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Studies on The Optimum Population Density of Carps Fry In Nursery Ponds

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STUDIES ON THE OPTIMUM POPULATION DENSITY OF CARPS FRY IN NURSERY PONDS

By

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DECLARATION

I declare that the present work is original and has not been published or submitted in part or full for any degree or prize.

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CERTIFICATE

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ABSTRACT

The present work is on the optimum population density of three major carps fry viz. *Labeo rohita*, *Catla catla* and *Cirrhina mrigala* in nursery ponds and tanks. A comperative study has been carried out on the growth rate of the fish fry on an exact time after releasing them in different nursery ponds and tanks at different ratios.

Chapter I : *Growth effect ; comperative study on physico-chemical factor and morphometric relationship with different density.*

The total length/standard length and total length/body depth relationships have been calculated in the linear regression equation for the three species of carp fry reared in tanks and ponds for initial and final measurements. It may be observed that SL and BD always depend upon TL ofthe species and positively correlated and the values were significant in all the cases.

The analysis of variance of TL between carp species and tank showed significance difference ($F=141.38, P<0.001$) with LSD = 19.857. In SL, ($F=89.325$, $P<0.001$) with LSD = 21.389. And in case of BD, ($F=22.829$, $P<0.01$) with LSD = 4.70. In ponds, the analysis of variance between carp species in TL showed significance difference ($F=37.81$, $P<0.001$) with LSD at 0.1% level of significance as 10.465. In case of SL

(F =32.47, $P < 0.001$) with LSD at 0.1% level of probability as 10.82. And in case of BD, i.e. (F =65.95, $P < 0.001$) with LSD = 1.03 at 0.01% level of probability.

Chapter II : Population density and growth effects.

Total length and total weight relationship, relative condition factor (Kn), condition factor for observed weight (K) and condition factor for calculated weight (k) has been calculated. The analysis of variance between total weight of three carp species and rearing tanks and ponds have been calculated. In tank, total weight of the fishes significantly differed (F =59.62, $P < 0.01$) with LSD at 1% probability in 3.58. In pond total weight differ significantly (F =9.70, $P < 0.01$) at 1% probability, with LSD = 4.88.

In three tanks highest (optimum) specific growth rate (SGR) = 3.074(1.0247 ± 0.1885) with net yield (ny) = 112.52 (37.51 ± 7.12) was found in tank I, and in five nursery pond optimum specific growth rate (SGR) = 2.1457 (0.7152 ± 0.0837) with net yield (ny) = 138.96 (46.32 ± 7.36) was found in pond V .

Chapter III : Effect of agro chemicals (inorganic fertilizers) on three major carp fry and fingerlings viz. *Labeo rohita* , *catla catla* and *Cirrhina mrigala*; Mortality rate behaviour and different hydrological factors.

Observation has been made on inorganic fertilizers viz. Urea, Triple super phosphate and Murate of potash on the fish fry with different densities on 12 earthen tubs (three replicants and one controlled in each density) and their behaviour and mortality with physical changes of water was observed. The behavioural response of the carps fry towards dissolved Urea, TSP, MP and UTM was dependent on concentration and length of exposure. It was observed that the survival capacity of fry was larger in case of higher density while it was least in lower density. It is evident that the survival rate was highest in controlled tubs. The rate decreased in all treated tubs but in thin density the mortality rate was higher.

C O N T E N T S

GENERAL INTRODUCTION

GENERAL INTRODUCTION

As in China, India and Phillipine, collection of millions of early fry of major carps from rivers and stocking them in nurseries for rearing is a common practice in Bangladesh. Different types of ponds, small or large, seasonal or perennial, shallow or deep are used as nurseries and different methods of preparation of the ponds are followed. There is, however, very little reliable information about these practices most of which are known only to a few farmers who keep the information from generation to generation. On such important aspects like the density of stocking and percentage of survival also, our information is meagre. Even the expert fish farmer is unable to ensure that his nursery pond will yield a satisfactory return every year. On the otherhand, reports of total failure in certain nurseries managed by such fish farmers are not uncommon. Even the ponds where they claim " good" results there is reason to believe that the percentage of survival of fry might not be very high when it is remembered that stocking invariably is very heavy and the predators are not always scrupulously eradicated (Alikunhi et al., 1955).

The general conditions under which carp culture is carried out have been briefly mentioned by Prashad (1919). According to whom the large majority of the tiny fry stocked in ponds are either preyed upon by predators or die owing to lack of food ; the later also causing stunted growth of the very few that survive.

Bangladesh is endowed with vast water areas with perennial inland waters, which is generally estimated as 1.58 million hectares. Along with ponds, haores, baores, beels, canals, estuaries, rivers and seas, the area of inundated paddy fields and other lowlaying places which remain under monsoon waters for about six months allowing seasonal fish culture which is estimated as 2.83 million hectares (Karim, 1978). According to an estimate (Ahmed, 1957), there are about 2,30,000 natural and artificial ponds, covering an area of 1,89,000 acres, but the majority of these ponds are in derelict condition and are used mainly for domestic and irrigation purposes. These water bodies may be utilised as an important source of food by scientific culture of suitable species of fish. During the recent years fish production has unfortunately failed to keep pace with the ever increasingly demand for fish at home and abroad due to lack of appropriate technology for scientific culture.

Bhuiyan's (1964) was the first inventory work on carps and other fishes in the then East Pakistan.

Imam & Habashy (1972) worked on the artificial feeding of carp fry and observed the effect of the food containing 35% protein, 49% carbohydrates together with and mineral substances, on the growth of the fry .

Shafi and Quddus (1974) worked on the length-weight relationship of the carp Catla catla.

Basu (1950 and 1951) worked on the effect of different combinations of oxygen and carbondioxide on larvae, fry and fingerlings of Indian food fishes, Catla catla (Ham), Labeo rohita (Ham.), Cirrhina mrigala (Ham.).

Khan (1940), worked on the oxygen requirement of the fingerlings of an Indian carp, Cirrhina mrigala (Ham.) Srivastava and Karamehandani(1964), made some works to find out the oxygen requirements of carp fry (8 to 23 mm. long) during the period of transport of limited volume of water.

Nabi (1982) worked on transportation system of carp fry and fingerlings and emphasis on polythylene bags and saline water technique which reduce the mortality rate during transportation, at the same time possibility of utilizing the tube-well water should be considered on priority basis.

Saha et al. ,(1956) worked on the influences of physical and chemical conditions on larvae, fry and fingerlings of major carps. Similar works were done by Albaster and Herbert (1954).

Kok and Pathak (1966), studied the toxicity of lindane to towes, tilapia and carps, which is used in the control of asiatic riceborer.

Hatching sucess depends upon temperature, fluctuating water levels and silt deposition Hassler (1970). The number of fry hatching can be extremely variable (Monten, 1948 ; Franklin and Smith, 1963) but little is known of the effects of density on survival. High density may lead to increased cannibalism (Carbine, 1945; Monten, 1950). Cannibalism may act as a regulator of population density both within and between year-classes (Kipling and Frost, 1970; Grimm, 1981; Mann, 1982). Wright and Giles (1987) worked on the survival, growth and diet of pike fry stocked at different densities in natural ponds.

Jhingran (1975) pointed out, some of the more consideration for attaining high fish production in stocking ponds are species combination , their ratio and rate of stocking.

Mollah *et al.* , (1978) worked on major carps, *Catla catla* (Ham.) to find out the fish population.

Alikunhi *et al.*, (1951) worked on the mortality of carp fry under supersaturation of dissolved oxygen in water.

Hasan *et* al., (1982) worked on the effect of stocking density on the growth of Nile tilapia in floating ponds.

Islam et al.,(1978) worked on the growth of Catla catla and Labeo rohita at different stocking rates with reference to some physico-chemical factors of the stocking ponds. Islam et al.,(1983) found that the growth of carps varied on different months depending upon the fluctuation of water temperature.

Dewan et al.,(1977) worked on the size and pattern of feeding of fry and fingerlings of three major carps viz. Labeo rohita (Ham.), Catla catla (Ham.), and Cirrhina mrigala (Ham.).

Alam et al., (1985) worked on the growth of silver carp Hypopthalmicthyes molitrix (Val.) with reference to some limnological parameters of rearing ponds.

Habib et al., (1983) worked to determine the monthly fluctuations and to compare the physico-chemical factors of water in two selected ponds

Paul (1982) prepared an inventory on fisheries research in Bangladesh. Where list of different publication of different organization shown very meagre list of research on the population density of carp fry in our country.

Bangladesh being a young nation is faced not only with the problem of production of sufficient food, but also with the question of production of quality food that would improve the general health of her rapidly multiplying population.

Blessed with innumearable bodies of freshwater, the nation has the potentiality to overcome the problem with the production of fish which is an essential source of quality animal protein. Already more than 80 percent of presently available animal protein comes from fish alone (Anone, 1966).

In Bangladesh a large number of ponds, ditches and canals are left without rearing fish, because of non availability of fish fry and fingerlings in the interior. If these water bodies are properly used for culture of fish fry and fingerlings by taking fish seed from fish seed multiplication farm in oxigenated polythene bag or by any other method, the fishermen of the interior region might be benefited and fish culture could be easy available to the common people. This could help to solve the problem of food protein in our country to certain extend.

On the light of above experiments, an attempt was made by the present approach to find out the optimum growth of the population of required number of carps in the required size of pond. On the nursery pond it will be great helpful in manage the nursery pond for optimum production of carp fry and fingerlings with respect to size and species composition.

CHAPTER - I

GROWTH EFFECT: COMPARATIVE STUDY ON PHYSICO-CHEMICAL FACTOR AND MORPHO-METRIC RELATIONSHIP WITH DIFFERENT DENSITY.

INTRODUCTION

The inland waters of our country is very rich but fish production per acre is low due to inadequate scienctific knowledge in fish culture and proper management. A given body of water can support a certain volume of fish life, and there is a carrying capacity for a pond, beyond which growth of fish gets retarded (Mollah et al.,1978). For maximum production in the shortest possible time one must have a clear idea about the stocking rate as the density of population is the one of the deciding factors in the growth of carps (Nakamura et al., 1954 ;Kawamoto et al., 1957; Vaas-van-oven, 1958). The knowledge of the total number of fishes and the species composition in a pond play an important role in scientific fish culture and management in obtaining the maximum yield and also to know the standing crop per unit area by size, weight and kind (Quddus et al.,1987).

Fish production in our country can be increased to several folds by adopting effective culture and management practices in our water bodies (Dewan et al.,1977).

Carps being the major and principal fresh water fish of our country, considerable number of work on different aspects of their biological conditions have been done by different persons on different occassion.

In addition to the perennial waterbodies, there is a fair number of village ponds which are shallow and seasonal and are ordinarily used for domestic purpose. Very little attention is being given to the upkeep of these ponds, which may be used as a distinct element in the village economy by culturing the major carps. An investigation was, therefore,undetaken with these fast growing carps fingerlings, viz.,*Labeo rohita* (Ham.), *Catla catla* (Ham)and *Cirrhina mrigala* (Ham) with the view to find out suitable stocking rate for these species in happa, tanks and nursery ponds for , what may be called, stand there fish production.

MATERIALS AND METHODS

The present investigation was carried out from June to December 1984 in Rajshahi University Campus and in Shalbon, Sopura, Rajshahi. For this purpose two happas in a pond, three cemented tanks and five mini nursery ponds were selected.

Preparation of Happas :

Happa is a floating cage in a pond for temporary stocking of fry and fingerlings. In this experiment two happas (1.05 m X 1.40 m X 1.50 m) were made. Bamboo poles were placed in the middle of the pond used for setting two nylon happas. The happas were tied with nylon rope with bamboo poles, side by side at a depth of 1.10 m. Nylon net (mesh size1mm) was used for preparing to happa. Wooden planks were placed on bamboos for acess the happa.

Preparation of tanks :

Three cemented tanks were used, one of which was located in the Shalbon, Sopura Rajshahi having size (2.50 m X 1.50mX 1.10 m.). Two other tanks were experimental tanks of the department of Zoology, Rajshahi University, each of them was (3.25 m X 1.45 m X 1.35 m) in size (Plate-1&2)

EXPERIMENTAL TANK II

PLATE I

EXPERIMENTAL TANK III

PARTIAL VIEW OF NURSERY PONDS

PLATE II

NURSERY POND I

NURSERY POND II

NURSERY POND III

NURSERY POND IV

NURSERY POND V

PLATE III

At first the tanks were poured with tap water and left for ten days, then the water was let out. Thereafter the bottom of the tanks with a height of 5 cm were filled with pond mud collected from a nearby pond. Then again tap water was poured in them. After four days, the mud present in water sedimented on the bottom and water became clear and ready for the experiment. All tanks were on well exposed sun light and wind.

<u>Preparation of ponds</u> :

Experiments with ponds were conducted at the nursery pond (Plate-3) (Fig-1a)of the department of Zoology, Rajshahi University. The ponds were identical in size (7.62m X 6.10m X 1.22m). All ponds were dried up in the summer and rainfed during rainy season having no inlet or outlet. They were well exposed to sun light and air.

<u>Stocking density</u> :

The carp fry of Rohu, Catla amd Mrigal(hereinafter called R,C and M respectively) were procured from the Fisheries Farm, Rajshahi, the size of which varied from 20 mm to 30 mm. The fry were stocked in a happafor checking out the unhealthy, morbid and dead fry. After checking the fry were realesed in happas ,tanks and ponds as following densities :

Happa I, R : C : M = 40 + 30 + 20 = 90

Happa II, R : C : M = 45 + 40 + 25 = 110

Tank I, R : C : M = 40 + 40 + 20 = 100

Tank II, R : C : M = 42 + 40 + 32 = 114

Tank III, R : C : M = 40 + 35 + 35 = 110

Pond I, R : C : M = 175 + 102 + 48 = 325

Pond II, R : C : M = 115 + 130 + 55 = 300

Pond III, R : C : M = 130 + 110 + 55 = 295

Pond IV, R : C : M = 137 + 83 + 55 = 275

Pond V, R : C : M = 115 + 105 + 75 = 295

Collection of water samples :

Water samples were collected from near the surface of three tanks and five nursery ponds at fortnight interval for a period of seven months from June to December 1984 during the experimental period on every sampling day between 6.30 a.m. and were put in blackened bottles of 500 ml. capacity. Hydrogen ion concentration, dissolved oxygen, water temperature and turbidity of water determined by using water quality checker (WQC-2A - TOA).

