Algal Abundances and Growth Performances of Nile Tilapia (*Oreochromis niloticus*) as Affected by Different Fertilizer Sources

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Abstract: The experiment was designed to study the effect of different fertilizer sources (chemical fertilizer, organic fertilizer or combined chemical +organic fertilization) on plankton abundances , growth performances of Nile tilapia juveniles and water quality parameters in concrete tanks compared to feeding fish at satiation .The average secchi disk readings were shallower in the chemical and combined fertilizer treatments compared to those of the ration and organic fertilizer treatments as a result of increased algal density and abundances. Ammonia and orthophosphate concentrations in the chemical and combined fertilizer treatments were higher with an increase in algal growth, abundance. Within fertilizer treatments, the daily weight gains of Nile tilapia reared in the chemical and combined fertilizer treatments (0.43 and 0.5 g/fish/day, respectively) were significantly higher than those reared in the organic fertilizer treatment (0.32g/ fish/ day). This indicated that the use of chemical fertilizer in a fertilization program is superior in increasing fish growth compared to that of the organic fertilizer .It can be concluded that Nile tilapia juveniles can obtain major nutritional requirements for growth(48% of its total feed requirements) from feeding only on algae during this stage of growth. Results of the current experiment recommended that organic fertilizer should not be used as sole source in fertilizer programs and should be combined with chemical fertilizer in order to produce good algal growth necessary for the nourishment of farmed fish.
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1. Introduction:

Pond fertilization through organic and inorganic sources has become a management protocol in aquaculture (Bhakta et al., 2006). Almost all extensive and the majority of semi- intensive aquaculture operations in Asia are dependent on the use of chemical fertilizers and organic manures (De Silva and Hasan, 2007). The purpose of pond fertilization is to augment fish production through autotrophic and heterotrophic pathways (Jha et al., 2008). Natural food supply is enhanced by using organic and inorganic fertilizers and low-cost supplemental feeds derived agricultural by-products (Halwart et al., 2002). It is well known that high fish yield can be achieved by higher abundance of plankton in culture system (Jha et al., 2004). Teferi et al.(2000) found that Nile tilapia was essentially planktivorous. Moreover, small tilapia filtered significantly more phytoplankton than larger individuals (Turker et al., 2003).

Chemical fertilization of ponds effectively stimulated primary productivity and mean chlorophyll a concentration (Green et al .,2002) and application of medium amount of chemical fertilizers (urea and TSP) as pond inputs has been proven to produce up to a three- fold increase in fish yield (Pant et al., 2002). Pond fertilization practices using animal wastes are widely used in many countries to sustain productivity at low costs (Gupta and Noble, 2001; Majumder et al., 2002) since soluble organic matter supplied to ponds by using manure stimulate phytoplankton growth (Sevilleja et al., 2001). Moreover, it increases biomass of zooplankton and benthic organisms (Atay and Demir, 1998). Consequently, animal wastes lead to increased biological productivity of ponds through various pathways, which result in an increase in fish production (Dhawan and kaur, 2002).

The study was designed to explore whether chemical fertilizer (nitrate and phosphate) is superior to organic fertilizer (pigeon manure) in promoting natural food abundance and fish growth compared to the combined use of both chemical and organic fertilizer in rearing tanks.

2. Materials and methods

The current experiment on growth performances of Nile tilapia (*Orechromis niloticus*) was conducted at the Fish Culture Research Unit, Faculty of Agric., Cairo Univ., Egypt. The experiment was performed in outdoor concrete tanks (2.0 x 1.2 x 1.0m each).

The experiment consisted of four treatments with three replicate tanks per treatment as follows:

1-The chemical fertilizer treatment included a weekly application of ammonium nitrate (NH4NO3, 33%N) at 2 g $/m^2$/week and superphosphate (P2O5, 15.5%P) at 2 g $/m^2$/week.

2-The organic fertilizer treatment included a weekly application of dry pigeon manure at a rate of 16 grams dry matter/m^2/ week (40 grams/ tank/ week).

3-The combined fertilizer treatment included the application of both chemical fertilizers (ammonium nitrate at 2 grams/ m^2/ week + superphosphate at 2 grams/ m^2/week) and pigeon manure fertilizer (16 grams dry matter/ m^2/week) in the same tank.

4-The ration treatment included the application of commercial diet (30% crude protein) as fish feed administrated to satiation, six day per week. The experiment lasted 90 days.

