EFFECT OF STOCKING DENSITY AND DIET TYPE ON GROWTH PERFORMANCE AND ECONOMIC EFFICIENCY OF GRASS CARP (*Ctenopharyngodon idella*) FRY IN NURSING PERIOD

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Key words: Grass carp- stocking density – growth performance- economic efficiency.

ABSTRACT

The present work was conducted in commercial farm at Shakshouk, Fayoum Governorate to study the effect of stocking density and diet type on growth performance, feed utilization and economic efficiency of grass carp fry during nursing period.

In this study 3600 grass carp fry with average weight 2.72 ± 0.4 g obtained from, Beni-Suif, General Authority for Fish Resources Development (GAFRD). Fry was distributed randomly on 12 hapas to examine six treatment, two stocking density (25 and 50 fry/m^3) and three diet types (manufactured diet, MD; formulated diet, FD and poultry manure with rice bran that fermented together, PMFD). Treatments were, (1) 25 fry/m^3 that fed MD, (2) 25 fry/m^3 that fed FD, (3) 25 fry/m^3 that fed PMFD, (4) 50 fry/m^3 that fed MD, (5) 50 fry/m^3 that fed FD and (6) 50 fry/m^3 that fed PMFD. Two hapas per each treatments, hapas was fixed in nursing pond (2100 m^2).

The results revealed that grass carp fry at a rat of 25 fry/m^3 exceeded significantly on final weight, total gain and daily gain that of the higher density. Final weight, weight gain and daily gain increased significantly with fry fed on manufactured diet than other diets. The lowest values of growth performance with fry nursed at density 50 fry/m^3 and fed PMFD.

Feed utilization was improved in the same trend of growth performance. But economic efficiency and net returns were improved with high density fry that fed on PMFD.

INTRODUCTION

During summer months, fish farm ponds face acute problems due to high temperature specially in shallow ponds. Extensive weed growth frequently clogs intake pumps and filter systems, interferes with recreational activities, and causes water quality to deteriorate. Methods of controlling excessive aquatic weed growth are mechanical (chaining, raking, weed cutters, hand harvesting), chemicals and biological. Mechanical methods are often labour-intensive and costly. Chemical treatments are also expensive and can directly or indirectly harm other aquatic life and water quality. Biological methods are the best to control aquatic weed.

Cyprinids are by far the largest group of cultured fish throughout the world (**FAO, 2006**) and grass carp is one of the largest members of the family Cyprinidae, and is the only member of the genus *Ctenopharyngodon* (**Froese and Pauly, 2004; ITIS, 2004; Shireman and Smith, 1983; Chilton and Muoneke 1992**). Grass carp (*Ctenopharyngodon idella*) were introduced into the polyculture in order to control weeds in ponds and increase pond productivity through supplementary feeding with terrestrial grass (*Pennisetum purpureum*). Grass carp is used worldwide for this purpose, and its growth performances are excellent in tropical areas (**Glasser *et al.,* 2003 and Froese and Pauly, 2004**).

Some experimental results of plant control by grass carp in canals and ditches are available from New Zealand (**Edwards and More 1975**), Egypt (**Gharably *et al.*, 1982**), England (**Mugridge *et al.,* 1982**), Sudan (**George 1983**) and California (**Stocker *et al.*, 1990**).

Grass carp have proven as effective control of nuisance aquatic plant growth (**Guillory and Gassaway 1978**). Cultured grass carp may reach up to 1 kg in the first year and grow approximately 2-3 kg/year in temperate areas and 4.5 kg/year in tropical areas (**Shireman and Smith 1983**). A study by **Shelton *et al.* (1981)** on grass carp growth at different stocking densities indicate that the growth was strongly affected by density.

The objective of this study was to investigate the effects of stocking density and diet type on nursing grass carp fry.

