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COMPARATIVE EFFECTS OF FERTILIZATION AND SUPPLEMENTARY FEED WITH RICE BRAN ON GROWTH PERFORMANCE ,WATER QUALITY PARAMETERS AND ECONOMIC RETURNS OF THE FISH UNDER POLYCULTURE PONDS

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ABSTRACT

A polyculture experiment was carried out on the Tilapia species(Wild Oreochromis niloticus and Oreochromis aureus),Common carp(Cyprinus carpio Ham.),gray mullet(Mugil cephalus), Grass carp (Ctenopharyngodon idella) and Silver carp (Hypophthalmichthys molitix) with the objectives to evaluate the effects of fertilizer types and rice bran (12.8% crude protein) as supplementary feed in fertilized ponds on growth performance in terms of average body weight (ABW), specific growth rate(SGR),feed conversation ratio(FCR) and total fish production of these fishes, water quality parameters and economic returns under polyculture in semi-intensive fish culture system supplemented with rice bran.

Seven earthen ponds(each = 4200 m^2 surface area) were randomly applied with no replicates. Each pond was stocked with 6000 wild Oreochromis Tilapia species,2000 Common carp,1000 gray mullet ,500 Grass carp and 500 silver carp. Four treated ponds were supplemented with rice bran at the rate of 5% of wet fish body weight daily and for a period of six months(180 days).

In this experiment, all the experimental ponds received the same quantity of N and P but the sources were different as given in Table 2.treated ponds showed a significant increase (P<0.01) in fish production. Results showed that organic + inorganic fertilizers + rice bran as supplementary feed remained the best treatment for maximum net marketable fish production of 2855.2 ±22.92 kg/fed/180 days , while the net marketable fish production under the effect of T1 ,T2 , T3, T4 , T5 and T6 were found to be 2418.2 ±11.89 , 1558.8 ±19.63 , 1617.5 ±17.47, 2159.0 ±12.78, 2330.3 ±15.29 and 2657.7 ±10.15 kg/fed/180 days , respectively .Thus for getting optimal fish production the fertilization of pond with supplementary feed is recommended.

Results indicated that most of water quality parameters were influenced by fertilization type while supplementary feed had a little effect. Factor analysis demonstrated that four factors (Phytoplankton *decomposition, Photosynthesis, chemical reactions and supplementary feed) were responsible for more than 77% of the explained variability that affected all water quality variables.. All water quality parameters were in the proper range of the growth of all fish species used in this experiment.*

Results of tow-way ANOVA indicated that fertilizer type was effective than supplementary feed on water quality parameters. The (T7) had the highest average of water quality parameters and plankton densities(cells/m^3)which led to the higher fish growth that received organic , inorganic and feed may be attributed to the increase in organic matter contents of this pond that may lead to consume natural food and release ammonia in a form of feces much greater than that in the other treatments. On the other hand, both of water temperature and pH were not affected neither by fertilizer type nor by supplementary feed. Both of total orthophosphate(PO_4- mg/l) and total alkalinity had significantly higher concentrations when ponds treated with chemical fertilizers than ponds treated with organic fertilizers,

***In conclusion**, fish culture growth was better, water quality, fish production and consequently economic returns can be optimized with in the treatment with organic and chemical fertilizers plus supplementary feeding than feeding alone or fertilization alone for polyculture in terms of economic efficiency and net revenue. The study suggested that maximizing production efficiency would require the combination of the three nutrient input sources (feed , organic and inorganic fertilizers). The study throw the lights on the importance of the need to increase yields of fish culture to meet the needs of small holder farmers raising fish for household consumption.*

Keywords: Fertilization, supplementary feed, rice bran, growth performance, water quality, economic returns, fish.

INTRODUCTION

Production of aquatic species through freshwater fisheries and aquaculture for protein supply is being encouraged throughout the world. According to nutritionists, fish is an excellent substitute of protein for red meat. Fish flesh contains all the essential amino acid and minerals *viz*., iodine, phosphorus, potassium, iron, copper and vitamin A and D in desirable concentrations(Sandhu, 2005). It serves as valuable source of protein to a healthy diet because of its low carbohydrate and unsaturated fat,especially Omega 3 contents (Razvi, 2006). So the inclusion of fish in our diet can make a valuable contribution to any diet that contain mainly cereals, starchy roots and sugar for the growth (Razvi, 2006; Salim, 2006; Yildrim *et al*., 2008).

The most important freshwater cultivable fishes in Egypt are major many *Tilapia* species (genus *Oreochromis: Oreochromis niloticus* and *Oreochromis aureus)* and *Mullet* species. Some exotic species such as Common carp [*Cyprinus carpio* (Ham.)], Grass carp (*Ctenopharyngodon idella*) and Silver carp (*Hypophthalmichthys molitix)* are also introduced (Hussein, 1995).

A combination of fertilization and /or supplementary feeding is used to bolster production in medium stocked earthen ponds where fish thrive in the absence of formulated feeds due to their ability to feed low on the food chain (Tacon, 2003).

Among the new trends in fish culture, integrated semi-intensive system seems to be the most acceptable due to the fact that various agricultural wastes and low value feedstuff can be utilized as a cost-effective source of fish feed. Fertilizers increase the level of primary productivity, dissolved oxygen, pH and total phosphorus (Qin *et al*.,1995).They increase fish production without risk of dietary diseases and also play an important role in the formation of soil structure. The growth of fish is strongly correlated with increase in phytoplankton and zooplankton productivity as a result of fertilization. Under polyculture system, the use of organic and inorganic fertilizers provides basic nutrients and elements required for the production of phytoplankton and zooplankton which serve as a major source of food for fish(Javed *et al*.,1992).

Supplementary feeding plays a vital role in semi-intensive system,offering the best means to enhance fish production within shortest possible time. It is useful in conversion of low value animal and vegetable proteins into quality proteins(Devaraj and Krishna,1981). Keeping in view the significance of fertilization and supplementary feeding, the present study was conducted to assess the growth performance of polyculture fishes in integrated semi-intensive ponds supplemented with rice bran.

