($P<0.05$) compared to the ration and control ponds. Fertilizers often are applied to increase phytoplankton growth and enhance availability of natural food organisms (Massaut, 1999).

Electric conductivity of water tended to be higher in fertilizer treatments, 0.689–0.773m.mohs/cm, than that of the ration treatments which ranged 0.645 – 0.646m mohs/cm. The control treatment had the least electric conductivity during the experimental period, averaging 0.56m mohs/cm due to the absence of artificial sources of minerals added to this treatment (Fig. 9).Earthen ponds treated with chemical fertilizer had shallower Secchi disk reading compared to those ponds treated with supplemental (17% CP) or complete diet (25%). Algal abundance as a source for fish nutrition was present at higher concentration treatments compared to the control treatment (Figure10).This was indicated by the shallower Secchi depth in ration treatments during the overall ($X = 21.3 - 21.7$ cm) when compared to that of control treatment ($X = 24.4$ cm). However, the fertilizer treatments had an over abundance of algae compared to the ration treatments indicated by the shallowest Secchi disk reading ($X = 15.05$ cm) as overall averages for the wholeexperiment.

The effect of protein content did not show significant differences in Secchi disk visibility among treatments during fall, winter and spring seasons. However, Secchi disk visibility was shallower in the 25% crude protein treatment (17.08 cm) compared to that of the 17% crude protein treatment during summer season.

Algae were the only source for nutrition in chemically fertilized ponds and the decreased secchi disk visibility in these treatments indicated a good potential for fish nutrition compared to control treatment, which had lower alga turbidity. There was a general tendency towards an increase in algae turbidity with increasing fertilizer dose in all seasons during the experiment. Both ration and algae constituted the sources of nutrition for fish in the ration treatments.

The results of the present study indicated a super abundance of algae in all fertilizer treatments over that of the ration and control treatments in all seasons. The control treatments had the lowest algal turbidity compared to that of ration treatments. The difference in algal abundance among treatments was more pronounced during summer season due to the combined effect of increased solar radiation and water temperature during that season coupled with a varied level of gradual accumulation of nitrogen and phosphorus salts in different treatments. Jamu *et al.*(1999) reported that Secchi disk visibility (SDV) is commonly used by aquaculture pond manger an as an indicator of phytoplankton concentration.

Body weight

Tilapia

Starting from an average weight of 17.5 g/fish at stocking, tilapia grew to a size of 94.45 – 274.0 g/fish by the end of the experiment depending on treatment (Table 3). The lowest average harvest weight for tilapia (94.4 g) was obtained under the control treatment where no nutritional inputs were applied. The ration treatments gave the highest average harvest weight, 274.0 g/fish for the high dietary protein and 261.15 g/fish for the low dietary protein treatments, respectively. Diana *et al.*, (1988) studied in Thailand that 8-12 ponds (250 m2) were stocked with all-male *Oreochromis niloticus* (25-35g) at a density of 1 fish/m^3. Monthly net fish yield was strongly correlated to physiochemical variables rainfall, Secchi disk depth, total phosphorus and water temperature included in the regression ($r^2 = 0.60$).

Tilapia reached an intermediate size in the fertilizer treatments ranging from 146.35 to 206.75g/fish by the end of the growing season. Being highest with high fertilizer dose and lowest for low fertilizer dose. This size was lower than that obtained under ration treatments and higher than that of the control treatment (Table 3).

In this respect, Nguenga *et al.*(1997) reported that the chemical fertilizers stimulate the natural productivity through photosynthesis. Traditional tilapia farming was limited to fertilizers, now a days tiliapia husbandry requires aquafarmers to stock fish at densities higher than could be supported by the natural productivity. The use of feeds in aquaculture systems has increased production and profits considerably. Their amount are 50% or more of the variable cost of most fish culture operation (Alceste & Jory, 2000). Consequently, it was concluded that the ration treatments yielded heavier fish than those of the fertilizer treatments.

Common carp

By the end of the experiment, common carp grew to a heavier size 133.58% more than that of tilapia as within species overall average of all treatments.

The dietary protein treatments gave the highest average weight (331.5 – 346.75 g/fish) (Table 4). Common carp responded favorably to the ration treatments compared to that of the fertilizer treatments. The differences in average final harvest weight between the ration treatments and the fertilizer treatments were statistically significant ($P<0.05$). Debeljak et al.,(1995) found that carp, *Cyprinus carpio*, was reared under the conditions of polyculture with silver carp, *Hypohalmichthys molitrix*, big head, *Aristichthys noblilis*, grass carp. The average individual weight of carp was 30% bigger in the fish pond with fertilization, and 145% in fish pond with feeding carp with pellets containing 20% protein of animal origin in comparison to control.

The three fertilizer treatments gave statistically different harvest sizes of common carp ($P<0.05$). The high, medium and low fertilizer treatments yielded an average final weight at harvest of 291.9,256.9and 192.0 g/fish, respectively. The lowest average harvest weight per fish was obtained under the control treatment (128.75 g/fish) where no input was applied.

There was a slight insignificant effect of protein level in the diet on size of common carp at harvest ($P<0.05$). The high dietary protein treatment produced slightly heavier fish (104.6%) than that of the low dietary protein treatment which indicate no effect of dietary protein level on growth rate of common carp.