MATERIALS AND METHODS

The present work was conducted at the commercial farm in Shakshuk region, Fayoum Governorate during the period from 20/5/2006 to 20/7/2006. The fry were put in 8 m^2 fine mesh net enclosures (hapas) fixed in nursing pond to evaluate the effect of two stocking densities and three types of diet, in a factorial design system for grass carp fry to reach to fingerlings size, to distributed on a farm ponds for controlling growing plants. Fry of grass carp *Ctenopharyngodon idella* were brought from Beni Suif hatchery and transferred farm.

3600 grass carp fry with average body weight of 2.72 ± 0.4 g were distributed randomly to 12 hapas to examined six treatment, two stocking densities (25 and 50 fry/m^3) and three diet types (manufactured diet, MD; formulated diet, FD and poultry manure with rice bran that fermented together, PMFD). The 1st treatment contained 25 fry/m^3 fed MD; the 2nd treatment contained 25 fry/m^3 fed FD; the 3rd treatment contained 25 fry/m^3 fed PMFD; the 4th treatment contained 50 fry/m^3 fed MD; the 5th treatment contained 50 fry/m^3 fed FD and the 6th treatment contained 50 fry/m^3 fed

PMFD). Two hapas were used per each treatments, the factorial design used in the experiment was presented in Table 1. The chemical composition of the tested diets were as follows, 25% CP, 6% EE, 8% CF, 9% ash, for MD, 25% CP, 7% EE, 9% CF, 6% ash for FD and 19% CP, 8% EE, 12% CF, 19% ash, for PMFD.

Fry fresh weight, number, feed offered, feed costs and selling prices were obtained. Growth and feed parameters, survival rates and net returns were calculated. Water pH, dissolved Oxygen (DO) and salinity were measured periodically by Orion digital pH meter model 201, Cole Parmer oxygen meter model 5946 and Orion 105 salinity meter, respectively.

Analysis of variance and comparisons between means were conducted applying Statgraphic Package Software (**SPSS, 1997**). The following formula was used for analysis of variance

$Y_{ijk} = \mu + S_i + T_j + ST_{ij} + e_{ijk}$ where

Y_{ijk} is observation, μ = overall mean, S = stocking density effect
T = type of diet effect, ST = the interaction between S and T,
e_{ijk} is the experimental error ijk is the rank following S, T and replicats.

Table (1). Factorial design used in the experiment.

Grass carp fry								
25/m^3				Diet type	50/m^3			
	rep 1	rep 2				rep 1	rep 2	
200			200	Manufactured diet (MD)	400			400
200			200	Formulated diet (FD)	400			400
200			200	Poultry manure and rice bran, fermented (PMFD)	400			400

RESULTS AND DISCUSSION

Water quality

Results of Table (2) showed water quality parameter recorded during the experimental period. Averages of these parameters (2.9, 6.45 and 8.36) were in the suitable range for grass carp fry (**Chilton and Muoneke, 1992; Shireman and Smith, 1983; Federenko and Fraser 1978**).

Table (2). Water quality parameters recorded during the experimental period.

Items	Salinity, ppt		DO, mg/l		pH	
	Min.	Max.	Min.	Max.	Min.	Max.
May	2.4	2.6	4.00	10.20	7.64	8.84
June	2.9	3.1	3.50	9.44	7.94	9.01
July	3.0	3.3	3.00	8.56	7.84	8.91
Average	2.77	3.0	3.50	9.40	7.81	8.92
Overall average	2.90		6.45		8.36	

Growth performance

Results on Table (3) showed the effect of stocking density on final weight, weight gain, daily gain and specific growth rate percentage (SGR). High values were recorded with low density and significantly differences than high density in all growth parameters. This may be due to the presence large area which each fry was taken and low crowdness in each hapa compared to high density regardless to diet type effect. Such trend was reported by **Shelton *et al.* (1981)** who reported that grass carp growth at different stocking densities was strongly affected by density. Also, **Wohlfarth *et al.* (1985)** showed that growth performance and survival of tilapia were influenced negatively by increasing fish stocking rate.