The enhanced production in the treated pond can be justified by the fact that crude protein in the form of rice polishing was not only taken as feed by the fish but also the leftover protein contributed to the fertility of the treated pond(Ahmed et al,2005). Javed *et al*. (1993) concluded that use of artificial feed was beneficial in two ways, (i) direct utilization of feed, (ii) indirect response of leftover feed in terms of planktonic productivity. The nitrogen supplemented in the form of crude protein resulted in significant increase in body weight of the fish. Virk and Saxena (2003) also reported that *Cyprinus carpio* and *Labeo rohita* in semi intensive polyculture ponds supplemented with diet containing Amaranthus seeds, showed better growth as compared to the control pond because Amaranthus seeds provided quality proteins to the fish. The fish showed better growth during warmer months of study under both the treatments. Goolish and Adelman (1984) also recorded significantly positive increase in the growth rate of fish (*Cyprinus carpio*) with concomitant increase in temperature. As was reported by Villaluz and Ungui (1983), they studied the effect of temperature on activity, feeding and growth of milk fish and concluded that growth was faster at higher temperature and slower at low temperature. The vegetable protein which is cheaper than animal protein can be used in the form of supplementary feed in semi-intensive fish culture system for better fish production (Ahmed *et al*,2005).Specific interactions among fish species are important in the sustenance of any polyculture system and much research work has been done on the culture of these fish species under different treatments (Keshavanath *et al.*, 2006; Sahu*et al*.,2007).

There are different opinions about the inclusion of Common carp in polyculture system. For instance, Ritvo *et al*. (2004) observed that Common carp has the potential to improve conditions in pond bottom soil. As a result, perturbations increase the oxygen transfer to the soil, decrease the concentration of toxic compounds, and enable more efficient food web recycling and nutrient release. According to Milstein *et al*. (2003), Common carp as a bottom feeding fish produces a fertilizing effect through a food web that benefits the filter feeding fishes and reduces the application of organic and inorganic fertilizers in the aquaculture practices. It grows rapidly with high protein diet and minimum feed coefficient and is considered as a target cultured fish, and plays a key role in pond management. It stimulate efficiency of liming and nutrient availability in the bottom of the ponds, so the inclusion of Common carp in polyculture is economical to farmer as it lowers the input and management costs and it also benefits the pond water ecosystem(Wahab *et al*. 2002;Alim *et al*., 2005).

The production of fish pond depends on the vegetation, which is dependent on the nutrients in the ponds. It is not possible to increase the production of cultivated fish by giving them the greater quantities of natural food directly. Organic manures and chemical fertilizers can be used to increase the planktonic biomass, on which fish mainly feeds. It stimulates the growth of natural food by providing essential deficient elements, which are utilized by the phyto-and zooplanktons. The fertilization in fish farming is to improve water quality and to increase the variety and quantity of phytoplankton and zooplankton, which eventually leads to high fish yield and economic returns. The ultimate goal of fertilization is to achieve suitable environmental conditions for the production of natural food for fish, but in comparison with organic manure, fertilizers increase the level of primary productivity, algae abundance, dissolved oxygen, pH and total phosphates(Afzal *et al*.,2007;Jana *et al*,2001)

Sustainable and successful freshwater fish culture on scientific basis principally depends upon the use of adequate, economically viable and environment friendly artificial feeds. Since the feed costs vary between 40 to 60% of the total managerial expenditure in fresh water fish culture system, provision of artificial feed increases the fish growth and production in the fertilized ponds and results in higher growth rates and yields than fertilization alone(Diana *et al.*,1994).With a view of reducing feed input cost in aquacultural practices, it is necessary to develop better feeding strategies by incorporating plant based feed with animal protein based diets in feeding practices(Abbas *et.al.*,2010)

Inappropriate feeding practices in aquaculture may lead to feed being wasted or to insufficient feed being provided, resulting in higher production costs (Mihelakakis *et al*., 2002) and contamination of the aquatic environment (Ng *et al*., 2000). An optimum feeding strategy is helpful to minimize the feed loss, reduce water pollution and decrease cost of aquaculture production. In general, feed management or feeding techniques have two main objectives, one is to encourage rapid and positive consumption and thus reducing leaching of nutrients wastage, the other is to provide greater potential for growth by minimizing the metabolic costs.

The objective of the present experiment was to evaluate the effects of fertilizer types and rice bran (12.8% crude protein) as supplementary feed in fertilized ponds on growth performance in terms of average body weight, specific growth rate and total fish production of *Tilapia* species (genus *Oreochromis:* Nile and blue Tilapia), Common carp , gray mullet, Grass carp and Silver carp, water quality parameters and economic returns under polyculture in semi-intensive fish culture system in Serow Fish Farm, under different treatments.

MATERIALS AND METHODS

This study was conducted in seven earthen ponds (each 4200 m^2 surface area) located at Serow Fish Farm,National Institute of Oceanography And Fisheries, Dukhlia Governorate ,Egypt. These ponds were firstly drained and cleaned, then supplied with drainage freshwater from El-Serow drainage canal to a depth of 1.2-1.5 m. The experimental period lasted for 6 months(180 days, initiated on first May till first November).

***Pond preparation*:** Before stocking, all the ponds were sun dried for fifteen days. Essential precautionary measures were taken to screen the water inlets to avoid the entry of intruders or exit the fish from ponds. After one week of taking these steps, each pond was watered up to 1.5 m and this water level was maintained throughout the experimental period. All the ponds were fertilized with organic manure (cow manure) as started dose to stimulate the productivity of the ponds.

