Bulgarian Journal of Agricultural Science, 19 (No 6) 2013, 1391-1395
Agricultural Academy

IMPACT OF SOME TECHNOLOGICAL FACTORS ON THE GROWTH OF CARP FISH (CYPRINIDAE) REARED IN AUTOCHTHONOUS POLYCULTURE

L. NIKOLOVA
Institute of Fisheries and Aquaculture, BG - 4003 Plovdiv, Bulgaria

Abstract

NIKOLOVA, L., 2013. Impact of some technological factors on the growth of carp fish (Cyprinidae) reared in autochthonous polyculture. *Bulg. J. Agric. Sci.,* 19: 1391-1395

The study was conducted in two consecutive years in the Fisheries and Aquaculture Institute – Plovdiv. For the needs of ecologo- and bio-friendly fish farming, the impact of some factors on the growth of carp fish reared in polyculture, based on a natural nutritive basis, have been investigated. Rearing in autochthonous polyculture led to satisfactorily fish growth. The polyculture structure is a significant source of common carp growth variation, as the impact decreases when taking into account intense vegetation in the pond, and increases when taking into account the size of the pond. Common carp had better growth in one-year polyculture. The polyculture structure had no impact on bighead carp growth. One-year old grass carp grew more intensively compared to two-year old grass carp. Fertilization is a significant source for growth variation, but the impact is specific for the different species. Positive effect of the factor is established only for bighead carp. Significant sources for growth variation in all studied species are pond size and macrophytes density level.

Key words: fishpond; natural food; carp; herbivorous fish; manure; macrophytes

Introduction

Vinogradov (1997) defines polyculture with herbivorous fish as a business and bioenergy profitable ecosystem. Lutz (2003) stated that polycuture farming provides more efficient use of environmental resources within the aquatic ecosystems. Autochthonous polyculture is based only on natural food sources, which grow in water reservoirs (Privezentsev, 1991). Fish growth is determined by the development of the natural nutritious basis of the water reservoir, which, on its turn is essentially influenced by the presence of the fishes of these species (Aleksandrijskaja and Kotljar, 1980; Radke and Kahl, 2002).

Autochthonous production systems are environmentally and b**io-friendly** and meet the current requirements for sustainability of agricultural production (Folke and Kautsky, 1992; Nikolova, 2006 etc.). Achieving sustainability in aquaculture requires a complex approach, as significant number of factors affects the production process. In this concern, it is necessary to know the mechanisms of interaction between the various components of the fish farm ecosystem.

The problems concerning the autochtonous polyculture have not been cleared up in our country. Our goal is to investigate the impact of some technological factors (stocking rate; manure; overgrowing; pond and pond area) on the growth of carp fish – common carp, grass carp and bighead carp reared in autochthonous polyculture.

Material and Methods

The study was conducted in two consecutive years in the Fisheries and Aquaculture Institute – Plovdiv within the "Introduction of Organic Farming in Warm-Water Fish Farming in Bulgaria Conditions" project funded by the Agricultural Academy.

In the 1st year of the experiment were used five fattening carp ponds with a total area of 1.47 ha, divided into two groups: Group I (n = 2) – fertilized with cattle manure (3 000 $kg.ha^{-1}$); Group II (n = 3) – not fertilized. In all experimental ponds equal mixed polyculture was used: year-old common carp (*Cyprinus carpio* L.)– 500 $pcs.ha^{-1}$ and bighead carp (*Aristichthys nobilis* Rich.)– 300 $pcs.ha^{-1}$; and 2-years old grass carp (*Ctenopharyngodon idella* Val.) – 100 $pcs.ha^{-1}$.

E-mail: lnn65r@abv.bg

Average weight of common carp at stocking was 0.071 kg; bighead carp - 0.034 kg; grass carp - 0.578 kg.