Silver carp

In contrast to tilapia and common carp, silver carp grew higher in the high fertilizer treatment compared to feed treatments. Silver carp in the high fertilizer treatment was heavier (339.0 g/fish : $P<0.05$) compared to both the low and high dietary protein treatments which had lower harvest size of 284.0 and 289.5 g/fish, respectively (Table 5). This may be due to that silver carp is efficient in natural food consumption and utilization compared to other species.

Silver carp change its feeding habits with growth, from a general planktonic feeder to a selective phytophagous one (Woynarovich, 1975). Wang et al.(1989) attributed these changes in feeding habits to development of filtering apparatus of filter feeders.

There was a tendency for silver carp to decrease in harvest size with the decrease in fertilizer dose. The high, medium and low fertilizer treatments yielded an average final weight of silver carp at harvest of 339.0, 266.3 and 194.7 g/fish respectively. The differences among all fertilizer treatments were statistically significant ($P<0.05$).This was due to the decrease in natural food availability and fish growth with the decrease in the fertilizer dose.

The dietary protein content did not have any significant effect on harvest size of silver carp ($P<0.05$). Silver carp grew to a size of 284 and 289.5 g/fish in low and high dietary protein treatments, respectively.There were no statistical differences between those treatments. The protein content in the diet did not affect the final harvest size of silver carp.

This may indicate that silver carp was able to highly utilize algal feed produced in high fertilizer treatment than the prepared diet in the ration treatments for producing heavier fish. This was evident when comparing final individual harvest weight in these treatments.

The ability of silver carp to feed on phytoplankton makes this fish especially suitable for polyculture (Smith,1988).Stocking lakes or ponds with silver carp has therefore been viewed as a biological means of regulating phytoplankton abundance (Laws & Weisburd, 1990).

Expected Yield

Expected harvest from experimental ponds was simulated using a natural mortality rate of fish 30% for all species in chemical fertilizer treatments and 15% for all species in ration treatments. The expected yield in the ration treatments amounted to 1024.8 and 1070.5 kg/pond in the low and high dietary protein, respectively (Table 6). While expected yield for high, medium and low fertilizer treatments were 686.7,577.1 and 461.6 kg/pond, respectively. The control treatment had the lowest expected harvest of 295.3 kg/pond compared to all treatments.These results

indicated that the expected harvest of the high fertilizer treatment was 49.23% and 55.89% compared to that of the ration fed fish.

It could be stated that common carp and silver carp were efficient in natural food utilization compared to tilapia in terms of growth rate and final harvest weight per treatment.

It can be concluded that in case of limited operating financial resources and low cost of aquaculture lands, the use of high dose chemical fertilizer would be economic under low stocking density of fish (1 fish/m^2) compared to the use of expensive feed components. The expected harvest from the high fertilizer treatment was equal to fish harvest obtained by Yusoff & McNabb (1989) (1034 kg/ha and 1713 kg/ha).

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Table (1) Experimental design of the husbandry methods.

Treatments	Stocking rate and combination
T1 = Supplemental diet (17% crude protein) administrated at 3% of standing stock/day	2100 units of tilapia 1050 units of c/c 350 units of s/c
T2 = Complete diet (25% crude protein) administrated at 3% of standing stock /day	2100 units of tilapia 1050 units c/c 350 units s/c
T3 = 10.61 kg ammonium nitrate (33% nitrogen) and 4.72 kg TSP (37% P_2O_5) per pond per 14 days (high fertilizer dose).	2100 units of tilapia 1050 units c/c 350 units s/c
T4 = 5.3 kg ammonium nitrate (33% nitrogen) and 2.36 kg TSP (37% P_2O_5) per pond per 14 days (medium fertilizer dose).	2100 units of tilapia 1050 units c/c 350 units s/c
T5 = 2.65 kg ammonium nitrate (33% nitrogen) and 1.18 kg TSP (37% P_2O_5) per pond per 14 days (low fertilizer dose).	2100 units of tilapia 1050 units c/c 350 units s/c
T6 = blank without any treatment (control)	2100 units of tilapia 1050 units c/c 350 units s/c

- T1 and T2 = pelleted fish feed adjusted to 3% of standing stock of fish adjusted on monthly basis.
- Experimental unit (one earthen pond) = 100.0 x 35.0 x 1.0m depth.

Table (2): Composition of two diets fed during grow out period as ration treatments.

Item	Diets	
	25% C.P.	17% CP
Dry matter (DM%)	91.5	88.8
Crude protein (CP%)	24.92	17.02
Ether extract (EE%)	10.93	10.64
Ash %	9.44	8.55
Crude fiber (CF%)	4.95	11.43
Nitrogen free extract (NFE%)	49.76	52.36
Gross energy (Kcal./kg feed)	4201.42	4663.0

