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The Effect of Fish Crop Rotation on the Productivity and Growth of Fish (Multi-Species Carp) Grown In Earthen Ponds in the South of Russia

Yaseen Hamed Farhan[1], Lydia M. Vasilyeva[2], Natalia V. Sudakova[3]

[1]Ph.D. student, Astrakhan State University, Russia; Ministry of Agriculture, Department of Agricultural Research, Baghdad, Iraq
ORCID: 0000-0002-8804-0837
[2]Ph.D in Agriculture, Professor, Chair of Biotechnology, Zoology, & Aquaculture, Astrakhan State University, 20a Tatischev Street, Astrakhan, 414056, Russia
ORCID: 0000-0002-4927-2088
[3]Ph.D. in Biology, Associate Professor, Chair of Aquaculture and Fish Diseases, Saint Petersburg State University of Veterinary Medicine; 107139, Russia, 196084, st. Chernigovskaya, 5 Saint-Petersburg
ORCID: 0000-0002-7916-3720

Email: [1]yaseenrussia@gmail.com, [2]bios94@mail.ru, [3]sudakorm@mail.ru,

Abstract: The introduction of the technique of alternating culture between Fish and agricultural crops does not require additional costs; such as the purchase of mineral fertilizers and industrial feeds. This technique uses organic fertilizers from the remains of plant shoots and residues of crop plants and melons, in addition to the natural feed base for earthen ponds or through the addition of feed from barley and wheat grains, which allowed increasing the productivity of fish several times. This experiment that used the technique of organic fertilizers from the remains of plant shoots and the remains of crop plants and melons, in addition to the natural feed base of earthen ponds or through the addition of additional feed from barley and wheat grains, which allowed to increase the productivity of fish several times. The results represented by an increase in biomass, where we observed an increase in biomass in ponds by 13.2% -11.8%, as well as an increase in survival rate by 5.4% -6%.

Keywords: fish crop, productivity, multi-species carp

1. INTRODUCTION

In many developing countries, there is a new consumer trend towards fresh live fish that is fed on natural products rather than artificial foods or frozen fish (Maertens & Swinnen, 2010). At present, much attention is paid to the development and application of environmentally friendly methods of combating fish diseases; the success of modern fish farming largely depends on ensuring the health and well-being of the ponds to be achieved the absence of diseases in fish farms through the implementation of preventive measures (Naumova et al., 2016). The improvement of the hydrobiological system of the ponds significantly leads to the provision of an optimal level of natural food base, which meets the

nutritional needs of cultured fishes in multi - species farming - carp and herbivorous fish (Maertens & Swinnen, 2010). The results of a comparative study of the anti-growth efficiency of different pond drainage cycles (after one and 5 years) using fish Rotate showed a reduction in parasite infestation of fish (carp, silver carp), no infectious agents, improvement in blood measurements, an increase in fish productivity with a one-year pond drainage cycle (using fish and crop rotation) compared to a 5-year drainage frequency (Naumova et al., 2016). However, carp feed on aquatic animals such as aquatic insects, insect larvae, worms, mollusks, snails and fish larvae, and consumption of snails and fish larvae occurs mostly in earthen ponds, where the probability of reproduction of matured fish is high. In addition, carp consume the seeds, leaves and seeds of aquatic and terrestrial plants, and decayed aquatic plants. The cultivating of carp in earthen ponds depends on the receptivity of this or that species to the use of grain feed provided by farmers. In these conditions the Daily growth rate of carp can reach 2-4% of body weight. Carp can weigh up to 0.6 to 1.0 kg during one season in mixed culture in earthen ponds in tropical and subtropical regions (FAO 2009). Herbivorous fish is one of the most effective biological methods of getting rid of highly developed and affordable vegetation, especially in the southern regions of Russia. For example, the Grass carp has the ability to consume higher aquatic plants, while the silver carp plays an important role in improving water quality by filtering large amounts of phytoplankton, residues and other organic substances, it radically changes the course of life processes, accelerates the circulation of substances and energy in environmental homogeneity, and as a result contributes to the stability of the hydrochemical system and the improvement of the sanitary condition of ponds. The mass development of phytoplankton creates significant obstacles, so the use of silver carp is the only means to combat and eliminate them (Studref 2021).

