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INTEGRATED FISH CULTURE WITH FARM ANIMALS

BY

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ABSTRACT

The present experiment was carried during one growing season (100 days) in earthen ponds. The objective of the study is to develop guidelines for the integration of ducks and buffaloes with fish by developing practical systems for fish in polyculture system using duck and buffalo manures. The treatments applied are buffalo manure only (BM), buffalo manure with supplementary feed (BM+F), duck manure only (DM) and duck manure with supplementary feed (DM+F). Each treatment was performed in triplicate, each in an earthen pond of an area of 2000 m². Each pond was stocked with 3000 Nile tilapia (*Oreochromis niloticus*), 940 blue tilapia (*O. aureus*), and 60 common carp (*Cyprinus carpio*). The obtained results can be summarized as follow:

- At the experiment start, body weight and body length of Nile tilapia was relatively similar and after 30 days of the experiment, body weights among treatments groups were significantly different and these differences continued till harvesting where the DM+F treatment produced the heaviest and longest fish bodies compared to the other treatments.
- Body weight and body length of blue tilapia and common carp showed the same trend of Nile tilapia.
- Specific growth rate (SGR) of Nile tilapia, blue tilapia and common carp were higher in treatments received BM+F and DM compared to those received BM or DM only and the differences were significant.
- The higher total fish production was obtained by DM+F group followed in a significant decreasing order by the other groups, BM+F, DM and BM, respectively .
- The net return (total returns - total costs) were 5036, 4739, 6657 and 5741 LE for the different treatments, BM; BM+F; DM and DM+F, respectively. Therefore, DM group recorded the best returns compared to the other treatment.

INTRODUCTION

The integrated farming of fish and livestock is widely practiced for maximizing protein production derived from a single source of animal feed. In this system the land animals are raised on balanced diets and their wastes (manure and feed wastage) are used by fish directly or indirectly (stimulate growth of planktonic and benthic organisms in the ponds) providing natural feeds for fish low in the food chain (Lin et al., 1993). The integration system increases the production of animals and decrease the cost of fish culture operations considerably, the duck droppings acting as substitute for as both supplementary feed and fertilizers which otherwise form over 60% of the input cost in fish culture, Sinha (1986).

Integrating the source of manure with the pond, i.e., growing the ducks, chickens, pigs, ect., on top of the pond has several advantages:

1. The nutritional value of the manure is preserved because losses of nitrogen and energy due to fermentation, evaporation and non-reversible coagulation are eliminated;
2. Feed residues (about 10 %) are eaten directly by fish;
3. The costs of collecting, sorting and transporting of the manure are eliminated;
4. Land area, which is otherwise needed for the manure-producing livestock, is saved;
5. Providing a neat solution to problems of environmental pollution by animal wastage (Plavink et al., 1983).
6. Duck disturb the surface water layers of ponds by swimming and playing and therefore water will be better aerated.
7. Ducks search for food in the shallow parts of the pond. By turning up the bottom, ducks promote decomposition and nutrient recycling in the water.

According to the 1998 census, Egypt has a population of buffaloes of around 3,573,000 and poultry population of 85,768,000 (chickens) and 19,009,000 (ducks). The wastes from these farm animals are sufficient to fertilize hundred thousand of feddan water area for fish culture in Egypt (CAMPS, 1998). Schroeder (1974) found that animal manure beside their nitrogen and phosphorus contents stimulate heterotrophic production, which increase tilapia production in ponds. The organic detritus and bacteria not only promoted the growth of zooplankton but also provided the food sources for filtering and omnivores species of fishes (Baotong 1981; Schroeder 1978 and 1980). Woynarovich, (1980) reported that a duck produced about 7 kg fresh manure over a period of 36 days and 500 ducks therefore produce about 3.0 to 3.5 tons during the same period and 100 ducks produced approximately 10,000 kg of manure over 12 month. He concluded that, 100 to 150 duck can give adequate fertilization of 1 ha of water. Also, he found that the manure contained 57% water and 26% organic matter and each 100 kg contain about 10 kg carbon, 1.4 kg $P_2 O_5$, 1 kg N, 0.6 kg potassium (K_2O),1.8 kg calcium and 2.8 kg of other

materials. A major difference between duck and buffalo manure lay in their carbon: nitrogen ratios, which are determined to be 10:1 and 26:1, respectively (AIT, 1986).

