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PRODUCTION PERFORMANCE OF FISH IN RICE FIELDS WITH INORGANIC FERTILIZATION

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ABSTRACT

This experiment was conducted to study the mutual effect between fish and rice in rice fields with inorganic fertilizers. Three different polycultures, P_1 (Nile tilapia + crayfish), P_2 (common carp + crayfish) and P_3 (Tilapia + carp + crayfish) were studied with T_1 (urea), T_2 (superphosphate), T_3 (urea + superphosphate), T_4 (without fertilizers). Meanwhile, a rice field free from fish was used to compare rice yield in the experimental treatments.

The results showed that water quality measurements were within the normal ranges and suitable for the experimental fishes. Urea + superphosphate treatment gave the types of phytoplankton and zooplankton needed by fishes and consequently gave the highest growth performance of carp and crayfish polyculture. The whole body composition of tilapia and carp had no clear trend in the different polycultures or treatments while crayfish was not affected. The rice yield increased by 9-13% when applying urea + superphosphate while the highest net return was obtained with superphosphate alone in carp–crayfish polyculture.

It could be recommended to raise common crap along with crayfish in rice fields fertilized with urea + superphosphate. If urea is high in price or unavailable, superphosphate alone is recommended. This system of production increases the net return of small farmers under similar conditions by increasing the rice yield beside the fish yield.

Keywords: fish, polyculture, rice and inorganic fertilizers.

INTRODUCTION

Rice-fish culture improves the ecological conditions in rice fields and therefore enhances growth of both fish and rice. Duanfu *et al.*, (1995) reported a positive effect on soil fertility due to accumulation of fish excreta being rich in N and P higher than cow manure. Raposas *et al.*, (1994) and Nie Da-Shu and Jiaguo (1995) found that fish increased rice yield by 4-28%, while Cruz (1994) found a reduction of weeds in rice field by 67%. In fact, the increase in fish production in fertilized culture has attributed to the increase in primary production (Azam *et al.*, 1983 and Kund-Hansen *et al.*, 1993) leading to greater fish yield (Seymour, 1980).

With inorganic fertilization, phosphorus element has been shown to be the first limiting element in fish production while nitrogen is the second element followed by potassium (Boyd, 1990) which increase phytoplankton production (Boyd *et al.*, 1981).

Urea, being a popular N source for stimulating algae production is hydrolyzed slowly into CO_2 and NH_3 (Chin and Kroontje, 1993) and is 7 times less expensive than chicken manure (Kund–Hansen *et al.*, 1993). Healey (1977) found that algae break urea down enzymatically inside the cell. The combined P and N increase fish yield higher than phosphorus alone (Hepher, 1962).

Because rice fields are rich in detritus, the most commonly stocked fish are Nile tilapia and common crap (Yin Pi-Zhen, 1983 and Duong, 1994) which can eradicate the pathogenic parasite as reported by Pan-Yinhe (1995). Meanwhile, Fernando (1993) found the possibility of raising Crayfish in rice fields being detrivorous and feed on periphyton attached to the submerged parts of rice plant. Besides, a polyculture of fish with different feeding habits allows utilizing each of feeds in water (Bardach *et al.*, 1973) and increases the production of fish (Cohen *et al.*, 1983). In Egypt, Rice-fish cultures produce 13,000 tons of fish from 24,000 feddans (fedd.) which represent only 2.3% of the total fish production (Abdel-Hakim *et al.*, 2000).

The objective of this work was to study the effect of inorganic fertilizers (Urea, superphosphate or both) on performance of Nile tilapia, common Carp and crayfish raised in different polycultures in rice fields. Meanwhile, rice yield was studied.

MATERIALS AND METHODS

1. Experimental fish:

Mono sex of Nile tilapia (*Oreochromis niloticus*) or common carp (*Cyprinus Carpio*) along with red swamp crayfish (*Procambarus clarkii*) were raised in different polycultures in rice fields as shown later. The tilapia and carp fish were bought from Abassa Hatchery, Abou-Hammad, Sharkia Governorate while crayfish was brought from Ismailia Canal. Their initial body weight was 25, 2 and 26.5 g., respectively, so that they reach the marketing weight at rice harvesting. They were adopted for 2 weeks before starting the experiment which lasted for 3 months. The body weight was recorded monthly to calculate body weight gain (BWG), specific growth rate (SGR). Meanwhile, the gut contents and body chemical composition were determined.

2. Rice fields:

Rice fields in Sharkia Governorate (1/2 fedd. each) were plowed and leveled. The ridge ditch system was used. The ditch dimensions were 75 cm width and 50 cm depth. Rice was planted on the ridge while fish was spaced at 15 X 15 cm with 4–5 plants per clump and 3 of rice plants ridge. Screens were placed at the inlet and outlet to prevent passage of fish.