The introduction of the technique of alternating culture between Fish and agricultural crops does not require additional costs; such as the purchase of mineral fertilizers and industrial feeds. This technique uses organic fertilizers from the remains of plant shoots and residues of crop plants and melons, in addition to the natural feed base for earthen ponds or through the addition of feed from barley and wheat grains, which allowed increasing the productivity of fish several times (Ponomarev et al., 2015). Aquaculture, using natural organic materials, is a point of intersection between two global technical trends ascending in the development of global agriculture: aquaculture and organic production (Lagutkina et al., 2016). The introduction of organic aquaculture technology using alternation expands a highly specialized approach to fish farming, and solves the functional problems of nutrient-depleted pond areas, which require more and more mineral fertilizers (nitrates, nitrites), through the use of mineral fertilizers by growing organic melons and crops (with natural and ecological soil enrichment) after the ponds are dried and prepared .

2. MATERIALS AND METHODS

The study was conducted in the Russian Federation / Astrakhan province at the BAM fish farm, which is one of the largist productive farms in the region, with a total area of 900 hectares, where the ponds are used for fish farming and the cultivation of watermelons and pumpkins. Four ponds were allocated for the study (fig. 1).

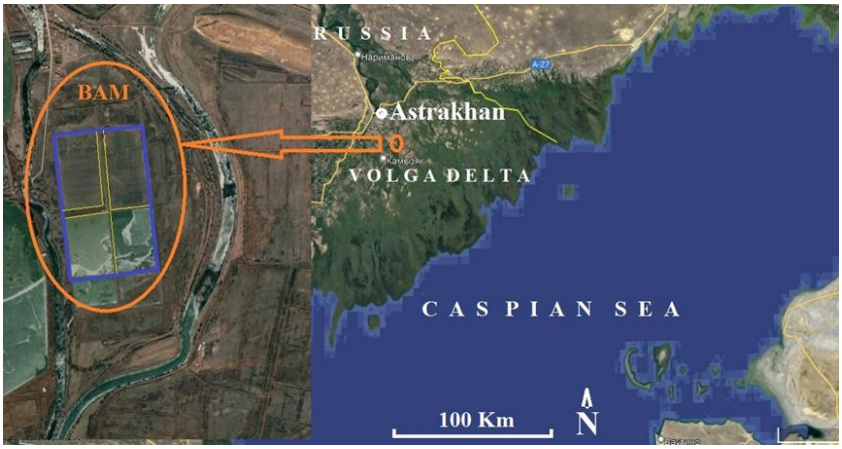

Figure 1

In the 2020 season, pond No. 2 was used for melon farming, while the remaining ponds Nos 1.3.4 were used for fish farming. That in these three ponds was studied the extent of the effect of alternately culture on the quantity and quality of fish in each pond, where pond No. 1 was used for fish farming immediately after watermelon cultivation, so used to compare with the other ponds 3 and 4 .

In mid-March, the yearlings were brought from the growing ponds inside the farm and planted in the earthen ponds or foraging ponds, where they were raised to reach commercial weight. Planting yearlings were weighed and distributed according to the following proportions (carp 40%, grass carp 20% and silver carp 40%). It was planted 12,000 common Carp at a average weight of 30 grams in the pond. 6000 Grass carp with an average weight of 30 grams, and 12,000 silver carp with an average weight of 25 grams. In the pond No. 3 it was planted 14,000 common carp with an average weight of 45 grams. 6360 Grass carp with an average weight of 30 grams, plus 13,000 silver carp with an average weight of 25 grams. 13,500 common carp were placed with an average weight of 55 grams, and 6500 grass carp with an average weight of 30 grams, plus 13,200 silver carp with an average weight of 30 grams. In pond No. 4, after the end of the season, the ponds were prepared for the winter. As for pond No. 2, the following operations were carried out:

After collecting melon crops, the preparation of ponds begins:

- Corral of cattle (cows and sheep).
- Processing of wet areas of the pond, quicklime, plowing the soil.
- Filling the pond with water.

Fish weight measurements were taken every two weeks with other oxygen, temperature and PH readings. Multi-read Portable Water Analyzer type (hi 9829-01042) was used to measure dissolved oxygen, pH and temperature. Green feed was given such as cane and papyrus, as well as cereals such as wheat and barley by 5% of the body weight, and was fed manually once a day at ten o'clock in the morning, where special places were allocated for food called (Feeding points) each pond contains six feeding places where the feed was given (wheat and Barley) after grinding.