Under the polyculture system of common carp, tilapia and silver carp, Barash et al., (1982) noticed that when fish ponds were integrated with duck, the ducks performance on the ponds was superior compared to the control in growth rate, feed efficiency, viability and cleanness of the feathers and skin and the average daily gain of the fish was 38.5 kg/ha which is not significantly different from ponds received similar mixtures of dry poultry manure plus supplementary feeds. They showed also that the integration system is very efficient and its use should be expanded in warm water aquaculture. Under the polyculture system of common carp *(Cyprinus carpio),* Chinese carps (*Ctenopharyngodon idella),* silver carp (*Hypophthlmichys molitrix)* and *O. mossambicus*, Schoonbee and Prinsloo (1988) found that fish yields obtained over a 5 to 6 month growing period using manures only as nutrient, fluctuated between 1.5 and 2.3 tons/ha but when ducks were combined with fish on the ponds, fish yields exceeding 9 tons/ha were obtained, in addition, a cumulative live mass yield of 36 ton/ha ducks was achieved over a 6-month-production period.

The fish–duck system produced average yield of 2197 kg/ha of carp in a 160 days growing period, and 7500 kg/ha of duck in 4 cycles during the grow out period (Pekar et al.,1993). Salama and Essa (1988), studied that the survival and growth rates of three fish species (common carp, gray mullet and tilapia) integrated with duck and without duck (control). They found that the survival and growth rates of fish reared in integrated ponds were better than those of the control.

The present study aimed to investigate the effect of different manuring sources (duck or buffalo manures) with or without supplementary feed on pond productivity and performance of Nile tilapia, blue tilapia and common carp in polyculture system.

MATERIALS AND METHODS

The present study was conducted at the Central Laboratory For Aquaculture Research at Abbassa, Sharkia Governorate, Egypt. In this experiment 12 earthen ponds were used, all ponds are identical in shape and size. Ponds are rectangular with an area of 2000 m^2 (about 0.48 feddan) and supplied with freshwater from Ismaellia Canal. Each pond was stocked with 3000 Nile tilapia (*Oreochromis niloticus*), 940 blue tilapia (*O. aureus*), and 60 common carp (*Cyprinus carpio*), then the ponds assigned at random into four treatment groups, each group composed of three replicates.

Ponds feeding and manuring:

The three ponds (replicates) of the first treatment group were fertilized with 5 kg/pond/day of BM. The second group (treatment) received 5 kg/pond/day BM+3% of the fish biomass supplementary feed (17% protein). The ponds of the third treatment were fertilized with manure released by 125 duck raised on a house built on a pond dike without additional feed. Ponds of the fourth treatment was fertilized also with the manure released by 125 duck raised in a house at a pond dike beside 3% of the fish biomass supplementary feed (17% crude protein). The effect of the following four treatments were evaluated in the present study:

1- BM , buffalo manure only (5 kg/day/pond).
2- BM+F, buffalo manure (5 kg/day/pond) + 3% of fish biomass supplementary feed (17% crude protein).
3- DM, buffalo manure only (5 kg/day/pond).
4- DM+F, buffalo manure (5 kg/day/pond) + 3% of fish biomass supplementary feed (17% crude protein).

A total number of 250 pekin duck aging 21 days with an average weight of 200g were used in this experiment. Ducks were divided between the two houses of the third and fourth treatments in equal numbers. Each duck house served for 3 ponds and ducklings were raised for 60 days. During the experimental period ducks were supplied with artificial feed (25% crude protein) at a rate of 5 to 10% of body weight per day. Table (1) show the proximate analysis of BM, DM and duck and fish supplementary feed.

Table (1): Proximate analysis of buffalo manure, duck manure and feeds.

A. Buffalo and duck manure						
	Crude protein %	Organic carbon %	Nitrogen %	Phos. %	C:N ratio	N:P ratio
Buffalo manure (BM)	10.25	38.39	1.64	0.29	23.41	5.66
Duck manure (DM)	23.8	41.58	3.81	1.23	10.91	3.10

B. Fish and duck supplementary feed				
	Crude protein %	Crude fat %	Crude fiber %	ME Kcal/kg
Fish supplementary feed	17.0	8.1	8.0	2500
Duck feed	25.0	6.5	7.0	2400

Fish samples and measurements:

Random samples (15 fish Nile tilapia, 15 fish blue tilapia and 10 fish of common carp) were taken from each pond to determine their body weight and length then all fish were returned to their ponds. Initial body weights to the nearest gram and body length to the nearest cm were recorded at the time of pond stocking and every 30 days till harvesting and the amount of feed was adjusted according to the changes in body weight.

Specific growth rate (SGR) was calculated according to the following formula:

$$SGR = \frac{LnW2 - LnW1}{t} \times 100$$

Where:
Ln = the natural log;
W_1 = initial weight;
W_2 = the final weight in "grams" and
t = period in days.