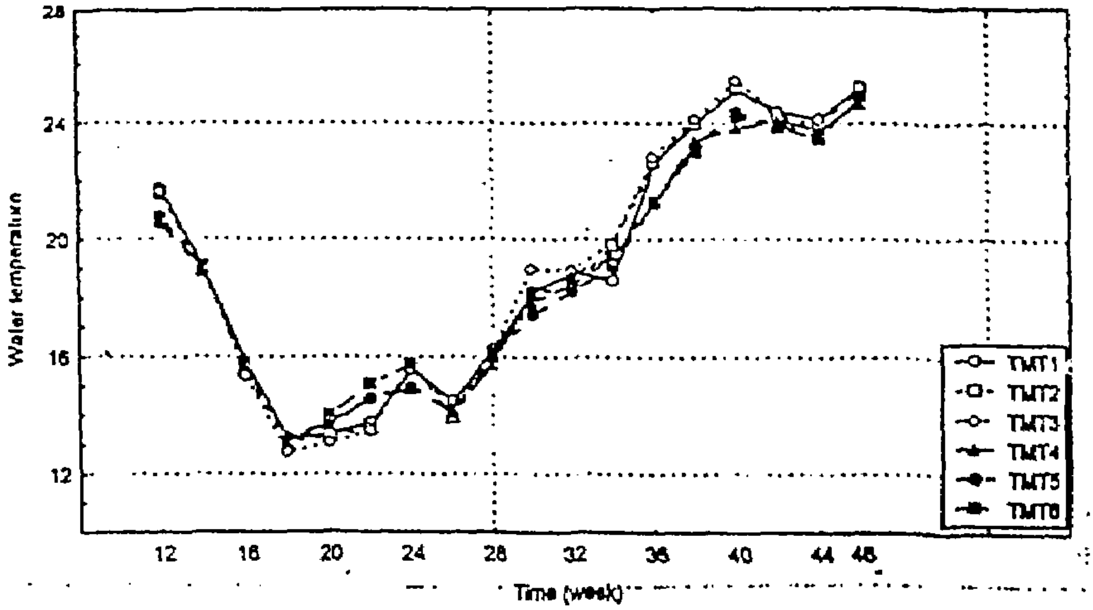

Fig. (1): Average water temperature (°C)) under different feed and fertilizer treatments as a function of time during the experimental period

TMT1: 17% C.P. TMT2: 25% C.P. TMT3: 1g N/m²
TMT4: 0.5 g N/m² TMT5: 0.25g N/m² TMT6: control

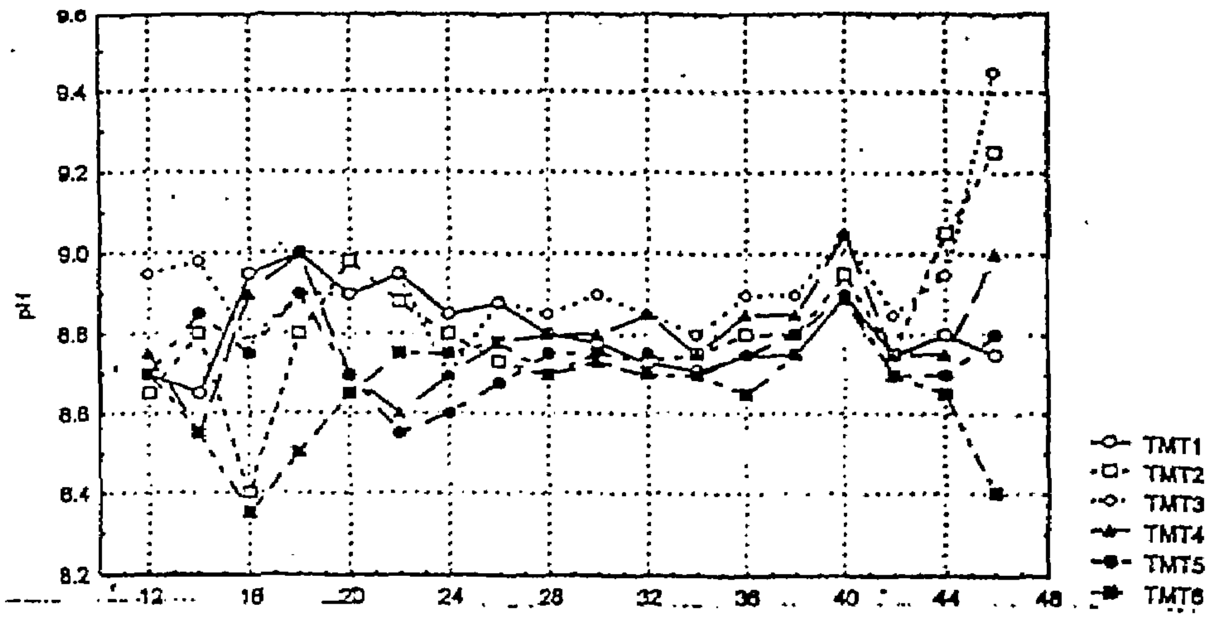

Fig. (2) :Mean of pH values under different feed and fertilizer treatments during the experimental period.

TMT1: 17% C.P. TMT2: 25% C.P. TMT3: 1g N/m²
TMT4: 0.5 g N/m² TMT5: 0.25g N/m² TMT6: control