3. RESULTS AND DISCUSSION

The results of measurements of environmental factors throughout the growing period of the season 2020 were shown in Table (1). It showed that the pH degree in pond No. 1 ranged from 7 to 8.3, while in pond No. 3 it ranged from 6.9 to 7.8, and in pond No. 4 the pH degree

did not exceed 7.7 and did not fall below 6.5 throughout the growing season. The temperature in the pond No. 3 recorded the lowest temperature -- 4.8 ◦C in March; the highest temperature was in the month of August at 29.5 C◦ in the pond No. 1. The prefer temperatures that were recorded in all cases which have occurred in which the best results of growth ranged between 18 and 25 C◦ in the months of May and June. This result differed a little bit about what reached by some scientists that the perfect class for the growth and life of fish ranging from 23 – 27 C◦ (Oyugi et al. 2012), this can be explained by the fact that the fish adapts to the conditions of the areas in which they live . The oxygen content in the pond water dropped to 4.7 mg / L in August in pond No. 4, and was the highest level of oxygen content in March for all ponds, reaching 9 mg / l.

The results of the monthly weight measurements throughout the breeding period for the season 2020 (Table 2) showed that the highest monthly weight rates were in the pond No. 1 throughout the study period and for the three species of common carp, grass carp and silver carp, where the final weight rate for the three species were (680 ±17.52, 663 ±12.23, 681.5±18.97) gr respectively. As for pond 2, the final weight rates were (560 ±20.76, 551 ±14.39, 584 ±13.41) gm. respectively. Final weight rates reached (583 ±12.90, 558 ±10.15, 587 ±11.92) in pond No. 4. When analyzing these data statistically, we found significant differences at a significant level (p>0.01) between the three ponds and for all species of fish.

Table 1

Indicators / Months	Pond 1 after Melon			Pond 3			Pond 4		
	PH	Temperature ◦C	DO. mg/L.	PH	Temperature ◦C	DO. mg/L.	PH	Temperature ◦C	DO. mg/L.
March	8.3	5.5	9	7.8	4.8	8	7.7	5	7.8
April	8.2	12	8.5	7.5	11	7.3	7.6	11.5	7.1
May	7.5	19	7	7.1	18.5	6	6.9	18	6.5
June	7	25	7	6.9	23	6.5	6.5	22	6
July	7.5	28.5	6.5	7	27	6	7	27.5	5.5
August	7	29.5	6	7	28.5	5	7	28	4.7
September	7.5	21	7	7.5	22	6	7.5	21.5	6

Table *2*

Ponds / Months	**Mean mass /g.**								
	Pond 1 after Melon			**Pond 3**			**Pond 4**		
	Common Carp	**Grass Carp**	**Silver Carp**	**Common Carp**	**Grass Carp**	**Silver Carp**	**Common Carp**	**Grass Carp**	**Silver Carp**
March	**30**	**30**	**25**	**45**	**30**	**25**	**55**	**30**	**30**

April	**100 ±4.72**	**110 ± 3.96a**	**100 ±4.44 a**	**95 ±3.62**	**85 ±3.46 b**	**85 ±3.77 b**	**90 ±3.39**	**80 ±2.35b**	**75 ±3.91 b**
May	**190 ±5.14a**	**200 ±7.4 3a**	**217 ±6.67 a**	**165 ±3.86b**	**155 ±3.70 b**	**150 ±3.17 c**	**155 ±3.62b**	**160 ±4.26b**	**170 ±3.86 b**
June	**345 ±10.22 a**	**349 ± 9.64a**	**375 ±8.76 a**	**285 ±6.43b**	**285 ±6.60 b**	**295 ±6.69 b**	**300 ±5.98b**	**293 ±5.94b**	**297 ±7.22 b**
July	**495 ±9.93a**	**499 ± 11.18 a**	**507 ±11.3 0a**	**395 ±11.36 b**	**405 ±62.5 6b**	**415 ±9.77 b**	**420 ±10.10 b**	**408 ±11.31 ab**	**417 ±9.18 b**
August	**605 ±15.78 a**	**601 ± 14.07 a**	**610 ±10.8 0a**	**490 ±8.04b**	**500 ±9.35 b**	**515 ±10.5 1b**	**520 ±10.74 b**	**503 ±7.75b**	**517 ±7.87 b**
Septemb er	**680 ±17.52 a**	**663 ± 12.23 a**	**681.5 ± 18.97 a**	**560 ±20.76 b**	**551 ±14.3 9b**	**584 ±13.4 1b**	**583 ±12.90 b**	**558 ±10.15 b**	**587 ±11.9 2b**

The results of the indicators and measurements for the 2020 season for all the study ponds are shown in (Table 3), that the pond No. 2 was used in this season 2020 for the cultivation of the melons, where the amount of the yield of the crop reached 56,000 kg / ha, which is higher than the rate of productivity of this crop in the usual agricultural lands that do not use agricultural rotation, where the increase was about 40% of the standard rate. In other research, watermelon productivity increased by 25 % over the standard rate (Lagutkina et al., 2016).