Statistical analysis:

The statistical analysis of data was carried out by applying the computer program SAS (1996) by adopting the following fixed model:

$$Y_{ijk} = \mu + R_i + T_j + e_{ijk}$$

where:
Y_{ijk} = observation of the ijk^{th} fish;
μ = overall mean;
R_i = fixed effect of the i^{th} replicate;
T_j = fixed effect of the j^{th} treatment and
e_{ijk} = a random error.

RESULTS AND DISCUSSION

Body weight:

As shown in table (2) average body weight of Nile tilapia at the experimental start ranged between 2.09 and 2.12 g and differences among treatment groups were insignificant indicating the complete randomization of fish distribution among the experimental groups. After 30 days of experimental start, average body weights for Nile tilapia for groups received BM, BM+F, DM and DM+F, were found to be 20.51, 33.40, 22.22 and 44.47 g, respectively. The analysis of variance of results during this period showed that DM+F treatment had significantly ($P<0.001$) heavier weights followed in a significant decreasing order by the BM+F, DM and BM groups, respectively. Body weights of Nile tilapia followed the same order during the periods of 60 and 90 days after experimental start where the DM+F groups was significantly ($P<0.001$) superior than the other groups.

At harvesting (100 days after start), averages of final body weights for the BM, BM+F, DM and DM+F groups were found to be 120.33, 135.09, 125.38 and 137.33g, respectively. Statistical evaluation of these results revealed that Nile tilapia in the DM+F group showed the highest body weight, followed in a significant ($P<0.001$) decreasing order by BM+F, DM and BM groups, respectively (Table 2). These results indicate that, supplementary feed increase the body weight of Nile tilapia when added to the fertilized ponds with both buffalo or duck manure compared to ponds fertilized only with BM or DM and this may be attributed to the availability of both supplementary feed and the presence of natural food enhanced by organic fertilization. These results agreed with those obtained by Soltan (1998) working with Nile tilapia and silver carp.

As shown in table (3) the average body weight of blue tilapia, *O. aureus* at the experimental start ranged between 2.12 and 2.27g with insignificant differences among treatment groups. After 30 days of experiment start average body weight of blue tilapia were 19.49, 22.62, 20.67 and 32.60 gm for the experimental groups BM, BM+F, DM and DM+F, respectively and the differences among these groups were significant ($P<0.001$). Blue tilapia in DM+F group had the heaviest body weight (32.60 gm) followed by BM+F (22.62 gm), DM (20.67 gm) and BM (19.49 gm) and this trend was continued till harvesting.

The results show that, blue tilapia reared in ponds fertilized by DM had the heaviest body weight compared to that fertilized with BM and this may be due to the high fertilization value of DM compared to BM (Table 1).

With regard to common carp, *Cyprinus carpio* results of Table (4) show that, at the experimental start, body weights were 24.6, 24.8, 24.9 and 25.1 g for the treatments BM, BM+F, DM and DM+F, respectively with insignificant differences between treatment groups. During the experimental periods 30, 60, 90 and 100 days (harvesting) of the experimental start, DM+F had the heaviest ($P<0.001$) body weight followed in a significant decreasing order by BM+F, DM and BM, respectively.

Generally, results obtained revealed that DM alone was superior in producing fish from the three species compared to BM alone and the final weights increased with supplementary feeds in both manuring sources. These results are in accordance with those obtained by Hassouna et al., (1998), who found that, Nile tilapia raised in fertilized ponds and supplied with artificial feed had the highest growth performance compared to fish raised in the fertilized ponds without feeds.

Table (2): Least square means, standard errors and analysis of variance for the effect of organic fertilization type on body weight of Nile tilapia.

Treatment (T)	No	Initial	30 days	60 day	90 days	Harvesting
BM	45	2.09±0.01	20.51±0.58 c	48.85±0.74 c	79.33±1.07 c	120.33±0.59 c
BM+F	45	2.09±0.01	33.40±0.58 b	59.80±0.74 b	86.29±1.07 b	135.09±0.59 a
DM	45	2.11±0.01	22.22±0.58 c	51.98±0.74 bc	83.96±1.07 b	125.38±0.59 b
DM+F	45	2.12±0.01	44.47±0.58 a	75.07±0.74 a	112.56±1.07a	137.33±0.59 a
Overall mean	180	2.10±0.01	30.15±0.29	58.85±0.37	90.53±0.53	129.53±0.59
Analysis of variance						
SOV	df	F-ratios				
Treatment	3	1.71	372.00***	252.45***	195.44***	183.50***
Replicates	2	0.276	1.137	0.36	0.233	1.909
Remainder df	174					
Remainder MS		0.009	14.97	24.46	51.55	15.83

Table (3): Least square means, standard errors and analysis of variance for the effect of organic fertilization type on body weight of blue tilapia.

