Fish culture in rice fields at Kafr El-Sheikh

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Abstract

The present study was carried out to find the most suitable fish species for stocking in rice field as well as selection the optimum fry size in this integration system. Two rice fields (4 feddans for each area) were stocked with fish as integration system. The first field stocked with 10000 fingerlings of Nile tilapia *Oreochromis niloticus* (2500 fingerlings/feddan) and the second field was stocked with 6000 fingerlings of common carp *Cyprinus carpio* (1500 fingerlings/feddan). The obtained results can be summarized as follows:

- The average body weight of *O. niloticus* increased from 26.2 g at the experimental start to 176.8 g at the end of the experiment with daily weight gain ranged from 0.54 to 2.08 g and the body length increased from 10.8 cm at the experimental start to 21.6 cm at the end of the experiment.
- The average body weight of *Cyprinus carpio* increased also from 11.7 at the experimental start to 154.5 g at the end of the experiment with daily weight gain ranged from 0.46 to 2.02 g and the body length increased from 6.9 at the experimental start to 20.4 cm at the end of the experiment.
- Specific growth rate (SGR) ranged from 0.81 to 2.69 for *O. niloticus* and 1.65 to 2.58 for *Cyprinus carpio.*
- Feed conversion ratio was 1.65 for *O. niloticus* and 1.24 for *Cyprinus carpio* for the *experimental period.*
- From economic point of view, the net return per feddan (fish only) was 708.2 L.E. for *O. niloticus* and 140.15 L.E. *Cyprinus carpio.*

Introduction

Rice is the dominant cereal crop in Asian and some African countries. It is the staple food of over 1.4 billion people in the world, mostly in Asia where 90% of all rice is grown and eaten Haut and Tan (1980). For most rural farmers, this single crop is virtually their also livelihood. It eccupies between half and two-thirds of the total arable land available in the principal rice producing countries. It also contributes up to 20% of their entire gross domestic product.

The oldest written record of rice-fish culture in Japan dates from 1844, although it is believed that it has been practiced long before that (Tamura, 1961).

The culture of fish in rice fields generally benefits rice culture. The yield of rice has been increased by about 15% in the Indo-Pacific countries by the introduction of fish (Hora and Pillay, 1962). Increases up to 7% have been recorded in China (China Freshwater Fish Committee, 1973) and 7% in Russia (Grist, 1965). This probably results from better aeration of the water and greater tillering (Hora and Pillay, 1962). The excreta of fish, the additional fertilizers used and any remnants of supplemental food also increase the fertility of soil. In rice culture, weeds can reduce yield by up to 50% (Coche, 1967).

The introduction of herbivorous fish controls weeds and reduces weeding labor and costs. Among the most useful species are *Punius gonionotus, Sarotherodon mossambicus, Trichogaster pectoralis* and *Cyprinus carpio.* Fish also eat harmiful organisms, such as insects and larvae. In China, the stem borer is said to have bean controlled by the introduction of fish (China Freshwater Fish Committee, 1973) and infestation of rates and pests can also be greatly reduced by the higher and

more sdid bunds ereated culture for rice-fish culture. Rice field fish can also contribute to the control of water borne diseases by feeding of aquatic intermidiate hosts, such as mosquito larvae (malaria) and fresh water molluscos (bilharzias). Rice-fish culture has perhaps on of the greater potentials for extensive exploitation of tilapia by the contemporaneous production of grains and fish protein on the same land. Not only can there be an increase of rice production by 5 to 15% (Huet, 1972), but also the additional production between 100 to 2250 kg/ha of fish from what would be an otherwise underutilized water. Though not widely practiced in Africa the method was developed to a significant extent in the Malagasy Rupub;ic using *S. mossambicus* and carp and rapidly developing in Egypt and Tanzanis (Shehadah, 1976). It has also been practiced in Zaire, Zambia, Rho desia and the Cameroon, mainly using Tilapia spp. (Coche, 1967). The specie *S. mossambicus* has also been used in Indonesia, Taiwan and Malaya (Huet, 1972) and also in the phillipines (Guerrero, 1975). In Egypt Sadek and Abdel-Hakim (1986) reported that culture of common carp in rice field for 153 days improved rice yield by 11.4% and the fish yield during the same period ranged between 38.3 kg in rice fish fields compared to 43.7 kg of fish ponds alone.