WEIGHING MACHINE

WATER QUALITY CHECKER MACHINE

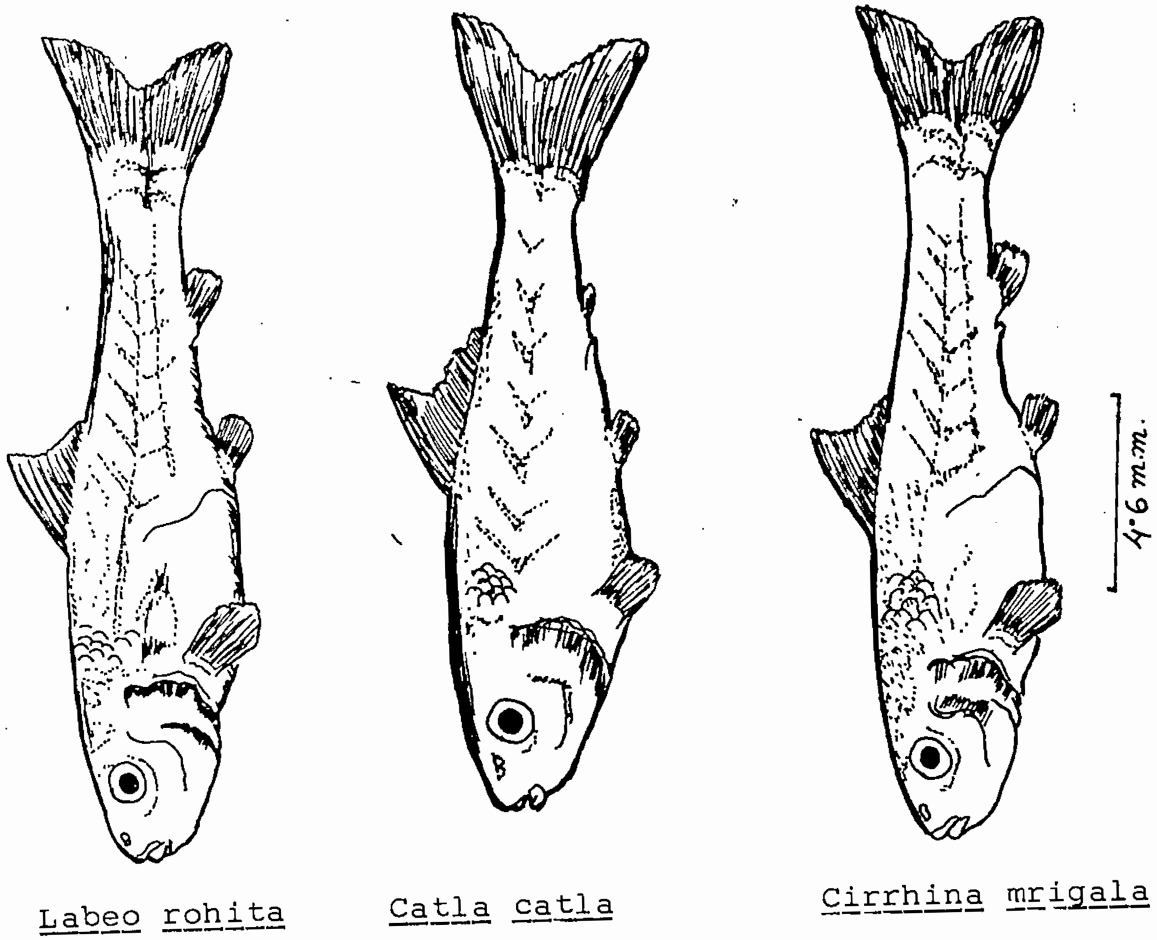
PLATE IV

Measurement of growth :

The initial total length of each species was recorded before releasing in the tanksand ponds. A representative sample of some ten specimens from each tanks and 15 specimens from each pond were kept aside and their total length, standard length, body depth and total weight were measured. Mean length and weight of total specimens of each species were calculated.

As in happas after 10 days the health of the fry decreased and soars appeared all over their body, the experiment in happas discontinued. In tanks after four months and in ponds after six months the entire stock was netted and their total lengths were recorded species wise and tank/pond wise. In laboratory, their total length, standard length and body depth (Hereinafter called TI, SL and BD respectively) were measured and the fishes were preserved in 5% formalin (Fig.1b).

Artificial feed were provided in each of the three tanks and five ponds at the rate of 50% of the total weight of fry of the tanks and ponds . Daily feed was prepared by mixing mustard oil cake and rice bran at a proportion of 1 : 1 and was kept in a pot with water for 3/4 hours and then released in the tanks and ponds . After a month the feed was increased to double.



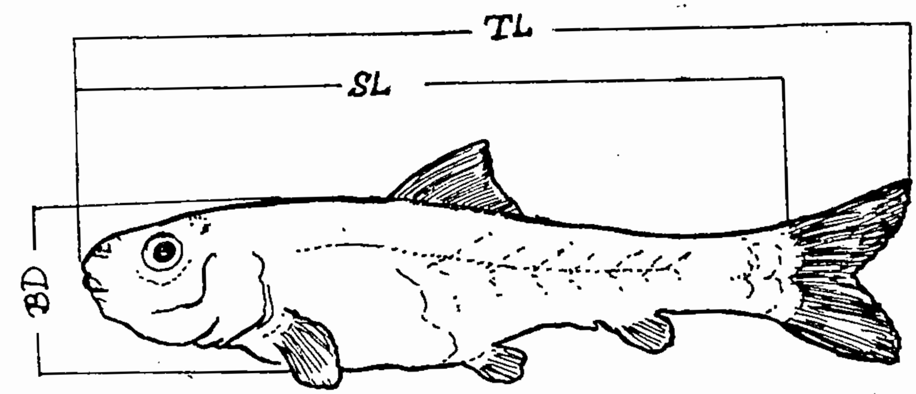


Fig.1b.Schematic diagram showing the different lengths.

RESULTS AND OBSERVATIONS

Monthly variations of the physical characters of the tanks and ponds used were recorded and have been presented in table 1 and 2 . The comperative data relating various body measurements of the fry reared in tanks and ponds have been presented in table 3 and 4. Biometrical relationships between different measurements of three carp fry are presented in table 5 and 6 for tanks and ponds respectively.

It was noticed that during experiments with happa, the fry decreased in health after 10 days and some sort of soar developed in their mouth . It was due to the fact that fry randomly swim within happa and tried to escape from it, so their mouth became bruised due to constant bedraggle with the nylon net of the happa . It was also noticed that after seven days all meshes of the nylon net were closed due to the formation of thick algal growth all over the net resulting water bloom. So, the fry culture in happa is not possible and the experiments were discontined with happa.

(A) Physico-chemical factors of the water.

Monthwise variation of the physical characters of the tank water have been presented in the table 1 and fig.2, pond water have been presented in table 2 and fig.3 and 4.

i) Hydrogen ion concentration of the water (pH)

The pH of water during the experimental months were recorded both in ponds and in tanks. It was observed that the range of pH in tanks varies from 6.4 to 8.5 with an average of 7.38 ± 0.43, 7.59 ± 0.30 and 7.28 ± 0.51 in tanks I,II and III respectively .

It was 7.38 ± 0.30, 7.44 ± 0.31, 7.42 ± 0.31, 7.38 ± 0.27 and 7.45 ± 0.20 in ponds I, II, III, IV and V respectively.

ii) Dissolved oxygen in ppm.

The dissolved oxygen in ppm. was measured and it was 2.29 ±0.48 in tank I ,3.09 ± 0.62 in tank II and 3.16 ± 0.5 in tank III ; where as it was 3.22 ± 0.54 , 3.13 ± 0.26, 3.03 ± 0.57, 3.09 ± 0.48 and 3.41 ± 0.32 in ponds I, II,III, IV and V respectively (table-2).

iii) Water temperature :

Water temperature in different months varies. But the temperature within tanks and ponds slightly varies which is not significant. The average water temperature in tanks were

Table-1 : Showing monthly variation of physical condition of tank water.

Tank No.	Months	pH	Dissolved O_2 in ppm.	Temp. in °C	Turbidity in ppm.
I	June	8.50	1.75	29.50	122.50
	July	7.20	2.25	31.50	185.00
	August	7.40	1.50	30.00	250.00
	Sept	6.40	3.65	28.50	250.00
	Mean	7.38	2.29	29.88	201.88
	± S.E.	0.43	0.48	0.63	30.57
II	July	8.35	1.65	31.50	210.00
	August	6.95	4.00	31.00	155.00
	Sept.	7.30	2.45	28.50	175.00
	Oct.	7.75	4.25	26.2	50.00
	Mean	7.59	3.09	29.30	147.50
	± S.E	0.30	0.62	1.23	34.43
III	July	7.75	3.45	31.20	107.50
	August	7.30	2.00	30.00	137.50
	Sept.	5.85	2.85	28.00	150.00
	Oct.	8.20	4.35	26.50	87.50
	Mean	7.28	3.16	28.93	120.50
	± S.E.	0.51	0.50	1.04	14.29

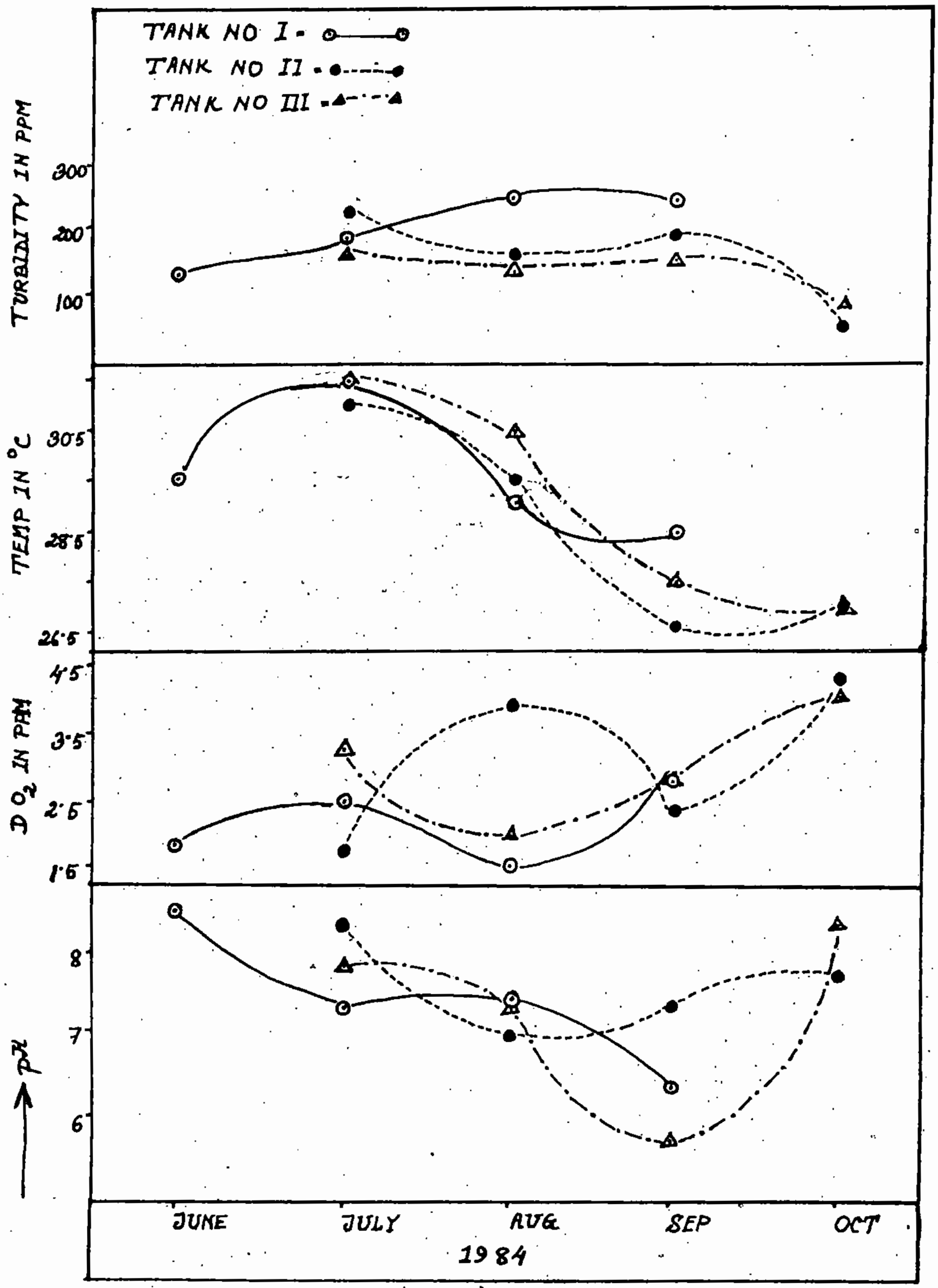


FIG.2. SHOWING MONTHWISE OBSERVATION OF pH, D.O_2, TEMP. AND TURBIDITY IN THE WATER OF EXPERIMENTAL TANK NO. I, II AND III.

Table-2 : Showing monthly variation of physical condition of pond water.

Pond No.	Months	pH	Dissolved O_2	Tempera-ture ^oC	Turbidity
I	July	8.10	2.35	30.50	217.00
	August	7.80	3.00	30.50	275.00
	September	8.00	1.55	29.50	130.00
	October	7.40	2.85	28.50	225.00
	November	6.65	4.60	26.00	132.50
	December	6.35	5.00	18.50	92.50
	Mean	7.38	3.22	27.25	178.58
	± S.E.	±0.30	± 0.54	±1.88	± 28.79
II	July	7.05	2.50	30.50	160.00
	August	7.80	2.80	30.50	275.00
	September	8.10	3.45	29.00	180.00
	October	8.30	2.45	28.00	190.00
	November	7.10	3.60	25.50	135.00
	December	6.30	4.00	17.50	87.50
	Mean	7.44	3.13	26.83	171.25
	± S.E.	± 0.31	±0.26	± 2.02	± 25.59
III	July	7.80	2.15	30.50	117.50
	August	7.95	2.30	29.50	134.50
	September	8.15	1.75	29.50	132.50
	October	7.55	2.80	28.50	157.50
	November	6.95	3.65	25.50	142.50
	December	6.10	5.55	17.50	85.00
	Mean	7.42	3.03	26.83	128.25
	± S.E.	±0.31	± 0.57	± 1.99	±10.17

Continued.