The growth performance parameters of juveniles were measured in terms of total length, body weight, specific growth rate, weight gain, daily weight gain and condition factor .Fish growth data were estimated using average individual weight and length to the nearest 0.1 g and 0.1 cm, respectively. The daily weight gain was determined using the formula (DWG) = $(WT_F - WT_I) / T$ where WT_F = final fish weight (g), WT_I = initial fish weight (g) and T= growing period (days) between initial and final weight. Specific growth rate (% body weight day $^{-1}$) was calculated using the formula: SGR=$(\ln WT_F - \ln WT_I) \times 100 / T$. The condition factor of fish was calculated from the formula $K= WT_F / L_F^3 \times 100$ where WT_F= final fish weight (g), L_F =the final total length (cm).

Water from each tank was tested once a month for temperature (C^o), secchi disk visibility (SD), PH, ammonium (NH_4), and orthophosphate – phosphorus (PO_4-P). All determinations were carried out in the Water Research Laboratory, Ministry of Irrigation, Qanater Khayria, Egypt .Chemical analyses were carried-out according to the Standard Methods, American Public Health Association (APHA, 1993).

Statistical analyses were performed using one way analysis of variance (ANOVA) and Duncan's multiple range test to determine differences among treatment means at a significance level of 0.05. Means (X) and standard deviations (S.D.) were calculated accordingly. Statistical tests on parameter values were conducted using (SAS INC, 1992) computer software.

3. Results and Discussion:

As shown in table (1), the average water temperatures during the experimental period were 28.6, 29.1, 29.7 and 28.7 C in chemical, organic, combined and ration treatments, respectively. This indicated that average water temperatures in all treatments were optimal for fish growth and algal production. Tilapia is known to increase their growth rate when water temperature is above 25 C^o, with optimal growth rate taken place when water temperature is 25-30 C^o (Boyd, 1990).

The overall average of total ammonia concentration in tank water during the experimental period indicated that the chemical fertilizer treatment had an over abundance of ammonia (0.708 mg / l) followed by combined fertilizer (0.623 mg / l), ration (0.475 mg / l) and organic fertilizer (0.381 mg / l) treatments, respectively. The shallow secchi disk readings during the experiment in the chemical fertilizer and combined fertilizer treatments (22.9 and 27.1 cm, respectively) were due to the effect of over- abundance of ammonia in water which increased algae growth. This resulted in an increase algae turbidity (concentration) and shallower secchi disk readings in those treatments.

Although organic fertilizer may be consumed directly or as manure- derived detritus after heterotrophic microbial activity, the role of manure or manure – derived detritus as a source of food for fish is not universally known (Knud-Hansen et al., 1993). Manure is a costless fertilizer that stimulate the development of natural foods especially phytoplankton and zooplankton (Lan et al.,2000). Animal wastes lead to increased biological productivity of ponds through various autotrophic (algae production) and heterotrophic (bacterial production) path-ways, which result in an increase in fish production (Orhibhabor and Ansa, 2006).

Plankton levels (phyto- and zooplankton) were significantly higher and fish growth was significantly more in manured ponds (Dhawan and kaur,2002). When comparing different treatments, zooplankton was significantly higher in manured ponds (Kumar et al., 2005) and the highest density of zooplankton was obtained from pond water that had high concentration of nitrogen and phosphorus salts (Lan et al., 2000). Organic manures contain almost all the essential nutrient elements (Jana et al.,2001) that stimulate the growth of plankton (Wurts,2000 ; Ansa & Jiya,2002; Kadri & Emmanuel,2003) and consequently, manure contains considerable quantities of nutrients for fish production (Gabriel et al., 2007).

Ammonia production in tank water of the three fertilizer treatments was mainly through the decomposition of dead algal by bacterial activity and the mineralization of algal protein into ammonia by fish and aquatic animals. According to Ludwig(1999) when organic fertilizers are added to pond they are decomposed by bacteria , releasing ammonia and phosphates which are rapidly utilized by phytoplankton and other bacteria (Jha etal., 2008). The three fertilizer treatments enhanced algal production and decomposition in their tanks and led to the accumulation of ammonia over time in the fertilized tanks .The high build up of ammonia concentration in the chemical fertilizer and combined fertilizer treatments was due to the increase in the intensity of algal production, followed by bacterial decomposition of dead algae in the sediment. Dead algae are mineralized to ammonia by bacterial action in the presence of aerobic conditions (Hargreaves, 1998).