This study was conducted to study the effect of stocking Nile tilapia (*Oreochromis niloticus*) and common carp (*Cyprinus carpio*) in rice fields at higher densities and weights with artificial feeds on fish final weights and the returns of such technology at kafr El-Sheikh governorate.

Materials and Methods

Location:

The present study was carried out in a medium size rice farm at Aryamone village, Kafr El-Sheikh Governorate. The farm consists of 8 feddans which divided into two experimental areas, 4 feddan for each. Both areas were prepared by digging canals inside the rice fields, which can be used by fishes in case of low water level. The dicks around the fields were increased in the height to maintain 20 cm water level at least during the period of study. Screens (80×80×130 cm) were fixed at the end of the canals to prevent fish escape and the entrance of foreign fishes into rice fields.

Fishes:

Nile tilapia *Oreochromis niloticus* fingerlings with an average weight of 26.2 g and common carp, *Cyprinus carpio* with an average weight of 11.7 g were purchased from fish hatchery at Fuwaa, Kafr El-Sheikh Governorate. Tilapia were stocked alone in the first area (4 feddan) at a stocking rate of 2500 fish/feddan , while carp was stocked in the other area (4 feddan) at a rate of 1500 fish/feddan.

Feeds:

Poultry feeds, cattle feeds as well as macaroni by-products were used in this study. Poultry feeds were delivered from a feed mill plants belonging to Kafr El-Sheikh Governorate. This feed contained 23% crude protein. Cattle feeds contained 11% protein. Fishes were fed on a mixture of the 3 ingredients at a rate of 3% of the biomass divided into two times daily.

Sampling:

A total of 50 fishes from each species of tilapia and common carp were sampled by a hand net at the start and every 4 weeks during the

period of the study. Fish length was measured in cm and fish weight was wet weighed in grams. The total biomass was estimated for each specie according to the average body weight, and the required daily feed stuffs were monthly calculated. Also, the specific growth rate, daily weight gain, feed conversion ratio (FCR) and condition factor were calculated for each specie. Water quality monthly tested for the dissolved oxygen, pH, total ammonia as well as the total plankton count to check the suitability of the water for fish growth. All water quality parameters were within the permissible levels for normal fish growth and development.

Specific growth rate (SGR) was calculated using the following formula (Hopkins, 1992): $SGR = 100 [\ln W_2 - \ln W_1 / t]$

Where $\ln W_1$ is the natural logarithm of the first fish weight in grams, $\ln W_2$ is the natural logarithm of the following fish weight in grams and t is the period in days.

Condition factor (K) was calculated by using the equation of Bagenal and Tesch (1978) as follow:

$$\mathbf{K = 100\ (W)/L^3}$$

where W and L are the individual weight and length of the fish, respectively.

Harvesting:

At the end of the rice period, all fishes were moved from rice fields using the bypass canals in the fields to the blind irrigation canal and fed till harvesting. At harvesting, collected fishes of each specie were sorted into suitable grades, weighed and the total fish yield was recorded.

Statistical analysis:

The statistical analysis of data was carried out by applying the computer program Harvey (1990).

Results and Discussion

The average body weight of Nile tilapia, *Oreochromis niloticus*, increased from 26.2±17.46 g at the beginning of study to 176.8±78.81 g at the end. These values were higher than that obtained by Mang-Umphan and Arce (1988). They found that, under the integrated rice-fish system, the body weight of Nile tilapia increased from 8.3-8.59 to 33.78-36.69 g during 75 days rice-fish culture period where fields were supplied with organic and inorganic fertilizers and combinations of both.