3. Experimental design:

Twelve treatments [3 polycultures (P) X 4 treatments (T)] were conducted as follows:

P_1 (250 Nile tilapia), P_2 (250 common carp) and P_3 (125 Nile tilapia + 125 carp), each polyculture was supplemented with 100 crayfish.

T_1, (urea 46%) at 8 Kg/1/2 fedd./month, T_2 (superphosphate 15.5%) at 18 Kg/1/2 fedd./month, T_3 (urea and superphosphate) at the same rates, T_4, no fertilizers were used. Meantime, a rice field free from fish was used to compare rice yield in the different experimental treatments.

4. Analytical methods:

4.1. Hydrochemical analysis:

Water quality in ditches was checked weekly to determine its temperature, dissolved Oxygen (DO), total and available phosphorous, total ammonia, pH and alkalinity according to Boyd (1990).

4.2. Phytoplankton assessment:

A sample of 500 ml water from each ditch was taken and preserved by adding 3.5 ml Luogol's solution and stored in the dark for enumeration and classification of phytoplankton according to American Public Health Association (APHA, 1985). Using Sedgwich-Rafter counting cell and the following equation, phytoplankton was counted:

No. phytoplankton / L = C X 100 / L W D S

Where C is number of organisms, L, W and D are length, width and depth of strip mm and S is number of counted strips.

4.3. Zooplankton assessment:

Zooplankton was counted and identified by collecting 10 L of ditch water and filtering through nylon net of 75 mm. It was preserved using 5% buffered formalin (20 g. sod. tetraborate + a liter of 37% formaldehyde). According to the following equation (Boyd, 1992), zooplankton was counted:

No. zooplankton / L = SN / D

Where S is volume of concentrate ml, N is number of organisms, and D is volume of filtrate in liters.

4.4. After end of the experimental period (3 months), 10 fish from each tilapia and carp were taken for gut content analysis. The contents for each species were collected and preserved in 10% formalin solution. Phytoplankton and zooplankton were identified by microscope.

4.5. The proximate chemical analysis of fish and phosphorous have been done according to A. O. A. C., (1984).

5. Economic analysis:

The economic efficiency of products of fish and rice crop was calculated as the net return per fedd. according to prices at the local market. The net return = total price of fish and rice – total costs (prices of fry, fertilizers, labor and rent).

6. Statistical analysis:

(SAS program 2000), Duncan multiple range test (Duncan, 1955) and the following the next model were used for statistical analysis:

$$Y_{ijk} = M + T_i + P_j + (TP)_{ij} + E_{ijk}$$

Where, Yijk is observations, M is overall mean, Ti is treatments, Pj is polycultures, (TP)ij is interaction.

RESULTS AND DISCUSSION

1. Water quality:

1.1. Hydrochemical analysis:

The results in table (1) showed that all parameters of water quality were in the suitable ranges recorded by Boyd *et al.*, (1981). The average values of most parameters were very approximate in all polycultures.

Table (1):The effect of different treatments on water quality of the different polycultures in rice field.