Treatment (T)	No.	Initial	30 days	60 day	90 days	Harvesting
BM	45	2.16±0.03	19.49±0.40 c	42.78±0.66 c	61.00±0.81d	100.53±1.09 d
BM+F	45	2.12±0.03	22.62±0.40 b	49.27±0.66 b	79.04±0.81b	125.89±1.09 b
DM	45	2.24±0.03	20.67±0.40 bc	44.38±0.66 c	73.87±0.81c	108.78±1.09 c
DM+F	45	2.27±0.03	32.60±0.40 a	65.16±0.66 a	95.49±0.81a	129.16±1.09 a
Overall mean	180	2.20±0.02	23.84±0.20	50.39±0.33	77.35±0.41	116.09±0.55
Analysis of variance						
SOV	df	F-ratios				
Treatment	3	1.79	233.87***	238.65***	310.30***	156.50***
Replicates	2	0.83	0.87	0.98	0.04	2.27
Remainder df	174					
Remainder MS		0.05	7.18	19.70	29.55	53.89

Table (4): Least square means, standard errors and analysis of variance for the effect of organic fertilization type on body weight of common carp.

Treatment (T)	No	Initial	30 days	60 day	90 days	Harvesting
BM	45	24.6±0.12	89.5±1.51c	171.1±3.41c	281.8±5.47 d	356.9±6.01 d
BM+F	45	24.8±0.12	102.5±1.51 b	206.0±3.41b	356.1±5.47 b	545.4±6.01 b
DM	45	24.9±0.12	76.0±1.51d	149.6±3.41d	303.5±5.47 c	488.3±6.01 c
DM+F	45	25.1±0.12	109.7±1.51 a	230.8±3.41a	378.4±5.47 a	558.7±6.01 a
Overall mean	180	24.8±0.06	94.4±0.75	189.4±1.71	329.9±2.73	487.3±3.00
Analysis of variance						
SOV	df	F-ratios				
Treatment	3	2.19	96.67***	111.5***	67.43***	235.3***
Replicates	2	1.62	3.10	0.63	0.074	0.857
Remainder df	174					
Remainder MS		1.417	68.33	350.12	896.71	1083.06

+ Means with the same letter in each column are not significantly different. **P<0.001

Body length:

At the experimental start averages of body length of Nile and blue tilapias as well as common carp did not differ significantly within each species tested, after 30, 60, 90 and 100 days from the experiment start, the longest bodies ($P<0.001$) were recorded for groups raised in ponds fertilized with duck manure and received the supplementary feed, DM+F followed in a decreasing order by the other treatment groups BM+F, DM and BM, respectively (tables 5, 6 and 7). These results indicate that duck manure with artificial feeds favor the growth in weight and in length in the three species tested. These results are in agreement with those reported by Hassouna et al (1998) with Nile tilapia and EL-Gendy (1998) with common carp.

Specific growth rate:

Average of specific growth rate (SGR) of Nile tilapia, blue tilapia and common carp during the experimental periods 30, 60, 90 and 100 days after the start of the experiment for groups (BM), (BM+F), (DM) and (DM+F) are presented in tables (8, 9 and 10). The averages of SGR during the whole experimental period for the same groups cited before were 1.76, 1.81, 1.73 and 1.81 for Nile tilapia, 1.67, 1.77, 1.69 and 1.76 for blue tilapia and 1.16, 1.34, 1.29 and 1.35 for common carp, respectively.

The obtained results indicated that duck manure increase SGR compared to buffalo and the increase was more pronounced by supplying fish by supplementary feed. These results are in agreement with those reported by EL-Gendy (1998) working with common carp.

Survival rate :

As evident in Table (11) fish survival rate was more than 90%. Survival rate for Nile tilapia ranged between 92-95% and 90.5-95% for blue tilapia and also ranged between 99.6 to 99.7% for common carp with insignificant differences between treatment groups for the studied fish species. It seems that survival rates obtained were in the normal ranges and this indicated the good environmental conditions of the pond.

Total fish production:

As shown in Table (12) the experimental treatment DM+F had the highest fish production of Nile tilapia (412 kg/pond), blue tilapia (121 kg/pond) and common carp (33.5 kg/pond) and subsequently total fish production (566.7 kg/pond) followed by the treatment BM+F which produced 405.3, 118.2, 32.4 and 555.9 kg/pond for the same fish species, respectively.