As shown in table (1) the total fish yield of tilapia was 1500 kg (375 kg/feddan), and this yield was higher than that obtained by Shaheen et al., (1959) who found that the total yield was 40 kg/ha of Nile tilapia cultured in rice fields. Haroon and Pittman (1997) found that the total yield of *O. niloticus* cultured in rice fields were 59.4 and 158.2 kg/ha when fish initial weight were 3.1 and 30.7 g, respectively. Also, Abdel-Hakim et al., (2000) found that the total yield of *O. niloticus* cultured in rice field was 77.9 kg/feddan.

So, the total number of tilapia at the end of study was 8484 fish with survival rate of 84.8% and this percentage was relatively lower than that obtained by Perez-Athanasiadias and Bellido-deCedeno (1989), who reported a survival rate of 90% for Nile tilapia in rice culture.

The average body weight of common carp, *Cyprinus carpio*, increased from 11.7±22.39 g at the experimental start to 154.5±47.2 g at the end of the study. The total fish yield of common carp was 800 kg (200 kg/feddan), this total yield of common carp (200 kg/feddan) was higher than that obtained by Sadek and Abdel-Hakim (1986), who found that the common carp yield ranged between 91.2 and 104 kg/ha within a growing season of 153 days in rice fields. The total fish yield/feddan obtained in the

present study (200 kg/feddan) was higher than 200 kg/ha and 158 kg/ha that reported by Elbolock and Labib (1967) and Jensen (1983) with common carp and mirror carp, respectively.

The final total number of carp was 5178 fish with a survival rate of 86.3% and this value of survival rate was higher than 75% and 67% that reported by Jensen (1983) and Sadek and Abdel-Hakim (1986) with mirror carp and common carp, respectively. Also, Haroon and Pittman (1997) found that the mean survival rate were 65.6 and 66.4% for *O. niloticus* culture in rice fields with initial weight of 3.1 and 30.7 g, respectively.

The average values of condition factor decreased gradually for Nile tilapia from 2.08 to 1.75 and decreased also for common carp from 3.56 to 1.82 at the beginning and at the end of the experiment (Tables 1 and 2), respectively. Therefore the overall condition factor reduced by 15.9 and 48.9% for Nile tilapia and common carp, respectively.

As presented in Tables (1 and 2) averages of the amount of feed consumed from all sources by tilapia (10000 fish stocked in four feddans) were 660 kg poultry feed 23% protein, 1000 kg of cattle feeds 11% protein 700 kg of macaroni by-products which doesn't suitable for human consumption. On the other hand, the amount of feed consumed by common carp (6000 fish stocked in four feddans) from all above mentioned sources were 300, 500 and 200 kg, respectively. Results of feed conversion ratio (FCR) showed that average FCR for tilapia was 1.65 kg feeds for each 1 kg gain in weight; while it was 1.24 for common carp.

Results of specific growth rate (SGR) show that the overall means of SGR of Nile tilapia was 1.59 which was near to 1.86 and 1.68 that obtained by Soltan et al., (1999) for Nile tilapia stocked on earthen ponds and fed artificial feed (25% crude protein). SGR for common carp decreased from 2.58 to 1.65 with overall mean of 2.15. Haroon and

Pittman (1997) found that, SGR of *O. niloticus* cultured in rice field was decreased from 4.12 to 1.80% day^{-1} and from 0.79 to 0.12% day^{-1} when the initial weight of *O. niloticus* were 3.1 and 30.7 g, respectively.

Results of the average daily weight gain for Nile tilapia and common carp indicated that, the average daily weight gain of Nile tilapia increased from 0.54 to 2.08 g with an average of 1.23 g (Table 1) and these values were higher than that obtained for common carp which increased from 0.46 to 2.02 g with a an average of 1.19 g (Table 2). The higher values of Nile tilapia daily weight gain compared with common carp may be due to the higher initial body weight of Nile tilapia (26.2 g) compared with that of common carp (11.7 g). Average daily weight gain recorded in the present study were higher than that reported by Mang-Umphan and Arce (1988) with Nile tilapia (0.34-0.39 g) and that of Jensen (1983) with mirror carp (1.1 g).