Item	Polycul.	Treatments				
		Urea (T_1)	Super phosph. (T_2)	Urea + Super phosph. (T_3)	Control (T_4)	Average mean
Temperature °C	P1	26.16 ± 1.16	26.33 ± 0.33	26.33 ± 0.88	27.33 ± 1.20	26.53 ± 0.45
	P2	25.66 ± 1.20	26.16 ± 1.16	26.00 ± 1.52	28.00 ± 0.27	26.45 ± 0.32
	P3	26.66 ± 1.20	26.66 ± 0.66	25.33 ± 0.88	27.00 ± 0.57	26.66 ± 0.76
	Average mean	26.16 ± 1.00	26.38 ± 0.36	25.88 ± 0.93	27.44 ± 0.75	
Dissolved oxygen (mg/L)	P1	6.16 ± 0.60	7.33 ± 0.44	6.73 ± 0.38	7.66 ± 0.66	6.97 ± 0.13
	P2	4.80 ± 0.75	7.43 ± 0.57	5.83 ± 0.33	9.00 ± 0.36	6.76 ± 0.35
	P3	4.8 ± 0.75	6.73 ± 0.43	5.8 ± 0.15	8.50 ± 0.57	6.45 ± 0.44
	Average mean	5.25 ± 0.66	7.16 ± 0.44	6.12 ± 0.32	8.38 ± 0.52	
Total phosphorus (mg/L)	P1	0.50 ± 0.24	1.50 ± 0.16	1.13 ± 0.11	0.14 ± 0.03	0.81 ± 0.09
	P2	1.02 ± 0.06	1.50 ± 0.36	0.44 ± 0.23	0.02 ± 0.00	0.74 ± 0.01
	P3	1.01 ± 0.27	1.64 ± 0.41	1.48 ± 0.28	0.04 ± 0.01	1.04 ± 0.11
	Average mean	0.84 ± 0.22	1.54 ± 0.35	1.01 ± 0.21	0.06 ± 0.02	
Available Phosphorus (mg/L)	P1	0.10 ± 0.01	0.21 ± 0.01	0.55 ± 0.03	0.03 ± 0.00	0.22 ± 0.01
	P2	0.34 ± 0.09	0.14 ± 0.34	0.31 ± 0.06	0.01 ± 0.00	0.20 ± 0.01
	P3	0.24 ± 0.09	0.39 ± 0.09	0.23 ± 0.03	0.02 ± 0.00	0.22 ± 0.02
	Average mean	0.22 ± 0.03	0.24 ± 0.37	0.36 ± 0.02	0.02 ± 0.00	
NH_3 (mg/L)	P1	1.25 ± 0.13	0.78 ± 0.07	0.99 ± 0.03	0.53 ± 0.18	0.88 ± 0.22
	P2	1.16 ± 0.04	0.36 ± 0.02	1.08 ± 0.11	0.69 ± 0.15	0.82 ± 0.14
	P3	0.37 ± 0.22	0.90 ± 0.02	1.10 ± 0.17	0.56 ± 0.22	0.73 ± 0.15
	Average mean	0.92 ± 0.15	0.62 ± 0.01	1.05 ± 0.13	0.59 ± 0.13	
pH	P1	9.12 ± 0.13	8.61 ± 0.13	8.85 ± 0.23	7.66 ± 0.07	8.56 ± 0.25
	P2	9.32 ± 0.20	8.41 ± 0.06	8.65 ± 0.10	7.17 ± 0.09	8.38 ± 0.04
	P3	9.24 ± 0.12	8.86 ± 0.29	8.24 ± 0.40	7.62 ± 0.22	8.49 ± 0.33
	Average mean	9.22 ± 0.21	8.62 ± 0.23	8.58 ± 0.22	7.48 ± 0.34	
ALK (mg/L)	P1	223.33 ± 33.83	225.00 ± 37.52	221.66 ± 49.18	175.00 ± 22.54	211.24 ± 20.22
	P2	206.66 ± 47.02	186.66 ± 30.33	181.66 ± 40.41	180.00 ± 15.27	188.74 ± 33.24
	P3	231.66 ± 31.66	190.00 ± 10.00	210.11 ± 20.81	175.27 ± 20.88	201.76 ± 15.97
	Average mean	220.55 ± 25.12	200.55 ± 18.32	204.47 ± 23.55	176.75 ± 18.31	

P1 = Nile tilapia + crayfish **P2 = Common carp + crayfish** **P3 = Nile tilapia + common carp + crayfish**

Table (2). The effect of different treatments on phytoplankton (Org/L) in the different polycultures in rice field.

Species	Treatments											
	Urea (T_1)			Super phosph. (T_2)			Urea + Super phosph. (T_3)			Control (T_4)		
	P_1	P_2	P_3	P_1	P_2	P_3	P_1	P_2	P_3	P_1	P_2	P_3
Blue-green algae	120000	150000	90000	60000	70000	40000	60000	16000	30000	5000	8000	20000
Blue-green algae %	95.75	95.42	95.85	88.02	79.02	77.32	86.59	89.39	54.27	71.53	65.51	74.76
Green algae	4840	6650	3500	8000	15550	11560	9000	1650	25000	1900	4197	6650
Diatom	376	411	290	119	3000	150	211	149	185	90	0	100
Euglenaphyta	110	130	100	50	30	20	84	100	90	0	15	2
Biomass	125326	157191	93890	68169	88580	51730	69295	17899	55275	6990	12212	26752
Biomass Av mean	125636			69493			47489			15318		

Table (3). The effect of different treatments on zooplankton (Org/L) in the different polycultures in rice field.

Species	*Treatments*											
	Urea (T_1)			**Super phosph. (T_2)**			**Urea + Super phosph.(T_3)**			**Control (T_4)**		
	P_1	P_2	P_3	P_1	P_2	P_3	P_1	P_2	P_3	P_1	P_2	P_3
Copepoda	1	13	17	1	2	27	3	3	9	2	2	0
Naupulii	3	5	3	1	2	1	5	2	3	2	1	0
Rotifera	1	2	2	8	2	3	10	18	19	3	2	0
Clodesra	3	3	2	6	1	3	8	10	9	3	1	0
Crustacea	1	2	2	1	1	2	2	1	1	1	1	0
Ostracoda	2	5	3	2	2	2	3	1	1	3	1	0
Biomass	11	30	29	19	10	38	31	35	42	14	8	0
Biomass Average mean	23.3			22.3			36			7.3		

Meanwhile, treating with urea (T_1) recorded the minimum value of DO (5.25 mg/L) and highest values of pH and alkalinity, while the highest levels of NH_3 (0.92-1.05 mg/L), were noticed in T_1 and T_3, respectively. The decrease in DO level may be due to the development of algae (blue–green and green) blooms (Table 2) at a high rate (99.6%) which consumed some O_2 at night. The NH_3 level was still in safe being under the toxic level of 2 mg/L mentioned by European Inland Fisheries Advisory Commission (EIFAC, 1993). The total and available phosphorus were higher in T_2 and T_3 due to application of superphosphate.