***Stocking of fish species in experimental ponds*:** Two weeks after manuring and ponds had been filled with water, each pond(with an area of one feddan),under fish polyculture system, was stocked randomly with 6000 mixed sexes fingerlings *Tilapia* species (Wild *O. niloticus* and *O. aureus)*, 2000 Common carp(*C. carpio Ham.*), 1000 grey mullet(*M. cephalus*),500 Grass carp (*C. idella*) and 500 Silver carp (*H. molitix).*The average initial body weight was recorded. There were no significant differences among treatments in the size of fish at stocking .Wild fingerlings *Tilapia* species and common carp used for the present study were collected locally from the Serow Fish Farm , during March grey mullet fry was collected and transplanted to the farm from the Mediterranean Sea near Damietta. Grass carp and Silver carp fingerlings were purchased from Abbassa Fish Hatchery belonging to the General Authority for Fish Resources Development (GAFRD), Ministry of Agriculture , Egypt.

***Fertilization and supplementary feed*:** Four treated ponds(T1,T5,T6 and T7)were supplemented with rice bran(12.8% crude protein) in mash form at the rate of 5 % of wet fish body weight twice daily at 09.00 h and 14.00h,from Saturday to Thursday for a period of six months. The chemical composition of the rice bran used are given in Table (1),and was estimated according to **AOAC (1994).**

Table 1: Approximate chemical composition,inorganic (Urea and TSP), organic(Cow manure) fertilizers and supplementary feed (rice bran) concentrations and nutrient applications rates as kg/pond during the experimental period in earthen ponds(% dry matter basis, Mean ± SE)

Treatments	Organic fertilizer. Cow manure (1%N+1% P)	Inorganic fertilizer (Urea+TSP) (46% N+46%P_2O_5	Supplementary feed (Rice bran)
Dry matter	89.11± 0.14	-	88.9±1.15
Crud protein	9.56	-	12.8±0.19
Ether extract	12.93±0.03	-	11.7±0.11
Crude fiber	11.49±0.07	-	10.9±0.08
Ash	4.08±0.08	-	10.4±0.12
N free extract	62.93±0.19	-	54.2±0.05
Nitrogen (%)	1.54±0.04	46.0	15.14±0.33
Phosphorus(%)	0.91±0.02	46.0	4.77±0.07
N:P ratio	2.16±0.23	1	3.17±0.15
Kg/ fed/180 days	2700±0.22	146±27	5770±0.06

The amount of organic, inorganic fertilizers and supplementary feed was calculated on N-P equivalence of 0.2 g N and 0.01 P/100 g wet body weight of fish daily(Islam, 2002), the sources of which were different. Inorganic fertilizers(Urea with 46.5% N and TSP 46% P) were used at a rate of 0.345 kg P/feddan (0.75 kg TSP/fedd.) and 2.5kg N/feddan(5.3kg urea/fedd.) every two weeks ,after stocking in water in plastic barrels and broadcasting this mixture over the pond water surface (Hussein,1995).Cow manure was broadcast over the ponds surface at a rate of 60 kg/fedd per week (Hussein and Abdl-Hakim ,2003).Seven treatments were randomly applied with no replicates each as follows :

T_1 = Supplementary feed,(rice bran), T_2 = organic fertilizers (cow manure), T_3 = inorganic fertilizers(Ch.), urea (46 %N) and triple superphosphate (46 % P_2O_5), T_4 = organic fertilizers + inorganic fertilizers , T_5= organic fertilizers + supplementary feed, T_6 = inorganic fertilizers + supplementary feed and, T_7 = organic fertilizers + inorganic fertilizers +supplementary feed.

In this experiment, all the experimental ponds received the same quantity of N and P but the sources were different as given in Table 2.

Table 2: Composition of experimental treatments applied on the basis of percentage of nitrogen

Source of Nitrogen	Nitrogen %
T1 = Supplementary feed,(rice bran)	100
T2 = Organic fertilizers(cow manure)	100
T3 =Inorganic fertilizers(Ch.), urea (46 %N) and triple superphosphate (46 % P_2O_5),	100
T4 = Organic fertilizers + inorganic fertilizers	50 +50
T5 = Organic fertilizers + supplementary feed,(rice bran)	50 + 50
T6 = Inorganic fertilizers + supplementary feed and,	50 +50
T7=Organic fertilizers+ inorganic fertilizers+ supplementary feed.	50 +25+25

The organic fertilizers(cow manure)and inorganic fertilizers [Urea (1.0 LE/Kg) +TSP(1.2 LE/Kg)] were added to the pond at biweekly interval ,while supplementary feed (rice bran) was added on daily basis. The amount of feed was increased fortnightly according to the measurement of fresh fish body weight. Fish growth was measured in terms of increase in body weight by random capturing of each fish species from the ponds on each fortnight ,throughout the experimental period .After obtaining the data, the fish were released back into their respective ponds.

Rice bran supplementary feed containing 12.8% crude protein (0.45 LE/Kg) was introduced to fish in T1,T5,T6 and T7 treatments ponds starting from day 30 till the end of the experiment at starvation level with feeding frequency twice daily at 1000 and 1400 h six days a week, total amount of feed added too each pond was used as an estimate of feed consumption.

Fish growth parameters: After every one month, the sample of fish for each weight (monthly) were 1000 fish / treatment weight collectively, cultured fish species were captured randomly by using drag net from each experimental treatment and released back into their respective ponds after recording the data for wet body weight (WBW) and specific growth rate (SGR). After one month interval, on the basis of WBW, amount of organic and inorganic fertilizer and supplementary feed to be added in fish ponds were determined for each treatment. Specific growth rate (SGR) was estimated by the formula given by Dhawan and Kaur (2002).

SGR=In (Final wet body weight)–In (Initial wet body weight) × 100

Culture period (days)

Wet body weight gain (wWG) (g) = mean final fish wWt. (g) - mean initial fish wWt. (g).

AGR (g/ day) = Final fish wt. (g) - Initial fish wt. (g)/ time (days).

The food conversion ratio (FCR) was calculated by the following equation:

Weight of feed added/increase in wet fish weight.