In the 2nd year of the experiment were used six fattening carp ponds with a total area of 1.59 ha, divided into two groups: Group I (n = 3) – fertilized with cattle manure (3 000 $kg.ha^{-1}$); Group II (n = 3) – not fertilized. In all experimental ponds, equal same age (year-old) polyculture was used: carp- 500 $pcs.ha^{-1}$; bighead carp – 300 $бр.ha^{-1}$; grass carp – 100 $бр.ha^{-1}$. Average weight of common carp at stocking was 0.031 kg; bighead carp - 0.021 kg; grass carp - 0.038 kg.

During the two years of the study, in all experimental ponds before flooding was used 300 $kg.ha^{-1}$ quicklime. In addition, during the vegetation period another 150 $kg.ha^{-1}$ were used. During the vegetation period, we monitored the hydrochemical and hydrobiological parameters of the ponds. We ascertained visually the growth of the macrophytes in the pond as % of the total area. To establish the intensity of the fish growth in the experimental ponds were conducted weight measurements of separate fish species at the beginning and the end of the vegetation period.

Analysis of variance was used for data processing. Linear models of the following general type were used:

Yijklm=μ+Yi+Tj+Ok+Bl+eijklm (Model 1);
Yijklm=μ+Yi+Tij+Ok+Bl+eijklm (Model 2);
Yijklm=μ+Yi+Tj+Oik+Bl+eijklm (Model 3);
Yijklmn=μ+Yi+Tj+Ok+Bl+Pm+eijklmn (Model 4),

where: Yijklm(n) – the weight of the fish from each spicies at the end of the vegetation period; μ – general average constant; Yi- fixed effect of the i^{th} polyculture structure (year); Tj- fixed effect of the manuring in the pond; Tij – random effect of the manuring in the frames of the year of the study; Ok- fixed effect of the k-level of the overgrowing; Oik – random effect of the k-level of overgrowing in the frames of i-th year of the study; Bl- fixed effect on the l-th pond used in formulas as regressor; Pm- fixed effect of the m-th of the pond area; e (…) – residual variance

Results and Discussion

Rearing in polyculture based on natural food base led to satisfactorily fish growth (Table 1). Year-old common carp grew better in even-aged polyculture, having reached 49.7% higher final live body weight, compared to joint cultivation with two-year old grass carp (Figure 1). Bighead carp grew virtually identically in both experimental years. For the grass carp, higher weights were recorded in three-year old fish, while one–year old fish grew more intensely.

The impact of some environmental factors can be adjusted by modifying the technological parameters of rearing (Muller, 1985), which is why, when developing any new technology requires initial examination of various parameters which are subsequently being gradually optimized. A number of authors (Muller, 1985; Veerina et al., 1999) noted that the structure of the fish stocking and fertilization of ponds are among the factors of greatest importance for fish production. Besides these, a complex of other abiotic and biotic factors influences the growth of fish in the pools. Table 2 presents the impact of factors we studied. The structure of polyculture significantly influenced the growth of common carp, as the impact is reduced taking into account the pond overgrowing and increased when taking into account the size of the pond. Practically the factor has no impact on the growth of bighead carp, and for the grass carp does not depend on other factors involved in the linear model. The importance of the stocking structure decreases more significantly only in case of joint study of fertilization of the pond within the year.

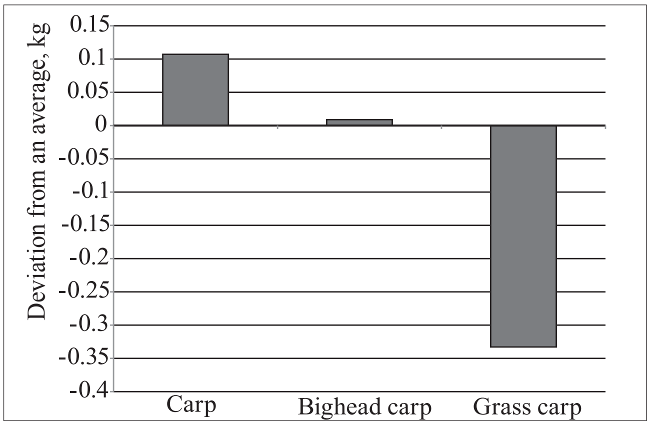

Fig. 1. Influence of the stocking structure on the fish growth (2nd year compared to average)