Mineralization of organic matter in sediment and the consequent regeneration of nutrients at the sediment-water interface in aquaculture ponds is important as a source of ammonia to the water column (Hargreaves, 1998). A simulation model describing ammonia dynamics in commercial catfish ponds estimated that 25 to 33% of the ammonia supplied to the water column was derived from the sediment (Hargreaves, 1997). As shown in Table (1), the chemical fertilizers stimulate the natural productivity, through photosynthesis, whereas animal manures provide, upon decomposition, nutrients for both autotrophs and heterotrophs (Nguenga el al., 1997).

The high ammonia concentration in the ration treatment (0.475 mg/l) was caused by the mineralization of dietary protein into ammonia during metabolism by fish and aquatic animals. Normally 40-90% of the nitrogenous wastes, resulting from the metabolism of dietary proteins is excreted by fish and shrimp as ammonia from the gills and in urine (Goddard, 1996).Most of this ammonia is excreted passively in the unionized form from the gills.

Phytoplankton is known to absorb ammonia readily at higher rate compared with nitrate (Boyd, 1990).Ammonia is known to be utilized by phytoplankton during the process of protein synthesis (Kumar et al., 2005). The major sources of ammonia in pond water are the direct excretion of ammonia by fish (Tucker and Boyd, 1985) and microbial decomposition in the sediments .In catfish ponds, daily feed addition during the warmer months results in inputs of 200 – 400 mg N/m3/day and 30-60 mg P/m3/ day (Massout, 1999). Nitrogen and phosphorus salts are known to be major nutrients required for the primary production of plankton in pond water (Kumar et al. 2005).

Total ammonia concentration (TAN) was a major factor that affected algae concentration and production in water during the experimental period.

This is in agreement with Padmavathi and Ptasad (2007) who indicated that high PH and ammonia levels are associated with algal blooms. Higher total ammonia concentrations in the chemical fertilizer and combined fertilizer treatments were correlated positively with higher algal abundances (shallower secchi disk readings).As shown in table (1), the lower total ammonia concentrations in the organic fertilizer and ration treatments produced lower algal abundances compared to other treatments. This indicated a lower efficiency of organic fertilizer in respect to ammonia production in water .The present results are in accordance with Green et al. (2002). Organic fertilizer should not be used as sole source in fertilizer programs and should be combined with chemical fertilizer in order to produce good algal growth necessary for the nourishment of farmed fish.

Orthophosphate (PO4 – P) was significantly higher ($p < 0.05$) in the chemical and combined fertilizer treatments compared to those of the organic fertilizer and ration treatments (table 1). The overall mean of orthophosphate concentrations were 0.575 and 0.527 mg – P /l for the chemical and combined fertilizer treatments, respectively, while those of the organic fertilizer and ration treatments were 0.295 and 0.18 mg - P/l , respectively. The increased algal abundances in the chemical and combined fertilizer treatments (secchi disk readings = 22.9 and 27.1 cm, respectively) were also due to the higher concentrations of orthophosphates in those treatments.

Fluctuations of environmental factors in relation to growth of *Tilapia mossambica* exposed to single superphosphate indicated that fish growth was dependent upon the plankton organisms .The harvest weight of fish was significantly positively correlated with the phosphate, available phosphorus and calcium carbonate (Sarkar and Konar, 1989). Soluble reactive phosphorus and total phosphorus concentrations were both correlated with fish production (Wudtisin and Boyd, 2005).

Averages orthophosphate (PO4 – P) concentrations were 0.295 and 0.187 mg/l PO4 – P in the organic fertilizer and ration treatments, respectively, which were much lower than those of other treatments (table 1). This lowered the photosynthetic rate and algal abundance in those treatments (secchi disk readings were 39.8 and 36.1 cm, respectively) and negatively affected growth rate of fish in the organic fertilizer treatment since algae is food material for fish. These results were consistent with Wudtisin and Boyd (2005).

Sources of orthophosphate (PO_4 –P) in ration treatment were primarily a product of dietary phosphorus metabolism by fish through excretory processes .Kund-Hansen et al. (1993) evaluated the functional role of chicken manure for Nile tilapia *Oreochromis niloticus* production in central Thailand. Regression analysis suggested that chicken manure P was about 10% effective as TSP-P at increasing net fish yield (NFY). Simple economic comparisons discourage the purchase of chicken manure as a source of soluble N and P for increasing algal productivity in Thailand (Knud- Hansen at al., 1993).

