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Fish culture

THE EFFECT OF MINERAL FERTILIZATION ON WATER CHEMISTRY OF CARP PONDS

WPŁYW NAWOŻENIA MINERALNEGO NA CHEMIZM WÓD STAWÓW KARPIOWYCH

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The basic physico-chemical parameters of the water were studied in the experimrntal fish ponds of "Draganici" (Yugoslaviv) during the rearing seasion of the 1985. The particular atetention was taken to the changes of ammounts of dissolved O_2 and NO_3^-, NH_4^+, and PO_4^{3-} ions in the water under the conditions of feetilized experimental ponds by the mineral fertilizer NPK with the formula of 17:8:9.

The concentration of oxgen in fertilized ponds increased in the middle of rearing season by 2 to 129%, while at the and it decreased by about 20% in comparison with nonfertilized ponds.

The need for phosphates was not ahown in September, but the necessity of nitrates was evident during the whole period under study.

The significant increase occured in ammount of NH_4^+ after fertilization, but already after the second day the aplication of fertilizers it constantly decreased.

INTRODUCTION

The fertilization of carp ponds can be considered as an important way of the intensification of fish culture. The obtained increase of natural fish food resources results in better growth and physiological condition of fish reared

(Guziur, Adamek, in press). The need of nitrogen and phosphorus fertilization on carp ponds was confirmed by long-term obsaervations of many authors in Yugoslavia (Plančić, Ristić 1961, Pujin 1966, Bralić et al. 1967, Bralić 1969, 1971, Debeljak 1968, 1970, 1973, 1978, 1981, Livojecic 19070, Rzanicanin, Balzer 1976, Debeljak et al. 1979, Fašaić et al. 1984). But in was found in any occasions that the fertilization using the inorganic nitrigen and phosphorus did not bring the positiv action (Fijan et al. 1964, Fijan 1966, Pujin et al. 1973), Manily in Czechoslovakia where the content of these chemical elements is extremely high in surface waters (e. g. Janecek et al. 1966, Herzog, Heteša 1968, Losos 1969). In these conditions the need of organic fertilizing using the wastes from animal husbandry and/or food industry seems to be much more topical way to keep the adequate conditions for successfull rearing of cyprinids (Adamek et al. 1987, in press, Brož. Nevrkla, in press).

Besides the effect on pond productivity especially hydrochemical remige and zoohygienic conditions are directly influenced by inorganic compounds. Many literature data confirm this facts. The influence of fertilization on chemical parameters of the water in carp ponds was studied relatively rarely in Yugoslavia (Asaj et al. 1962, Debeljak, Turk 1981, Fašaić et al. 1984, Debeljak, Fašaić 1985, Fašaić 1985), although this problem is well known for a long time, esp. in the connection with hogh fish stock density per surface unit and intensive feeding of fish by artificial feeds.

The aim of our studies was to determine the doses and terms of fertilization resulting in increasing productivitx and keeping fo good zoohygienic conditions of treated ponds. The correct application of fertilizers can be considered as a very profylactic interference as well.

MATHERIAL AND METHODS

The observations were performed in fish farm "Draganici" during the rearing season of the year 1985, and five variants in nine experimental ponds (the acreage 1000 m^2) were used.

The variant I (ponds 4 and 5) was used as the control without fertilizing and the variants II (ponds 2 and 3), III (pond 7), IV (ponds 9 and 10), and V (ponds 12 and 13) were fertilized by mineral fertilizer NPK. (formula 17 : 8 : 9). Fertilizing was applied in six doses using 100 and/ or 150 $kg.ha^{-1}$ during the rearing season (23.05. to 09.09.1985). Totally, 800 kg per ha of fertilizer were used.

The one-year-old fish (carp, bighead carp, silver carp, and grass carp) in stocking rates of 3000 $ind.ha^{-1}$ (variant I and II), 3200 ind. ha^{-1} (variant III), 3400 ind. ha^{-1} (variant V) were stocked into the experimental ponds. The losses of fish in individual variants were as follows: I – 18.5%, II – 20.7%, III – 18.5%, IV 25.0%, and V – 17.3%.