Table (5): Least square means, standard errors and analysis of variance for the effect of organic fertilization type on body length of Nile tilapia.

Treatment (T)	No of fish	Initial	30 days	60 day	90 days	Harvesting
BM	45	2.24±0.03 a	3.87±0.09 bc	5.29±0.07 b	7.73±0.16 b	0.87±0.18b
BM+F	45	2.25±0.03 a	4.07±0.09 b	5.87±0.07 b	8.58±0.16 b	3.53±0.18 ab
DM	45	2.21±0.03 a	4.00±0.09 b	5.71±0.07 b	7.78±0.16 b	1.24±0.18 b
DM+F	45	2.22±0.03 a	5.00±0.09 a	7.16±0.07 a	11.04±0.16 a	4.87±0.18 a
Overall mean	180	2.23±0.01	4.23±0.04	6.01±0.03	8.78±0.08	2.54±0.09
Analysis of variance						
SOV	df	F-ratios				
Treatment	3	2.374	36.86***	136.06***	91.28***	95.85***
Replicates	2	1.36	1.58	5.48**	19.94***	29.85***
Remainder df	174					
Remainder MS		0.04	0.38	0.21	1.19	1.46

Table (6): Least square means, standard errors and analysis of variance for the effect of organic fertilization type on body length of blue tilapia.

Treatment (T)	No of fish	Initial	30 days	60 day	90 days	Harvesting
BM	45	2.10±0.02 a	3.64±0.06 ab	5.02±0.04 b	6.87±0.07 b	8.56±0.09 c
BM+F	45	2.07±0.02 a	3.31±0.06 b	5.00±0.04 b	7.51±0.07 a	9.53±0.09 b
DM	45	2.10±0.02 a	3.96±0.06 a	4.82±0.04 c	6.93±0.07 b	8.69±0.09 c
DM+F	45	2.10±0.02 a	4.04±0.06 a	7.11±0.04 a	7.49±0.07 a	11.84±0.09 a
Overall mean	180	2.09±0.02	3.74±0.03	5.49±0.02	7.20±0.03	9.66±0.04
Analysis of variance						
SOV	df	F-ratios				
Treatment	3	1.06	31.42***	777.75***	28.00***	311.76***
Replicates	2	2.07	0.56	1.06	1.80	2.51
Remainder df	174					
Remainder MS		0.01	0.16	0.07	0.19	0.33

Table (7): Least square means, standard errors and analysis of variance for the effect of organic fertilization type on body length of common carp.

Treatment (T)	No of fish	Initial	30 days	60 day	90 days	Harvesting
BM	45	8.42±0.09 a	8.67±0.13 b	10.83±0.10 c	15.20±0.14 b	17.70±0.12 c
BM+F	45	8.49±0.09 a	9.80±0.13 a	13.87±0.10 a	16.43±0.14 a	18.70±0.12 b
DM	45	8.73±0.09 a	7.13±0.13 c	12.37±0.10 b	13.67±0.14 c	19.60±0.12 ab
DM+F	45	8.87±0.09 a	9.19±0.13 a	13.18±0.10 a	15.42±0.14 b	20.40±0.12 a
Overall mean	180	8.63±0.04	8.70±0.06	12.56±0.10	5.18±0.07	19.11±0.06
Analysis of variance						
SOV	df	F-ratios				
Treatment	3	2.43	78.62***	168.60***	63.27***	97.08***
Replicates	2	0.16	5.07**	7.94***	6.12**	3.41*
Remainder df	174					
Remainder MS		1.23	0.50	0.30	0.62	0.42

\+ Means with the same letter in each column are not significantly different.

* P<0.05 ** P<0.01 *** P<0.001

Table (8): Least square means, standard errors and analysis of variance for the effect of organic fertilization type on specific growth rate of Nile tilapia.

Treatment (T)	No of ponds	0-30 day	30-60 day	60-90 day	90-100 day	Average of 100 day
BM	3	3.31±0.48 a	1.26±0.02 a	0.70±0.03 a	1.81±0.05 a	1.76±0.02 a
BM+F	3	3.01±0.48 a	0.84±0.02 b	0.54±0.03 b	1.95±0.05 a	1.81±0.02 a
DM	3	3.40±0.48 a	1.23±0.02 a	0.70±0.03 a	1.74±0.05 a	1.73±0.02 a
DM+F	3	3.41±0.48 a	0.76±0.02 c	0.58±0.03 b	0.89±0.05 b	1.81±0.02 a
Overall mean	12	3.50±0.24	1.02±0.01	0.63±0.01	1.60±0.03	1.78±0.01
Analysis of variance						
SOV	df	F-ratios				
Treatment	3	1.60	187.61***	9.46**	80.66***	5.01*
Replicates	2	1.00	1.03	0.105	0.204	0.90
Remainder df	6					
Remainder MS		0.69	0.001	0.002	0.009	0.001

Table (9): Least square means, standard errors and analysis of variance for the effect of organic fertilization type on specific growth rate of blue tilapia.