1.2. Hydrobiological analysis:

The results in Table (2) indicated that supplementation with urea (T_1) gave the biggest biomass (125636 org/L) in which blue–green algae constituted about 96%. In this connection, Prowse (1969) indicated that blue–green algae is not penetrated by digestive enzymes inside fish while Westhuizen *et al.*, (1986) found that it releases toxins causing death of fish. The control treatment (T_4) contained the least mass of phytoplankton (15318 org/L) and blue–green algae being not fertilized. On the other hand, urea + superphosphate treatment (T_3) offered suitable conditions for production of useful phytoplankton and decreased mass of blue–green algae compared with T_1 and T_2 being 77, 96 and 81%, as average means, respectively which agree with findings of Hepher (1962) and Yusoff and Mc Nabb (1989) who found that the combined N + P is better than P alone.

The results in Table (3) showed that T_3 (urea + phosphate) contained the highest mass of zooplankton (36 org/L) especially rotifera and clodesra which are small in size and preferred by fish as mentioned by Mc Cauley and Dowing (1985).

Generally, Wyban and Sweeney (1991) reported that phytoplankton is the primary producer in the food chain of aquatic ecosystems and it maintains other communities such as zooplankton and benthic organisms that fish consume directly. Meanwhile, the diatom blooms promote fish growth by providing DO and removing the toxic ammonia.

Opposite to common carp, the gut content analysis (Table 4) revealed that all species of zooplankton and phytoplankton except Euglina and blue–green algae existed in Nile tilapia.

Table (4).:Gut content of N. tilapia and C. carp in the different treatments.

Fish	Phytoplankton				Zooplankton					
	Blue green algae	Green algae	Diatom	Euglena-phyta	Copepoda	Nauplii	Rotifera	Clodesra	Larva of crustacea	Ostracoda
N. tilapia	N	F	F	N	F	F	F	F	F	F
C. carp	F	F	F	F	F	F	F	F	F	F

N = Nill. F = Found.

In this connection, Kido (1996) reported that both tilapia and common carp feed low in the food chain and therefore are preferred species in rice–fish culture systems. De Silva and Perera (1984) and Gatachew (1988) noticed that tilapia feed mainly on algae and algae-based detritus.

2. Body weight:

The results in Table (5) indicated that in P_1 and P_3, superphosphate alone (T_2) or urea + superphosphate (T_3) gave the highest significant ($P \leq 0.05$) final body weight of tilapia and crayfish while (T_1) and (T_4) resulted in the lowest body weight.

In P_2 and P_3, urea + superphosphate (T_3) gave significantly ($P \leq 0.05$) the highest body weight of C. carp. The specific growth rate followed the same trend. These results agree with findings of Yusoff and Mc Nabb (1989) and Amal *et al.* (1996).

This means that superphosphate is a unique fertilizer owing to the decreased blue green algae abundance (Table 2) as indicated before by Mohammed (1997). Meanwhile, superphosphate had no deleterious effect such as the urea. The highest body weight gain of C. carp compared with tilapia made Hora and Pially (1962) to propose C. carp for culture being omnivorous and high activity of intestinal bacteria.

3. Whole body chemical composition:

Generally, the results in Table (6) showed that there was no consistent trend in changes of body chemical composition due to polycultures or treatments. The body chemical composition of crayfish (Table 7) was not affected by the experimental treatments in the different polycultures. Due to its body structure, crayfish contained 10% CF and was highest in DM and ash content while lowest in CP and EE contents compared with tilapia and carp. These results coincide with those obtained by Weatharly and Gill (1987).

4. Yield of rice and fish:

4.1. Rice yield:

The results in Table (8) showed that the significant ($P \leq 0.05$) highest rice yield (1550.8 Kg) was obtained with urea + superphosphate fertilizer (T_3). The rice yield increased by 9-13% when fish was raised in rice fields compared with rice field free from fish (1375 Kg). Such increase may be due to improved aeration of soil, increased soil fertility and reduced weed and insects. These results agree with those obtained by Cruz (1994) and Abdel-Hakim *et al.*, (2000).