The experimental ponds were treated by calcium hydrate in the dose of 2000 $kg.ha^{-1}$ before stockingof fish.

Chemical analysis os water were performed before fertilizing and from the first to the seventh day after that. Following chemical parameters were measured in the water: oxygen, carbon dioxide. pH, Ca^{2+}, Mg^{2+}, nitrates, ammonium, phosphates, and COD ($KMnO_4$) values. Water analysis were performed by "Methods of physico-chemical) analyses of water" (1966), these colorimetric ones using electric colorimeter, and pH-meter "Iskra".

RESULTS

During the breeding season, about 40, and 80-90% of the surface of experimental ponds (5, 7, 9, 10, and 2, 3, 4, 12 and 13, resp.) were overgrown by macrophytes. *Trapa natans, Ceratophyllum demersum, Ranunculus sp., Myriophyllum sp., Potamogeton pectinatus* and *Potomogeton natans* dominated in these plant communities.

Table 1

The average water temperature in individual months of rearing season

Month	May	June	July	Aug.	Sept.	Oct.
Temparature (°C)	21.4	21.0	23.8	23.1	19.7	18.8

Table 2

The average values of analysed parameters in individual variations of experimental ponds ($\bar{x} \pm S\bar{x}$)

Parameter	I	II	III	IV	V
O_2 ($mg.l^{-1}$)	6.52 ± 0.69	4.98 ± 0.56	6.07 ± 0.39	7.19 ± 0.64	6.74 ± 0.63
O_2 saturation (%)	73.91 ± 7.44	57.45 ± 6.66	69.18 ± 5.00	82.36 ± 7.46	77.45 ± 7.62
CO_2 ($mg.l^{-1}$)	2.99 ± 0.47	4.51 ± 0.51	6.84 ± 1.81	3.57 ± 0.35	4.10 ± 0.35
C.O.D.–Mn ($mg.l^{-1}$)	19.11 ± 1.67	19.42 ± 1.22	63.37 ± 3.42	25.70 ± 1.74	23.59 ± 1.19
Ca^{2+} ($mg.l^{-1}$)	60.01 ± 5.12	55.29 ± 1.78	55.64 ± 4.23	52.96 ± 2.38	52.33 ± 1.88
Mg^{2+} ($mg.l^{-1}$)	25.81 ± 2.46	23.57 ± 2.24	28.31 ± 5.13	26.95 ± 2.54	27.76 ± 2.77
NO_3^- ($mg.l^{-1}$)	0.24 ± 0.03	0.33 ± 0.05	0.36 ± 0.06	0.27 ± 0.03	0.47 ± 0.06
NH_4^+ ($mg.l^{-1}$)	0.46 ± 0.02	0.41 ± 0.05	1.25 ± 0.15	0.78 ± 0.07	0.66 ± 0.06
PO_4^{3-} ($mg.l^{-1}$)	0.18 ± 0.01	0.19 ± 0.02	0.49 ± 0.06	0.25 ± 0.01	0.24 ± 0.02
pH	7.97 ± 0.05	7.80 ± 0.03	7.85 ± 0.10	8.07 ± 0.02	8.01 ± 0.02

Currently registered water temperature varied from 15 to 27°C. The observations of temperature during the breeding season are given in Table I snd Fig. 1, and the average values of individual hydrochemical parameters are given in Table 2.