Treatment (T)	No of ponds	0-30 day	30-60 day	60-90 day	90-100 day	Average of 100 day
BM	3	3.21±0.02 b	1.14±0.02 a	0.51±0.02 b	2.17±0.02 a	1.67±0.01 b
BM+F	3	3.43±0.02 ab	1.13±0.02 a	0.68±0.02 a	2.02±0.02 b	1.77±0.01 a
DM	3	3.22±0.02 b	1.11±0.02 a	0.74±0.02 a	1.68±0.02 c	1.69±0.01 b
DM+F	3	3.86±0.02 a	1.00±0.02 b	0.55±0.02 b	1.31±0.02 d	1.76±0.01 a
Overall mean	12	3.43±0.01	1.09±0.01	0.62±0.01	1.80±0.01	1.72±0.01
Analysis of variance						
SOV	df	F-ratios				
Treatment	3	152.01***	7.47**	40.64***	331.85***	29.48***
Replicates	2	0.36	0.56	0.09	8.85**	0.69
Remainder df	6					
Remainder MS		0.002	0.002	0.001	0.001	0.0003

Table (10): Least square means, standard errors and analysis of variance for the effect of organic fertilization type on specific growth rate of common carp .

Treatment (T)	No of ponds	0-30 day	30-60 day	60-90 day	90-100 day	Average of 100 day
BM	3	1.87±0.02 c	0.94±0.02 b	0.72±0.01 b	1.02±0.05 d	1.16±0.01 b
BM+F	3	2.06±0.02 b	1.01±0.02 ab	0.79±0.01 b	1.85±0.05 b	1.34±0.01 a
DM	3	1.62±0.02 d	0.98±0.02 b	1.02±0.01 a	2.06±0.05 a	1.29±0.01 a
DM+F	3	2.14±0.02 a	1.08±0.02 a	0.72±0.01 b	1.69±0.05 c	1.35±0.01 a
Overall mean	12	1.92±0.01	1.00±0.01	0.82±0.01	1.66±0.02	1.29±0.002
Analysis of variance						
SOV	df	F-ratios				
Treatment	3	220.43***	8.63**	253.66***	86.56***	352.00***
Replicates	2	1.46	0.36	6.93	1.96	2.74
Remainder df	6					
Remainder MS		0.001	0.001	0.0002	0.007	0.0001

+ Means with the same letter in each column are not significantly different.
* P<0.05 ** P<0.01 *** P<0.001

The lowest total fish yields were obtained by treatments BM (467.8 kg) and DM (504.4 kg) groups indicating the higher fertilization value of DM compared to BM. Generally, treatment DM+F produced the highest fish production (566.7 kg/pond) followed by BM+F (555.9 kg/pond), DM (504.4 kg/pond) and BM 476.8 kg/pond, respectively. These results are in accordance with those obtained by Hassouna et al., (1998). Also, Schoonbee and Prinsloo (1988) found that fish yield of common carp and tilapia obtained over a 5-6 month growing season using only duck manure as nutrient, fluctuated between 1.5 and 2.3 tons/ha but when ducks were combined with fish on the pond, fish yields exceeding 9 ton/ha were obtained.

Duck yield

At the end of the experiment percentages of duck survival were 98.4 and 97.6% for groups DM and DM+F, respectively. Survival rate for both treatments are in the permissible rates indicating that integration of ducks on fish ponds had desirable effect on duck survival because of no contact between the ducks and their manure and also due to the excellent environmental conditions. At the end of experimental period average duck weight were 2.5 Kg for both treatments studied and duck yield were 307.5 and 304 kg for DM and DM+F groups, respectively. These results indicate that ducks could be integrated with fish ponds under Egyptian condition which represents an extra income for the fish farmer.