Table 1
Live weight of the fish at rearing in autochtonous polyculture, kg

Fish	1st year		2nd year		Average	
	LS	m	LS	m	LS	m
Common carp	0.431	0.013	0.645	0.010	0.538	0.007
Bighead carp	0.533	0.029	0.552	0.023	0.542	0.016
Grass carp	1.564	0.055	0.898	0.041	1.231	0.032

Fertilization has been a significant source of variation in the fish growth, but in all three species, impact is specific. For grass carp significant growth differences in fertilized and non-fertilized ponds is established only in the frames of the year, while for the bighead carp it is the opposite - the in general the factor influenced, but in the frames of the year non-significant effect is established. For common carp significant differences in the fish growth for fertilized and non-fertilized ponds is established for both - the entire duration of the experiment, and in the frames of the year.

Fertilization of ponds has not contributed to improve the common carp and grass carp growth (Figure 2). The difference in end body weight is not significant (for common carp – 6.5%; grass carp – 5.8%) but is in favor of non-fertilized ponds. While bighead carp had better growth in fertilized ponds as the difference compared to non-fertilized is 13%.

Trends outlined in our study are similar to those established by Afzal et al. (2007). The authors indicate that organic manure fertilization resulted in a 35.3% higher end body weight of bighead carp compared to non-fertilized ponds, as bighead carp had best growth in fertilized ponds compared to other fish species.

The pond overgrowing appears to have significant impact on the growth of all species included in the polyculture, as for grass carp and bighead carp the factor have impact that is more significant in the frames of the year (Table 2).

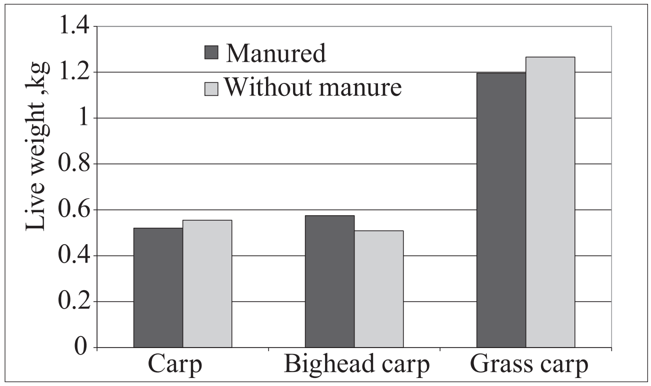

Fig. 2. Influence of the manure on the fish growth

For common carp reared in ponds without vegetation, the end average body weight was 0.717 kg. With increasing of vegetation by 30%, it decreased by 34%, while for ponds with vegetation over 30% the decrease was 98% compared to ponds without vegetation (Figure 3). For grass carp and bighead carp the impact curve is not straight, as it is for the common carp. The highest body weight (1.286 kg) is reached by the grass carp in ponds with under 30% vegetation, but with increase of vegetation level live body weight decreased by 11.7%. Bighead carp in ponds with no vegetation reach the highest end body weight (0.732 kg), but no drastic reduction

Table 2
Influence of basic technology factors on the fish growth

Model	Factor	F- measure and significance level		
		Carp	Bighead carp	Grass carp
1	Stocking rate	123.939***	0.196	80.979***
	Manure	5.672*	4.258*	1.405
	Overgrowing	48.359***	16.893***	1.015
	Pond	90.808***	24.147***	26.998***
2	Stocking rate	6.747	0.037	9.859*
	Manure in the frames of the year	19.33***	2.137	9.171***
	Overgrowing	68.382***	10.922***	3.58*
	Pond	119.635***	22.364***	39.998***
3	Stocking rate	1.281	0.302	24.615*
	Manure	2.863*	4.111*	2.353
	Overgrowing in the frames of the year	32.251***	11.339***	6.953***
	Pond	84.813***	24.175***	19.941***
4	Stocking rate	14.210***	2.156	17.109***
	Manure	13.772***	9.609**	0.278
	Overgrowing	45.472***	18.919***	3.388*
	Pond area	16.444***	5.819**	3.581*
	Pond	91.493***	16.185***	0.001