Table-2 continued

Pond No	Months	pH	Dissolved O_2	Temperature ^oC	Turbidity in ppm.
IV	July	6.65	1.80	30.00	225.00
	August	7.95	2.25	29.50	185.00
	September	8.15	2.75	29.00	130.00
	October	7.75	3.25	28.50	225.00
	November	6.80	3.35	25.50	150.00
	December	6.95	5.15	17.50	67.50
	Mean	7.38	3.09	26.67	163.75
	± S.E.	± 0.27	± 0.48	± 1.94	± 24.87
V	July	7.95	1.80	30.00	147.50
	August	7.65	2.15	30.00	167.50
	September	8.00	3.35	29.50	225.00
	October	7.15	3.30	28.00	137.50
	November	7.05	2.05	26.50	146.00
	December	6.90	7.80	18.00	72.50
	Mean	7.45	3.41	27.00	149.33
	± S.E.	± 0.20	± 0.92	± 1.89	± 20.09

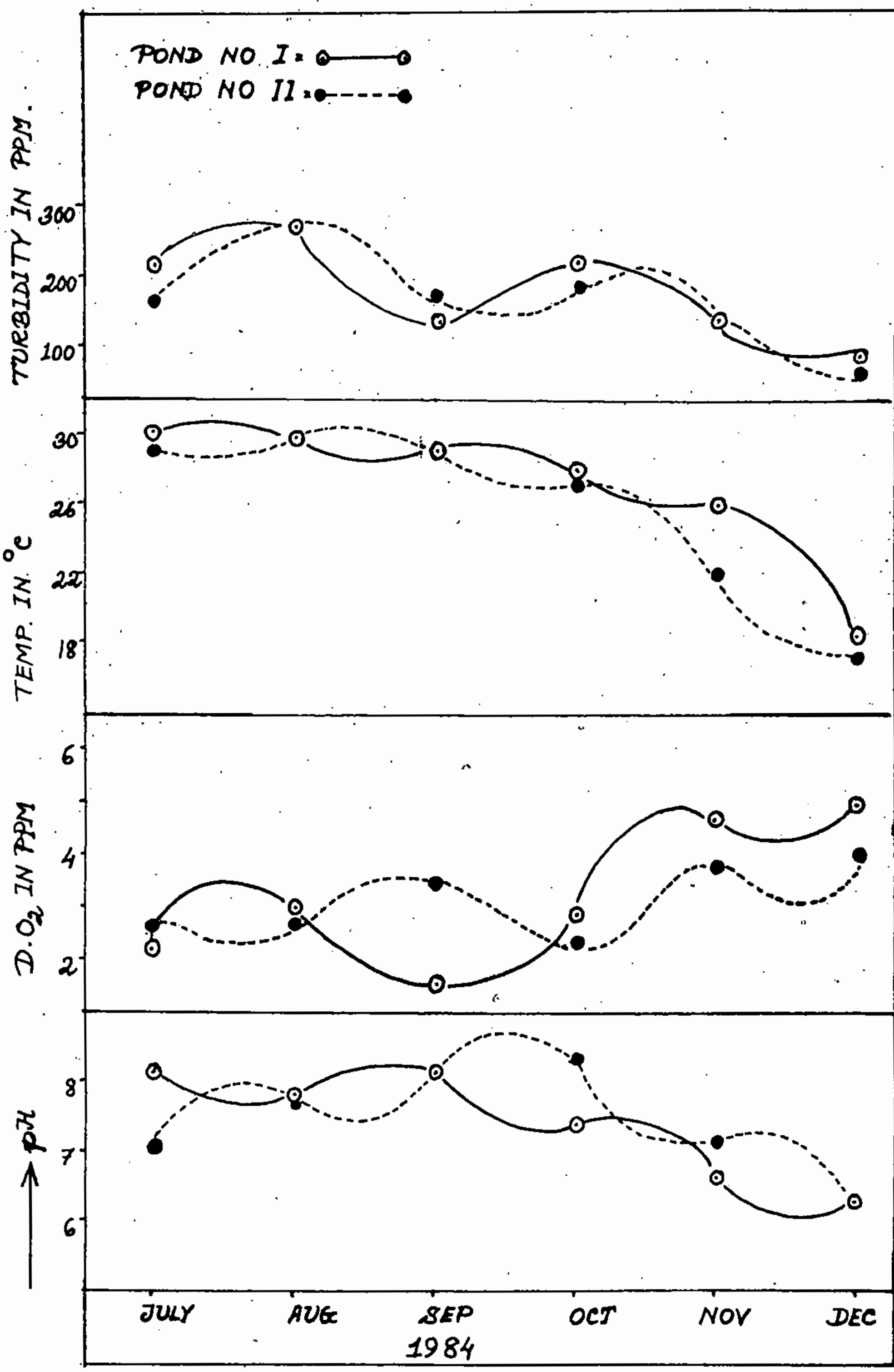


FIG. 3. SHOWING MONTHWISE OBSERVATION OF pH, $D.O_2$, TEMP. AND TURBIDITY IN THE EXPERIMENTAL POND NO. I AND II.

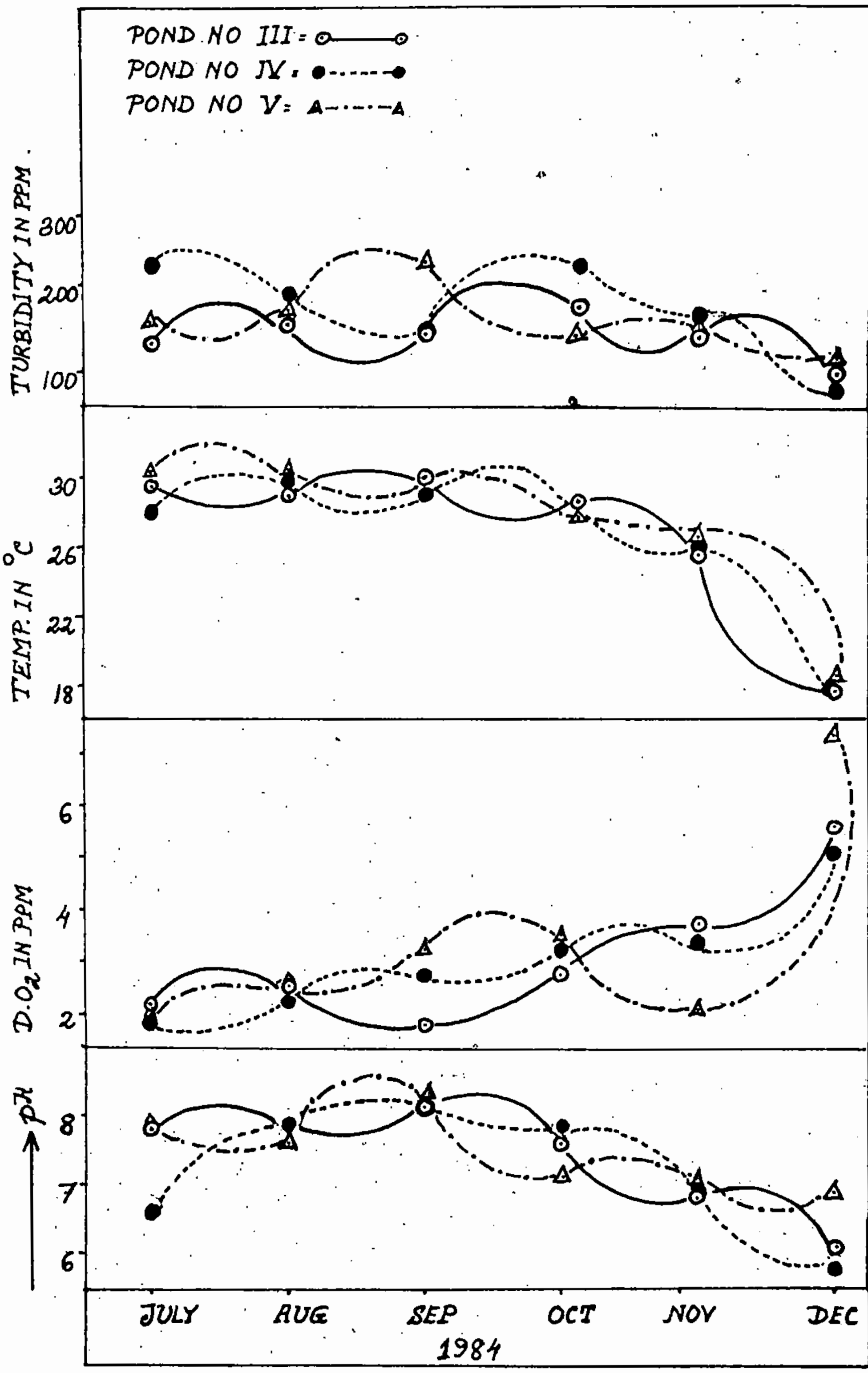


FIG. 4. SHOWING MONTHWISE OBSERVATION OF pH, $D.O_2$, TEMP. AND TURBIDITY OF THE EXPERIMENTAL POND NO. III, IV AND V.

29.88 ± 0.63, 29.3 ± 1.23 and 28.93 ± 1.04 °C, whereas in five ponds it was 27.25 ± 1.88, 26.83 ± 2.02, 26.83 ± 1.99, 26.67 ± 1.94 and 27.00 ± 1.89°C respectively. It may be noticed that the water temperature gradually falls as the winter comes and it was the month of August when the temperature was maximum.

iv) Turbidity of water :

The turbidity of water in ppm has been recorded. It was observed that turbidity of water in tank I gradually increased due to presence of phytoplankton, whereas in other tanks the turbidity more or less decreased. In open ponds also the turbidity gradually decreased with the decreased in temperature. In tanks the minimum turbidity was recorded as 87.50 ppm in tank III in October against maximum of 250.00 ppm in tank I in August and September. In the ponds the minimum turbidity was recorded as 67.50 ppm in pond IV in December against maximum turbidity of 275.00 in August in ponds I and II.

B) Total length and standard length :

It was observed that the total length (TL) and standard length (SL) of all the fry species increased in tank I, which provided with lesser number of fry for rearing (R : C : M : = 40 + 40 + 20= 100). In other two tanks the growth rate was not significant .

Appendix table-I. Analysis of variance of TL between carp species and tanks .

Carp species	Tank replication			Total	Mean ± S.E.
	I	II	III		
L. rohita	65.36	35.29	34.51	135.16	45.05 ± 10.16
C. catla	71.75	32.48	33.34	137.57	45.85 ± 12.94
C. mrigala	64.35	31.37	34.50	130.22	43.40 ± 10.51
Total	201.48	99.14	102.35	402.95	134.30
Mean ± S.E.	67.15 ±2.32	33.05 ±1.17	34.12 ±0.39	134.32 ±2.16	44.77 ±0.72

C.F = 18040.966 SSS^2 = 9.359

TSS^2 = 2297.10 tss^2 = 2255.831

Source of variance	Sum of square	Degrees of freedom	Mean square	Variance ratio (F)
Between sp.	9.359	2	4.6795	0.588 NS.
Between tanks	2255.831	2	1127.915	141.387 ($P < 0.001$)
Residual	31.910	4	7.9775	
Total	2297.10	8		

LSD = 19.857.

Table-3 : Showing morphometric measurements of carp fry reared in tanks.

Carp species	Tank replication no.	Initial measurements in mm.				Final measurement in mm.			
		No, of fry	TL ± S.E.	SL ± S.E.	BD ± S.E	No. of fry	TL ± S.E	SL ± S.E	BD ± S.E
	I	40	35.73 ± 0.93	25.48 ± 0.77	7.15 ± 0.18	36	65.36 ± 1.62	52.80±1.44	12.75 ± 0.39
L.rohita	II	42	26.42 ± 0.91	20.26 ± 0.77	6.28 ± 0.27	34	35.29 ± 1.11	28.38± 1.15	9.23 ± 0.31
	III	40	28.37 ± 1.21	23.15 ± 1.09	6.07 ± 0.25	37	34.51 ± 0.95	27.62± 0.96	8.97 ± 0.34
	I	40	34.08 ± 1.17	24.53 ± 1.04	7.20 ± 0.19	28	71.75 ± 1.43	60.22± 1.38	16.50 ± 0.27
C.catla	II	40	21.42 ± 0.74	15.55 ± 0.67	5.90 ± 0.21	35	32.48 ± 0.88	25.05± 0.94	9.20 ± 0.29
	III	35	29.45 ± 1.32	23.60 ± 1.24	6.22 ± 0.27	25	33.34 ± 1.46	26.72± 1.36	8.41 ± 0.44
	I	20	33.45 ± 1.62	24.00 ± 1.59	6.75 ± 0.29	17	64.35 ± 1.88	52.94± 1.77	14.41 ± 0.47
C.mrigala	II	32	22.68 ± 0.91	16.81 ± 0.26	5.71 ± 0.26	29	31.37 ± 0.89	24.27± 0.72	7.55 ± 0.30
	III	35	28.48 ± 1.09	22.60 ± 1.08	6.37 ± 0.30	24	34.50 ± 1.22	27.50 ±1.11	8.08 ± 0.41

Appendix table-II. Analysis of variance of SL between carp species and tanks.

Carp species	Tank replication I	II	III	Total	Mean ± S.E.
L.rohita	52.81	28.38	27.62	108.81	36.27 ± 8.27
C.catla	60.21	25.05	26.72	111.98	37.33 ± 11.45
C.mrigala	52.94	24.27	27.50	104.71	34.90 ± 9.07
Total	165.96	77.70	81.84	325.5	108.5
Mean	52.32	25.90	27.28	108.5	36.17
± S.E.	± 2.45	± 1.26	± 0.28	± 2.11	± 0.70

C.F = 11772.25 SSS^2 = 8.856

TSS^2 = 1699.564 tss^2 = 1653.682

Source of variance	Sum of square	Degrees of freedom	Mean square	Variance ratio (F)
Between sp.	8.856	2	4.428	0.478 NS.
Between tanks	1653.682	2	826.841	89.325 ($P < 0.001$)
Residual	37.026	4	9.2565	
Total	1699.564	8		

LSD = 21.389

The analysis of variance being significant ($P < 0.001$, Appendix table I) with least significant difference at 0.1% level of probability has been calculated as 19.86, i.e., the mean TL of all the carp fry in tank I significantly varied with other tanks, there is no significant difference in mean TL in tanks II and III.

The initial TL in tank I was 35.73 ± 0.93 and the final measurement was 65.36 ± 1.62 (all in mm.) for L.rohita fry. It was 34.08 ± 1.17 mm. and 71.75 ± 1.43 mm. as initial and final TL for C.catla fry. The measurements were 33.45 ± 1.62 mm. and 64.35 ± 1.88 mm. respectively for C.mrigala (Table-3).

The standard length (SL) was also found better in fry reared in tank I. The SL were 25.48 ± 0.77, 24.53 ± 1.04 and 24.00 ± 1.59 (all in mm.) for L.rohita, C. catla, and C.mrigala fry when they were realesed in tank I and it was 52.80 ± 1.44, 60.22 ± 1.38 and 52.94 ±1.77 (all in mm.) when they were recaptured for the above three species respectively (Table-3). The analysis of variance again shows significant difference between the tanks ($F = 89.32$, $P < 0.001$, Appendix table-II) with at least significance difference at 0.1% level of significance as 21.39, which indicates that the mean SL of the fry in tank I significantly differ with tanks II and III, but the later two do not provide any significant difference in SL.

Table-4 : Showing morphometric measurements of carp fry reared in ponds.