Because of low N and P content and high oxygen consumption, organic fertilizer alone is unlikely to provide adequate nutrients for algae and sufficient oxygen for fish. To stimulate the growth of food organisms for fish in aquaculture ponds, a combined use of inorganic and organic fertilizer is recommended, but the amount of organic fertilizer should be determined with care to avoid water quality deterioration (Qin et al., 1995).

As shown in table (1), early morning pH in concrete tanks were significantly high ($p<0.05$) in the chemical fertilizer treatment (8.5) than those of the combined fertilizer (7.86) or ration (7.63) treatments. This may by due to the higher algal growth and production in the chemical fertilizer treatment compared to other treatments. The pH of water increases when plants are rapidly removing carbon dioxide from water for use in photosynthesis (Boyd, 1990).

Table (1). Averages of water quality parameters in experimental tanks under different fertilizer treatments.

Parameter / Treatment	**chemical fertilizer**	**organic fertilizer**	**combined fertilizer**	**ration treatment**
Water temperature (C°)	$28.6^{a} \pm 0.8$	$29.1^{a} \pm 1.2$	$29.7^{a} \pm 1.5$	$28.7^{a} \pm 0.7$
Total ammonia (mg-N/l)	$0.708^{a} \pm 0.18$	$0.381^{b} \pm 0.16$	$0.623^{ab} \pm 0.19$	$0.475^{ab} \pm 0.09$
Early morning pH	$8.5^{a} \pm 0.4$	$7.46^{b} \pm 0.51$	$7.86^{ab} \pm 0.25$	$7.63^{b} \pm 0.45$
Orthophosphate (mg-P/l)	$0.575^{a} \pm 0.03$	$0.295^{b} \pm 0.04$	$0.527^{a} \pm 0.1$	$0.18^{b} \pm 0.03$
Secchi disc depth (cm)	$22.9^{a} \pm 6.3$	$39.8^{c} \pm 5.6$	$27.1^{ab} \pm 2.6$	$36.1^{bc} \pm 4.7$

-a,b,c means with different superscripts among treatments are significantly different($p < 0.05$).

The least early morning pH (7.46) was observed in the organic fertilizer treatment ($p<0.05$). This was due to the negative effect of the organic manure on the pH value of water. In this case, heterotrophic activities of aerobic bacteria reduces pH through respiration (Boyd, 1990). Early morning pH in the combined fertilizer and ration treatments were significantly lower ($p<0.05$) compared to that of the chemical fertilizer treatment. This may be due to their higher organic inputs (diet or manure inputs) and the increased heterotrophic activities by aerobic bacteria on these inputs .Organic manure and dietary wastes decompose and serve as a continuous source of carbon dioxide (Boyd, 1990) and when carbon dioxide accumulates in water ,water pH declines.

The higher early morning pH reflected higher algal production and increased photosynthetic activities that resulted in higher algal concentration and abundances .These results are in accordance with Padmavathi and Ptasad (2007)who elucidated the fact that high PH levels were associated with algal blooms

.In intensive aquaculture, high density algal blooms can lead to high water pH (Pote et al., 1990) and the relationship of photosynthesis and respiration to pond pH has been well documented by Tucker & Boyd (1985) and Boyd (1990) who reported that autotrophic activity increases water pH through CO_2 absorption, while heterotrophic activity decreases water pH through respiration**.**

The average secchi disk readings were significantly lower ($p<0.05$) in the chemical and combined fertilizer treatments (22.9 and 27.1cm, respectively) compared to those of the ration and organic fertilizer treatments (36.1 and 39.8 cm, respectively).This was due to the increased algal density and abundance in the chemical and combined fertilizer treatments compared to other treatments. The ammonia and orthophosphate concentrations in the chemical and combined fertilizer treatments were significantly higher ($p < 0.05$), increasing algal growth, abundances and biological turbidity of water reducing water visibility in those treatments.

The secchi disk visibility data indicated that the chemical and combined fertilizer treatments had good algal abundances and were better considering sound water quality management applied in fish farming. Semi-intensive aquaculture ponds often develop dense phytoplankton population (hlorophyll A > 250 mg ⁄ m^3 and secchi disk visibility < 20 cm) in response to a high rate of nutrient input (Hargreaves, 1998). In addition, monthly net fish yield of *Oreochromis niloticus* was strongly correlated to secchi disk depth, total phosphorus and water temperature (Diana et al., 1988).