Because of the fact that silver carp is phytoplankton feeder (Ibrahim, 1997and 2006; Zhang *et al*., 2006) it wasn't included in FCR calculations.

Total fish production under different treatments: At the end of the experiment, total harvested fish of experimental fish species were weighed to calculate the total fish production.

Water and fish samples: Water quality samples were collected biweekly from each pond manually from the middle of water column by putting a closed sample bottle and opened in the desired depth, this procedure was done in different five spots in each pond then samples were mixed in a plastic bucket and 1 litter sample was taken as a representative water sample of each pond. These samples were taken 1 week after fertilizer application. At the time of sampling, water temperature, dissolved oxygen visibility was measured in addition to their measurements two times weekly. Water temperature and dissolved oxygen were measure at 900 h using dissolved oxygen meter model Orion 835 A, pH was measured by Acumen 25 meter, total alkalinity, orthophosphate (Po_4) nitrate (No_3), total ammonia nitrogen (TAN;$NH_{3/4}$) were measured according to Boyd(1990) and APHA(1985).Phytoplankton , zooplankton and chlorophyll-a were calculated using Vollenweider (1969) equation. Plankton concentrations in the various treatments were related to fish production. Gross and net primary productivity were measured fortnightly using the light and dark bottle method according to the following equations(Cole 1983) :

$$\text{Gross productivity } (mgO_2/\ m^3/h) = \frac{(LB - DB) \times 1000}{PQXt}$$

$$\text{Net productivity } (mgO_2/\ m^3/h) = \frac{(LB - IB) \times 1000}{PQXt}$$

Where: LB is the concentration of oxygen in the light bottle(mg/L),DB is the concentration of oxygen in the dark bottle(mg/L),IB is the concentration of oxygen in the initial bottle(mg/L),PQ is the photosynthetic quotient(assumed to be 1.2),and t is hours of incubation.

Samples of each fish species from each pond were collected monthly, and then fish was weighed and immediately returned to the water of the same pond. At the end of the experiment, all fish were harvested and weighted.

Simple economic analysis was performed to estimate the net return and net revenue (NR= net return(EL) / total costs(EL)) for the seven treatments using the market retail prices of fish, feed and local market labor fees etc. at the time of the study. All calculations were made by the Egyptian currency. Tilapia prices were set at 6.0, and 5.0 LE /kg for 1st, and 2nd grades respectively, common carp price was 4.0 LE/kg , gray mullet price was 11.5LE/kg, grass carp and silver carp price were 4.0 LE/Kg .The inputs and outputs of each treatment were carefully recorded. Data were analyzed according to Ahmed and Fatimah (1998).

Statistical analysis: The variation in parameters and significance and their interaction among the different treatments for these parameters were tested by using analysis of variance (ANOVA). One-way ANOVA in completely randomized design was used to test the effect of the treatments on water quality, fish growth and economic parameters. Two-way ANOVA was used to test the effect of fertilizer and/or supplementary feed(rice bran) as well as their interaction on water quality and growth parameters. Significant results were compared using Duncan's Multiple Range Tests(1955) with repeated sampling to observe the comparison of mean values among the treatments .Differences were considered significant at($P \leq 0.05$ and $P \leq 0.01$). All statistics were done using SAS program ver. 9.1 (SAS, 2005).

RESULTS AND DISCUSSION

As shown in Table (3) all of water quality parameters were affected by treatments except for water temperature which didn't differ among treatments ($P > 0.05$).The Use of inorganic and organic fertilizers and supplementary feed improved water quality through stimulation of natural food, mainly phytoplankton and zooplankton, suitable for the filter feeding tilapia, mullet and carp species .Organic fertilizers acts as an energy source for bacterial growth , but the aerobic decomposition of organic matter by bacteria is an important drain of oxygen supplies in ponds (Boyd,1982). Both phytoplankton and zooplankton biomass were significantly higher in ponds with improved fertilization compared to ponds with poor nutrition (Table 3). Total ammonia nitrogen fluctuated throughout experiment but remained below 1 mg/ L and at the pH levels observed; PO4 ,NO2 , NO3 and total alkalinity (mg$CaCo_3$/l) probably did not adversely affect fish performance. Major water quality parameters measured during the study remained in the favorable range for fish culture (Boyd, 1990), suggesting that cultured fish growth performance was not limited by any of the water quality parameters. Comparable results were obtained by Lawson (1995). All ponds were within acceptable range of water quality parameters during the study.

As shown in Table (3), average water temperatures during the experiment ranged from 27.2 to 28.5 ºC . No significant differences($P \leq 0.05$) were observed in water temperatures among treatments. However, the higher value of water temperature in T7 (28.5±0.91) received organic , inorganic and feed may be attributed to the increase in organic matter contents of this pond that may lead to temperature increase . This range was beneficial to fish culture and these are in agreement with results of Hussein and Abdel-Hakim(2003).The concentration of dissolved oxygen(DO)treated ponds were significantly($P \leq 0.05$) influenced by the experimental treatments. Oxygen levels in all treatment ranged between (5.4 - 7.3mg/ L) throughout the experiment, and were within the optimum range and higher than 5 mg/ L which reported by Boyd (1998) as the minimum desirable DO level in fish ponds. These are in agreement with results of Hussein and Abdel-Hakim (2003).