Carp species	Pond replication no.	Initial measurement in mm.				Final measurement in mm.			
		No.of fry	TL ± S.E	SL ± S.E	BD ± S.E	No.of fry	TL ± S.E	SL ± S.E	BD ± S.E.
<u>L.rohita</u>	I	175	26.24 ± 0.48	20.61 ± 0.46	5.56 ± 0.12	151	52.03 ± 0.58	41.15 ± 0.56	11.96 ± 0.09
	II	115	27.08 ± 0.51	21.26 ± 0.51	6.83 ± 0.21	101	56.36 ± 0.96	46.85 ± 0.92	12.08 ± 0.17
	III	130	25.42 ± 0.50	19.63 ± 0.52	7.26 ± 0.18	112	57.72 ± 0.84	48.58 ± 0.82	11.50 ± 0.22
	IV	137	26.70 ± 0.51	20.86 ± 0.49	7.27 ± 0.15	101	60.75 ± 0.85	51.55 ± 0.83	11.20 ± 0.18
	V	115	26.76 ± 0.50	20.78 ± 0.49	7.67 ± 0.15	96	60.04 ± 0.82	50.83 ± 0.81	11.02 ± 0.14
<u>C.catla</u>	I	101	25.24 ± 0.60	19.48 ± 0.57	7.05 ± 0.20	94	62.32 ± 0.72	52.91 ± 0.66	12.26 ± 0.16
	II	130	27.02 ± 0.58	20.96 ± 0.56	7.40 ± 0.19	124	61.04 ± 0.75	51.68 ± 0.76	11.83 ± 0.17
	III	110	25.45 ± 0.55	19.79 ± 0.55	6.79 ± 0.17	97	59.67 ± 0.89	50.41 ± 0.88	11.35 ± 0.18
	IV	83	26.59 ± 0.70	20.50 ± 0.69	6.98 ± 0.18	79	61.78 ± 0.83	52.44 ± 0.83	11.29 ± 0.16
	V	105	27.93 ± 0.57	21.94 ± 0.57	8.20 ± 0.14	84	63.83 ± 0.77	53.61 ± 0.75	11.39 ± 0.16
<u>C.mrigala</u>	I	48	26.04 ± 1.05	20.31 ± 1.04	7.29 ± 0.33	41	34.96 ± 1.30	26.48 ± 1.18	9.68 ± 0.30
	II	55	26.29 ± 0.87	20.40 ± 0.83	7.18 ± 0.26	42	48.04 ± 1.88	39.82 ± 1.82	9.44 ± 0.30
	III	55	23.21 ± 0.68	17.41 ± 0.69	6.45 ± 0.19	37	46.81 ± 1.48	37.75 ± 1.70	10.18 ± 0.34
	IV	55	25.52 ± 0.82	19.63 ± 0.82	6.89 ± 0.23	42	43.59 ± 1.20	34.47 ± 1.19	9.21 ± 0.28
	V	75	28.24 ± 0.72	22.18 ± 0.71	8.18 ± 0.18	41	48.48 ± 1.25	39.09 ± 1.27	9.24 ± 0.24

Appendix table-III . Analysis of variance of TL between carp species and ponds.

Carp species	Replication of ponds.					Total	Mean ± S.E.
	I	II	III	IV	V		
L.rohita	52.03	56.36	57.72	60.75	60.04	286.90	57.38 ± 1.55
C.catla	62.32	61.04	59.67	61.78	63.83	308.64	61.73 ± 1.54
C.mrigala	34.96	48.04	46.81	43.59	48.48	221.88	44.38 ± 2.51
Total	149.31	165.44	164.20	166.12	172.35	817.42	162.48
Mean	49.77	55.15	54.73	55.37	57.45	272.42	
± S.E.	± 7.97	± 3.80	± 4.00	± 5.90	± 4.62		

C.F = 44545.03 SSS^2 = 746.17

TSS^2 = 969.91 PSS^2 = 101.21

Source of variance	Sum of square	Degrees of freedom	Mean square	Variance ratio (F)
Between sp.	815.169	2	407.58	37.813 *** (P<0.001)
Between pond	96.932	4	24.233	2.258 NS.
Residual	86.229	8	10.779	
Total	998.33	14		

LSD /sp = 10.465

Appendix table-IV. Analysis of variance of SL between carp species and ponds.

Carp species	Pond replication					Total	Mean ± S.E.
	I	II	III	IV	V		
L.rohita	41.15	46.85	48.58	51.55	50.83	238.96	47.79 ± 0.45
C.catla	52.91	51.68	50.41	52.44	53.61	261.05	52.21 ± 0.55
C.mrigala	26.43	39.82	37.75	34.47	39.09	117.56	35.51 ± 2.19
Total	120.49	138.35	136.74	138.46	143.53	677.57	
Mean	40.163	46.117	45.58	46.153	47.84		
± S.E.	± 6.26	± 2.81	± 3.23	± 4.78	± 3.64		

C.F = 30606.74 SSS^2 = 748.568

TSS^2 = 943.506 PSS^2 = 102.734

Source of variance	Sum of square	Degrees of freedom	Mean square	Variance ratio (F)
Between sp.	748.568	2	374.284	32.473*** ($P < 0.001$).
Between pond	102.734	4	25.684	2.21 NS.
Residual	92.204	8	11.526	
Total	943.506	14		

LSD for sp. = 10.821

But the experiments with ponds the results are somewhat different. As all ponds were in the same plot (Fig-Ia) and the natural conditions were same too so there was no difference either in TL or Sl, though the ratio of the carp species were realeased in different proportions and different densities. This indicates that the pond size was significant to rear the highest number of fry used.

The total length and standard length of the three species of carp fry has been presented in Table-4. It was observed that the average TL of the fry (final measurement) were 57.38 ± 1.55 mm for L. rohita fry, 61.73 ± 0.69 mm. for C.catla fry and 44.38 ± 2.51 mm. for C.mrigala, whereas the SL were 47.79 ± 1.85 mm, 52.21 ± 0.55 mm. and 35.52 ± 2.44 mm. for the above species respectively. The analysis of variance between carp species in TL shows significance difference (F =37.81, $P < 0.001$, Appendix table III) with LSD at 0.1% level of significance as 10.465, i.e., the mean TL of L.rohita fry significantly differ with mean TL of C.mrigala fry, but there is no significant difference between TL of C.catla and C.mrigala fry.

In case of SL the analysis of variance also shows significance difference between species of fry used (F=32.47, $P < 0.001$, Appendix table IV) with LSD at 0.1% level of probability as 10.82, which indicates that the mean SL of L.rohita

Table-5. Showing regression coefficients and correlation values of carp fry reared in tanks.

Carp species	Tank replication no.	Dependent variables	Independent variables	Initial a	Initial b	Initial r	Final a	Final b	Final r
L.rohita	I	SL	TL	- 1.7033	.7531	.8823	-3.2458	.8576	.9235
		BD	TL	1.7847	.1542	.5845	.7858	.1830	.5692
	II	SL	TL	- 1.6359	.8286	.9444	-7.8126	1.0255	.9701
		BD	TL	- .4791	.2637	.7656	1.4623	.2202	.6793
	III	SL	TL	- 2.1497	.8916	.9887	-6.6683	.9935	.9658
		BD	TL	1.0334	.1786	.7373	-2.0346	.3189	.8056
C.catla	I	SL	TL	- 7.1341	.9206	.9611	-6.4323	.9289	9269
		BD	TL	2.5480	.1372	.7609	7.5698	.1240	.4640
	II	SL	TL	- 3.1506	.8728	.9410	-1.5214	1.0117	.9020
		BD	TL	.2880	.2561	.7925	1.3525	.2420	.5396
	III	SL	TL	-3. 7243	.9276	.9856	-3.9147	.9188	.9712
		BD	TL	.5925	.1913	.8707	-.9567	.2810	.8393
C.mrigala	I	SL	TL	-7 .0720	.9229	.9449	-4.0300	.8853	.8837
		BD	TL	1 .2137	.1640	.7415	.2519	.2200	.7671
	II	SL	TL	-3 8819	.9121	.9479	-4.6529	.9219	.9455
		BD	TL	.0685	.2463	.7247	-4.0939	.3711	.8653
	III	SL	TL	-5. 3174	.9800	.9783	-3.6458	.9028	.9807
		BD	TL	- . 7696	.2507	.7986	-2.4184	.3044	.8354

Table-6. Regression coefficients and correlation values of carp fry in nursery ponds.

Carp species	pond replication no.	Dependent variables y	Independent variables x	Initial a	Initial b	Initial r	Final a	Final b	Final r
L.rohita	I	SL	TL	-4.2210	.9376	.9525	-6.5965	.9187	.9249
		BD	TL	.6142	.1886	.6207	4.9999	.1340	.6930
	II	SL	TL	-5.3283	.9819	.9807	-6.6979	.9483	.9686
		BD	TL	-3.0502	.3649	.7673	3.3123	.1557	.7980
	III	SL	TL	-5.1746	.9757	.9909	-7.5513	.9724	.9793
		BD	TL	- .7507	.3152	.8129	1.3717	.1756	.8546
	IV	SL	TL	-5.1983	.9757	.9885	-7.7622	.9767	.9959
		BD	TL	.2141	.2645	.8356	- .7277	.1965	.8658
	V	SL	TL	-5.2381	.9722	.9926	-7.9847	.9796	.9938
		BD	TL	.4427	.2703	.8649	2.0921	.1487	.7577
C.catla	I	SL	TL	-4.0742	.9284	.9798	-3.7275	.9088	.9571
		BD	TL	- .8096	.3104	.8654	.3051	.1919	.7617
	II	SL	TL	-4.9922	.9553	.9710	-5.3702	.9394	.9563
		BD	TL	- .7679	.3025	.8795	.0422	.1933	.8018
	III	SL	TL	-4.7811	.9650	.9897	-8.3437	.9847	.9950
		BD	TL	- .0864	.2701	.8261	- .4291	.1974	.9276
	IV	SL	TL	-5.7834	.9887	.9945	-8.9821	.9942	.9742
		BD	TL	.3159	.2509	.8965	.3452	.1772	.8241
	V	SL	TL	-5.7644	.9919	.9964	-8.0111	.9809	.9924
		BD	TL	1.8827	.2262	.8591	- .2814	.1856	.8272
C.mrigala	I	SL	TL	-5.3634	.9852	.9877	-5.0077	.9004	.9827
		BD	TL	- .5171	.2999	.8945	2.0164	.2195	.8903
	II	SL	TL	-4.7778	.9577	.9927	-7.8578	.9797	.8851
		BD	TL	.2617	.2838	.8894	2.2115	.1508	.8774
	III	SL	TL	-4.4487	.9496	.9815	-7.9616	.9767	.9937
		BD	TL	- .2617	.2838	.8894	2.2115	.1508	.8774
	IV	SL	TL	-5.6013	.9887	.9945	-8 .6699	.9897	.9919
		BD	TL	.0623	.2675	.9285	.0911	.2093	.7955
	V	SL	TL	-5.5551	.9824	.9948	-6.0734	.9366	.9261
		BD	TL	1.7756	.2270	.8070	1.0017	.1700	.7808

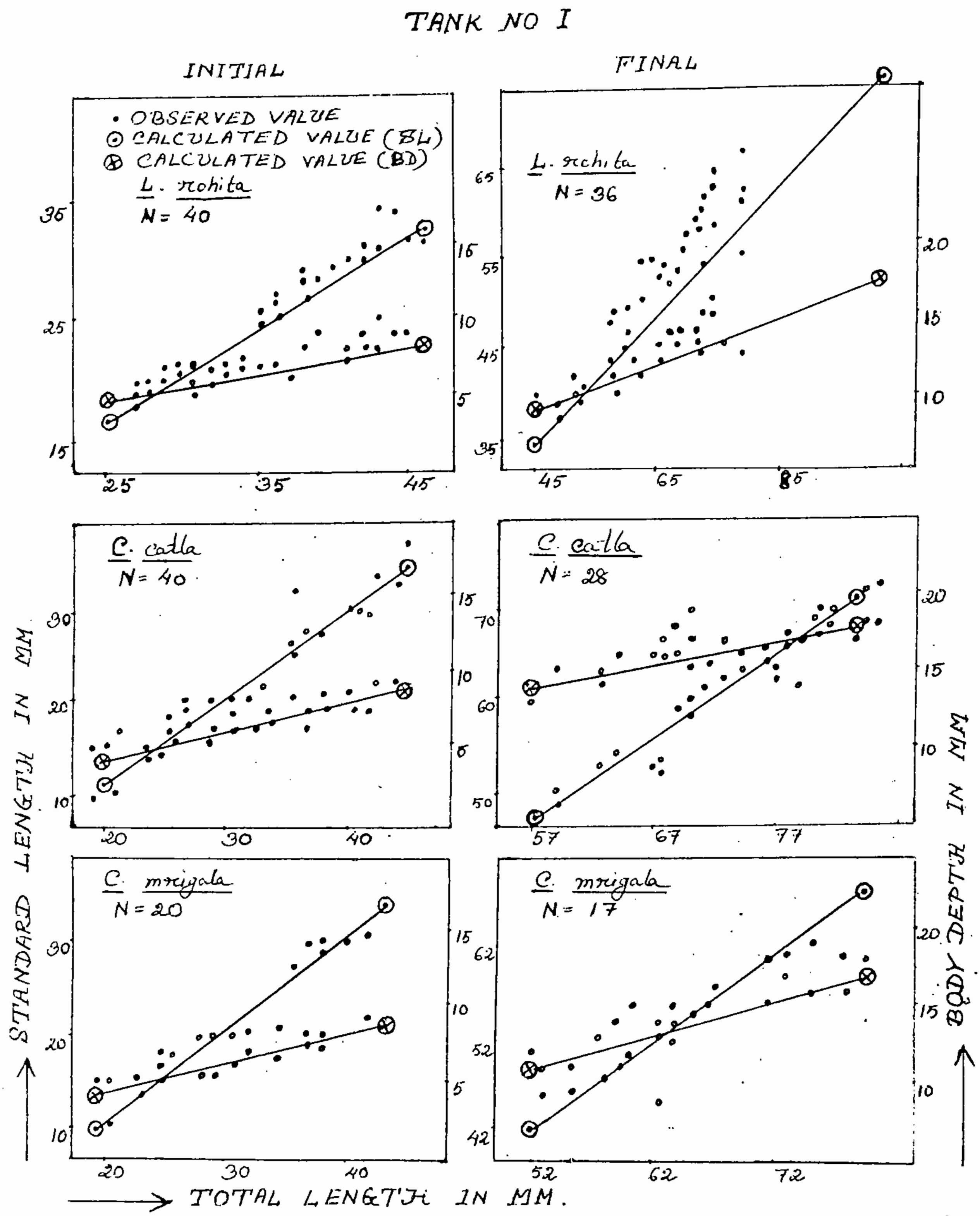


FIG. 5. SHOWING INITIAL AND FINAL RELATIONSHIP BETWEEN TOTAL LENGTH (TL), STANDARD LENGTH (SL) AND BODY DEPTH (BD) OF L. rohita, C. catla AND C. mrigala REARED IN TANK NO. I.