Economic efficiency:

Results presented in Table (14) show that, for all treatments applied, the costs of labor and fingerlings were the same for all treatments (total of three ponds for each treatment). Costs of duckling, fish and duck feeds as well as buffalo manure costs differed according the treatments. Also, depreciation costs for duck houses were 50 LE for treatments DM and DM+F. As presented in the same table, total costs for treatments BM, BM+F, DM and DM+F are found to be 1400, 2766, 2516 and 4259 LE, respectively. Percentages of total costs for BM+F, DM and DM+F compared to that of BM (the lowest 100%) are 197.60, 179.71 and 304.21%, respectively (Table 14). The increases in costs for BM+F, DM and DM+F compared to BM are due mainly to the costs of fish feeds in BM+F and costs of duck and duck feeds in DM and to all extra costs for DM+F i.e duck and its feeds and fish feeds. The total returns for BM, BM+F, DM and DM+F were 6436, 7505, 9173 and 10000 LE, respectively. The net returns (total returns -costs) for the same treatment groups were 5036, 4739, 6657 and 5741 LE, respectively indicating that the highest returns were obtained by the group DM where duck were integrated with fish ponds without any extra feeding followed in a decreasing order by DM+F, BM and BM+F, respectively. Results of the present study provide necessary empirical support to the conclusion that the system is very efficient and its use should be expanded under the Egyptian conditions. From the economical point of view results may lead us to recommend the integration of ducks on fish ponds without applying any supplementary feeds for fish to achieve the highest net returns and also two or three duck cycles (each of 60 days) must be combined to make a single fish cycle of about 120 or 180 growing season.

Table (11): Least square means, standard errors and analysis of variance of the effect of organic fertilization type on survival rate.

Treatment	No of ponds	Nile tilapia	Blue tilapia	Common carp
BM	3	92.0±1.5 a	90.5±1.8 a	99.7±0.5 a
BM+F	3	93.0±1.5 a	95.0±1.8 a	99.3±0.5 a
DM	3	93.0±1.5 a	90.0±1.8 a	99.7±0.5 a
DM+F	3	95.0±1.5 a	95.0±1.8 a	99.7±0.5 a
Overall mean	12	93.3±0.8 a	92.6±1.0 a	99.6±0.2 a
Analysis of variance				
SOV	df	F-ratio		
Treatment	3	0.671	2.153	0.125
Replicates	2	0.247	0.226	0.500
Remainder df	6			
Remainder MS		7.08	10.23	0.67

+ Means with the same letter in each column are not significantly different.

Table (12): Least square means, standard errors and analysis of variance for the effect of organic fertilization type on fish production.

Treatment	No of ponds	Nile tilapia	Blue tilapia	Common carp	Total fish production /pond
BM	3	361.0±2.2 c	94.4±0.7 d	21.5±0.2 c	476.8±3.1 d
BM+F	3	405.3±2.2 a	118.2±0.7 b	32.4±0.2 a	555.9±3.1 b
DM	3	376.1±2.2 b	102.3±0.7 c	29.3±0.2 b	504.4±3.1 c
DM+F	3	412.0±2.2 a	121.2±0.7 a	33.5±0.2 a	566.7±3.1 a
Overall mean	12	388.6±1.1	109.0±0.3	29.2±0.2	526.0±1.5
Analysis of variance					
SOV	df	F-ratio			
Treatment	3	120.43***	380.43***	969.65***	189.26***
Replicates	2	1.24	4.17	2.47	2.23
Remainder df	6				
Remainder MS		14.49	1.29	0.1	28.73

+ Means with the same letter in each column are not significantly different.
*** $P<0.001$

Table (13): Ducks yield after 60 days growing period.

Treatment	Initial body weight (gm)	Survival%	Average Weight (Kg)	Total production (Kg)
DM	200	98.4	2.5	307.5
DM+F	200	97.6	2.5	304.0

Table (14): Economic efficiency for the fish-duck and buffalo integration system.

Item	BM	BM+F	DM	DM+F
Production (kg)				
Fish production / treatment (3 ponds)	1430.4	1667.7	1513.2	1700.1
Duck production / treatment (3 ponds)	-	-	307.5	304.0
Costs / treatment (total of 3 ponds)				
Labor for rearing fish (100day)	250	250	250	250
Price of fingerlings	1000	1000	1000	1000
Price of ducklings	-	-	296	296
Price of feed (fish)	-	1366	-	1743
Price of feed (duck)	-	-	920	920
Price of buffalo manure	150	150	-	-
Depreciation of duck house 10%	-	-	50	50
Total costs / treatment (total of 3 ponds)	1400	2766	2516	4259
% of the smallest value	100%	197.60%	179.71%	304.21%
Returns / treatment (total of 3 ponds)				
Fish	6436	7505	6810	7650
Duck	-	-	2153	2128
Extra duck manure 8.9m^3×50 LE/ m^3	-	-	222	222
Total returns	6436	7505	9173	10000
Net returns (total returns-total costs)	5036	4739	6657	5741

All values calculated based on the total of 3 ponds for each treatment.