Results illustrated in Table (3) show that the total costs for tilapia in the form of fry and feed were 3457.2 L.E., and returns were 6290.0 L.E. representing the total yield of tilapia in all grades. The net revenue obtained by tilapia calculated as returns over costs was 2832.8 LE. In this study results revealed that tilapia culture in rice fields may produce 708.2 L.E./feddan as over returns plus the yield of rice.

Results of common carp (Table, 3) revealed that costs of production in the form of fry and feeds were 1030.4 L.E., while the returns obtained with common carp were 1600 L.E. and the net revenue from four feddans 560.6 L.E., i.e. 140.15 L.E. per feddan at the end of study. The low income of common carp in this study was due to its low selling price, thus the average weights at the end of the study was very low and did not reach the suitable market size which almost over one kg per fish. In this connection

the price of carps in Egypt are very low due to the fact that the Egyptian consumer dose not prefer this fish species.

From the previous results it can be recommend that,

- As concerned with fish fry to be cultured in rice fields, the average weight at stocking should not be less than 50-60 g for both species.
- Based on the results obtained in this study we recommend the rice farmers to start fish culture in rice fields very early by digging more deep canals in the rice fields to grow the fish for longer time (to achieve the marketable size), thus the new varieties of rice which require short time (90 days or less) to ripening. Furthermore, the irrigation canals (especially the blind ones) could be used for this reason after rice harvesting to keep the rice fish for longer periods.
- Because of the high selling value of tilapia, we recommend to culture it instead of the common carp in rice fields.

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Table (1): Growth performance of Nile tilapia, *Oerochromis niloticus*, cultured in rice fields at Kafr El-Sheikh Governorate.

Month	Body weight (gm) Mean ± S.D	Body length (cm) Mean ± S.D	Condition factor (K)	Specific growth rate (SGR)	Daily weight gain	Total biomass (kg)	Total feed (kg)	Feed conversion ratio
June	26.2±17.46	10.8±2.55	2.08	-	-	262	236	-
July	58.8±21.19	11.7±1.98	3.67	2.69	1.09	588	529	0.72
Aug.	74.9±38.40	15.7±2.97	1.94	0.81	0.54	749	674	3.29
Sept.	114.3±42.75	18.4±2.55	1.84	1.41	1.31	1143	1029	1.71
Oct.	176.8±78.81	21.6±3.31	1.75	1.45	2.08	1500	-	2.88
				1.59	1.23	1500	2468	1.65

Table (2): Growth performance of Common carp, *Cyprinus carpio* cultured in rice fields at Kafr El-Sheikh Governorate.

Month	Body weight (gm) Mean ± S.D	Body length (cm) Mean ± S.D	Condition factor (K)	Specific growth rate (SGR)	Daily weight gain	Total biomass (kg)	Total feed (kg)	Feed conversion ratio
June	11.7±22.39	6.9±1.62	3.56	-	-	70.2	63.3	-
July	25.4±16.09	9.6±2.96	2.87	2.58	0.46	152.4	137.1	0.77
Aug.	53.2±17.88	13.80±2.08	2.02	2.46	0.93	319.2	287.1	0.82
Sept.	93.8±34.99	16.6±1.95	2.05	1.89	1.35	562.8	506.4	1.18
Oct.	154.0±47.20	20.4±3.05	1.82	1.65	2.02	800.0	-	2.14
				2.15	1.19	800.0	993.9	1.24

Table (3):Cost and returns of Nile tilapia, and common carp cultured in rice fields at Kafr El-Sheikh Governorate.