Pond No. 3, which was farmed with fish, where we conducted all the measurements and calculations required; the results of what we obtained that the amount of fish remaining in the pond was 12640 common carp with a survival rate 90.3%, and 5795 grass carp with a survival rate of 91.1%, and 11701 silver carp with a survival rate of 90%. The final weight was 560 ±20.76 gr for common carp , 551 .14.39 gr for grass carp , and 584. 13.41 gr for silver carp, with a biomass of 17,105 KG / pond. The fish yield per hectare was 570.2 kg / ha.

In pond No. 4, the results we obtained through all measurements and readings that we carried out throughout the study period, we found that the number of fish deaths amounted to 1397 fish common carp with a survival rate of 89.7 % , and 636 grass carp with a survival rate of 90.2 % , 1292 fish silver carp with a survival rate of 90.2 %, (583 ±12.90 , 558 ±10.15 , 587 ±11.92) gr respectively . The weight gain was (528, 528 and 557) gr, respectively. The amount of feed consumed by carp fish was 18,000 kg and the feed conversion rate amounted to 2.82 per 1 kg live weight, while the amount of biomass of aquarium fish we obtained amounted to 17,319 KG / basin. The productivity of fish per hectare was 577.3 kg / ha.

As for the comparison pond No. 1, the average final weight of common carp reached 680 ±17.52 G, (which is higher than the average final weight of carp in pond No. 3 by 21.4%, and from pond No. 4 by 16.6 %). The average final weight was 663 ±12.23 gr (higher than the

results of pond 3 by 20.3% and pond 4 by 18.8 %). The silver carp is 681.5± 18.97 gr (higher than the final weight of the silver carp in pond No. 3 by 16.7% and pond No. 4 by 16.1 %), with a final biomass of fish of 19367.5 KG / pond for all species of Fish. The number of deaths of common carp reached 591 fish during the growing period and a survival rate of 95.1 %, the number of deaths of carp fish was less than pond No. 3 by 56.5% and pond No. 4 by 57.7 %). Fish deaths were 256 fish with a survival rate of 95.7% (mortality was lower than pond No. 3 by 54.7% and pond No. 4 by 59.7%). The silver carp had 553 fish with a survival rate of 95.4% (the number of silver carp deaths was 57.4% lower than the number of deaths in pond No. 3 and 57.2% lower than pond No. 4). As for the weight increase that we got after the end of the growing season in September, the average carp fish was 650 g, the grass carp was 633 gr, and the silver carp was 656.5gr. The amount of feed consumed in pond No. 1 was 18000 kg , and the feed conversion factor was 2.4 per 1 kg live weight , the amount of fish production was 774.7 kg / ha , where the Kg/ pond.

Having obtained these valuable results in pond No. 1, which was used immediately after melon farming, we can now compare the species of fish in this pond and the effect of land farming on these species, where we noticed that the best survival rate was for the grass carp fish, which is higher than the common carp by 0.6%, and higher than the silver fish by 0.3 %. The best weight gain for silverfish was 1% more than for carp and 3.7% more. Figure 2 also shows the monthly weight increases for all ponds and for all species, where we see clear differences between the three species as well as between ponds.

We also observed that in pond 1, which gave the best results from the other two ponds, the best survival rate was for fish, which was 0.6% higher than common carp, and 0.3% higher than silver carp. The best weight gain for silver carp was 1% more than for carp and 3.7% grass carp.

Also for the crop of melon we observed a 40% increase in productivity.

increment/ gr.