Concentrations of both ammonia and orthophosphate salts required to increase algal growth were least in the organic and ration treatments. This lowered algal abundances and increased secchi disk visibility depth in those treatments. The ration treatment did not receive any fertilizers consequently, algal abundance (turbidity) was lower and secchi disk reading was higher in that treatment.

Algae were the major source for Nile tilapia nutrition in the fertilized tanks, and the decreased secchi disk visibilities in the fertilizer treatments indicated a good potential for fish nutrition. Jamu et al (1999) reported that secchi reading is commonly used by aquaculture pond managers as an indicator of algae concentration in pond water. Almazan and Boyd (1978) found a high degree of correlation between phytoplankton abundances, secchi disk visibility, gross productivity and chlorophyll "a" content.

During this investigation, an over–abundance of algae (required for fish nutrition) in the chemical and combined fertilizer treatments over those of organic and ration treatments was detected. Algae or manure or both were the major sources of fish nutrition in the fertilizer treatments, while both diet (30% crude protein) and algae were the sources of fish nutrition in the ration treatment.

In fish farming practices where fish nutrition depend largely or entirely on natural food produced by fertilization programs, levels of algal abundances (reflected by secchi disk readings) are positively correlated with fish yield (Dhawan and Kaur, 2002). Ponds used for intensive fish culture are normally turbid with algae which grows in response to additions of fertilizer or fish feed (Boyd, 1990; Green et al.,2002). Ponds which received applications of fish feed also had abundant phytoplankton growth because roughly 75 percent of the nutrients in feed are excretory products during the process of metabolism (Boyd, 1979).

When secchi disk visibility is shallower, this reflects a high algal abundance in the photic zone which is positively correlated with fish growth and nutrition (Abbas and Hafeez-Ur- Rehman, 2005). Secchi disk visibility is commonly used by aquaculture pond managers as an indicator of phytoplankton concentration (Jamu et al. , 1999 ; Wudtisin & Boyd ,2005) . It is well known that Nile tilapia could obtain more than 50% of its nutritional requirements from feeding only on algae and zooplankton, especially during the Juvenile stage of growth (Turker et al., 2003). Consequently, using low cost fertilization programs can highly reduce nutritional requirements for dietary ration (Abbas and Hafeez – Ur- Rehman, 2005).

Kumar et al. (2004) demonstrated that a mix of manure and organic fertilizers was successful in fish culture. Such a combination of fertilizers promotes both autotrophic and heterotrophic organisms in the pond and enables better nutrient management as well as maintenance of water quality (Kumar et al.,2002).Recent studies have shown that the combined use of inorganic and organic fertilizers is effective in productivity improvement in earthen ponds (Grozev et al., 2001 ; Kumar et al. ,2004 ; Afzal et al. ,2007 ; Jha et al. , 2008).Moreover, the combined use of inorganic and organic fertilizers is effective in maintaining phytoplankton and zooplankton population in rearing ponds (Qin & Culver ,1992 ; Afzal et al. , 2007) .

The least algal abundances ($p < 0.05$) was observed in the organic fertilizer treatment .This was due to the decreased efficiency ($p< 0.05$) of organic fertilizer in promoting algal growth and abundances compared to other fertilizer treatments. The decreased organic fertilizer efficiency in promoting algal abundances was due to its lower dose (2.3 gm ⁄ m^2 ⁄ day) in the present study and lower content of phosphorus compared to that of chemical fertilizers. Moreover, bacterial activity on decomposable organic fertilizer (manure) consumes a high proportion of ammonia (TAN) and phosphate released in water during the process of manure decomposition .Those ammonia and phosphate are necessary components for bacterial growth on manure particles. This process, in addition to the lower phosphate content of manure, lowered the organic fertilizer (manure) efficiency in promoting algal growth and abundances compared to those of other fertilizer treatments. It is well known that phosphorus play a major role in promoting algal growth and abundances in water of aquaculture ponds (Wudtisin and Boyd,2005).

Algal abundances in the ration treatment (artificial diet to satiation) were of low magnitude and were enhanced by the direct excretion of ammonia and phosphate by fish as a result of dietary protein metabolism (Boyd, 1990). Nile tilapia juveniles were feeding on both diet and plankton in the ration treatment.