(*P<0.05; **P<0.01; ***P<0.001)

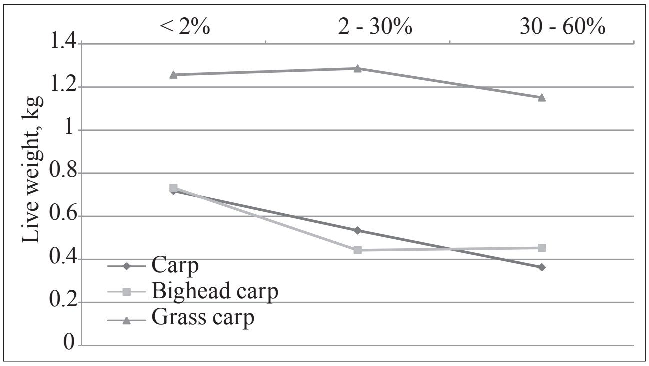

Fig. 3. Influence of the pond overgrowing (%) on the fish growth

in end body weight was observed with increase of vegetation level. The difference based on this indicator for fish in ponds with under and over 30% represents only 2.5%.

Our results are similar to those obtained by Abdel-Tawwab (2006) when examining the impact of aquatic macrophytes on the growth of tilapia and common carp. The author has established credible deterioration of fish growth with increase of vegetation up to 75% and recommended that the level of macrophytes in the ponds should not exceed 25%.

Studied factors do not exhaust the vast array of factors influencing the fish growth. This exhibits well the influence of the basin (Table 2) included in all models as a regressor.

Smart et al. (1997) indicate that the pond as a factor significantly affects the fish growth and the failure to consider this can lead to serious errors in results analysis. Moiseev et al. (1975) indicate that for some fish species is observed size difference, depending on the ponds size – crucial carp in a big ponds is larger, and fish in larger fish tanks grew faster. Dill and Ben-Tuvia (1988) noted that the small size ponds allow higher yields with use semi-intensive technologies. Gordon and Erman (1974) reported that the pond size is correlated negatively with the fish growth and total production rate. Zhang et al. (1987) report the decrease of the production rate with increase of pond size also.

In our study, in most cases, the pond size has more significant impact than other factors. Non-significant impact of the pond is established only for grass carp, when pond size was included in the model. Obviously, the impact of the pond recorded in the previous models for this species is limited to his area. In experimental conditions, the end body weight of the grass carp decreases with increase of pond size. The difference in parameter between small and large ponds is 63.8%.

The pond area has significant impact on growth of common carp and bighead carp. For bighead carp, the growth is improved by increasing the pond area. In larger ponds the bighead carp reached twice as high weight (0.735 kg), compared with smaller ponds (0.354 kg). Common carp in ponds of up to 3 da reached the same end body weight (0.418 and 0.419 kg), while in larger ponds live body weight of the fish increased by 70%.

In the study of the impact of the pond size on the fish growth in integrated fish-duck system, we also established significant impact of the factor on the common carp, grass carp and bighead carp growth (Nikolova, 2003). Significant impact of the pond area on carp fish was established in our other studies (Nikolova, 2004).

Conclusions

Rearing in polyculture based on natural food base led to satisfactorily fish growth. The polyculture structure is a significant source of common carp growth variation, as the impact decreases when taking into account intense vegetation in the pond, and increases when taking into account the size of the pond. Common carp had better growth in one-year polyculture. The polyculture structure had no impact on bighead carp growth. One-year old grass carp grew more intensively compared to two-year old grass carp. Fertilization is a significant source for growth variation, but the impact is specific for the different species. Positive effect of the factor is established only for bighead carp. Significant sources for growth variation in all studied species are pond size and macrophytes density level. Therefore, these factors should be included in models for analysis of variance.