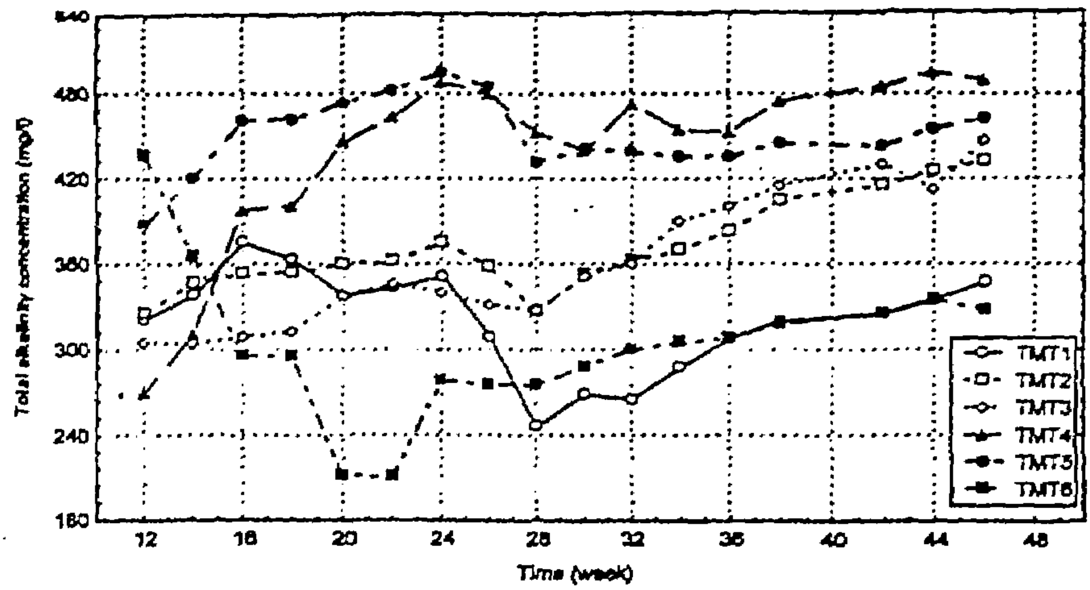

Fig. (3): Total alkalinity (expressed as mg $CaCO_3$/l) observed in pond water under different feed and fertilizer treatments during the experimental period.

TMT1: 17% C.P. TMT2: 25% C.P. TMT3: 1g N/m²
TMT4: 0.5 g N/m² TMT5: 0.25g N/m² TMT6: control

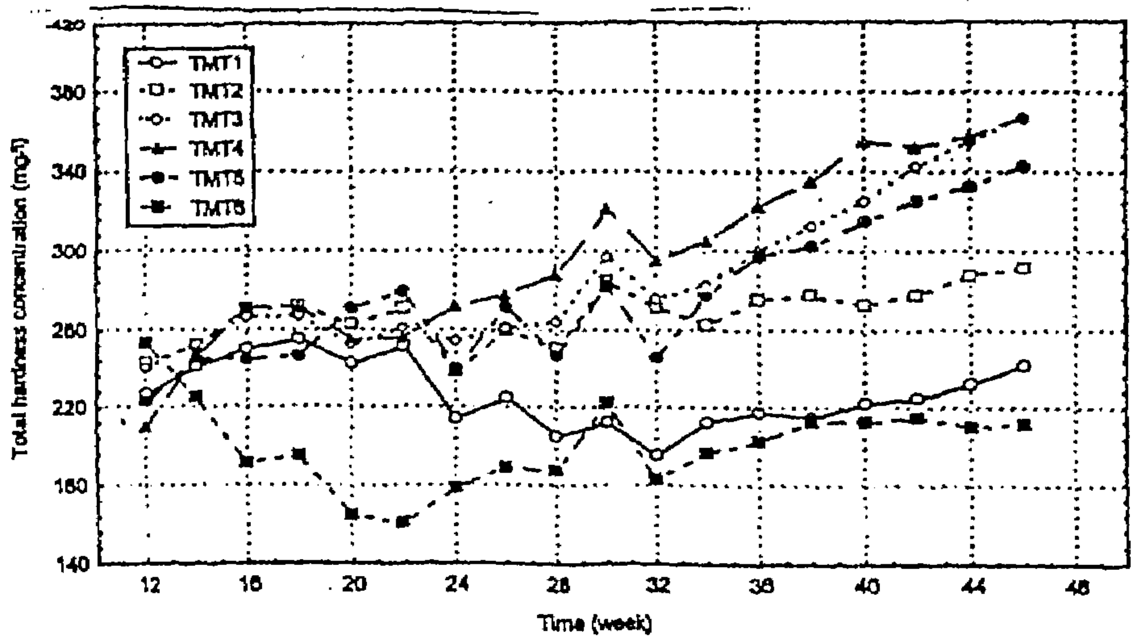

Fig. (4): Mean of total hardness (expressed as mg $CaCO_3$/l) in pond water subjected to different feed and fertilizer treatments during the experimental period.

TMT1: 17% C.P. TMT2: 25% C.P. TMT3: 1g N/m²
TMT4: 0.5 g N/m² TMT5: 0.25g N/m² TMT6: control