Because of low N and P content and high oxygen consumption, organic fertilizer alone is unlikely to provide adequate nutrients for algae and sufficient oxygen for fish (Kumar et al., 2004) , consequently, to stimulate the growth of food organisms for fish in aquaculture ponds, a combined use of inorganic and organic fertilizer is recommended (Jha et al ., 2008).

It is concluded that the use of combined (chemical + organic) fertilizer promoted algal growth and abundances necessary for the nutrition of Nile tilapia. These fertilizer programs are of low costs and can enhance fish production in semi – intensive farming systems.

As shown in table (2) , average body weight of Nile tilapia Juveniles increased from 38.6- 42.6 grams at the start of the experiment to 81.3, 71.0 , 85.5 and 119.0 grams at the end of the experiment for the chemical fertilizer, organic fertilizer, combined fertilizer and ration treatments, respectively.

Final weight of Nile tilapia fed at satiation was heavier than those raised in the combined fertilizer treatment by 39.2%. Better growth performances of Nile tilapia in the ration treatment was achieved as a result of feeding on both algae and prepared diet compared to those reared in the fertilizer treatments which were feeding mainly on algae or manure or both.

Fish growth was influenced by the presence of natural food (Pant et al., 2002). Fish growth is slower on plankton feeding alone because larger fish lack the capacity to acquire sufficient ration even in ponds with high plankton stocks. Moreover, feeding is begun as a supplement to plankton forage, and soon becomes the dominant nutritional source, and rapid, near optimal growth is attained on a ration of approximately 50% of satiation amounts (Szyper et al. ,1996).

The present results indicated that Nile tilapia juveniles can obtain major nutritional requirements for growth (more than 48% of its total feed requirements) from feeding only on algae during the juvenile stage of growth compared to that of ration treatment where dietary inputs were offered. Based on analyses of stomach content, up to half the food intake of tilapia in intensively fed ponds was natural food, which indicated its substantial contribution to tilapia growth (Lim, 1989). Evaluation of the growth performance of major carps in fertilized ponds supplemented with feed, indicated that primary productivity (i.e. plankton) contributed 57.4 % towards the increase in fish yield (Aziz et al. ,2002) .

As Nile tilapia derives most of their nutrition from phytoplankton (Colman and Edwards, 1987), a strong correlation between algae production and net fish yield was expected (Knud- Hansen and Batterson, 1994; Green et al ., 2002).Most often natural food forms the basis of fish nutrition with artificial supplement (diet) given to increase fish production (O' Grady and Spillett, 1985).

The results confirmed that the best growth of *Oreochromis niloticus* was in the ration treatment (1.25% per day), followed by fish in the combined fertilizer treatment (0.81% per day).Comparing different fertilizer treatments ,the chemical fertilizer and combined treatments had significantly higher specific growth rates (0.81 and 0.71% per day, respectively) than that of organic fertilizer treatment (0.57% per day) .

Growth of fish was significantly increased by the increases in level of natural food (Pant et al., 2002 and 2004). In addition, some fish derive a high proportion of their food from plankton organisms, rather form supplement (i.e. artificial diet) and these fish maintain rapid growth even though they compete poorly for supplement (Wahlam and Shephard, 1988). Consequently, organic and inorganic fertilizations can produce high plankton abundances to be capable of supporting fish growth (Jha et al., 2008).

As shown in table (2) , net fish yield increments in fertilizer treatments ranged 0.64- 1.0 gram /m^2/day (equivalent to 6.4-10.0 kg fish weight/ ha/day) and were significantly lower ($p<0.05$) than that of the ration treatment fed at satiation which averaged 1.78 gram / m^2/ day(equivalent to 17.8 kg fish weight/ ha/ day). The lowest ($p< 0.05$) net fish yield increment (0.64 gram / m^2/ day) was observed in tanks fertilized with organic manure which was equivalent to 6.4 kg fish weight/ ha/ day.

Maximum manuring rate recommended in earthen ponds are 50 grams dry manure per square meter per week (Nyandat, 2007).Ponds fertilized with four levels of chicken manure (12.5, 50 and 100 g dry weight/ m^2/ week) during 149 day experiment for Nile tilapia, yielded from 4.9 to 15.7 kg fish weight/ ha/ day (Kund – Hansen et al., 1991). Net fish yield was correlated to both net primary productivity and chicken manure fertilization .This is agreement with Dhawan and Kaur (2002) and Jha et al. (2008). Zhu et al. (1990) reported that the average net fish yield (different species of carp) in many experiments, was 10.2 kg/ha/day over a growing period of 150-200 days.