4.2. Fish yield:

The total fish yield (Table 8) was highest in P_2 (34.4 Kg) followed by P_3 (29.4 Kg). This may be due to the higher growth rate of C. carp compared with tilapia. Meanwhile, the highest significant ($P \leq 0.05$) fish yield was obtained in T3 followed by T_2. These results agree with results obtained by Mohammed (1997) .The significant ($P \leq 0.05$) low fish yield in T_1 may be due to the low content of green algae and high content of un-preferred blue-green algae with urea treatment (Table 2).

Table (5): The effect of different treatments on average final live body weight (g) and specific growth rate of fish in the different polycultures in rice field.

Item			Urea (T_1)	Super phosph. (T_2)	Urea + Super phosph. (T_3)	Control (T_4)
Body weight (g)						
(P_1)	Tilapia	Initial	25.00 ± 0.00	25.00 ± 0.00	25.00 ± 0.00	25.00 ± 0.00
		Final	75.00 ± 2.88^{B}	87.00 ± 3.51^{A}	87.66 ± 1.45^{A}	76.00 ± 2.08^{B}
	Cray Fish	Initial	29.33 ± 2.31	30.33 ± 1.75	28.66 ± 1.34	26.00 ± 1.54
		Final	41.33 ± 1.85^{BC}	44.66 ± 3.17^{AB}	50.66 ± 1.20^{A}	38.00 ± 5.68^{C}
(P_2)	C. Carp	Initial	2.00 ± 0.00	2.00 ± 0.00	2.00 ± 0.00	2.00 ± 0.00
		Final	77.33 ± 1.45^{C}	126.00 ± 3.05^{B}	148.33 ± 4.40^{A}	132.00 ± 1.52^{B}
	Cray Fish	Initial	27.00 ± 1.21	28.66 ± 1.31	27.00 ± 1.10	31.00 ± 1.00
		Final	44.33 ± 1.11^{AB}	40.66 ± 2.25^{C}	42.33 ± 2.38^{BC}	39.66 ± 2.21^{C}
(P_3)	Tilapia	Initial	25.00 ± 0.00	25.00 ± 0.00	25.00 ± 0.00	25.00 ± 0.00
		Final	63.66 ± 4.09^{D}	113.00 ± 4.04^{A}	94.33 ± 3.48^{B}	75.33 ± 2.60^{C}
	C. Carp	Initial	2.00 ± 0.00	2.00 ± 0.00	2.00 ± 0.00	2.00 ± 0.00
		Final	71.66 ± 1.11^{D}	117.66 ± 1.45^{B}	153.66 ± 2.33^{A}	103.33 ± 2.60^{C}
	Cray Fish	Initial	30.33 ± 1.11	30.00 ± 2.43	31.67 ± 0.00	26.67 ± 2.60
		Final	38.66 ± 0.88^{C}	40.00 ± 0.57^{BC}	50.33 ± 1.85^{A}	36.33 ± 0.00^{C}
Specific growth rate, %/day (1)						
(P_1)	Tilapia		1.220 ± 0.001^{B}	1.390 ± 0.000^{A}	1.390 ± 0.000^{A}	1.240 ± 0.001^{B}
	Crayfish		0.380 ± 0.001^{C}	0.430 ± 0.000^{B}	0.630 ± 0.001^{A}	0.420 ± 0.001^{B}
(P_2)	C. carp		4.060 ± 0.000^{C}	4.600 ± 0.000^{B}	4.780 ± 0.000^{A}	4.660 ± 0.000^{B}
	Crayfish		0.550 ± 0.001^{A}	0.390 ± 0.001^{C}	0.500 ± 0.002^{B}	0.270 ± 0.001^{D}
(P_3)	Tilapia		1.040 ± 0.001^{D}	1.680 ± 0.000^{A}	1.480 ± 0.000^{B}	1.230 ± 0.001^{C}
	C. carp		3.970 ± 0.000^{D}	4.520 ± 0.000^{B}	4.820 ± 0.000^{A}	4.380 ± 0.001^{C}
	Crayfish		0.270 ± 0.001^{C}	0.320 ± 0.000^{B}	0.510 ± 0.000^{A}	0.340 ± 0.000^{B}

Means with different superscripts on the same row are significantly ($P \leq 0.05$) different.

(1) $SGR = \frac{Ln\ WF - Ln\ WO}{TF - TO} \times 100$ Where Ln = Natural Log., WF = Final Weight, WO = Initial Weight, TF – TO = Experimental Period) according to Allen and Woolter (1982).

Table (6). The effect of different treatments on whole body chemical composition of tilapia and c. carp in the different polycultures in rice field (D M basis).