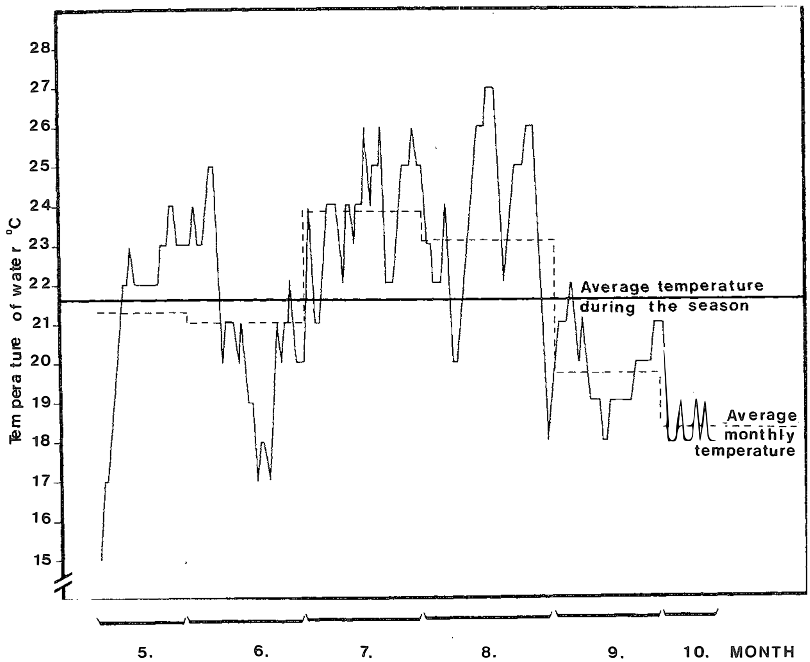

Fig. 1. Daily dynamics of water temperature during the rearing season

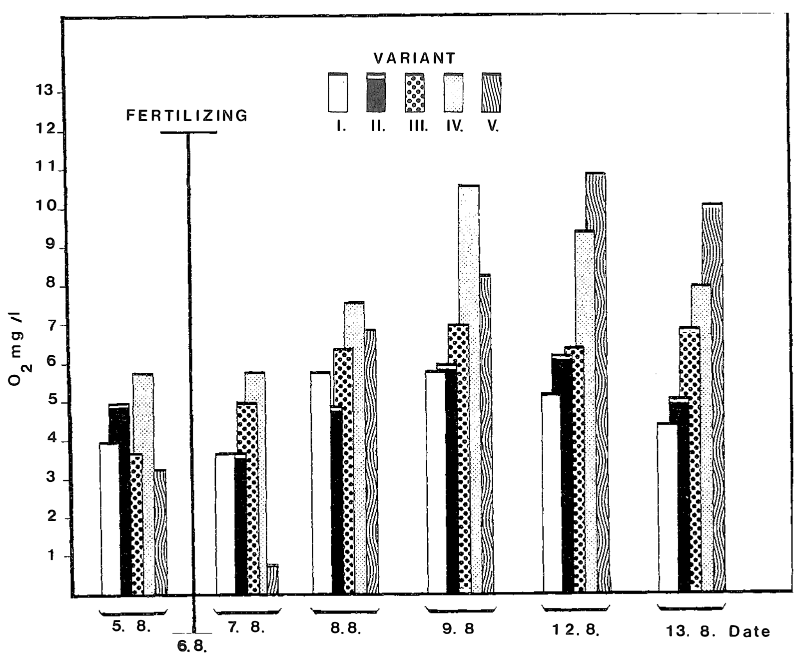

Fig. 2. The average oxygen content in the water of different experimental pond variants before and after fertilizing on Aug. 6[th], 1985

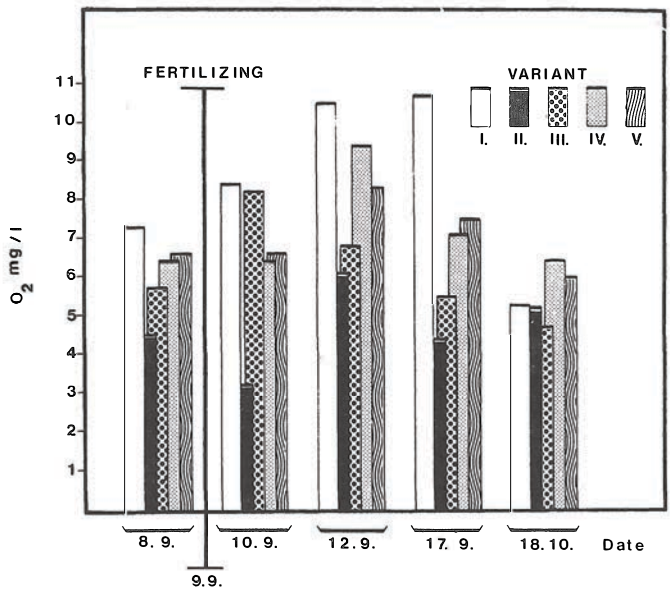

Fig. 3. The average oxygen content in the water of different experimental pond variations before and after fertilizing on Sept. 9th, 1985