Results of the effected diet type on final weight, weight gain, daily gain and SGR were shown in Table (4). There was a significant effect, high values were recorded with manufactured diet followed by formulated diet and then fermented diet. These results may be due to good values of nutrients in manufactured diet because of balanced composition, extrusion, heat treatment and pellets form, which not allowed to lose in water pond and stayed long time in a solid form, which gave a good chance for fry to consume all diet than other diets. Formulated diet approximately balanced, but in a powder form may due to loss of different nutrients in pond water especially when fry moved around the feeder. Fermented diet had a good smell to attract the fry and encouraged phytoplankton and zooplankton growths which fry depends mainly on it beside small parts of rice bran, these lead to poor growth compared to manufactured diet. Such poor growth may be due to its lower CP (19%) and growth energy along with its higher CF (**Hassouna *et al.*, 2002**).

Table (3). Effect of stocking density of grass carp on growth performance and survival rate during the nursing period.

Item	Grass carp/m²		SED
	25	50	
Initial weight, g	2.73	2.72	0.007
Final weight, g	14.30[a]	12.17[b]	0.86
Total gain[1], g	11.57[a]	9.45[b]	0.86
Daily gain[2], g	0.19[a]	0.15[b]	0.014
SGR[3] %	2.67[a]	2.42[b]	0.10

- Averages in the same row having different superscripts are significantly different ($P \leq 0.01$).
- SED, standard error of differences.
1, Final weight – initial weight
2, Weight gain/period, day (62) 3, {(ln W_2 – ln W_1) ×100/days number}

Table (4). Effect of diet type on growth performance and survival rate of grass carp during the nursing period.

Item	Diet type			SED
	MD	FD	PMFD	
Initial weight, g	2.73	2.72	2.73	0.009
Final weight, g	14.60[a]	13.58[ab]	11.53[b]	0.96
Total gain[1], g	11.87[a]	10.86[ab]	8.80[b]	0.95
Daily gain[2], g	0.19[a]	0.18[ab]	0.14[b]	0.02
SGR[3] %	2.70[a]	2.59[a]	2.32[b]	0.11

-Averages in the same row having different superscripts are significantly different ($P \leq 0.01$).
- SED, standard error of differences.
1, Final weight – initial weight
2, Weight gain/period, day (62) 3, {(ln W_2 – ln W_1) ×100/days number}

Results of interaction between stocking density and diet type of grass carp fry were presented in Table (5). Final weight, weight gain, daily gain and SGR were significantly affected. The highest values obtained were with manufactured diet at low density of grass carp fry followed by formulated diet at the same density, but the lowest values obtained were with fermented diet at high density and the other treatment were in between. These results may be due to the good feed and environment of manufactured diet at low density, and the bad environment and overcrowdness at high density with fermented diet.

Table (5). Effect of stocking density and diet type on growth performance and survival rate of grass carp during the nursing period.

Item	Grass carp/m^2						SED
	25			50			
	MD	FD	PMFD	MD	FD	PMFD	
Initial weight, g	2.74	2.72	2.72	2.72	2.72	2.73	0.013
Final weight, g	16.10^a	14.55^b	12.25^c	13.10^c	12.60^c	10.80^d	0.51
Total gain[1], g	13.36^a	11.83^b	9.53^c	10.38^c	9.88^c	8.07^d	0.51
Daily gain[2], g	0.22^a	0.19^b	0.15^c	0.17^c	0.16^c	0.13^d	0.008
SGR[3] %	2.86^a	2.70^b	2.43^c	2.54^c	2.47^c	2.22^d	0.057

- Averages in the same row having different superscripts are significantly different ($P \leq 0.01$).
- SED, standard error of differences.

1, Final weight – initial weight

2, Weight gain/period, day (62)   3, $\{(\ln W_2 - \ln W_1) \times 100/\text{days number}\}$

Feed utilization and survival rate

Feed utilization results are presented in Tables (6, 7 and 8). Feed conversion ratio (FCR) was significantly better with low density of grass carp fry than high density and significantly better with manufactured diet than formulated and fermented diet. These results due to the increase in fry growth. Regarding the interaction between stock density and diet type, significant better FCR was obtained with manufactured and formulated diet at low density than the other treatment. The work of **Shelton *et al.* (1981)** on grass carp growth at different stocking densities indicate that the growth was strongly affected by density and **Hassouna *et al.* (2002)** on the effect of diet confirm such results.