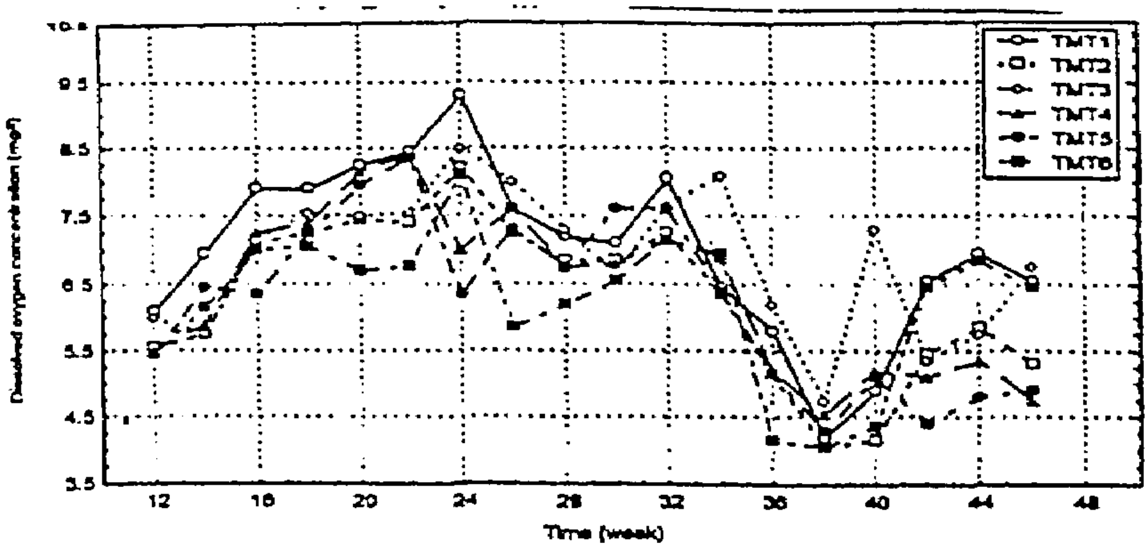

Fig. (5) :Concentrations of dissolved oxygen (mg/l) in water in earthen ponds treated with different feed and fertilizer treatments during the experimental period.

TMT1: 17% C.P. TMT2: 25% C.P. TMT3: 1g N/m³
TMT4: 0.5 g N/m² TMT5: 0.25g N/m² TMT6: control

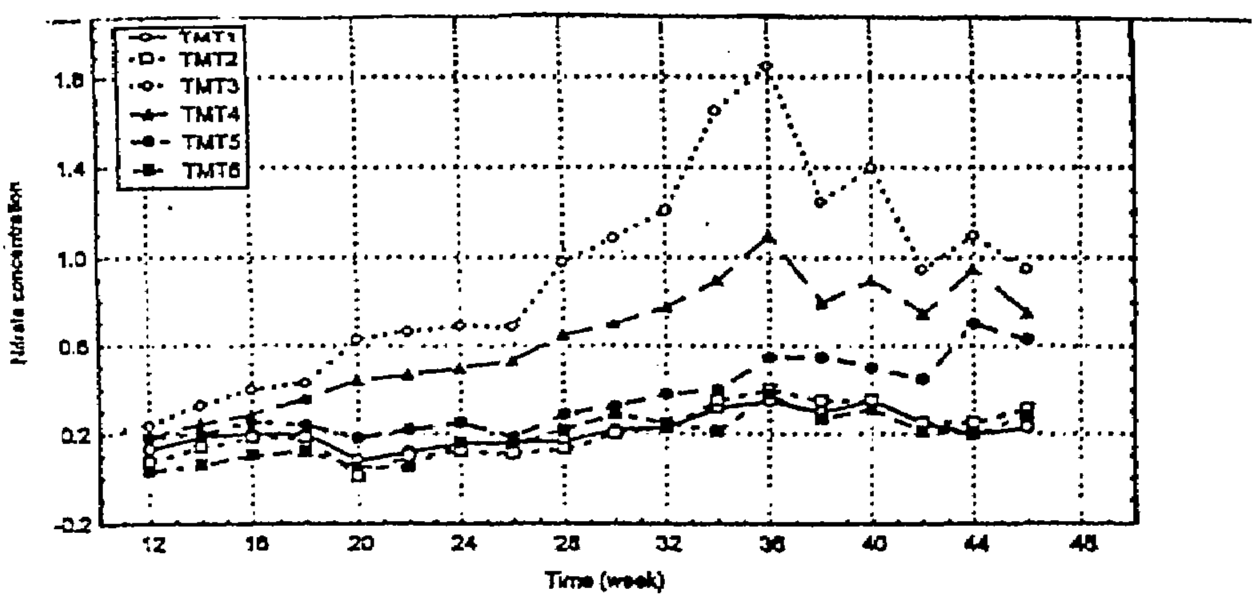

Fig.(6) :Average concentrations of nitrate (mgNO3-N/l) in water earthen ponds treated with different feed and fertilizer treatments during the experimental period.

TMT1: 17% C.P. TMT2: 25% C.P. TMT3: 1g N/m³
TMT4: 0.5 g N/m² TMT5: 0.25g N/m² TMT6: control