PH remained fairly alkaline throughout the study period. pH ranged between 8.1(T2) and 8.6(T7) and significantly($P \leq 0.05$) influenced by the experimental treatments and this is in agreement with Boyd (1998) and Hussein and Abdel-Hakim(2003). Boyd(1990) reported that application of ammonium and urea- based fertilizers can cause acidification of pond water because of nitrification, which produces two hydrogen ions from each ammonium ion .The orthophosphours (PO_4 -mg P/l) concentrations ranged between 0.09 and 0.17 mg/l and were significantly($P \leq 0.05$) influenced by the experimental treatments . The ammonia concentrations (NH_4-mgN/l) were significantly($P \leq 0.05$) influenced by the experimental treatments and they ranged between 0.22-0.36 mg/l. These results show a slight increase in ammonia concentration with the increase of the pH, which is in agreement with Hussein and Abdel-Hakim(2003). They reported an ammonia concentration of (0.181-0.297 mg/ L) in ponds fertilized with chicken manure and inorganic fertilizers. These low concentrations of ammonia may be attributed to ammonia utilization by phytoplankton (Boyd, 1998) or oxidation of ammonia nitrite especially in high dissolved oxygen level conditions (Boyd, 2000). Total ammonia nitrogen fluctuated throughout experiment but remained below 1 mg/ L and at the pH levels observed; unionized ammonia probably did not adversely affect fish performance. Major water quality parameters measured during the study remained in the favorable range for fish culture (Boyd, 1990), suggesting that fish growth performance was not limited by any of the water quality parameters. Comparable results were obtained by Hussein (2002).Alkalinity (as $mgCaCo_3/l$) values ranged from 217mg/l (T3) to 339 mg/l (T7) and were significantly($P \leq 0.05$)influenced by the experimental treatments. Diana *et al., (*1994) reported that fertilization alone led to low alkalinity. Even though the values of physic-chemical characteristics of water ponds during the experimental period were within the acceptable limits for tilapia, carps and mullet as indicated by Miranda-filho *et al*. (1996).

The use of inorganic fertilizer improved water quality through stimulation of natural food , mainly phytoplankton and zooplankton .Both phytoplankton and zooplankton biomass were significantly ($P \leq 0.05$) higher in ponds with improved fertilization compared to ponds with poor nutrition (Table 3).

Chlorophyll-a (mg/l) ,number of phytoplankton and zooplankton per liter in water , net productivity and gross productivity($gO_2/m^2/h$)of different treated ponds and Performance of fish cultured for 6 months in earthen ponds using feed,fertilizers and feed plus fertilizer, improved and poor inputs are presented in Table (3).There were significantly($P \leq 0.05$)influenced by the experimental treatments .Net primary productivity values indicated a greater autotrophic concentration to fish growth with the chemical fertilizer treatment.Noriege-Curtis(1979)reported that fish production in intensively manured ponds was not due exclusively to primary production, but also to heterotrophic production.Net primary productivity in organically fertilized ponds in Hondoras was significantly greater than in inorganically fertilized ponds(Green *et al*.,1989a and 1990a).

Results of factor analysis (Table 4) showed that four factors (Phytoplankton decomposition, Photosynthesis,chemical reactions and supplementary feed) were responsible for more than 77% of the explained variability that affected all water quality variables.

The first factor had positive correlation with water temperature, phosphorus, chlorophyll"a" concentrations ,phytoplankton standing groups, zooplankton standing groups, net productivity and gross productivity, while it had negative correlation with dissolved oxygen,pH,NH_4 and total alkalinity, these relationships reflects the opposition between phytoplankton decomposition (the increase in water temperature and phosphorus contents promotes phytoplankton growth that decreases DO,pH,NH_4 and total alkalinity) and decomposition of phytoplankton cells (after blooms phytoplankton cells decays that liberates phosphate into water reducing pH while fermentation reduces oxygen content).

The second factor shows positively correlated with water temperature and negatively correlated with pH, PO_4 NO^2 , $NO_3$and total alkalinity available phosphorus and nitrate, reflects the chemical reaction (the increase in water temperature accelerates the chemical reactions that transform $CaCo_3$, Po_4, NO_3 to other forms of calcium phosphorus and nitrogen compounds reduces alkalinity, orthophosphate , nitrate and nitrite concentrations).

The third factor shows negative correlation between supplementary feed and DO,pH,NH_4 and total alkalinity , while it had negative correlation with water temperature , chlorophyll "a" concentrations ,phytoplankton standing groups, net productivity and gross productivity.

Table 4: Variables analysis, the four main effective factors that were responsible for 77% of explained variance for all treatments of fertilizations and supplementary feed during the experimental period in earthen ponds (in 180 days).

Variables	Factor 1	Factor 2	Factor 3	Factor 4
Water temp.(^{0}C)	0.89[a]	0.63[a]	0.74[a]	0.21[c]
DO (mg/l)	- 0.83[a]	0.06[c]	-0.54[a]	0.39[c]
pH	-0.71[a]	-0.41[b]	-0.61[a]	- 0.22[c]
PO_4	0.62[a]	-0.79[a]	0.33[c]	- 0.17[c]
NO_2 (mg N/l)	0.32[b]	-0.66[a]	0.12[c]	- 0.11[c]
NO_3 (mg N/l)	0.25[b]	-0.57[a]	0.06[c]	- 0.29[c]
NH_4 (mgN/l)	-0.14[c]	0.14[c]	- 0.56[a]	0.21[c]
Total alkalinity (mgCaCo$_3$/l)	-0.11[c]	- 0.53[a]	-0.44[b]	0.86[a]
Chlorophyll a (µg/l)	0.72[a]	0.27[c]	0.57[b]	0.79[a]
Phyt. stand.crops (No.x10^7org./m^3)	-	0.36[c]	0.63[c]	0.93[a]
Zoopl.Stand. crops (No.x10^5org./m^3)	0.94[a]	0.42[b]	0.37[b]	0.57[a]
Net productivity (mg O_2/m^2/h)	0.89[a]	0.53[a]	0.52[a]	0.71[a]
Gross productivity (mg O_2/m^2/h)	0.76[a]	0.34[c]	0.61[a]	0.86[a]
Explained variance (%)	29	24	9	15
Interpretation	Phytoplankton decomposition	Chemical reaction	Supplementary feed	Photosynthesis

Means with different letters in the same column in each main effect are significantly different(Duncan's multiple range test at $P<0.05$).