TANK NO.II

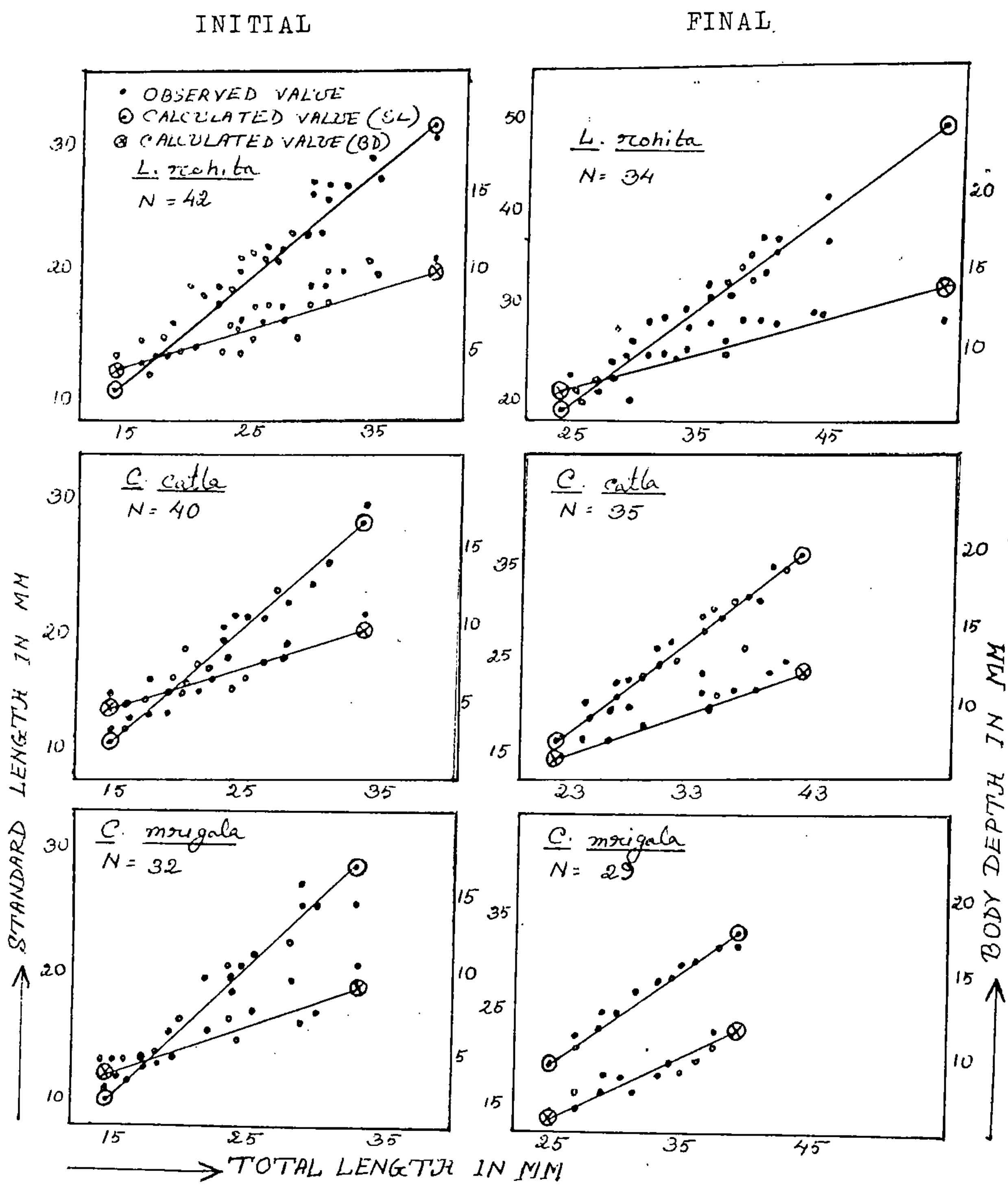


FIG.6.SHOWING INITIAL AND FINAL RELATIONSHIP BETWEEN TOTAL-LENGTH(TL),STANDARD LENGTH(SL)AND BODY DEPTH(BD)OF L.rohita,C.catla AND C.mrigala REARED IN TANK NO.II.

TANK NO.III.

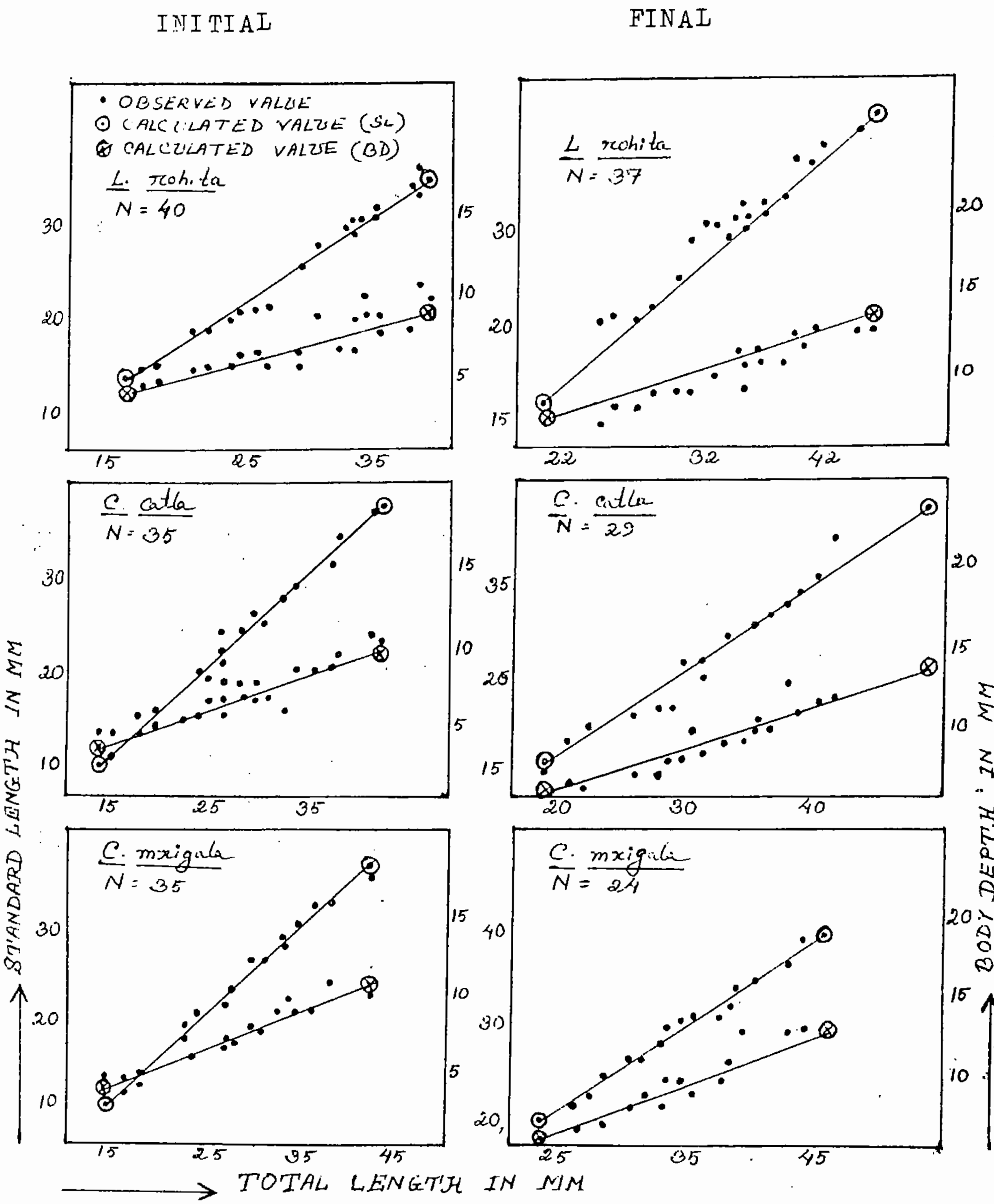


FIG.7.SHOWING INITIAL AND FINAL RELATIONSHIP BETWEEN TOTAL LENGTH(TL),STANDARD LENGTH(SL)AND BODY DEPTH(BD)OF. *L.rohita*,*C.catla* AND *C.mrigala* REARED IN TANK NO.III.

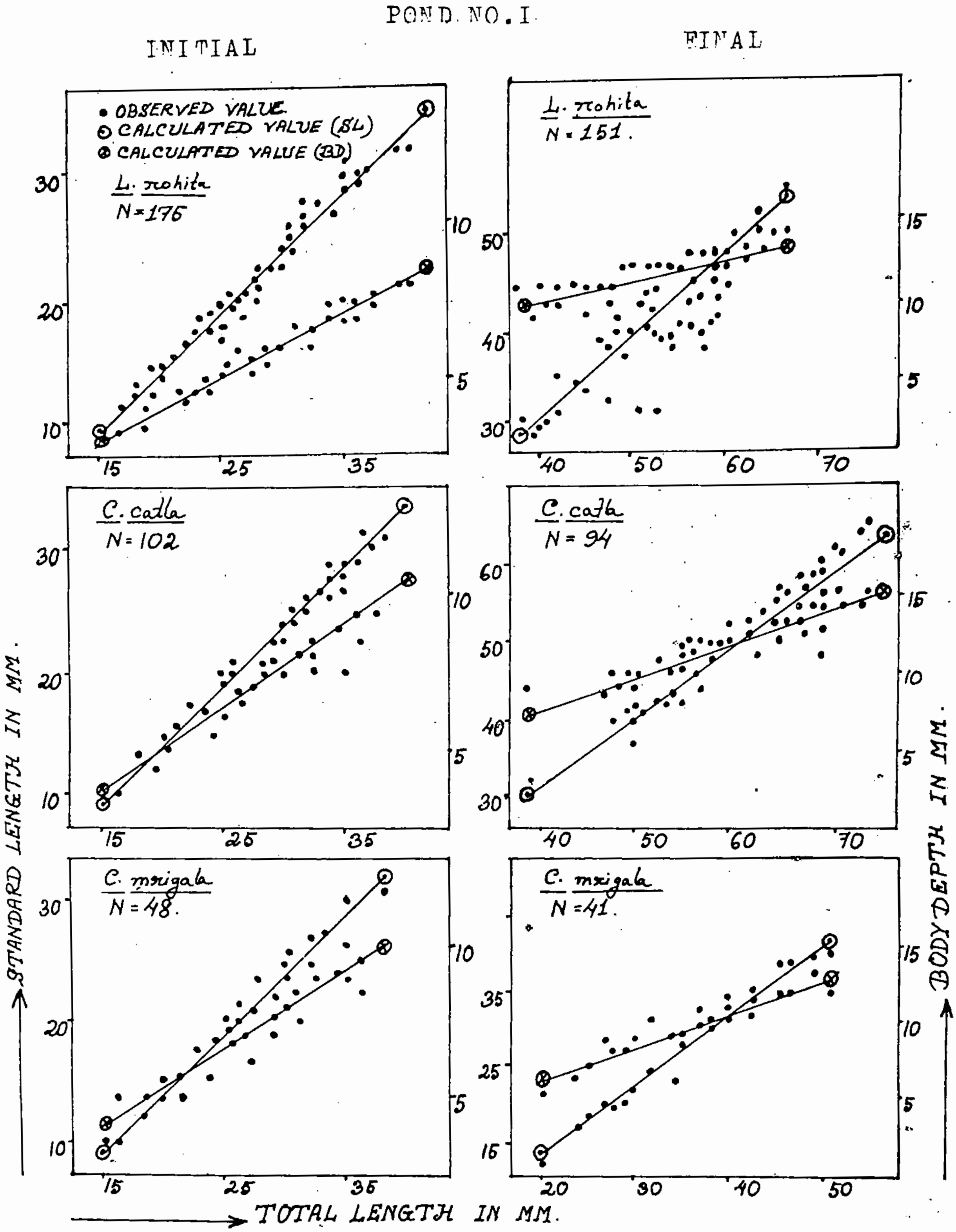


FIG. 8. SHOWING INITIAL AND FINAL RELATIONSHIP BETWEEN TOTAL LENGTH (TL), STANDARD LENGTH (SL) AND BODY DEPTH (BD) OF *L. rohita*, *C. catla* AND *C. mrigala* REARED IN POND NO. I.

POND NO.II

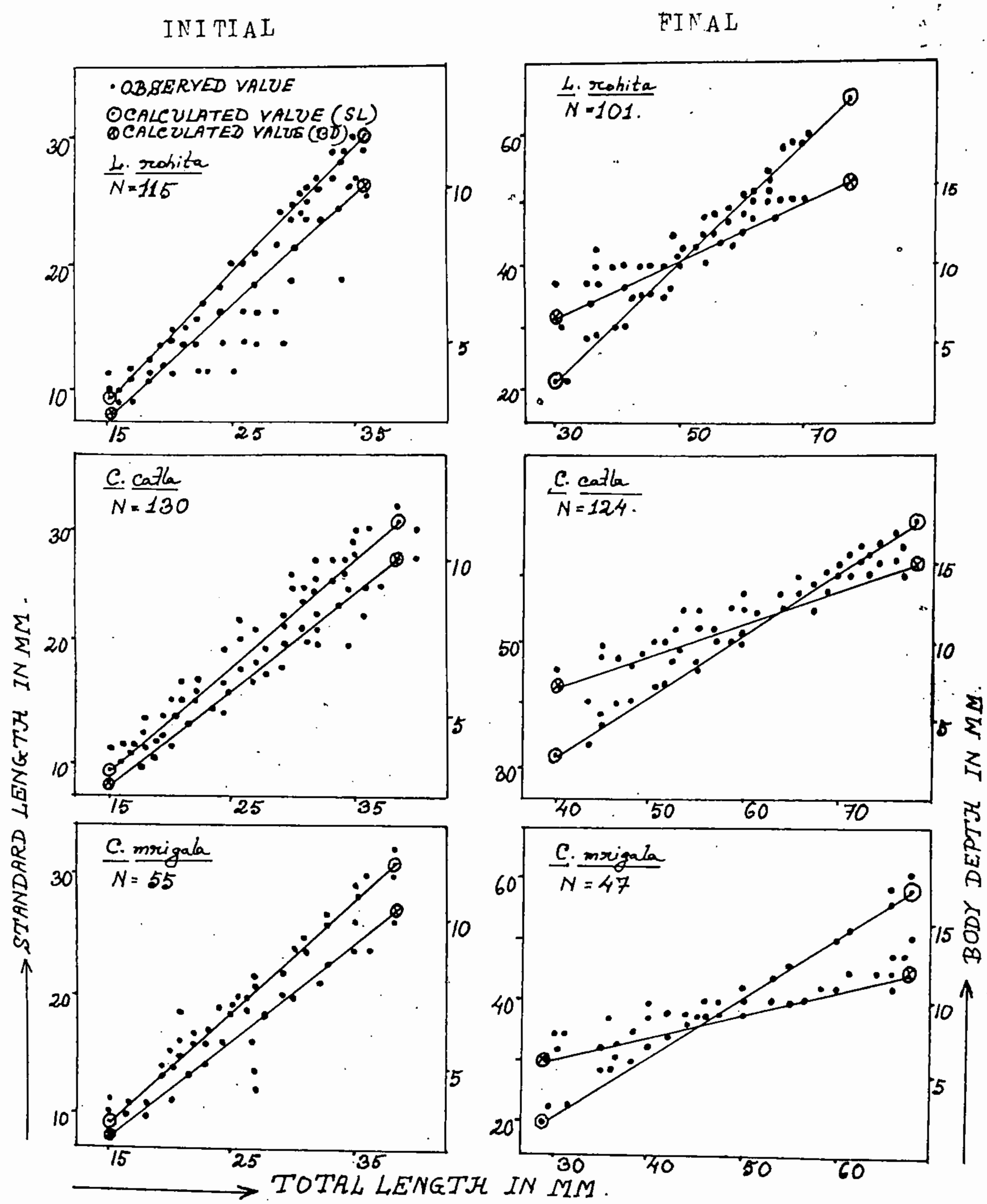


FIG.9. SHOWING INITIAL AND FINAL RELATIONSHIP BETWEEN TOTAL LENGTH(TL), STANDARD LENGTH(SL) AND BODY DEPTH(BD) OF L. rohita, C. catla AND C. mrigala REARED IN POND NO.II.