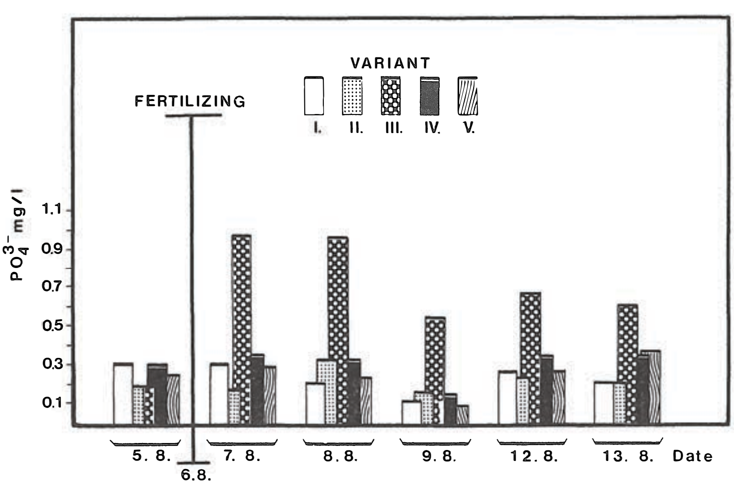

Fig. 4. The average phosphates content in the water of different experimental pond variants before and after fertilizing on Aug. 6th, 1985

Evident fluctuations of oxygen concentration in the water of experimental ponds were confirmed during the period of observations. In the morning (measured at about 7 a. m.), the oxygen content varied from 0.64 to 14.4 $mg.l^{-1}$. The lover differences in oxygen content were registered during August (min.

0.64 $mg.l^{-1}$, max. 12.32 $mg.l^{-1}$), the values measured during September were much higher min. 2.2 $mg.l^{-1}$, max. 14.4 $mg.l^{-1}$). The dynamics of oxygen dissolved in the water during the period of observations is given in Fig. 2 and 3.

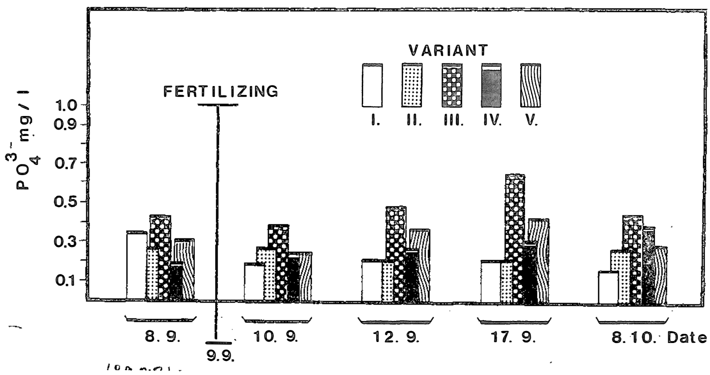

Fig. 5. The average phosphates content in the water of different experimental pond variations before and after fertilizing on Sept. 9th, 1985