The fourth factor shows positive correlation between total alkalinity in one hand and with chlorophyll "a" content, zooplankton standing crops, net productivity and gross productivity in the other hand, which interpreted as photosynthesis process (significant correlation between the availability of carbon measured by both alkalinity and phytoplankton cells measured by chlorophyll "a" in the water column interpreted as photosynthesis), and it had a negative correlation with pH, PO_4,NO_2 and NO_3,

The data on the growth performance of all experimental fish as effected by the experimental treatments (cow manure , chemical fertilizer and supplementary feed) are presented in Table 5.

Average initial weight (g/fish), average final weight (g/fish), average net weight gain(g/fish), SGR, FCR, condition factor(K) and total fish production(ton/feddan) for wild *Tilapia* species(*O.niloticus* and *O.aureus),* Common carp(*C. carpio*) , gray mullet (*M. cephalus*),Grass carp(*C. idella*) and Silver carp (*H. molitix)* separately presented for each fish species and each treatment in Table (5).

It can be noticed that these results were significant differences ($P<0.05$) among different experimental treatments (cow manure , chemical fertilizer and supplementary feed(rice bran) . The experimental fish on (T7) had a significantly ($p\leq0.05$) highest fish average final weight (g/fish), average net weight gain(g/fish), SGR, FCR, condition factor(K) and total fish production(ton/feddan) for all experimental fish species .

As presented in Table (5), T7 treatment had the highest ($p<0.05$) total production (2855.2Kg / feddan), followed by T6 treatment(2657.7 Kg/feddan) then T5(2330.3 Kg/feddan) , T4(2159.0 Kg/feddan) ,T1(2418.2 Kg/feddan) and T3(1617.5 Kg/feddan) respectively, while T2 treatment was the lowest total production (1558.8 Kg/feddan) which received poor input , cow manure only). Average final wet weight ,net weight gain ,SGR , FCR , condition factor(K) followed the same manner of production parameters, however FCR has the highest value in T5 treatment , while the best FCR (i.e. the lowest) was achieved by T7 treatment. These are in agreement with results of Hussein and Abdel-Hakim (2003), and Eid *et al*.,(2010) .

On the basis of comparison of mean values of average body weight in different treatments, the growth performance of wild *Tilapia* species(*O. niloticus* and *O. aureus),* Common carp(*C.carpio*),gray mullet (*M.cephalus*), Grass carp (*C. idella*) and Silver carp (*H. molitix)* for all treatments of fertilizations and supplementary feed during the experimental period (in 180 days) were better with T7 (cow manure + inorganic fertilizers (U+TSP)+supplementary feed),while the other treatments were lower than this treatment (Table 5). As evident from comparison of means of average body weight, T7 was the best treatment as compared to other treatments.

The results of the present investigation revealed that at the end of the experiment, all the cultured fish species gained maximum weight with cow manure, inorganic fertilizer and supplementary feed was added as compared to other treatments .

Data for SGR revealed the significant ($P < 0.05$) difference for the treatments in all treatments, which corroborates with the results were findings of Hussein (2002) , Hussein and Abdel-Hakim (2003) and Sahu *et al*. (2007) for these species. In the present study, it was observed that higher fish production was observed in cow manure+ supplementary feed when compared with inorganic fertilizer was used. The results are in accordance with the findings of Mahboob and Sheri (1997), who obtained the fish production of 9400 kg-1 ha-

1yr-1 by using broiler dropping as compared to 7400 kg/ha/yr by using NPK fertilizer with major carps. These are in agreement with results of Hussein and Abdel-Hakim (2003).

The highest gross fish production of these cultured fish species was due to the role of both fertilization and supplementary feed throughout the study period. This might be due to the provision of fertilization and supplementary feed (Diana *et al.,* 1994; Veerina *et al*., 1999 and Hussein and Abdel-Hakim ,2003). Abbas *et al*.,(2010) concluded that manipulation of Common carp along with the major carps and the provision of supplementary feed and fertilization enhanced the growth rate as well as production in semi intensive culture system. Furthermore it increased the effectiveness of liming application and the availability of nutrients to phytoplankton and zooplankton for the fish species in polyculture system, which is helpful in the reduction of input costs. These results are in line with those obtained by Hussein (2002),who reported a significant increase in fish yield due to the effect of organic fertilizer on the planktonic productivity of a commercial pond. Hassan *et al*. (2000)reported that cowdung fertilization exerted significant effect on the growth performance of major carps. These results are also in confirmatory with those of Aziz *et al*.(2002), who studied the growth performance of major carps in fertilized ponds supplemented with feed containing 28% crude protein and reported that a planktonic productivity of 22.14 mg/l produced an average fish yield of 7826.08g. These workers, through the regression studies, calculated the contribution of primary productivity towards increase in fish yield to be 57.40%.

Ahmed *et al*.(2005) showed that average gain in body weight of all the fish species together was less in the control pond than that in the pond treated with supplementary feed (rice polishing), and The supplementary feeding caused a significant increase in fish yield in the treated pond. So, the semi-intensive condition gave 1.477 times greater fish production than the simple extensive one.

In the present experiment, the enhanced production in the treated pond can be justified by the fact that crude protein in the form of rice bran was not only taken as feed by the fish but also the leftover protein contributed to the fertility of the treated pond (Ahmed *et al*.,2005). Javed *et al*. (1993) concluded that use of artificial feed was beneficial in two ways,(i)direct utilization of feed,(ii)indirect response of leftover feed in terms of planktonic productivity.The nitrogen supplemented in the form of crude protein resulted in significant increase in body weight of the fish.Ahmed *etal*.(2005) concluded that the vegetable protein(rice polish) which is cheaper than animal protein can be used in the form of supplementary feed in semi-intensive fish culture system for better fish production.