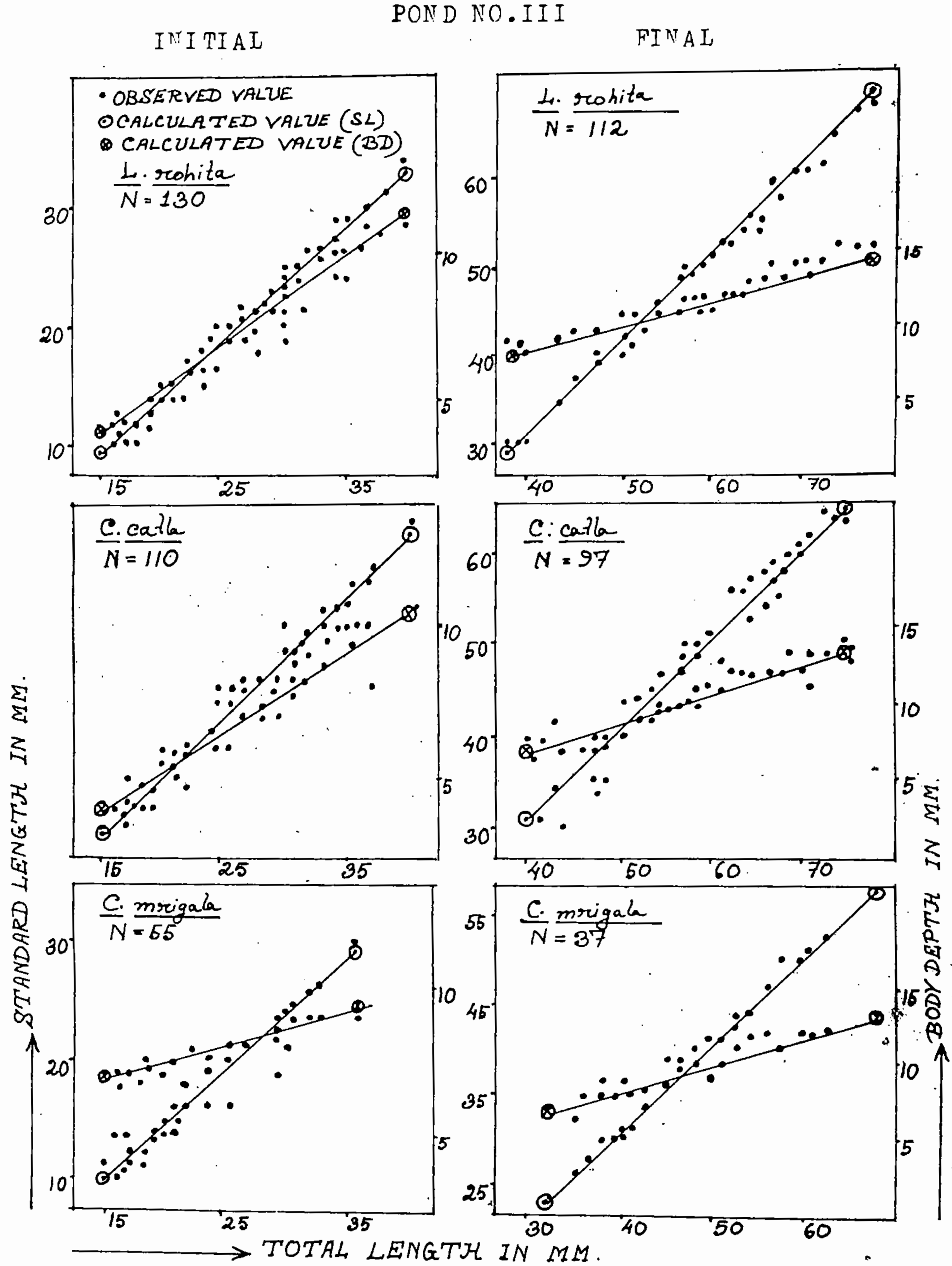


FIG. 10. SHOWING INITIAL AND FINAL RELATIONSHIP BETWEEN TOTA LENGTH(TL); STANDARD LENGTH(SL) AND BODY DEPTH(BD) OF *L. rohita*, *C. catla* AND *C. mrigala* REARED IN POND NO.II

POND NO. IV.

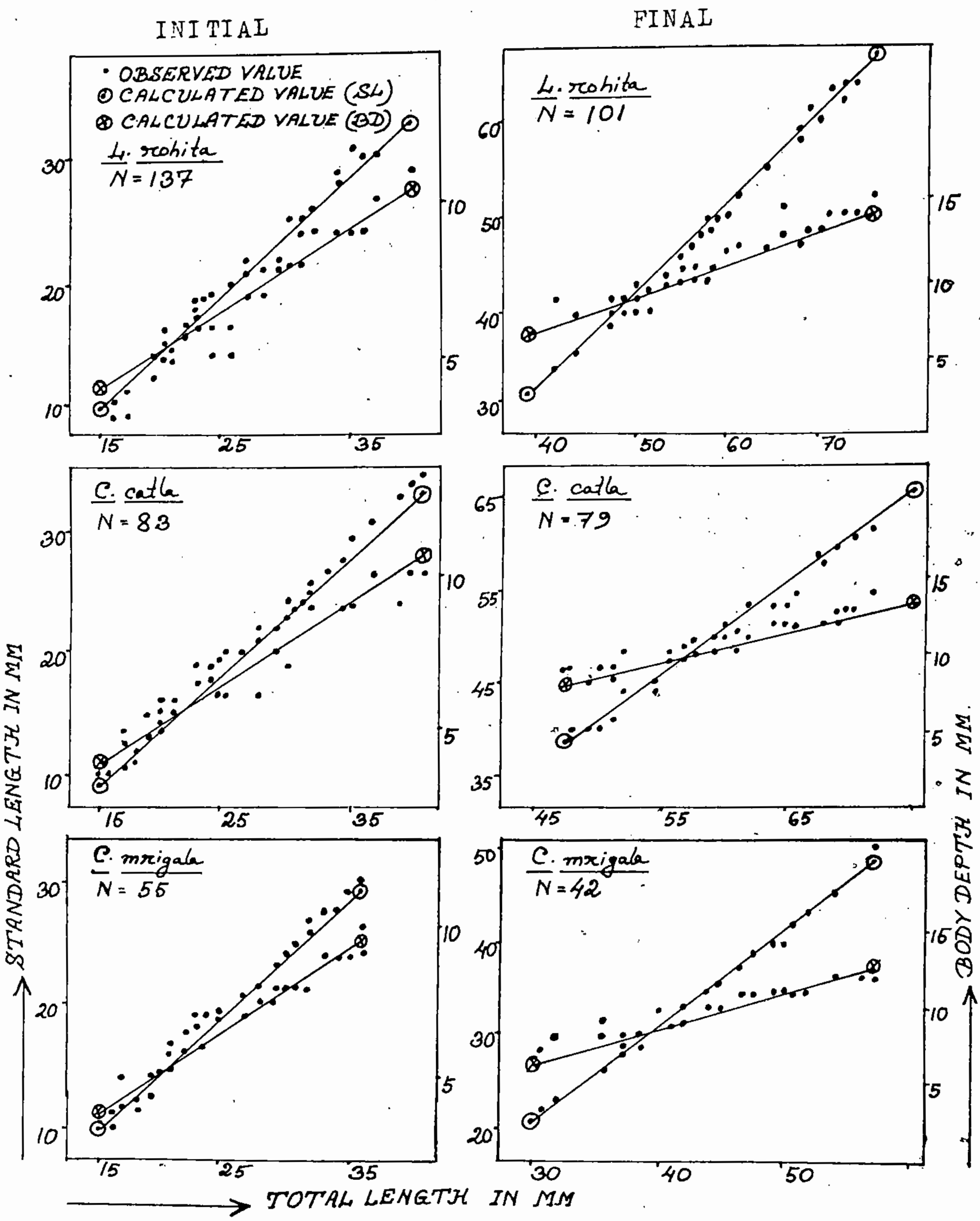


FIG. 11. SHOWING INITIAL AND FINAL RELATIONSHIP BETWEEN TOTAL LENGTH(TL), STANDARD LENGTH(SL) AND BODY DEPTH(BD) OF L. rohita, C. catla AND C. mrigala REARED IN POND NO. IV.

POND NO.V

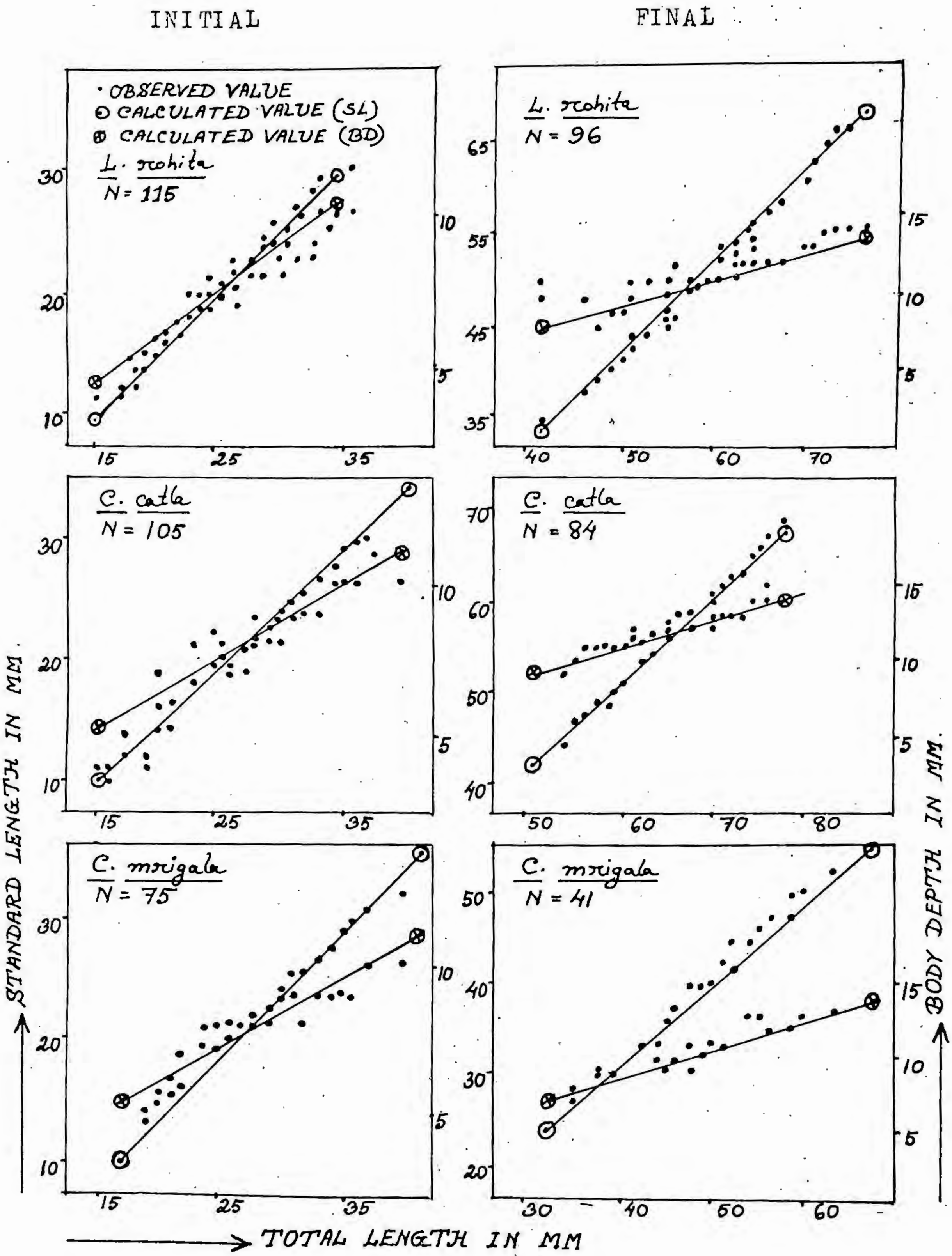


FIG. 12. SHOWING INITIAL AND FINAL RELATIONSHIP BETWEEN TOTAL LENGTH (TL), STANDARD LENGTH (SL) AND BODY DEPTH (BD) OF L. rohita, C. catla AND C. mrigala REARED IN POND NO.V.

Appendix table-V. Analysis of variance of BD between carp species and tanks.

Carp species	Tank replication I	II	III	Total	Mean ± S.E.
<u>L.rohita</u>	12.75	9.23	8.97	30.95	10.32 ± 1.22
<u>C.catla</u>	16.50	9.20	8.41	34.11	11.37 ± 2.58
<u>C.mrigala</u>	14.41	7.55	8.08	30.04	10.01 ± 2.20
Total	43.66	25.98	25.46	95.10	31.70
Mean	14.55	8.66	8.49	31.70	10.57
± S.E.	±1.08	±0.56	±0.26	±1.23	±0.41

C.F = 1004.84 $\qquad$ SSS^2 = 3.042

TSS^2 = 80.88 $\qquad$ tss^2 = 71.57

Source of variance	Sum of square	Degrees of freedom	Mean square	Variance ratio (F)
Between sp.	3.04	2	1.52	0.969 NS.
Between tanks	71.57	2	35.785	22.829 ($P < 0.01$)
Residual	6.27	4	1.5675	
Total	80.88	8		

LSD = 4.703.

and *C.catla* fry significantly differ with the mean SL of *C.mrigala*.

The SL in most cases increases with the increase in total length. The total length (x) and standard length (y) relationship has been calculated in the linear regression equation for the three species of carp fry reared in tanks (table-5) and in ponds (table-6) for initial and final measurements. It may be observed from the tables that SL always depend upon TL. of the species and always positively correlated and the values were significant in all the cases.

C) Total length and body depth :

The body depth of the fry were recorded at the time of releasing and after capture and the measurements are compared with the total length. The body depth in tank I (7.15 ± 0.18 mm. and 12.75 ± 0.39 mm. for initial and final measurements of *L.rohita*, 7.20 ± 0.19 and 16.50 ± 0.27 mm. for *C.catla* and 6.75 ± 0.29 mm. and 14.41 ± 0.47 mm. for *C.mrigala* respectively) than in tank II and tank III.

Analysis of variance shows that there is significant difference in BD in three different tank used ($F = 22.83$, $P < 0.01$, appendix table V) with LSD value at 1% level of significance as 4.70, which indicate that the BD of the fry in tank I

Appendix table-VI. Analysis of variance of BD between carp species and ponds.