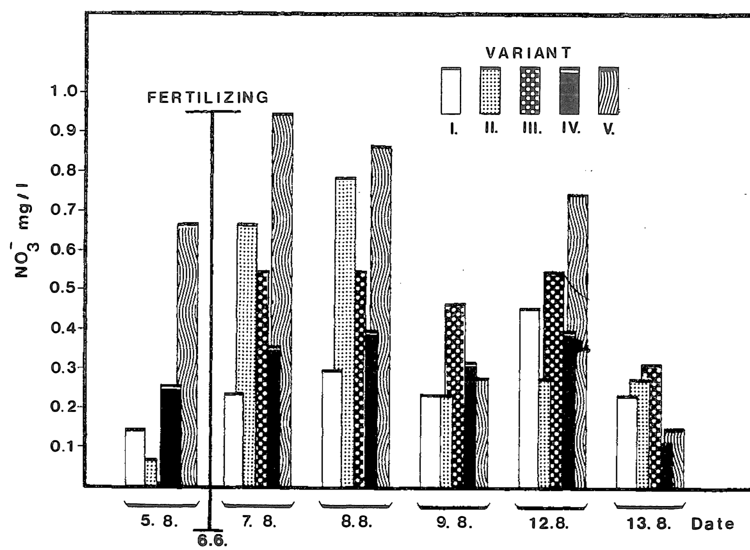

Fig. 6. The average nitrates content in the water of different experimental pond variants before and after fertilizing on Aug. 6th, 1985

The dynamics of phosphates, nitrates and ammonium was registered immediately after the application of fertilizers. The results obtained are documented in Fig. 4 - 9. The highest content of phosphates in the water was registered in pond 3 in August from the first to the first to the seventh day after fertilization. Sudden raise of phosphate content immediately after fertilization persisted there for seven days, followed by the slow decrease.

The increase of phosphates in the water already the second day after fertilization was registered in remaining ponds, but in the third day its concentration decreased. It testifies its rapid consumtion by phytoplankton and macrophytes in these experimental ponds.

During September, the phosphate concentration increased just the first day after fertilization and stood on the favourable values until the eighth day sfter this treatment. Its increase occured until the first half of October, one month after fertilizing. The level of phosphates in fertilized ponds was very favourable and higher than in non-fertilized ponds. The utilization of phosphates in September was lower in comparison with its consumption in August.

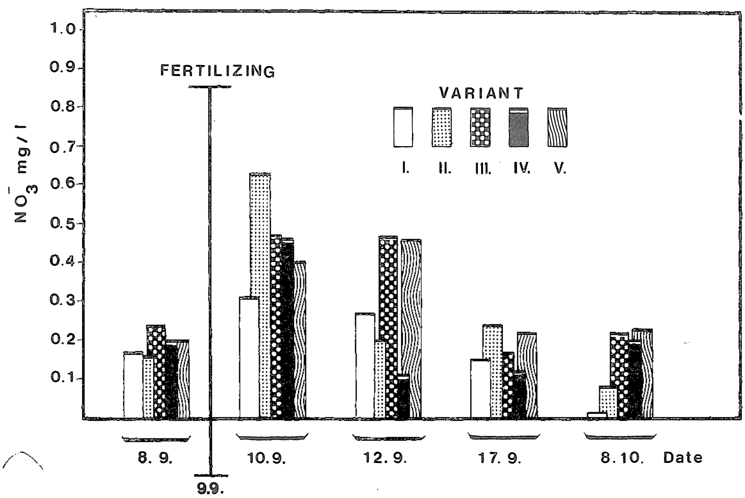

Fig. 7. The average nitrates content in the water of different experimental pond variants before and after fertilizing on Sept. 9^{th}, 1985

Similar results were obtained in dynamics of ammonium and nitrate jons. The nitrate concentration increased in both terms just the first day after applications of fertilizer and stood on this level only until the second day. Then, the continuous and irregular decrease of nitrate concentration was observed from the third to seventh day after fertilization. The following conclusion can be made from this fact, that the need of nitrates was higher in experimental ponds (differently from phosphates) during the period of observations.

A special inerest should be taken to the results of the observations of ammonium nitrogen dynamics. During the experiments, the evident increase of ammonium ions occured in fertilized ponds just the first day after treatment. Increased concentrations of ammonium ions in the water were registered until the second day after fertilization. The continuous decrease of their content followed later until the seventh day after the treatment except of the ponds in variant II where already the third day after fertilization the ammonium content evidently dropped.