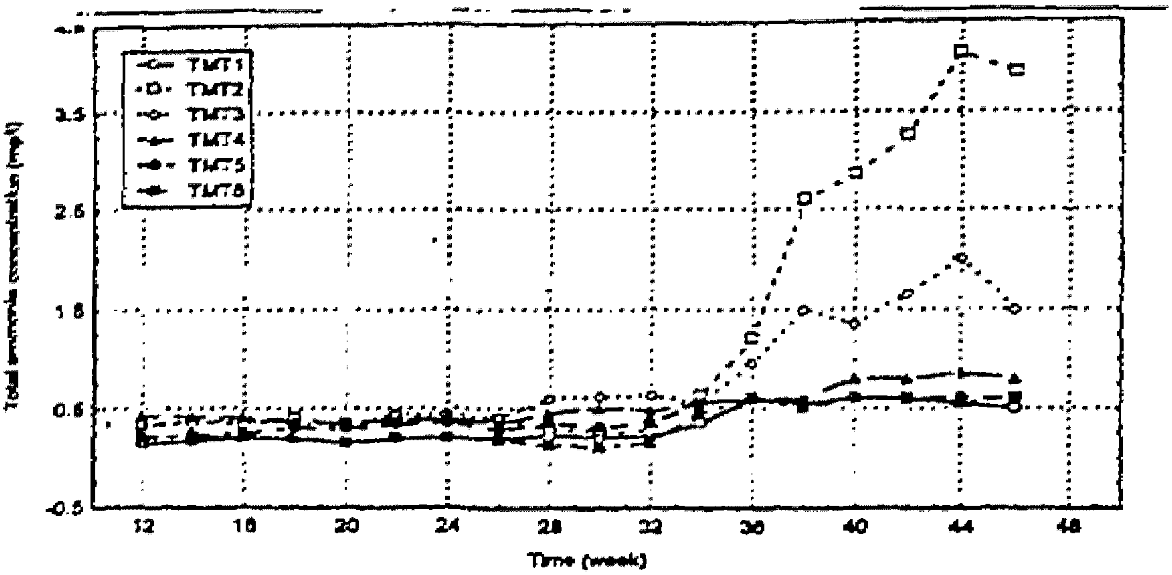

Fig. (7) Total ammonia concentrations (mg-N/l) as a function of time under different feed and fertilizer treatments during the experimental period.

TMT1: 17% C.P. TMT2: 25% C.P. TMT3: 1g N/m^2
TMT4: 0.5 g N/m^2 TMT5: 0.25g N/m^2 TMT6: control

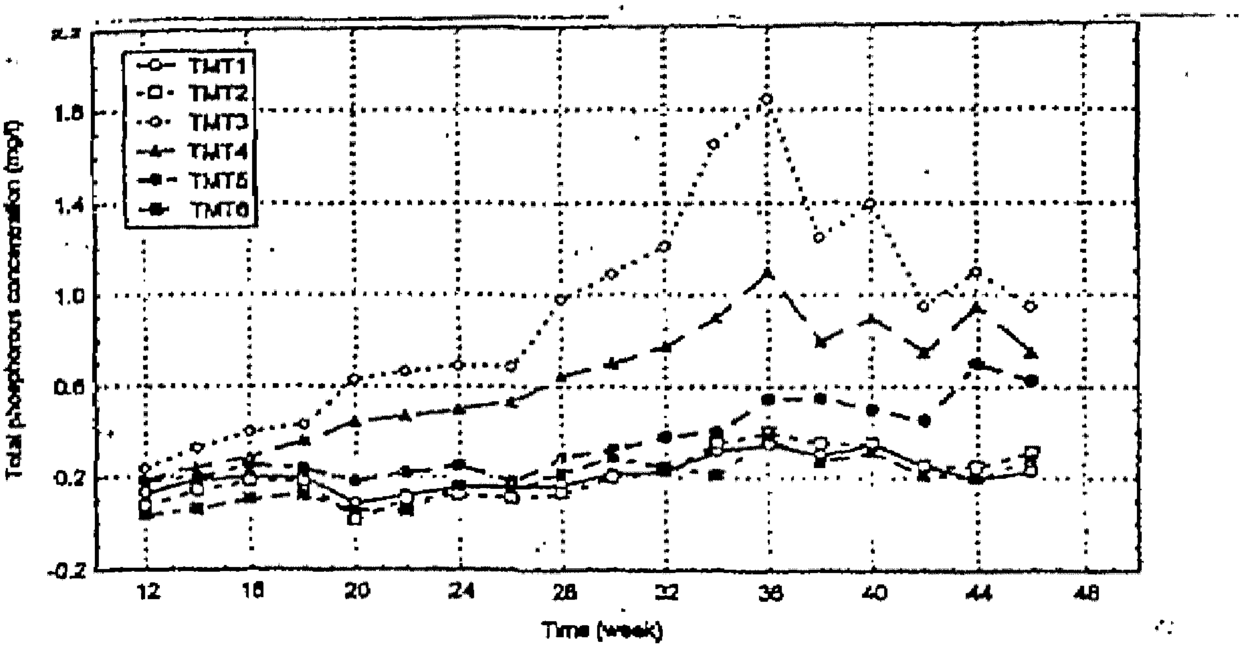

Fig. (8):Average concentrations of total phosphorous (mg.-P/l) in water in earthen ponds treated with different feed and fertilizer treatments during the experimental period.

TMT1: 17% C.P. TMT2: 25% C.P. TMT3: 1g N/m^2
TMT4: 0.5 g N/m^2 TMT5: 0.25g N/m^2 TMT6: control