Costs and returns		Nile tilapia Oerochromis niloticus				Common carp *Cyprinus carpio*			
		No.	Units	Price/unit	Total	No.	Units	Price/unit	Total
Costs	Fry	10	1000	179.9	1799.2	6	1000	47.4	284.4
	Poultry feed	660	Kg	0.98	648	300	kg	0.98	295.0
	Cattle feed	1000	Kg	0.80	800	500	kg	0.80	400.0
	Macaroni	700	Kg	0.30	210	200	kg	0.30	60.0
	Total				3457.2				1039.4
Returns	Fish grade I	680	Kg	5.5	3740	-	-	-	-
	Fish grade II	500	Kg	3.5	1750	-	-	-	-
	Fish grade III	320	Kg	2.5	800	800	kg	2.0	1600
	Total				6290				1600
Net returns		2832.8				560.6			
Net return/feddan		708.2				140.15			

الملخص العربى

إستزراع الأسماك فى حقول الأرز فى محافظة كفر الشيخ

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

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أجريت هذه التجربة بغرض تحديد أفضل أنواع الأسماك التى يمكن إستزراعها فى حقول الأرز وكذلك تحديد أنسب حجم لزريعة هذه الأسماك عند الإستزراع. هذا وقد أختيرت إحدى مزارع الأرز الخاصه فى محافظة كفر الشيخ مساحتها ٨ أفدنه قسمت إلى قطعتين مساحة كل منها ٤ أفدنه وبعد زراعة القطعتين بالأرز وضع فى القطعة الأولى ١٠٠٠٠ إصبعية بلطى (٢٦٫٢ جرام) وفى القطعة الثانية ٦٠٠٠ إصبعيه مبروك بمعدل كثافة مقداره ٢٥٠٠ إصبعيه/فدان للبلطى ، ١٥٠٠ إصبعيه/فدان للمبروك. ثم أخذت عينات من الأسماك عند بداية التجربة لقياس وزن و طول الجسم ثم كررت هذه المقاييس شهرياً لقياس وزن وطول الجسم وكذلك معدل النمو النسبى ومعدل النمو المطلق ومعدل تحويل الغذاء. وكان من أهم النتائج المتحصل عليها ما يلى:

١- زادت أوزان أسماك البلطى النيلى من ٢٦٫٢ جرام عند بداية التجربة إلى ١٧٦٫٨ جرام عند نهاية فترة التجربة كما زاد طول الجسم من ١٠٫٨ إلى ٢١٫٦ سم عند بداية ونهاية التجربة .

٢- زادت أوزان أسماك المبروك من ١١٫٧ جرام عند بداية التجربة إلى ١٥٤ جرام عند نهاية فترة التجربة كما زاد طول الجسم من ٦٫٩ إلى ٢٠٫٤ سم عند بداية ونهاية التجربة.

٣ – تزايدت قيمة الزياده اليوميه المطلقه فى وزن الجسم من ٠٫٥٤ إلى ٢٫٠٨ بمتوسط مقداره ١٫٢٣ جرام/يوم وذلك بالنسبه لأسماك البلطلى النيلى كما تزايدت قيمة الزياده اليوميه المطلقه فى وزن الجسم من ٠٫٤٦ إلى ٢٫٠٢ بمتوسط مقداره ١٫١٩ جرام/يوم وذلك بالنسبه لأسماك المبروك.

٣- تراوحت قيمة معدل النمو النسبى ما بين ٠٫٨١–٢٫٥٨ لأسماك البلطى ، ١٫٦٥–٢٫٥٨ لأسماك المبروك.

٤–كان متوسط معدل تحويل الغذاء ١٫٦٥ للبلطى و ١٫٢٤ للمبروك.

٥–كان العائد الاقتصادي من إستزراع الأسماك فى حقول الأرز ٧٠٨٫٢ جنيه مصرى للفدان المستزرع بأسماك البلطى، ١٤٠٫١٥ جنيه مصرى للفدان المستزرع بأسماك المبروك هذا بالإضافة إلى ثمن محصول الأرز.

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