Table (6). Effect of stocking density of grass carp on feed utilization and survival rate during the nursing period.

Item	Grass carp		SED
	25	50	
Feed intake, kg/hapa	6.87	12.33	----
FCR	3.46^b	3.86^a	0.10
Fingerlings No/haps	177	352	----
Survival rate	88.50	88.00	1.51

- Averages in the same row having different superscripts are significantly different ($P \leq$ 0.01).

Table (7). Effect of diet type on feed utilization and survival rate during the nursing period.

Item	Diet type			SED
	MD	FD	PMFD	
Feed intake, kg/hapa	10.50	9.75	8.55	----
FCR	3.43[b]	3.39[b]	4.03[a]	0.14
Fingerlings No/haps	266	272	255	----
Survival rate	88.67[b]	90.67[a]	85.00[c]	0.73

- Averages in the same row having different superscripts are significantly different ($P \leq 0.01$).

Table (8). Effect of stocking density and diet type on growth performance and survival rate of grass carp during the nursing period.

Item	Grass carp/m^2						SED
	25			50			
	MD	FD	PMFD	MD	FD	PMFD	
Feed intake, kg/hapa	7.60	6.90	6.10	13.40	12.60	11.00	----
FCR	3.30[d]	3.30[d]	3.87[b]	3.76[b]	3.61[c]	4.30[a]	0.11
Fingerlings No/haps	177	181	173	355	363	338	----
Survival rate	88.5[ab]	90.5[a]	86.5[b]	88.75[ab]	90.75[a]	84.50[c]	1.25

- Averages in the same row having different superscripts are significantly different ($P \leq 0.01$).

Survival rate was significantly improved with formulated diet followed by manufactured and fermented diet, this improvement may be due to the presence of Nigella sativa seeds in FD diet which have some properties as antiseptic, antibacterial and antibiotic activities.

Economic efficiency

Results of economic efficiency as affected by stocking density of grass carp fry, diet type and interaction between them are shown in Tables (9, 10 and 11). The best net returns per 1000 fry and net returns/total cost were obtained with the high density of grass carp fry and fermented diet regarding the mean effects of stocking density (Table 9) and diet type (Table 10), respectively. The interaction between stocking density and diet type showed that the best economic efficiency was with fry at high density that fed fermented diet. These results due to the equality in selling price of 1000 fingerlings at the end of the experiment and that of other managerial costs, beside the low price of fermented diets compared to other tested diets.

Under the experimental conditions, the fry that stocked at low density and fed the manufactured diet showed the best growth performance. Even though, the high density of fry that fed the fermented diet was more economic at commercial scale.

Table (9). Effect of stocking density of grass carp on economic efficiency during the nursing period.

Item	Grass carp/m^2	
	25	50
Feed cost/hapa, L.E	9.86	17.64
Fry cost /hapa, L.E	14	28
Other cost /hapa, L.E	10	10
Total cost /hapa, L.E	33.86	55.64
Hapa selling price	44.17	87.92
Net returnes/hapa	10.31	32.28
Net returnes/1000 fry	58.48	92.13
Net returnes/cost, %	30.45	58.00

- Price of one kg of manufactured, formulated and fermented diet was 2.1, 1.4 and 0.65 L.E. respectively and the price of 1000 fry at start was 70 L.E.
- Selling price of 1000 fingerlings was 250 L.E.

Table (10). Effect of diet type on economic efficiency of grass carp during the nursing period.