DISCUSSION

The water chemistry analyses confirmed the seasonal fluctuations of invidual parameters in experimental ponds, and this fact is considered as a characteristic phenomenon of carp ponds. The comparison of the average values of individual chemical parameters cinfirmed the differences in contents of NO_3^-, NH_4^-, and PO_4^{3-} ions in the water of some fertilized variants compared with non-fertilized ponds especially in following facts: NO_3^- ion content increased in variant II by 38%, in variant III by 50%, in variant IV by 13%, and in variant V by 96%. NH_4^+ ion content in variants II - V increased in comoarison with non-fertilized variant I by 0, 172, 70 and 43%, resp. and PO_4^{3-} ion content by 6, 162, 39 and 33%, resp.

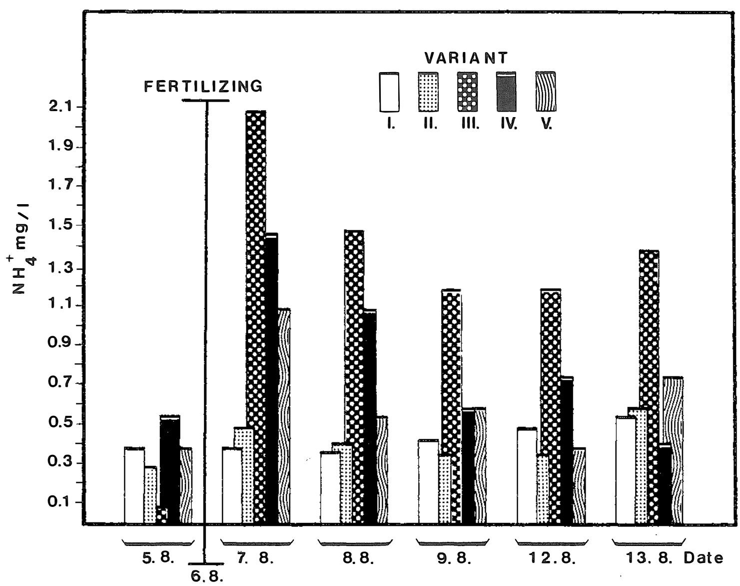

Fig. 8. The average ammonium content in the water of different experimental pond variants before and after fertilizing on Aug. 6th, 1985

In August, the irregular average values of oxygen concentration were registered before fertilizing and two days after that. From the third to seventh day after the application of fertilizers, the oxygen content in the water ot the fertilized ponds was by 2 to 129% higher as compared with non-fertilized control variant.

The different curve of oxygen content dynamics in the water was registered during September and at the beginingg of November. In non-fertilized varian its content varried in average from 5.44 to 10.64 $mg.l^{-1}$, while in fertilized ponds fluctuated these values from 3.28 to 9.52 $mg.l^{-1}$. Higher content of oxygen in the water of non-fertilized ponds was registered especially in September.

This dynamics of oxygen in the water can be explained by different development of photoplankton communities and different water temperature. In August, when the water temperature was always higher than 20°C, the rapid development of phytoplankton was observed three days after fertilizing. Due to the photosyntetic activitx of phytoplankton, the oxygen content in the water was enhanced. The dropping of water temperature under 20°C in September lead to the lower development of phytoplankton and resulted in the lower abudance so that fertilizers could not influence its production so effectively in this time. Vinberg's (1958) results confirm this assumption.

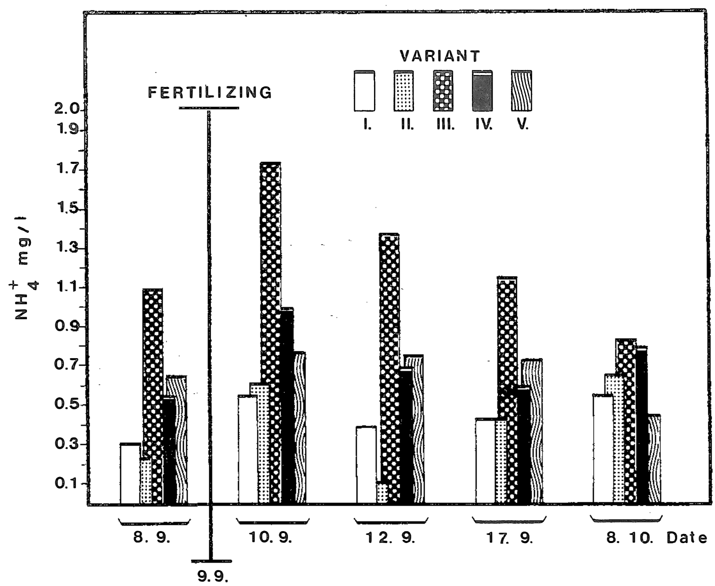

Fig. 9. The average ammonium content in the water of different experimental pond variants before and after fertilizing on Sept. 9th, 1985