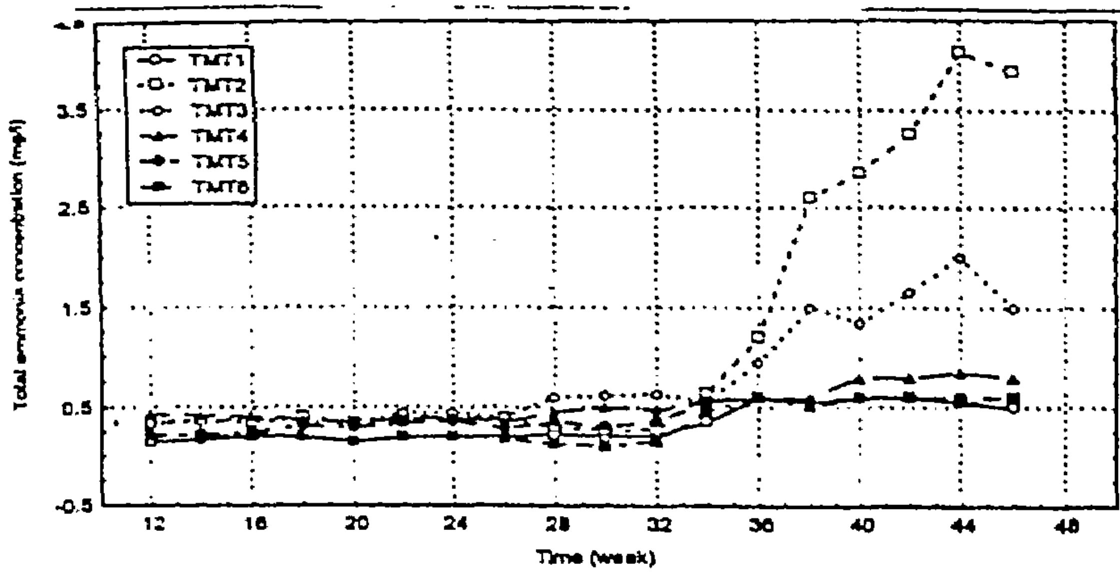

Fig. (7) Total ammonia concentrations (mg-N/l) as a function of time under different feed and fertilizer treatments during the experimental period.

TMT1: 17% C.P. TMT2: 25% C.P. TMT3: 1g N/m²
TMT4: 0.5 g N/m² TMT5: 0.25g N/m² TMT6: control

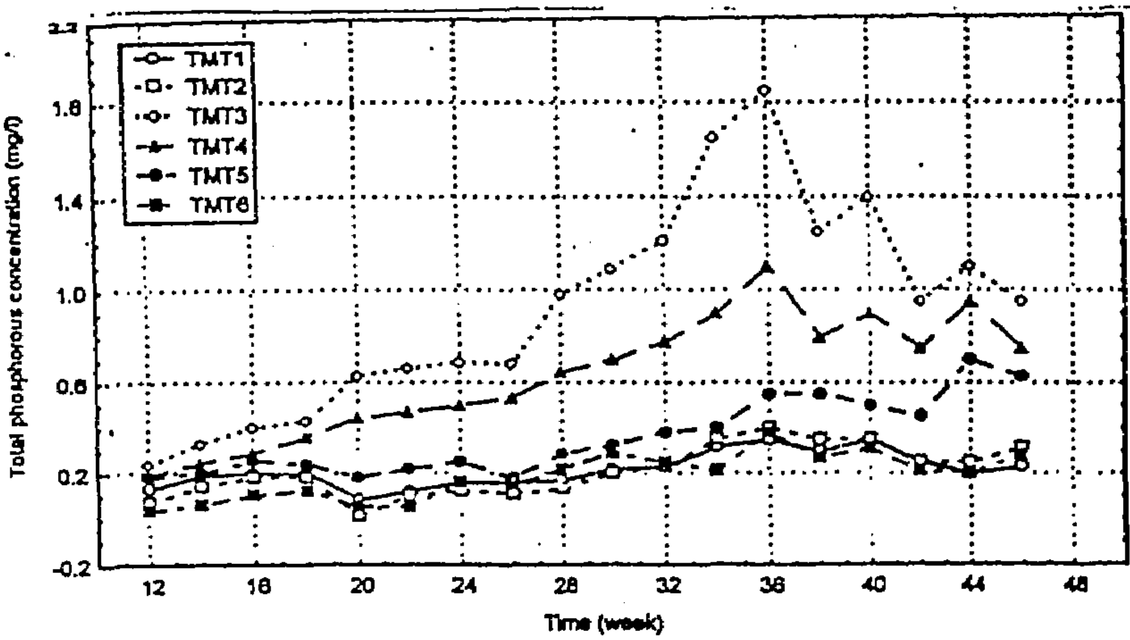

Fig. (8):Average concentrations of total phosphorous (mg.-P/l) in water in earthen ponds treated with different feed and fertilizer treatments during the experimental period.

TMT1: 17% C.P. TMT2: 25% C.P. TMT3: 1g N/m²
TMT4: 0.5 g N/m² TMT5: 0.25g N/m² TMT6: control

Table (3): *Average* body weight (gm/fish) (± S.D) of tilapia fish (Oreochraomis sp.) under different feed and fertilizer treatments during the culture period.*

Period (week)	Treatments								
	Tmt1	Tmt2	Tmt3	Tmt4	Tmt5	Tmt6	Pro. > F	CV%	Grand mean (X ± S.D.)
Week 11	65.60 b ± 9.83	82.60 a ± 10.39	74.90 a ± 2[illegible].65	60.40 b ± 9.42	58.90 b ± 17.07	31.90 c ± 12.70	0.0001	23.65	62.38 ± 17.44
Week 24	90.9 b ± 13.91	118.35 a ± 33.08	8[illegible].15 bc ± 19.27	77.10 c ± 16.16	76.70 c ± 17.56	60.40 d ± 13.20	0.0001	23.42	85.43 ± 19.49
Week 28	128.0 a ± 59.58	130.80 a ± 46.73	98.1 b ± 32.02	95.70 b ± 17.07	93.20 b ± 15.58	75.20 b ± 21.43	0.0001	34.73	103.50 ± 21.40
Week 32	158.39 ± 68.46	164.45 a ± 43.79	116.4 b ± 27.17	105.20 bc ± 44.01	100.50 bc ± 26.92	83.65 c ± 26.61	0.0001	34.79	121.41 ± 32.77
Week 37	191.10 a ± 65.69	205.35 a ± 47.78	146.85 b ± 27.70	126.05 bc ± 35.01	116.00 c ± 25.01	89.50 d ± 26.35	0.0001	28.43	145.80 ± 44.82
Week 41	225.25 a ± 68.51	247.75 a ± 46.49	175.60 b ± 39.09	144.50 c ± 38.24	131.10c ± 24.81	92.75 d ± 26.336	0.0001	25.44	169.49 ± 58.76
Week 46	261.15 a ± 78.44	274.00 a ± [illegible]	206.75 b ± 38.73	171.15 c ± 40.40	146.35 c ± 20.29	94.45 d ± 27.16	0.0001	24.90	192.30 ± 68.93