Item		Treatments				Start
		Urea (T_1)	Super phosph. (T_2)	Urea + Super phosph. (T_3)	Control (T_0)	
Dry matter%						
(P_1)	Nile tilapia	25.66 ± 0.66^{AB}	23.33 ± 0.33^{C}	25.44 ± 0.20^{AB}	22.00 ± 0.00^{D}	21.50 ± 0.73
(P_2)	C. carp	19.00 ± 0.73^{D}	18.79 ± 1.52^{D}	20.06 ± 0.23^{D}	14.20 ± 0.15^{E}	16.30 ± 0.17
(P_3)	Nile tilapia	25.33 ± 0.33^{AB}	25.37 ± 0.66^{AB}	24.66 ± 0.33^{BC}	19.66 ± 0.33^{D}	21.50 ± 0.73
	C. carp	19.81 ± 0.06^{D}	26.89 ± 0.45^{A}	20.00 ± 0.00^{D}	15.16 ± 0.72^{E}	16.30 ± 0.17
Crude protein%						
(P_1)	Nile tilapia	62.71 ± 0.06^{AB}	69.05 ± 0.43^{A}	64.98 ± 0.21^{A}	57.63 ± 0.00^{BCD}	55.34 ± 0.22
(P_2)	C. carp	59.40 ± 0.45^{BCD}	58.36 ± 0.12^{BCD}	59.20 ± 0.30^{BCD}	61.88 ± 0.16^{ABC}	60.40 ± 0.41
(P_3)	Nile tilapia	65.38 ± 0.65^{A}	63.78 ± 0.16^{AB}	62.76 ± 0.33^{AB}	58.28 ± 0.42^{BCD}	55.34 ± 0.22
	C. carp	53.11 ± 9.70^{CD}	59.31 ± 0.01^{BCD}	58.10 ± 0.00^{ABC}	62.01 ± 0.28^{ABC}	60.40 ± 0.41
Ash%						
(P_1)	Nile tilapia	25.83 ± 0.93^{C}	16.06 ± 0.04^{I}	18.40 ± 0.19^{FG}	31.87 ± 0.24^{A}	29.90 ± 0.85
(P_2)	C. carp	15.01 ± 0.57^{J}	17.46 ± 0.05^{GH}	16.37 ± 0.06^{HI}	20.32 ± 0.27^{E}	20.50 ± 0.11
(P_3)	Nile tilapia	22.31 ± 0.36^{D}	18.90 ± 0.01^{FG}	25.39 ± 0.25^{C}	30.01 ± 0.27^{B}	29.90 ± 0.85
	C. carp	17.09 ± 0.68^{GH}	17.03 ± 0.09^{GH}	16.81 ± 0.52^{HI}	17.23 ± 0.77^{GH}	20.5 ± 0.11
Ether extract%						
(P_1)	Nile tilapia	11.46 ± 0.33^{FG}	14.89 ± 0.31^{E}	16.62 ± 0.06^{D}	10.50 ± 0.33^{G}	14.76 ± 0.31
(P_2)	C. carp	25.59 ± 1.78^{AB}	24.18 ± 0.86^{AB}	24.43 ± 0.08^{AB}	17.80 ± 0.28^{D}	19.10 ± 1.21
(P_3)	Nile tilapia	12.31 ± 0.18^{F}	17.32 ± 0.02^{D}	11.89 ± 0.21^{FG}	11.71 ± 0.11^{FG}	14.76 ± 0.13
	C. carp	29.79 ± 1.34^{A}	23.66 ± 0.00^{B}	25.18 ± 0.51^{AB}	20.76 ± 0.57^{C}	19.10 ± 0.31

Means with different superscripts on the same row and column (within each item) are significantly ($P \leq 0.05$) different.

Table (7): The effect of different treatments on whole body chemical composition of the crayfish in the different polycultures in rice field (on D M basis).