The differences between the ammonium nitrogen dynamics in variant II and remaining experimantal pond were registered during the observations. It is difficult to explain this fact, because in September this concentration increased again. The highest content of NH_4^+ ion was registered in the pond of variant III where the average concentration over 1 mg,l^{-1} persisted during the whole period under study until the seventh day after fertilization. The increase of ammonium ions was lower in remaining ponds, where after the maximum values in the first day the irregular dropping was registered until the seventh day after fertilizing. The dynamics of ammonium nitrogen after fertilizing shows the need of very corefull application of fertilizers containing the nitrogen in the form of ammonium.

The ammount of fertilizer NPK of formulation 17:8:9 in both doses exsceeded 100 and 150 $kg.ha^{-1}$, what is about 17 and 25 $kg.ha^{-1}$ of pure nitrogen in ammonium and nitrate from, resp. This ammount lead to rapid increased of ammonium ion in pond water. Due to the increased content of NH_4^+ ion in the water and hogh pH values, the ammount of fertilizer containing nitrogen in ammonium from must be controlled and the application must be practised so that not to allow the increase of non-ionized from of ammonium to the values inducing the harmfull effect on fish.

SUMMARY

The applied inorganic fertilizer NPK of the formula 17:8:9 in total ammount 800 $kg.ha^{-1}$ in six doses (100 and 150 $kg.ha^{-1}$) did not deteriorate zoohygienic conditions in experimental ponds during the breeding season of the year 1985.

The oxygen dynamics in the water of fertilized ponds was irregular during the experimental period. Its values increased in the middle of culturing season by 2 - 129% and decreased at the end of the experiments by 20% in comparison with non-fertilized ponds.

The amount of PO_4^{3-} ions oncreased after fertilization. Higher consumption of phosphates was observed in summer. Its need was not shown in September.

The dynamics of NO_3^- ion until 8 days after fertilization confirmed its need in experimental ponds during the whole period under study.

Rapid increase of NH_4^+ ion was registered in the fertilized ponds immediately after application of fertilizer, followed by the continuous decrease from the second to the eighth day after fertilization.

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WPŁYW NAWOŻENIA MINERALNEGO NA CHEMIZM WÓD STAWÓW KARPIOWYCH

STRESZCZENIE

Nawóz mineralny NPK (o składzie 17:8:9), zastosowany w 6 dawkach po 100 lub 150 kg/ha (ogółem 800 kg/ha) nie pogorszył warunków zoohigienicznych w stawach doświadczalnych, w sezonie hodowlanym 1985 roku.

Stwierdzono różnice w zawartości tlenu w wodzie nawożonych stawów, w trakcie przeprowadzanego doświadczenia. W połowie sezonu hodowlanego zawartość tlenu w wodzie wzrosła o 2 do 12%, pod koniec eksperymentu zaś, zmalała o 20% w porównaniu do stawów nie nawożonych.

Ilość jonów fosforanowych wzrosła po nawożeniu. Wyższy pobór fosforanów obserowano w sezonie letnim, przy braku zapotrzebowania na nie we wrześniu.

Zmiany zawartości jonów azotanowych w wodzie, obserowano do 8 dnia po nawożeniu, potwierdziły zapotrzebowanie na nie w trakcie całego okresu hodowlanego. W przypadku jonów amonowych, odnotowano raptowny wzrost ich ilości bezpośrednio po zastosowaniu nawozu, po którym notowano stały spadek ich ilości między drugim a ósmym dniem po nawożeniu.

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