* Averages designated by different letters were significantly different at the 0.05 level of probability by Duncan's new multiple range test (horizontal comparison only)

Table (4): *Average** body weight (gm/fish) (± S.D) of common carp fish (*Cyprinus carpio.*) raised under different feed and fertilizer treatments during the experimental period.

Period (week)	Treatments								
	Tmt1	Tmt2	Tmt3	Tmt4	Tmt5	Tmt6	Pro. > F	CV%	Grand mean (X ± S.D)
Week 11	64.30 bc ± 15.584	82.55 a ± 18.89	67.95b ± 16.10	59.30 bc ± 14.79	54.90 c ± 14.04	42.70 d ± 9.836	0.0001	24.41	61.95 ± 15.36
Week 24	155.95ab ± 76.635	180.35 a ± 104.01	159.55 ab ± 65.86	151.55 ab ± 60.38	126.90 bc ± 26.78	90.6 d ± 10.945	0.0059	44.68	144.25 ± 31.32
Week 28	207.80a ± 69.70	226.2 a ± 63.12	169.75 b ± 77.53	152.10 bc ± 33.54	135.05 cd ± 35.69	91.58 d ± 22.59	0.0001	33.63	163.74 ± 49.08
Week 32	238.35 a ± 37.50	23: 25 ab ± 58.99	198.70 bc ± 90.59	185.8 c ± 48.41	150.05 d ± 54.12	104.45 e ± 29.673	0.0001	30.62	184.93' ± 50.94
Week 37	260.85 ab ± 361.75	266.25 a ± 55.83	232.30 bc ± 65.33	210.4 c ± 47.93	168.3 d ± 54.92	115.9 e ± 29.059	0.0001	23.85	209.00 ± 58.02
Week 41	289.09 ± 42.44	295.45 a ± 93.20	260.50 ab ± 75.77	232.85 b ± 46.11	180.25 c ± 40.17	123.25 d ± 28.667	0.0001	25.57	230.21 ± 67.19
Week 46	331.50 ab ± 77.64	346.75 a ± 118.03	291.00bc ± 82.47	256.00 c ± 45.58	192.00 d ± 39.58	128.75e ± 50.442	0.0001	28.76	257.66 ± 84.18

* Averages designated by different letters were significantly different at the 0.05 level of probability by Duncan's new multiple range test (horizontal comparison only)

Table (5): Average* body weight (gm/fish) (± S.D) of silver carp fish (*Hypopohthalmichthys molitrix*) under different feed and fertilizer treatments during the experimental period.

Period (week)	Treatments								
	Tmt1	Tmt2	Tmt3	Tmt4	Tmt5	Tmt6	Pro. > F	CV%	Grand mean (X ± S.D.)
Week 11	35.85 c ± 12.32	35.50 c ± 15.03	55.50 a ± 15.46	44.15 b ± 8.81	37.9 bc ± 8.90	16.5d ± 4.968	0.0001	30.71	37.56 ± 12.77
Week 24	92.15 c ± 17.5'	89.25 c ± 20.47	149.70 a ± 26.09	120.1 b ± 25.82	88.50 c ± 18.36	46.65 d ± 16.740	0.0001	21.67	97.72 ± 34.63
Week 28	112. 5 c ± 16.81	109.75 cd ± 20.09	151.95 a ± 42.36	128.65 b ± 26.60	94.75 d ± 17.87	48.4 e ± 11.905	0.0001	22.90	107.70 ± 34.95
Week 32	127.35 b ± 18.09	127.5 b ± 18.95	162.0 a ± 45.05	143.75 b ± 27.28	103.5 c ± 16.63	62.85 d ± 27.064	0.0001	22.52	121.15 ± 34.55
Week 37	150.50 c ± 16.92	152.0 c ± 18.52	206.25 a ± 46.70	172.25b ± 33.26	121.75 d ± 17.26	72.5 e ± 17.129	0.0001	18.79	145.87 ± 45.53
Week 41	190.00 c ± 31.03	19 .0 c ± 43.44	254.5 a ± 42.85	215.2 b ± 28.68	159.75 d ± 28.25	86.75 e ± 17.717	0.0001	18.13	183.20 ± 56.74
Week 46	284.00 b ± 42.35	289.50 b ± 59.55	339.00 a ± 24.58	266.25 b ± 32.03	194.75 c ± 28.67	102.0 d ± 30.796	0.0001	15.52	245.91 ± 84.56

* Averages designated by differen letters were significantly different at the 0.05 level of probability by Duncan's new multiple range test (horizontal comparison only).