	Item	Treatments				
		Urea (T_1)	Super phosph. (T_2)	Urea + Super phosph. (T_3)	Control (T_4)	Start
(P_1)	DM	92.12 ± 0.12	90.01 ± 0.33	90.20 ± 0.13	90.00 ± 0.23	87.25 ± 0.17
	CP	32.33 ± 0.05	32.43 ± 0.01	32.04 ± 0.03	32.00 ± 0.03	29.78 ± 0.33
	EE	1.60 ± 0.21	1.59 ± 0.27	1.53 ± 0.53	1.40 ± 0.11	0.99 ± 0.21
	Ash	32.00 ± 0.61	32.33 ± 0.81	32.33 ± 0.45	32.00 ± 0.33	35.91 ± 0.37
	CF	10.20 ± 1.11	10.21 ± 0.92	10.11 ± 0.87	10.10 ± 0.85	7.24 ± 0.19
	NFE	23.87 ± 0.95	23.44 ± 0.80	23.99 ± 0.90	24.50 ± 1.01	29.08 ± 1.00
(P_2)	DM	90.11 ± 1.11	90.00 ± 0.99	90.00 ± 0.55	90.11 ± 0.69	87.25 ± 0.17
	CP	31.81 ± 0.12	32.00 ± 0.91	32.00 ± 0.24	32.00 ± 0.10	29.78 ± 0.33
	EE	1.55 ± 0.22	1.33 ± 0.04	1.51 ± 0.18	1.42 ± 0.41	0.99 ± 0.21
	Ash	32.00 ± 0.55	32.00 ± 0.34	32.17 ± 0.51	32.19 ± 0.34	35.91 ± 0.37
	CF	10.00 ± 1.09	10.10 ± 1.23	10.10 ± 1.30	10.00 ± 0.33	7.24 ± 0.19
	NFE	24.64 ± 1.04	24.57 ± 0.80	24.22 ± 0.96	24.39 ± 1.01	26.08 ± 1.05
(P_3)	DM	90.23 ± 1.33	90.20 ± 0.99	90.20 ± 1.32	90.00 ± 0.65	87.25 ± 0.17
	CP	32.11 ± 0.35	32.0 ± 1.20	32.10 ± 0.31	32.00 ± 0.57	29.78 ± 0.33
	EE	1.39 ± 0.11	1.50 ± 0.21	1.52 ± 0.22	1.51 ± 0.09	0.99 ± 0.21
	Ash	32.0 ± 1.10	32.0 ± 0.27	32.00 ± 0.67	32.00 ± 0.08	35.91 ± 0.37
	CF	10.12 ± 0.39	10.00 ± 0.59	10.11 ± 0.33	10.00 ± 0.71	7.24 ± 0.19
	NFE	24.38 ± 0.49	24.50 ± 0.62	24.27 ± 0.75	24.49 ± 0.90	26.08 ± 0.80

Means with different superscripts on the same row (within each item) are significantly ($P \leq 0.05$) different.

Table (8): The effect of different treatments on rice yield and fish yield (Kg/1/2 fedd.) in the different polycultures in rice field.

Polyculture	Treatment				Average mean	No fish
	Urea (T_1)	Super phosph. (T_2)	Urea + Super phosph. (T_3)	Control (T_4)		
			Rice yield			
(P_1)	1525 ± 0.06^{BC}	1540 ± 0.10^{B}	1550 ± 0.10^{A}	1500 ± 0.00^{C}	1528.75	1375 ± 0.67^{D}
(P_2)	1520 ± 0.03^{BC}	1545 ± 0.06^{B}	1552.5 ± 0.06^{A}	1502.5 ± 0.00^{C}	1530.00	1375 ± 0.67^{D}
(P_3)	1515 ± 0.06^{BC}	1530 ± 0.16^{B}	1550 ± 0.16^{A}	1500 ± 0.00^{C}	1523.75	1375 ± 0.67^{D}
Average mean	1520	1538.33	1550.83	1500.83		1375
			Fish yield			
(P_1)	22.88 ± 0.77^{EF}	26.21 ± 0.65^{D}	26.98 ± 0.27^{D}	22.80 ± 1.05^{EF}	24.72	
(P_2)	23.67 ± 0.33^{E}	35.56 ± 0.53^{B}	41.31 ± 1.47^{A}	36.96 ± 0.51^{B}	34.37	
(P_3)	20.78 ± 0.74^{F}	32.83 ± 0.61^{C}	36.03 ± 0.60^{B}	27.96 ± 1.34^{D}	29.40	
Average mean	22.44	31.53	34.77	29.24		

Means with the same superscript on the same row and column (within each item) are significantly ($P \leq 0.05$) different.

Table (9). The economic study of different treatments in different polycultures in rice field.

Operation costs (L.E.)		Total costs (L.E./fedd.)			Returns (L.E./fedd.)						Total returns (L.E./fedd.)			Net returns (L.E./fedd.)[1]		
					Fish			Rice								
		P_1	P_2	P_3	P_1	P_2	P_3	P_1	P_2	P_3	P_1	P_2	P_3	P_1	P_2	P_3
Urea (T_1)	54.08	971.48	916.48	943.40	253.58	205.00	203.90	1372.50	1368.00	1363.50	1626.08	1573.00	1567.40	654.60	656.52	624.00
Super phosph. (T_2)	56.52	937.92	918.92	945.92	300.06	327.24	332.78	1395	1397.20	1395	1695.06	1724.44	1727.78	658.06	862.04	718.78
Urea + Super phosph. (T_3)	110.60	1028	862.40	1009	288.86	285.46	308.10	1386	1390.50	1377	1674.86	1675.96	1685.10	564.86	757.04	739.18
Control (T_4)		917.40	862.40	889.40	250.80	294.36	256.54	1350.00	1352.20	1350.00	1600.80	1646.56	1606.54	683.40	784.16	717.14
No fish		825	825	825	0	0	0	1237.50	1237.50	1237.50	1237.50	1237.50	1237.50	412.50	412.50	412.50

[1] Net return = total return – total cost

Price of fish fingerlings (L.E./fedd.)