References

Abdel-Tawwab, M., 2006. Effect of Free-Floating Macrophyte, *Azolla pinnata*, on Water Physico-Chemistry, Primary Productivity and the Production of Nile Tilapia, *Oreochromis niloticus* L., and Common Carp, *Cyprinus carpio* L., in Fertilized Earthen Ponds. *Journal of Applied Aquaculture*, **18** (1): 21-41.

Afzal, M., A. Rab, N. Akhtar, M. Farhan Khan, A. Barlas and M. Qayyum, 2007. Effect of Organic and Inorganic Fertilizers on the Growth Performance of Bighead Carp (*Aristichthys nobilis*) in Polyculture System. *International Journal of Agriculture & Biology*, **9** (6): 931-933.

Aleksandrijskaja, A. and O. Kotljar, 1980. Polyculture in the foreign fish culture. *Fisheries and Fishing*, **4**: 9-10 (Ru).

Dill, W. A. and A. Ben-Tuvia, 1988. The inland fisheries of Israel. *BAMIDGEH*, **40** (3):75-104.

Gordon, L. M. and L. A. Erman, 1974. Ways of increase of efficiency of fisheries. Food industry- Moscow, p. 285. (Ru).

Lutz, G., 2003. Polyculture: Principles, Practices, Problems, and Promise. Aquaculture Magazine, http://www.aquaculturemag.com/siteenglish/printed/archives/issues03/03articles/LutzFeatureMarApr2003.pdf

Moiseev, P. A., A. S. Vavilkin and I. I. Curanova, 1975. Ichthyology and fish culture. Food Industry- Moscow, p. 280 (Ru)

Muller, V., 1985. Rearing of carp in the ponds. In: V. Steffens (Editor) Industrial cultivation of fish, Moscow, *Agropromizdat,* pp. 37-64 (Ru)

Nikolova, L. N., 2004. Investigation of complex influence of some paratipe factors on growing of the carp, reared in polyculture. *Animal Husbandry Sci*., **3**: 73-76. (Bg).

Nikolova, L. N., 2003. Investigation of some technological parts of the integrated rearing of fish and ducks in the fish ponds. PhD Th., Stara Zagora, p. 198. (Bg).

Nikolova, L.N., 2006. Organic farming and its application in aquaculture. *Animal Husbandry Sci*., **6**: 65-72 (Bg).

Privezencev, Ju.A., 1991. Industrial Fish Farming. *Agropromizdat*, Moscow, p. 368. (Ru).

Radke, R.,W. and Kahl, 2002. Effects of a filter-feeding fish [silver carp, *Hypophthalmichthys molitrix* (Val.)] on phyto- and zooplankton in a mesotrophic reservoir: results from an enclosure experiment. *Freshwater Biology*, **47** (12): 2337-2344.

Smart, T., J. Riley and G. Haylor, 1997. Eliminating pond differences with cross-over designs. *Aquaculture Research*, **28** (8): 621-627.

Veerina, S., M. Nandeesha, S. de-Silva and M. Ahmed, 1999. An analysis of production factors in carp farming in Andhra Pradesh, India. *Aquaculture Research*, **30** (11-12): 805-814.

Vinogradov, V. K., 1997. Herbivorous fish and new objects for fisheries and aquaculture in Russia. *Fish Farming and Fisheries*, 2: 7-8 (Ru).

Zhang, F., Y. Zhu and X. Zhou, 1987. Studies on the ecological effects of varying the size of fishponds loaded with manures and feeds. *Aquaculture*, **60**(2): 107-116.

Folke, C. and N. Kautsky, 1992. Aquaculture with its environment: Prospects for sustainability. *Ocean & Coastal Management*, **17** (1): 5–24.

Received December, 12, 2012; accepted for printing June, 2, 2013.