Carp species	Pond replication					Total	Mean ± S.E.
	I	II	III	IV	V		
L. rohita	11.96	12.08	11.50	11.20	11.02	57.76	11.552 ± 0.185
C. catla	12.26	11.83	11.35	11.29	11.39	58.12	11.624 ± 0.17
C. mrigala	9.68	9.44	10.18	9.21	9.24	47.75	9.55 ± 0.16
Total	33.90	33.35	33.03	31.70	31.65	163.63	
Mean	11.30	11.12	11.01	10.57	10.55		
± S.E.	±0.67	±0.69	±0.34	±0.55	±0.54		

C.F = 1784.99 SSS^2 = 13.85
TSS^2 = 16.04 PSS^2 = 1.35

Source of variance	Sum of square	Degrees of freedom	Mean square	Variance ratio (F)
Between sp.	13.85	2	6.925	65.952 *** ($P < 0.001$)
Between pond	1.35	4	0.338	3. 214
Residual	0.84	8	0.105	
Total	16.04	14		

LSD for sp. = 1.033

significantly differ with tanks II and tanks III, whereas within laters there is no significant difference.

In case of ponds the BD of the fry more or less similar in all the ponds used. But here like TL and SL the BD also differ significantly within the species of fry. The average BD of the fry were 11.55 $\pm$ 0.21 mm, 11.62 $\pm$ 0.18 mm. and 9.55 $\pm$ 0.18 mm. for L. rohita, C.catla and C.mrigala respectively. The analysis of variance shows that (F =65.95, $P < 0.001$. Appendix table-VI) the mean BD of fry of L.rohita and C.catla significantly(LSD = 1.033 at 0.1% level of probability)differ with the BD of C.mrigala fry.

The relationship between TL and BD has been calculated by establishing the regression equation of Body depth(y) on Total length (x) for the tanks (table-5) and ponds (table-6). It shows that all the values highly correlated.

The straight lines obtained from the regression equations of SL and BD on TL for the fry reared in tanks and in ponds has been presented in Figures 5,6,7,8,9,10,11 and 12 respectively.

DISCUSSION

The size of the fish population points to an under-stocking of the pond when its area is considered. But the unbalanced stocking rate is responsible for the moderate growth in length and in weight, even though all the physico-chemical and biological characteristics of the ecosystem are found to be favourable for the growth of major carps (Mollah et al., 1978). According to Medawar (1945) the first law of growth is that size is a monotonic increase function with age. This is sure for fishes when growth is measured in terms of length. In many fishes where form and specific gravity do not change significantly throughout life, length and weight bear a specific relationship from which the physical wellbeing of a fish can be ascertained for a given body of water at a given time.

The importance of physico-chemical characters in water on the foundation of food chain is enormous. Because, the growth and nourishment of primary producers are entirely dependent on the availability of nutrients. These producers are eaten directly or indirectly by fishes. In the present experiment it was observed that water temperature varied in various months. The transparency of water normally indicate productivity. The turbidity of natural waters may be either due to suspended inorganic substances, such as silt and clay, or due to planktonic organisms (Jhingran, 1975). Jhingran (1975), also point out that turbidity is an important limiting factor in the productivity of a pond.Remarkable variations were observed between tanks and ponds. Sahaiand Sinha (1969) recorded the lowest value of transparency in May during heavy phytoplanktonic growth and highest in August and september during heavy rainfall. Mollah and Haque (1978) also recorded higher transparency in July.

In the present investigation the recorded pH value were within productive range. Edwards (1958) reported that pH values decreased in deeper mud due to increase in free carbondioxide. Sreenivasan (1964) and Dewan (1973) also agreed with this view. Mollah and Haque (1978) reported the pH values has an inverse relation with free carbondioxide in water.

Variation of oxygen concentration were observed between ponds and tanks. The dissolved oxygen was always higher at surface water as a result of greater photosynthetic activity of phytoplankton in the surface water and direct contact with air. Lower concentration of dissolved oxygen in the bottom was probably due to the higher rate of decomposition of organic matter and use of oxygen for respiration of plants and animals and for benthos. Oppenheimer et al.,(1978) reported the higher dissolved oxygen at surface water.

Dissolved oxygen in water at the time of stocking was low in pond ranging from 1.55 to 2.50 ppm. Alikunhi (1955) also found low dissolved oxygen ranging from 0.8 to 1.4 ppm. only.

It can be seen from the foregoing account that the calculated values for the variables plotted against the total length are closely distributed along the regression line and do not reveal any marked variation. Similar findings have been made by Ganguly *et al.*,(1959),Chunder (197[illegible]), Prakash and Varma (1982) in the fishes studied by them . Literature available regarding the growth rate of the various variables in relation to the total length indicate that in fishes the growth of various morphological body parts varied from species to species.

CHAPTER-II

POPULATION DENSITY AND GROWTH EFFECTS : TOTAL LENGTH TOTAL WEIGHT RELATIONSHIP; RELATIVE CONDITION FACTOR ; CONDITION FACTOR FOR OBSERVED WEIGHT ; CONDITION FACTOR FOR CALCULATED WEIGHT; SPECIFIC GROWTH RATE ; NET YIELD AND MORTALITY/ SURVIVAL PERCENTAGE .

INTRODUCTION

Fishermen carry their fish fry and fingerlings for their ponds from different fish seed multiplication center much above their requirements, due to lack of knowledge of their accurate requirements. This incurs financial loss to them by way of transpotation cost, death of fry and fingerlings during carriage and ultimately in getting optimum yield from the ponds. If they have exact knowledge of the stocking density of carp fry in the nursery ponds they can easily avoid such losses.

The present work will give the knowledge of accurate number of required fish fry and fingerlings for specific area of water body which can render maximum yields.

In order to get such optimum result of growth of fishes a scientific study in fish culture that involves length-weight relationship , mortality and servival percentage and growth rate of carps fry is essential. In fishery biology, the study of length-weight relationship serves a two fold purpose ; first to establish mathematical relationship between two variables, length and weight; and second to measure the variations from the expected weight from length of individual fish or group of fishes (Le cren, 1951 ; Thomas, 1969 ; Safi and Quddus, 1974).

Among the various biological aspects of fish, the total length-standard length and total length-total weight relationship of fish are of importance in fishery management culture, regulation and also ascertaining the environmental suitability of a particular fish in particular area (Quddus *et al*.,1987).

A good number of works have been done on stocking density of fish in rearing ponds (Islam *et al*.,1978; Mollah *et al*.,1978; Hasan *et al*.,1982) and on population estimation (Quddus *et al*.,1987) that helped the present work on stocking density of fish fry and fingerlings in the nursery pond.

MATERIALS AND METHODS

The present experiment was conducted over a period of seven months; from June, 1984 to December 1984, in three cemented tanks and five mini nursery ponds. the tanks were numbered as I,II and III respectively and the ponds were numbered as I,II,III,IV and V respectively. Nursery ponds were situated on the northern side of the third Science Building of Rajshahi University. Preparation of the tanks,ponds and stocking density are same as described in the preceeding experiment.

Measurement and growth of fry.

The initial total length and total weight of each species was recorded before releasing in the tanks and ponds. After rearing the fry in the tanks for four months and in the ponds for six months, entire stock was recovered by netting and the final data on length, weight, relative condition factor, condition factor for observed and calculated weights, survival and mortality rates were calculated specieswise and tank /pond wise.

For calculating the relationship between total length (TL) and total weight (TW) the following regression relationship was used :

$$W = aL^n \qquad \text{(I)}$$

Where ,"a" is a constant and "n" is an exponant. The exponential form of relationship in formula(1) can be expressed in the logarithmic form :

$$\text{Log}_{10} W = \text{Log}_{10} a + n \text{ Log}_{10} L \quad \text{-------------} \quad (II)$$

In other wards, when form and specific gravity of the fish do not change at all during its life time"ideal". The values of constants "a" and "n" were determined by the following equations (Rounsefell and Everhart,1953 ; Lagler, 1956):

$$\text{Log } a = \frac{\text{logTW.(logTL)-logTL(logTL.logTW)}}{\text{N. (logTL)-(logTL)}} \text{---------} (III)$$

$$\text{and } n = \frac{\text{logTW-N.log a}}{\text{logTL}} \quad \text{-----------------} \quad (I^{V})$$

For expressing the relative wellbeing of individuals an entirely different expression of the cube law relationship of the length-weight relationship is used,called as " condition factor" or " coefficient of condition or "ponderal index".

The condition factor or the coefficient of condition can be determined by two ways, either from the observed values, or from the calculated values.

The general formula of condition factors (K, for observed value and k, for calculated value) is

$$TW = KTL^3 \quad \text{-------------------------} \quad (V)$$

Which can be written as,

$$K = TW/TL^3 \quad \text{-------------------------} \quad (VI)$$

where, TW is the weight in gms, TL is the total length in mm. K is the factor of proportion. The formula no VI can also be written as,

$$K = \frac{TW \cdot 10^5}{TL^3} \quad \text{-----------------------} \quad (VII)$$

To eliminate the effects of length and correlated factors, the relative condition factor (K_n) was calculated . The formula for the relative condition factor stands as,

$$K_n = \frac{W}{\bar{W}} \quad \text{-----------------------} \quad (VIII)$$

where , W is the observed total weight and $\bar{W}$ is the calculated total weight. The relative condition factor was calculated for all the species individually (Lecren, 1951 ; Brown, 1957 ; Doha and Dewan , 1967):

Specific growth rate (SGR):

According to Sadler and Lynam (1986), specific growth rate (SGR) of carp fingerlings in each individual tanks and sponds were calculated as,

$$SGR = \frac{100 \times (\log_e \text{final wt.} - \log_e \text{initial wt.})}{\text{time (days)}} \quad \text{---} \quad (IX)$$

Yield of fishes :

The estimated gross production (egp), calculated net production (cnp) and net yield (ny) both species wise and tank/pond wise were calculated according to the following formulae :

$$egp = Wtf \times n_{st} \quad \text{(X)}$$

$$cnp = Wtf \times n_{sv} \quad \text{(XI)}$$

$$ny = cnp - Wtf \quad \text{(XII)}$$

Where egp = is the estimated gross production,

cnp = is the calculated net production.

ny = is the net yield.

wtf is the weight of the fingerlings stocked, n_{st} is the number of fingerlings stocked n_{sv} is the number of fingerlings surviving (Islam et al., 1978)

RESULTS AND OBSERVATIONS

In present investigation, three cemented tanks and five mini nursery ponds were used. Three major carps fry species viz. *Labeo rohita*, *Catla catla*, and *Cirrhina mrigala* (here in after called R.C and M respectively) were released in each tanks and ponds in different stocking rates for the experiment and following results are found.

(A) Total length (TL) and total weight(TWT) relationship:

The initial and final length weight relationship (TL/TWT) and regression values and the correlation of coefficient of individual species on individual tanks and ponds are given in Table 7 and 8 and fig. 13,14,15,16, 17,18,19 and 20 respectively. Initial total length ranged from 15 to 45 mm and weight ranged from 0.25 to 1.95 gms. Generally the initial "n" value lies near about 1 and final "n" value varies from 1 to 2.

In cemented tanks finally highest value was found in case of R.C and M in tanks no. I.

Rohu, $\log w = - 4.3376 + 2.6204 \log L$

$r = .9804$

Catla, $\log w = - 3.1059 + 1.9891 \log L$

$r = .9704$

Table : 7. Length-weight relationship of different carps fry and fingerlings reared in tanks.

Carps species	Tank replication no.	No. of fishes.	Initial observation: Value of log a	Value of n	Value of r	No. of fishes	Final Observation: Value of log a	Value of n	Value of r
	I	40	-1.4037	0.9814	0.9431	36	-4.3376	2.6204	0.9804
Lebeo rohita	II	42	-2.9952	1.9298	0.9970	34	-2.2128	1.5539	0.9912
	III	40	-3.0686	1.8744	0.8673	37	-1.9478	1.4005	0.9821
	I	40	-1.8658	1.2681	0.9819	28	-3.1059	1.9891	0.9793
Catla catla	II	40	-2.8822	1.7952	0.8554	35	-2.1238	1.5213	0.9958
	III	35	-2.8460	1.7304	0.9879	29	-1.7002	1.2145	0.9471
	I	20	-1.8140	1.2112	0.8513	17	-4.1127	2.5324	0.9819
Cirrhina mrigala	II	32	-2.8476	1.7663	0.8417	29	-1.8968	1.8799	0.9886
	III	35	-2.5284	1.4985	0.9717	24	-2.1406	1.4606	9.9920

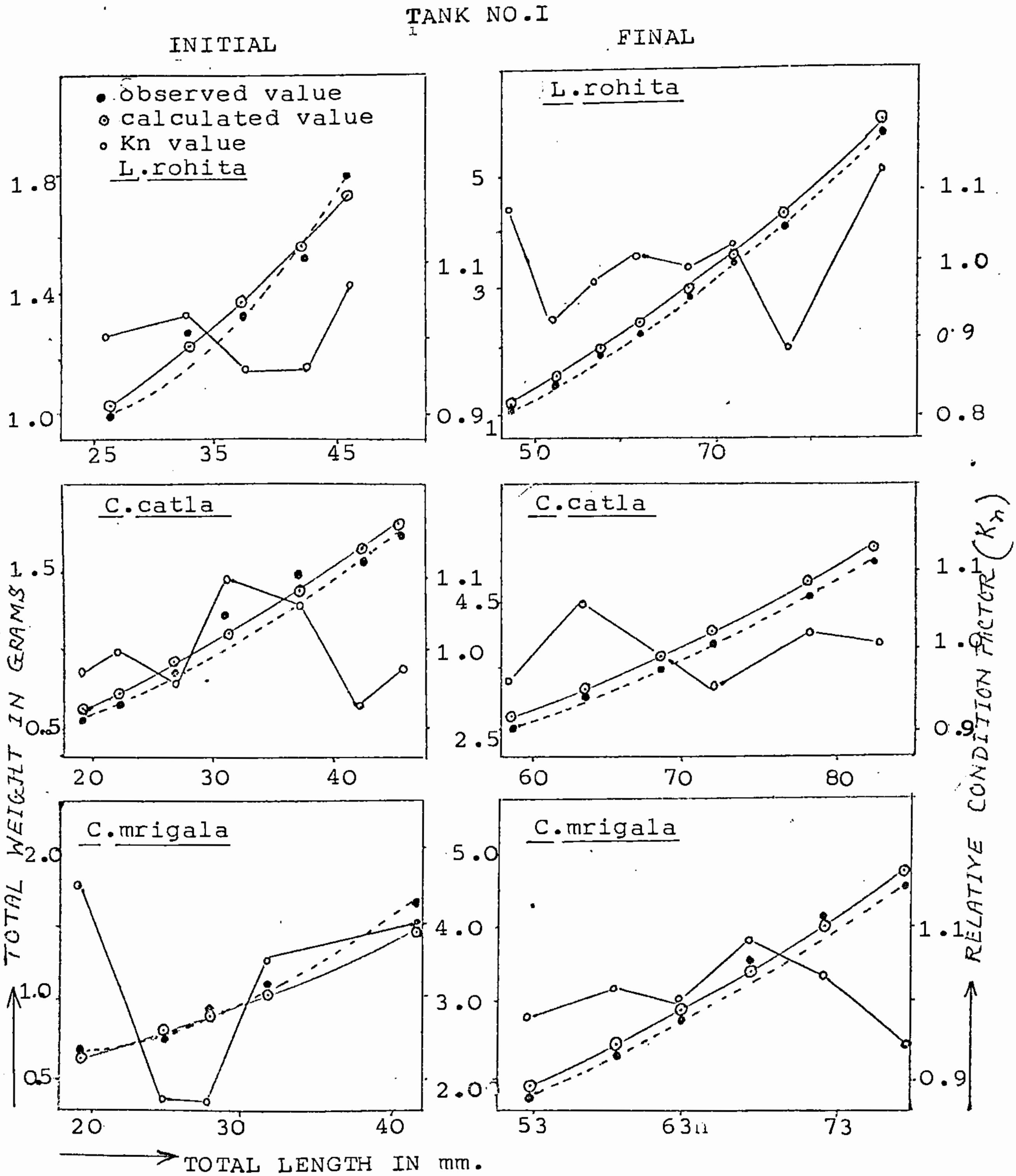


Fig.13 SHOWING THE INITIAL AND FINAL TOTAL LENGTH AND TOTAL WEIGHT RELATIONSHIP AND RELATIVE CONDITION FACTOR(Kn)OF CARPS FRY REARED IN TANK I.