The increased fish production in ponds received fertilization with feeding may be mainly due to the abundance of natural food which resulted from the available nutritive elements required for increasing the concentration of phytoplankton in ponds. Moreover the suitable environmental conditions may be also participating in these results (Table 3). Some researchers have shown that supplemental feeding in fertilized ponds resulted in significant higher growth rates and greater yield than fertilization alone (Green, 1992; Diana *et al*., 1994 and Hussein and Abdel-Hakim, 2003). Diana *et al*. (1996) emphasized that, from a pond management perspective, pond fertilizing early in the grow-out phase, then adding supplemental feed once Nile tilapia reach 100- 150 g, is an efficient way to grow large tilapia. However, excessive increase in variable cost due to the high price of formulated feed is a growing concern among tilapia growers as this could lead to a negative net return and thus, an economically unviable practice. Certainly, it is more economic procedure of aquaculture practice, more than any other factor, which influences its long-term adoptability and, therefore, proper assessment of economic performance of culture system is essential.

The optimal level of cow manure had been estimated from a response curve determined from a previous experiment (Hussein and Abdel-Hakim, 2003) and was typical of the level of sustained fertilization managed by resource-poor farmers. The loading levels of dry cow manure alone used in the current study produced low and erratic production, unlikely to satisfy needs of farmers for subsistence or cash. The carrying capacity of the system was quickly exceeded at the stocking density used, resulting in minimal individual growth. There was little evidence that lack of food stimulated raising of fish even at the lowest level of nutrient input.

The economical analyses for all treatment are presented in Table 6. Results revealed that the highest yield were obtained in T7followed byT6,T1,T5,T4,T3 and T2, respectively. Fish growth and net yield were significantly($P<0.05$)affected by nutrient level. Significant differences ($P<0.05$) in individual weight of fish raised on different levels of nutrient input were observed from month 2 onwards.

In the current trial, the levels of recruitment in experimental fish raised from fingerlings for a period of 6 months were different, as was the harvested individual mean size and yield of fish. Two main reasons may explain this result. Firstly, the effect of fertilization which increase the phytoplankton and zooplankton which utilized by cultured fish and feeding which help for growth performance. Nile tilapia fed on planktonic algae, detrital /fungal flocks, or zooplankton which feed on algae and detritus (Knud-Hansen *et al*., 1993). Supplemental feeds are used in pond culture to increase fish growth and yields (Li and Yakupitiyage, 2003).

The results of the study showed a significant($P<0.05$) increase in net income in culturing experimental fish under fertilization plus feeding as compared to culturing fish under feeding or fertilization only. In the present study, negative net return obtained in the treatment with fertilization followed by feeding was due to the low production caused by poor growth performance of

experimental fish in the treatment. This study demonstrated that fertilization plus formulated diet produced higher yield than formulated diet only, and, hence, the practice of fertilization plus feeding is more cost-effective than using fertilization followed by feeding for experimental fish culture.

The results of the study confirms the view of Hussein and Abdel-Hakim(2003) that the yield of T1 , T2 , T3 ,T4 and T5 treatments culture models , the profit from ponds pisciculture 295.2 , 1740.7 , 880.8, 4085 and 2477.4 LE/fed ,respectively. Further to this accounting of the cost to produce 1 kg tilapia revealed that unit production cost was lower in the treatment with fertilization plus feeding (1.28 LE/ kg fish) than that in the treatment with fertilization only (1.45 LE kg/ fish), suggesting that production costs can be significantly reduced in a fish farming system where an efficient fertilization program is applied. As costs of fertilizer is much less than feed(1.55 LE kg/ fish), better feed conversion ratio in fertilization plus feeding treatments were reflected in feed costs saving and thus, an increased net return.

Two-way ANOVA (Table 7) indicated that fertilizer type was effective than supplementary feed on water quality parameters. The (T7) had the highest ($P \leq 0.05$) average of water quality parameters and plankton densities(cells/m^3)which attributed to the higher fish growth that received organic , inorganic and feed may be attributed to the increase in organic matter contents of this pond that may lead to consume natural food and release ammonia in a form of feces much greater than that in the other treatments. On the other hand, both of water temperature and pH were not affected neither by fertilizer type nor by supplementary feed. Both of total orthophosphate(PO_4- mg/l) and total alkalinity had significantly higher concentrations when ponds treated with chemical fertilizers than ponds treated with organic fertilizers, this mainly due to increases in photosynthesis activity in ponds treated with organic fertilizers. Boyd (1990) stated that the increase in the rate of photosynthesis leads to the consumption of carbon dioxide(Co_2)and hydrolysis of bicarbonate (HCo_3).

Analysis of variance on the final average body weight of these cultured fish species showed a highly significant difference($P<0.05$) among the species, treatments as well as among the interaction of species and treatments (Table 8). Comparison of mean values of average body weight showed that all the fish species under test attained maximum average body weight with organic manure, inorganic fertilization and supplementary feed. However there was a non-significant difference ($P<0.05$) in all other treatments for all fish species (Table 8).

Two-Way ANOVA and main effects by fertilization type and Supplementary feed on growth performance and economics efficiency for all experimental treatments of fertilizations and supplementary feed during the experimental period (in 180 days) as well as their interaction on fish growth performance and economic parameters (Table 8), indicated that total fish

production was affected by fertilization type, chemical (1617.5 Kg/ feddan) was higher than, organic (1558.8 Kg/ feddan) while Supplementary feed had a highly significant difference($P<0.05$) among the species, in total fish production. On the other hand, economic parameters were influenced by Supplementary feed and a lesser degree by fertilization type. On the other hand their was a highly significant difference($P<0.05$) between organic and chemical fertilizers neither in Net return nor in Net Revenue, however, chemical fertilizer was a highly significant difference($P<0.05$) in net return than organic whereas it was lower in Net Revenue than chemical fertilizers.

In conclusion, fish culture growth was better, water quality, fish production and consequently economic returns can be optimized with in the treatment with organic and chemical fertilizers plus supplementary feeding than feeding alone or fertilization alone for polyculture in terms of economic efficiency and net revenue (Table 8), The study suggested that maximizing production efficiency would require the combination of the three nutrient input sources (feed , organic and inorganic fertilizers).The study throw the lights on the importance of the need to increase yields of fish culture.