A significant increase in Nile tilapia production attained in the combined fertilizer treatment indicated that the combined use of chemical and organic fertilizers promoted fish production (10.0 kg/ha/day) above that attained either by single use of chemical fertilizer (8.6 kg/ha/day) or organic manure (6.4 kg/ha/day).These results are in

Table (2) .Averages of growth performance parameters of Nile tilapia juveniles under different fertilizer treatments.

Parameter / Treatment	chemical fertilizer	organic fertilizer	combined fertilizer	ration treatment
Initial weight (grams/fish)	42.6 ^{a} ± 2.9	42.6 ^{a} ± 4.1	40.6 ^{a} ± 2.9	38.6 ^{a} ± 0.4
Final weight (grams/fish)	81.3 ^{b} ± 10.1	71.0 ^{c} ± 6.3	85.5 ^{b} ± 15.6	119.0 ^{a} ± 10.5
Weight gain (grams/fish)	38.7 ^{b} ± 8.3	28.4 ^{c} ± 4.4	44.9 ^{b} ± 13.6	80.4 ^{a} ± 10.5
Daily weight gain (g/fish/day)	0.43 ^{b} ± 0.09	0.32 ^{c} ± 0.4	0.5 ^{b} ± 0.15	0.89 ^{a}± 0.12
Condition factor	1.66 ^{bc}± 0.19	1.48 ^{c} ± 0.22	1.74 ^{b} ± 0.39	2.12 ^{a} ± 0.13
Specific growth rate (% per day)	0.71 ^{c} ± 0.1	0.57 ^{d} ± 0.07	0.81 ^{b} ± 0.15	1.25 ^{a} ± 0.1
Net yield (gram/ m^2/day)	0.86	0.64	1.0	1.78

-a,b,c means with different superscripts among treatments are significantly different($p < 0.05$).

accordance with Kumar (2004), Terziyski et al.(2007) and Afzal et al . (2007).

High nutrient inputs led to a two - fold increase in monthly net adult yield (9.0 kg/ha/d) over low input ponds (4.5 kg/ha/d) and there was a significant difference in net adult yield and biomass between organically (11.2 kg/ha/day) and inorganically (9.0 kg/ha/day) fertilized ponds at high nutrient loading (Diana et al. ,1991).Increased fertilization rate resulted in larger fish yields and higher primary production (Dhawan and Kaur, 2002; Kumar et al., 2002; Jha et al.,2004).

Green et al. (1989) compared yields of tilapia (*O. niloticus)* in sets of ponds receiving chicken litter, cow manure or chemical fertilization. The added nitrogen was equal in all three treatments. Chemical fertilization and cow manure supported similar fish yields, 8.0 and 8.6 kg/ha per day, respectively. The yield with chicken manure was 11.7 kg/ha per day.

When net fish yield increment in the ration treatment was compared to those of the fertilizer treatments, the importance of algae as a source for tilapia nutrition during medium size stages was evident. Increasing algal growth and abundances in the chemical and combined fertilizer treatments caused an increase in growth of Nile tilapia at a proportional rate parallel to algae production. There was a positive correlation between net fish yield increment and algal concentration (secchi readings) in rearing tanks.

Organic and inorganic fertilizers are often used in fish ponds to increase pond fertility and to improve fish production (Shrestha & Lin, 1996; Grozev et al., 2001; Terziyski et al., 2007). Popma et al. (1995) described pond management practices, and fish yields for Guatemalan farmers with less than two hectares of land: average total fish yield form non-integrated ponds receiving approximately 500 kg of nutrients /ha- month was 8.4 kg /ha/day. At nutrient loading rates near 1500 kg /ha- month, net fish yields averaged 12.7 kg/ha /day in 6 months. Fish production cycles were usually 4 to 9 months.

In conclusion, the most productive treatment of the experiment was that of tanks fed at satiation, followed by that of the combined fertilizer treatment (17.8 and 10.0 kg/ha /day, respectively). Moreover, when the chemical fertilizer and ration treatments were compared, it was evident that Nile tilapia at medium size range can obtain at least 48% of their nutritional requirements from feeding only on algae.

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