P_1 = 112.37

P_2 = 37.40

P_3 = 92.40

Price of rice seeds = 75 L.E.

Land renting = 400 L.E./fedd.

Labor = 350 L.E./fedd.

Selling price of:

One kg of Nile Tilapia = 5.00 L.E.

One kg of common carp = 3.50 L.E.

One kg of Crayfish = 8.00 L.E.

One ton of rice grain = 450 L.E.

The high carp yield without fertilizers (T_4) may be due to its nature of feeding which eat earth worms and other terrestrial invertebrates and various detritus materials beside algae (Bardach *et al.*, 1973).

5. Economic analysis:

The results in Table (9) showed that the lowest net return was noticed in field without fish (412.5 L.E./fedd.). The highest net return was achieved in P_2 (C. carp + crayfish) being 656-862 L.E./fedd.) followed by P_3 being 624-739 L.E./fedd.). Meanwhile, the highest net return was obtained in T_2 (superphosphate) in P_2 being 862 L.E./fedd.), while the lowest one was noticed in T_1 P_3 (624 L.E./fedd.).

Although treating with urea + superphosphate gave the best performance of fish (Table 8), superphosphate achieved the highest net return. These results agree with those obtained by Cruz (1994) and Abdel-Hakim *et al.*, (2000).

Crayfish may be sold as human food. Meanwhile, processing of crayfish results in wastes of carapace and viscera of high protein content which can be used as a protein source in diets of fish. In this connection, Fatma *et al.*, (2003) successfully replaced 50% of fish meal by crayfish meal in diets for tilapia. Meanwhile, Agouz and Tonsy (2003) found that crayfish meal can replace 75% of fish meal protein in diets of polyculture of tilapia, carp and mullet.

CONCLUSION

A polyculture of common carp and crayfish is advised to be stocked in rice fields to achieve high yield of rice and fish using urea + superphosphate fertilizer (4N:1P) if urea is low in price and available. Otherwise, superphosphate alone (18 Kg/fedd./month) could be used. Such system of production increases the net return of small farmers under similar conditions by increasing rice yield beside the fish yield.

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الأداء الإنتاجي للأسماك في حقول الأرز مع التسميد المعدني

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أجريت هذه التجربة لدراسة التأثير المتبادل بين الأسماك النامية في مزارع مختلطة في حقول الأرز وبين محصول الأرز. وقد تم استخدام ثلاثة تكوينات من الأسماك الأولى (البلطي النيلي + استاكوزا المياه العذبة)، والثانية (المبروك العادي + الاستاكوزا)، والثالثة (البلطي + المبروك + الاستاكوزا) مع التسميد المعدني في المعاملة الأولى (اليوريا) وفي الثانية (سوبر فوسفات) والثالثة (يوريا + سوبر فوسفات) والرابعة بدون تسميد. واستخدم حقل أرز خالي من الأسماك لمقارنة محصول الأرز في المعاملات السابقة.

وقد أظهرت النتائج أن مواصفات المياه كانت مناسبة لجميع الأسماك بينما ارتفعت نسبة الأمونيا ونسبة الحموضة مع انخفاض الأكسوجين الذائب في المعاملات التي احتوت على اليوريا. وأن المعاملة باليوريا وسوبر فوسفات زادت من نمو البلانكتون بنوعيه والذي أثر بالتالي على وزن الاسماك المكتسب ومعدل النمو النسبي وكذلك محصول السمك بالزيادة.

كما زاد محصول الأرز بنسب ٩-١٣% عند تنمية الأسماك في حقول الأرز مقارنة مع محصول الأرز الخالي من الأسماك. وزاد صافي الدخل عند استزراع المبروك العادي والاستاكوزا مع التسميد بالسوبر فوسفات بمقدار ١٥٩-٢١٠% عن صافي الدخل في حقول الأرز الخالية من الاسماك.

ويمكن النصح بتنمية المبروك العادي مع استاكوزا المياه العذبة في حقول الأرز بنسب ١٠٠:٢٥٠ على التوالي في نصف الفدان مع التسميد بخليط من اليوريا + سوبر فوسفات (٤ ن:١ فو) في حالة رخص سعر اليوريا وإلا فينصح بالتسميد بسوبر فوسفات فقط بمعدل ١٨ كجم/١/٢ فدان/ شهريًا. وهذا النظام من الانتاج يتيح الفرصة لصغار المزارعين لزيادة دخلهم عن طريق زيادة محصول الأرز الناتج بالإضافة إلى مورد مالي من تسويق محصول السمك الناتج.