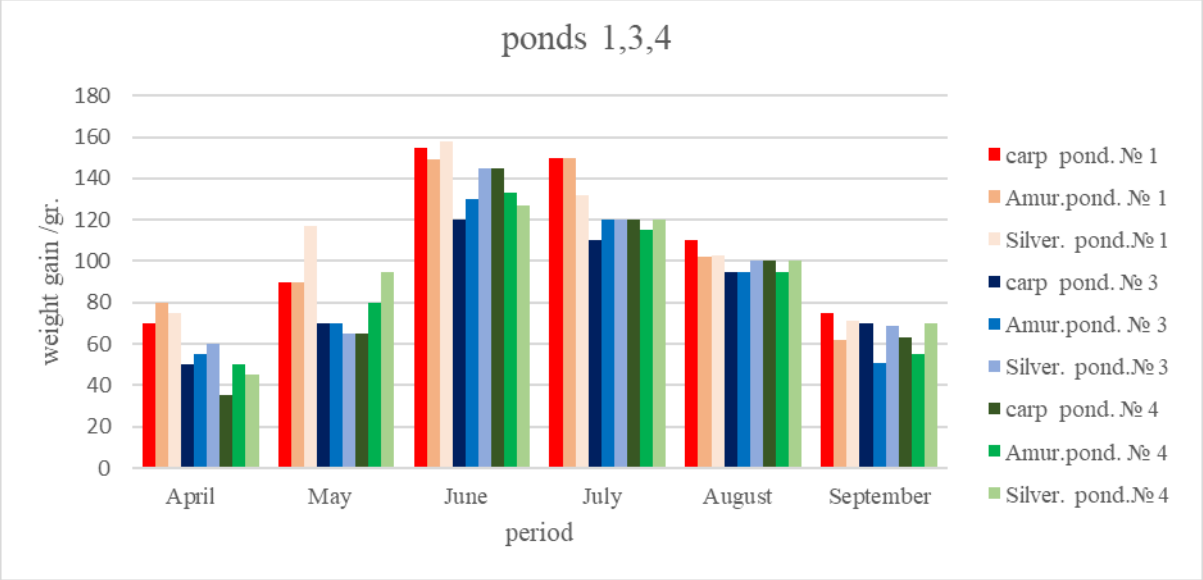

Figure 2

Table 3

Ponds	Pond No. 1 (25 Ha.) after melons			Pond No. 2 (25 Ha.)	Pond No. 3 (25 Ha.)			Pond No. 4 (25 Ha.)		
Type of culture	**Common Carp**	**Grass Carp**	**Silver Carp**	**Melon**	**Common Carp**	**Grass Carp**	**Silver Carp**	**Common Carp**	**Grass Carp**	**Silver Carp**
Planting density. pcs/pond	12000	6000	12000	-	14000	6360	13000	13500	6500	13200
Initial mass. gr	30	30	25	-	45	30	25	55	30	30
Initial biomass of fish. kg/pond	360	150	360	-	585	130.8	300	742.5	135	396
Waste pcs.	591	256	553	-	1360	565	1299	1397	636	1292
The final quantity. pcs/pond	11409	5744	11447	-	12640	5795	11701	12103	5864	11908
Survival rate %	95.1	95.7	95.4		90.3	91.1	90	89.7	90.2	90.2
Final mass, gr	680 ±17.52 a	663 ±12.23 a	681.5± 18.97a	-	560 ±20.76 b	551 ±14.39b	584 ±13.41b	583 ±12.90 b	558 ±10.15b	587 ±11.92b
Final biomass of fish. kg/pond	7758.1	3808.3	7801.1	-	7078.4	3193.1	6833.4	7056.1	3272.1	6990
Average growth. g	650	633	656.5	-	515	521	559	528	528	557
Average Growth . day. g	3.5	3.4	3.6		2.8	2.8	3	2.9	2.9	3
Biomass gain. kg/pond	7415.9	3636	7515	-	6509.6	3019.2	6540.9	6390.4	3096.2	6632.8
Quantity of	18000	-	-	-	18000	-	-	18000	-	-

consumed feed. kg										
Feed Coefficient	2.4	-	-	-	2.8	-	-	2.82	-	-
Fish productivity, kg/ha	310.3	152.3	312.1	-	236	106.4	227.8	235.2	109.1	233
Overall Fish productivity, kg/ha	**774.7**				**570.2**			**577.3**		
Fish productivity, kg/pond	19367.5			-	17105			17319		
Productivity, kg/ha				**56000**						
Cultivation period	(6 months) From mid-march to mid-September									

4. CONCLUSION

We conclude from this study that fish alternating culture with crops can increase productivity, where we observed an increase in biomass in pond No. 1 by 13.2% from pond No. 3, and by 11.8% from pond No. 4, as well as increases the survival rate, where in pond No. 1 from pond No. 3 by 5.4% and pond No. 4 by 6 %.

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