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الملخص العربى

التربية المتكامله للأسماك مع حيوانات المزرعة

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** المعمل المركزى لبحوث الثروة السمكيه بالعباسه – مركز البحوث الزراعيه – وزارة الزراعة

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أجريت هذه الدراسه بالمعمل المركزى لبحوث الثروة السمكيه بالعباسه – أبوحماد – محافظة الشرقيه. وقد أستمرت التجربة لمدة ١٠٠ يوم وذلك بهدف دراسة وتقييم إستخدام نظام التربية المتكامله بين البط والماشية والأسماك على الصفات الإنتاجيه والإقتصاديه لإستزراع الأسماك تحت هذا النظام. وقد أستخدم فى هذا التجربه ١٢ حوض من الأحواض الترابيه مساحة كل منها ٢٠٠٠م٢ قسمت إلى ٤ مجموعات (معاملات) وأشتملت كل مجموعه على ٣ أحواض (مكررات). ثم وزعت زريعة البلطى والمبروك فى كل حوض بمعدل ٣٠٠٠ سمكه بلطى نيلى + ٩٤٠ سمكه بلطى أوريا + ٦٠ سمكه مبروك عادي لتصل الكثافة الكليه فى الحوض إلى ٤٠٠٠ سمكه. وقد سمدت الأحواض الثلاثه للمعاملة الأولى بإستخدام ٥كجم روث ماشيه لكل حوض فى اليوم وكذلك سمدت أحواض المعامله الثانيه بإستخدام ٥كجم روث ماشيه/حوض/يوم بالإضافه إلى إمداد الأسماك بعلف إضافى (١٧% بروتين) وذلك بمعدل ٣% من كتلة الأسماك الحيه يومياً. أما الأحواض الثلاثة للمعامله الثالثه فقد سمدت بإستخدام زرق البط الناتج من ١٢٥ بطه تم تسكينها فى مسكن مقام على جسر أحد أحواض هذه المعامله أما المجموعه الرابعه فقد تم تسميد الأحواض بها عن طريق الزرق الناتج من ١٢٥ بطه تم تسكينها أيضاً فى مسكن مقام على جسر أحد أحواض هذه المعامله بالإضافه إلى إمداد الأسماك ب ٣% من وزن الجسم عليقه إضافيه (١٧% بروتين خام) كما تم تغذية البط بإستخدام عليقه تحتوى على ٢٥% بروتين خام. وكان من أهم النتائج المتحصل عليها ما يلى:

- اعطت المعامله الرابعه التى أستخدم فيها زرق البط+الأعلاف الإضافيه مقاييس أكبر لوزن الجسم وذلك بالنسبه لأنواع الأسماك الثلاثه (البلطى النيلى، البلطى الأوريا والمبروك العادى) وذلك من اليوم ٣٠ وحتى نهاية التجربه (الحصاد). وكانت الإختلافات الراجعه إلى تأثير المعامله الغذائيه على وزن الجسم إختلافات معنويه.
- أعطت كذلك المعامله الرابعه مقاييس أكبر لطول الجسم طول فترة التجربه مقارنة بالمعاملات الثلاثه الأخرى بعد مرور شهر من بداية التجربه وحتى الحصاد (١٠٠ يوم) وكانت هذه الإختلافات معنويه لأنواع الأسماك الثلاثة.
- أظهرت الأسماك المرباه فى الأحواض التى سمدت بروث الماشيه أو زرق البط بالإضافه إلى التغذيه على العلف الإضافى أعطت معدلات نمو نسبى وإنتاجيه كليه عاليه مقارنة بتلك التى ربيت فى الأحواض المسمده فقط.
- أعطت المعاملة الرابعة (زرق البط+العلف الإضافى) أعلى إنتاج للأسماك ثم المعاملات الثلاثة الأخرى (روث الماشية+العلف الإضافى ، زرق البط ، روث الماشية)على التوالى وكانت الإختلافات الراجعة إلى تأثير المعامله معنوية على محصول الأسماك الناتجة.
- من الناحيه الإقتصاديه كان العائد الصافى ٥٠٣٦، ٤٧٣٩، ٦٦٥٧ و ٥٧٤١ جنيه للمعاملات الأربع التى استخدم فيها روث الماشية، روث الماشيه+الأعلاف الإضافية ، زرق البط و زرق البط+الأعلاف الإضافية على التوالى. ومن ذلك نجد أن المعامله الثالثة والتى أستخدم فيها زرق البط فقط كمصدر للتسميد بدون إستخدام الأعلاف الإضافية للأسماك قد أعطت أفضل عائد صافى لرأس المال المستغل فى الإنتاج.