More research should be conducted on fertilization regimes and to what extent (i.e. period and/or percent), ponds can depend on fertilizers instead of feed either completely or partially.

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مقارنة تأثيرات التسميد والغذاء الأضافى على أداء نمو الأسماك وجودة المياه والعائد الأقتصادى للأسماك فى الأستزراع المتعدد شبه المكثف فى أحواض غذيت أضافياَ بنخالة الأرز

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تم أجراء تجربة أستزراع شبه مكثف متعدد لأسماك البلطى (البلطى النيلى والبلطى الأوريا من الطبيعة) والمبروك العادى والبورى والمبروك الحشائش والمبروك الفضى بهدف تقييم تأثيرات أنواع التسميد ونخالة الأرز (١٢.٨% بروتين خام) كغذاء أضافى فى الأحواض المسمدة على أداء النمو من حيث متوسط وزن الجسم ، ومعدل النمو النوعى ، ونسبة الغذاء المختبر، والأنتاج الكلى لهذا السمك ، ووحدات قياس جودة المياه،

والعائد الأقتصادى الأستزراع المتعددالأنواع فى نظام الأستزراع الشبه مكثف مع نخالة الأرز كغذاء أضافى فى مزرعة بحوث الأسماك بالسرو – المعهد القومى لعلوم البحار والمصايد – محافظة الدقهلية .

تم تجهيز سبعة أحواض أرضية مساحة كل حوض ٤٢٠٠ م٢ . و تم تخزين كل حوض بمعدل ٦٠٠٠ بلطى طبيعى من جنس النيلى والأوريا ، و٢٠٠٠ مبروك عادى ، و١٠٠٠ بورى ، و٥٠٠ مبروك حشائش ،و٥٠٠ مبروك فضى . تم أضافة نخالة الأرز لأربعة أحواض من التجربة بمعدل ٥% من وزن السمك الرطب يومياً خلال مدة التجربة لفترة ٦ شهور(١٨٠ يوم). الأحواض المعاملة تم أضافة السماد بمعدل ٠.٢٠ جم نيتروجين و ٠.٠١ جم فوسفور / ١٠٠ جم من وزن الجسم الرطب والغذاء الأضافى يومياً ، من المصادر المختلفة . سبعة معاملات طُبِّقتْ بشكل عشوائي بدون مكررات كُلّ كالتّالي :

معاملة ١ = غذاء إضافي (نخالة أرز) - معاملة ٢ = مخصّبات عضوية (سماد بقرةِ)، معاملة ٣ = مخصّبات غيرعضوية(كيماوية) اليوريا (٤٦% ن) سوبر فوسفات الثلاثى (٤٦% فو٢ أ٥) - معاملة ٤ = مخصّبات عضوية + مخصّبات غير عضوية، معاملة ٥ = مخصّبات عضوية + غذاء إضافي، معاملة ٦ = مخصّبات غير عضوية + غذاء إضافي، ومعاملة ٧ = مخصّبات عضوية + مخصّبات غير عضوية + غذاء إضافى .

فى هذة التجربة كل أحواض التجربة المعاملة أستقبلت نفس الكمية من النيتروجين والفوسفور ولكن المصادر كانت مختلفة .الأحواض المعاملة أظهرت زيادة معنوية فى أنتاج الأسماك .والنتائج أظهرت أن السماد العضوى + السماد الغير عضوى (الكيماوى) +نخالة الأرز كغذاء أضافى تعتبر أحسن معاملة لأكبر أنتاج سمكى يمكن تسويقه هو ٢٨٥٥.٢ كج/فدان /١٨٠ يوم .بينما كان الأنتاج السمكى الممكن تسويقه للمعاملات ١ و٢ و٣ و٤ و٥ و٦ وجد أنه ٢٤١٨.٢ و ١٥٥٨.٨ و ١٦١٧.٥ و ٢١٥٩.٠ و ٢٣٣٠.٣ و ٢٦٥٧.٧ كج / فدان/ ١٨٠ يوم ، على التوالى . لذلك للحصول على أكبر أنتاج سمكى يوصى بتسميد الحوض مع الغذاء الأضافى .

تدل على أن معظم خصائص جودة المياه تتأثر بواسطة نوع السماد بينما الغذاء الأضافى تأثيره قليل one-way ANOVA تحليل المعامل برهن على وجود أربعة عوامل هى (تحلل الفيتوبلانكتون والتمثيل الضوئى والتفاعل الكيماوى والغذاء الأضافى) تكون مسئولة عن ٧٧% من تفسير المتغير الذى يؤثر على كل متغيرات خصائص المياه . كل وحدات خصائص جودة المياه كانت تدور فى النطاق الملائم لنمو جميع أنواع السمك المستخدم فى التجربة .

تدل على أن نوع التسميد أكثر تأثيراً عن الغذاء الأضافى على وحدات جودة خصائص المياهTwo-way ANOVA نتائج التحليل وكثافة البلانكتون (عدد الخلايا/ م٣). التحليل الأحصائى والتأثيرات الأساسية لنوع التسميد والغذاء الأضافى على أداء النمو والكفاءة الأقتصادية لكل المعاملات التجريبية خلال فترة التجربة مع تداخلاتها على أداء النمو تدل على أن الأنتاج الكلى للسمك قد تأثر بنوع السماد ، ومن ناحية أخرى يوجد أختلاف معنوى كبير بين السماد الكيماوى والعضوى فى العائد الأقتصادى .

التوصية: يمكن التوصية بأن النمو الجيد للسمك المستزرع ، وجودة المياه ،وأنتاج السمك و العائد الأقتصادى المرتفع يمكن تعظيمه بالمعاملة بواسطة التسميد العضوى والغير عضوى بالأضافة الى الغذاء الأضافى .