Item	Diet type		
	MD	FD	PMFD
Feed cost /hapa, L.E	22.05	13.65	5.56
Fry cost /hapa, L.E	21	21	21
Other cost /hapa, L.E	10	10	10
Total cost /hapa, L.E	53.05	44.65	36.56
Hapa selling price	66.44	67.94	63.75
Net returnes/hapa	13.39	23.29	27.19
Net returnes/1000 fry	50.65	85.85	106.63
Net returnes/cost, %	25.24	52.16	74.37

- Price of one kg of manufactured, formulated and fermented diet was 2.1, 1.4 and 0.65 L.E. respectively and the price of 1000 fry at start was 70 L.E.
- Selling price of 1000 fingerlings was 250 L.E.

Table (11). Effect of stocking density and diet type on economic efficiency of grass carp during the nursing period.

Item	Grass carp/m^2					
	25			50		
	MD	FD	PMFD	MD	FD	PMFD
Feed cost /hapa, L.E	15.96	9.66	3.96	28.14	17.64	7.15
Fry cost /hapa, L.E	14	14	14	28	28	28
Other cost /hapa, L.E	10	10	10	10	10	10
Total cost /hapa, L.E	39.96	33.66	27.96	66.14	55.64	45.15
Hapa selling price	44.12	45.25	43.12	88.75	90.63	84.37
Net returnes/hapa	4.16	11.65	15.16	22.61	34.99	39.22
Net returnes/1000 fry	24.23	64.03	88.38	63.69	96.72	116.42
Net returnes/cost, %	10.41	34.61	54.22	34.19	62.72	86.87

- Price of one kg of manufactured, formulated and fermented diet was 2.1, 1.4 and 0.65 L.E. respectively and the price of 1000 fry at start was 70 L.E.
- Selling price of 1000 fingerlings was 250 L.E.

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تأثير كثافة التخزين ونوع العليقة على مظاهر النمو والكفاءة الاقتصادية لزريعة مبروك الحشائش أثناء فترة التحضين

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أجريت هذه الدراسة فى مزرعة تجارية بمنطقة شكشوك- محافظة الفيوم وذلك لدراسة تأثير كثافة تخزين زريعة المبروك ونوع العليقة على معدلات النمو والاستفادة من الغذاء والكفاءة الاقتصادية أثناء فترة التحصين.

استخدم فى هذه الدراسة ٣٦٠٠ زريعة مبروك حشائش متوسط وزنها ٢,٧٢ ± ٠,٤ جم تم الحصول عليها من مفرخ هيئة تنمية الثروة السمكية ببنى سويف وزعت الزريعة على ست معاملات فى نظام عاملى (٢ × ٣) وذلك باستخدام معدلين تخزين (٢٥ و ٥٠ زريعة/م٣) وثلاث أنواع من العلائق (عليقة تجارية مصنعة، عليقة مركبة بالمزرعة، فرشة الدواجن مع رجيع الكون وتم تخميرهم ٢٤ ساعة) وضعت كل معاملة فى هابتين مساحة الهابة ٨ م٣ وثبتت الهابات فى حضان ترابى مساحته ٠,٥ فدان وقد أظهرت النتائج ان:

- زريعة المبروك المخزنة بكثافة ٢٥ زريعة/م٣ تفوقت معنويا فى الوزن النهائى ومعدل الزيادة الكلية واليومية عن الكثافة العالية. كذلك تفوقت الزريعة المغذاة على العليقة المصنعة تجاريا فى الوزن النهائى ومعدلات الزيادة الكلية واليومية عن باقى العلائق.
- تحسن الوزن النهائى ومعدل الزيادة الكلية واليومية للزريعة المرباة بكثافة ٢٥ زريعة للمتر وتغذت على العليقة المصنعة تجاريا عن باقى المعاملات وكانت أقل القيم لمظاهر النمو مع الزريعة التى حضنت بكثافة ٥٠ زريعة للمتر وتغذت على فرشة الدواجن والرجيع المخمر.
- تحسنت مظاهر الاستفادة من الغذاء بنفس اتجاه مظاهر النمو أما الكفاءة الاقتصادية والعائد من التربية وهو مايهم المربى فى هذه المرحلة فكانت أحسن النتائج مع الكثافة العالية والتى تغذت على فرشة الدواجن والرجيع المخمر.