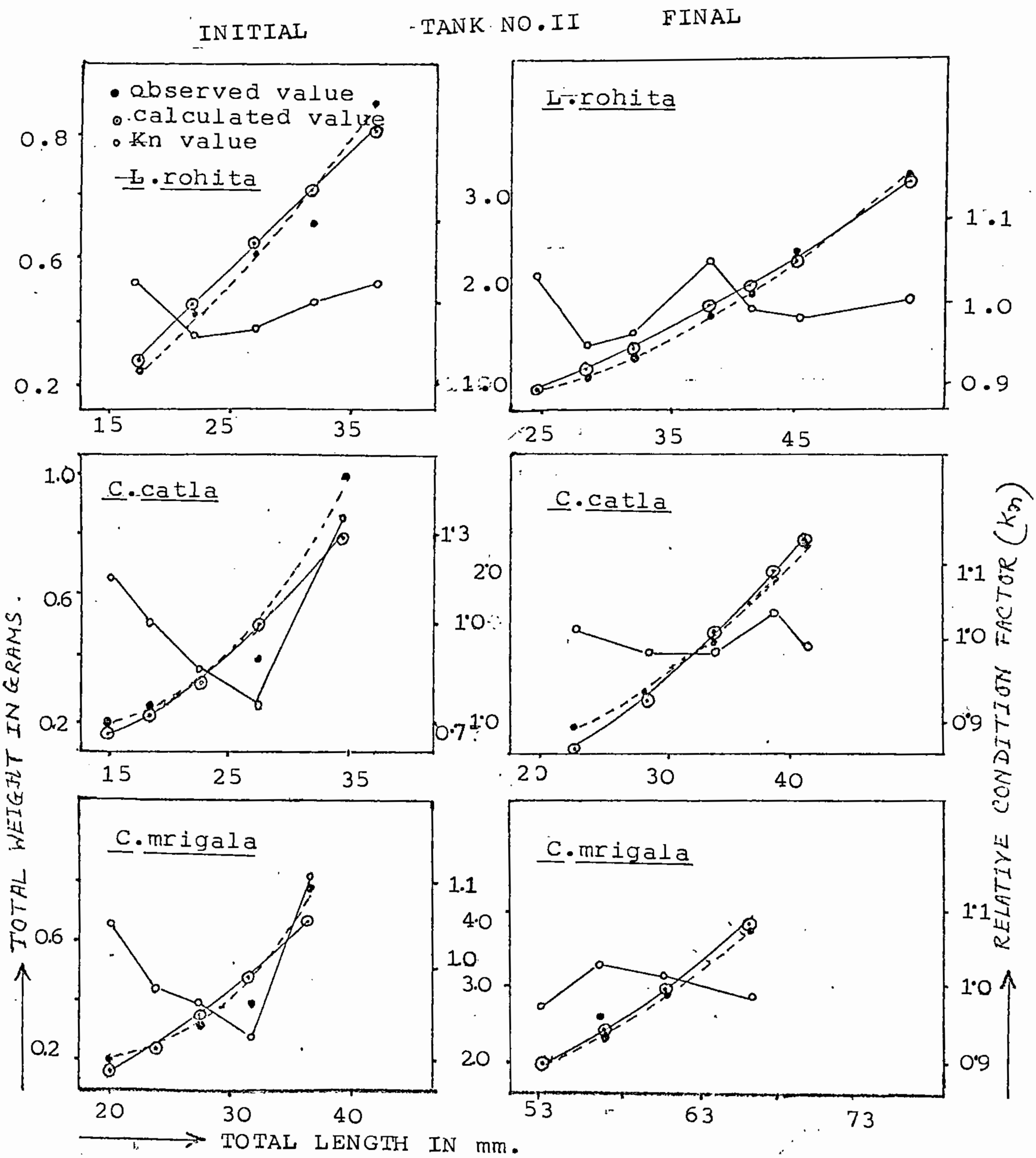


Fig.14. SHOWING THE INITIAL AND FINAL TOTAL LENGTH, TOTAL WEIGHT RELATIONSHIP AND RELATIVE CONDITION FACTOR (Kn) OF CARPS FRY REARED IN TANK II

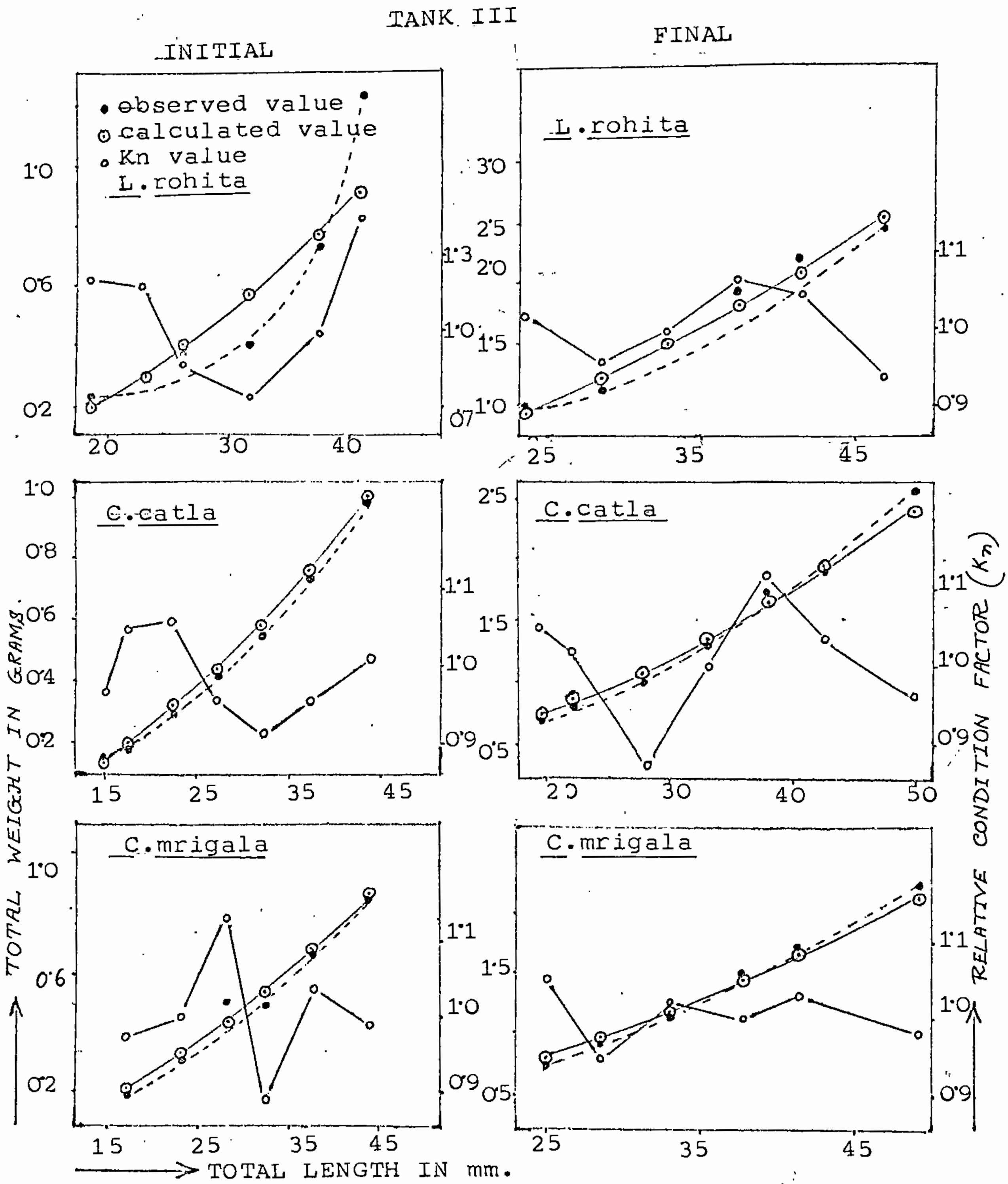


Fig.15. SHOWING INITIAL AND FINAL TOTAL LENGTH AND TOTAL WEIGHT RELATIONSHIP AND RELATIVE CONDITION FACTOR (Kn) OF CARPS FRY REARED IN TANK III.

Table-8 : Length -weight relationship of different carps fry and fingerlings reared in nursery ponds.

Carps species	Pond replication no.	Initial observation				Final observation			
		No. of fishes	Value of log a	Value of log n	Value of r	No. of fishes	Value of log a	Value of log n	Value of r
Labeo rohita	I	175	-2.0976	1.4594	0.9865	151	-2.0298	1.4675	0.9899
	II	115	-1.8766	1.2664	0.9973	101	-2.7915	1.8909	0.9834
	III	130	-1.7321	1.1651	0.9853	112	-2.0608	1.4882	0.9898
	IV	137	-1.7517	1.1826	0.9844	101	-1.9652	1.4348	0.9773
	V	115	-1.8836	1.2711	0.9912	96	-2.1386	1.5301	0.9910
Catla catla	I	101	-1.9907	1.3421	0.9991	94	-2.4129	1.6834	0.9343
	II	130	-1.9283	1.3257	0.9880	124	-0.9358	0.6863	0.8453
	III	110	-1.9052	1.2943	0.9887	97	-2.0610	1.4935	0.9972
	IV	83	-1.7172	1.1431	0.9664	79	-2.0854	1.5067	0.9932
	V	105	-2.0401	1.3933	0.9827	84	-1.9414	1.4268	0.9934
Cirrhina mrigala	I	48	-2.0024	1.3475	0.9863	41	-1.5581	1.1649	0.9624
	II	55	-1.6571	1.1166	0.9760	42	-2.4187	1.6904	0.9774
	III	55	-1.8633	1.2640	0.9804	37	-2.1599	1.5388	0.9952
	IV	55	-1.9123	1.2899	0.9941	42	-2.8502	1.9396	0.9952
	V	75	-1.8468	1.2603	0.9782	41	-2.8319	1.9105	0.9869

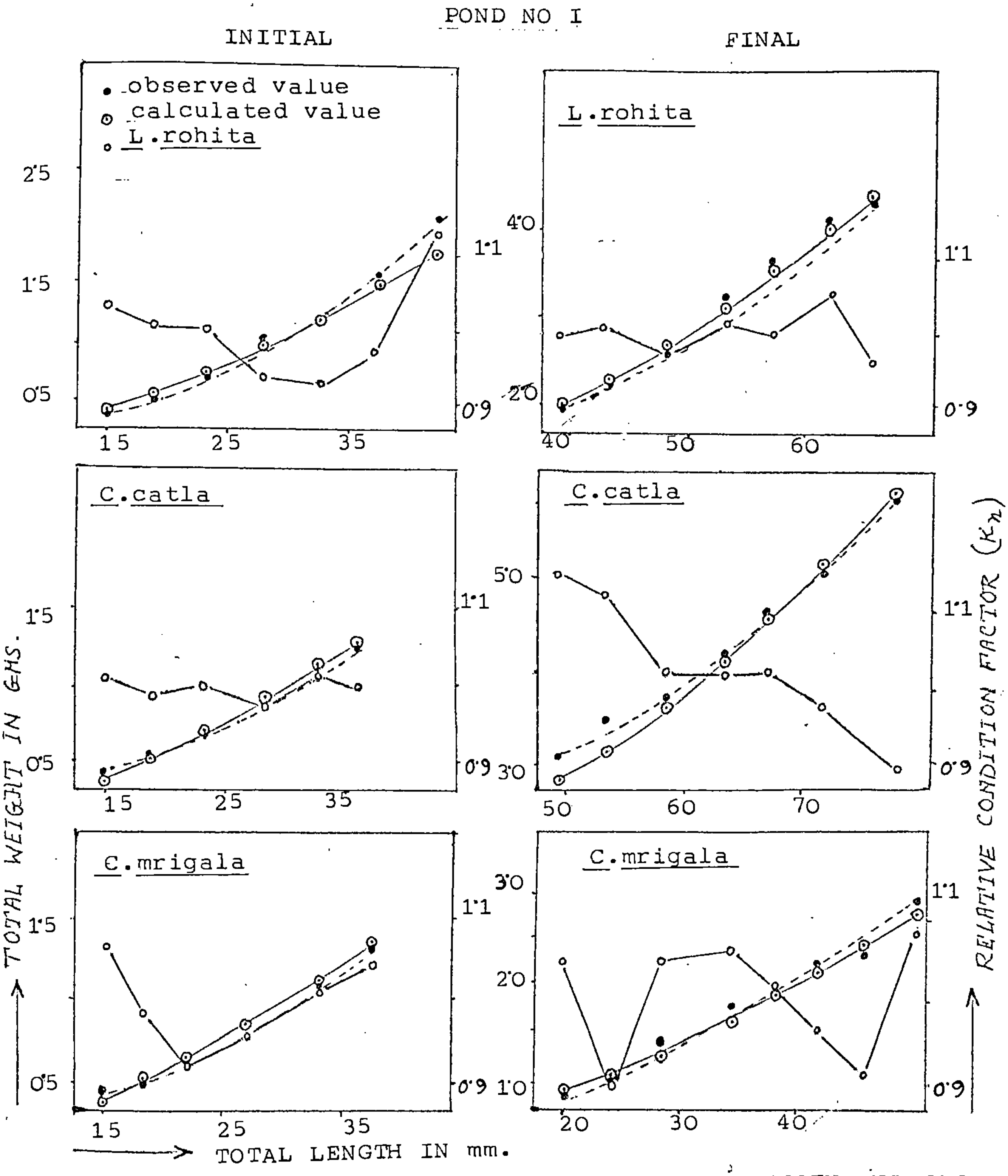


Fig.16. SHOWING THE INITIAL AND FINAL TOTAL LENGTH AND TOTAL WEIGHT RELATIONSHIP AND RELATIVE CONDITION FACTOR (Kn) OF CARPS FRY REARED IN POND I.

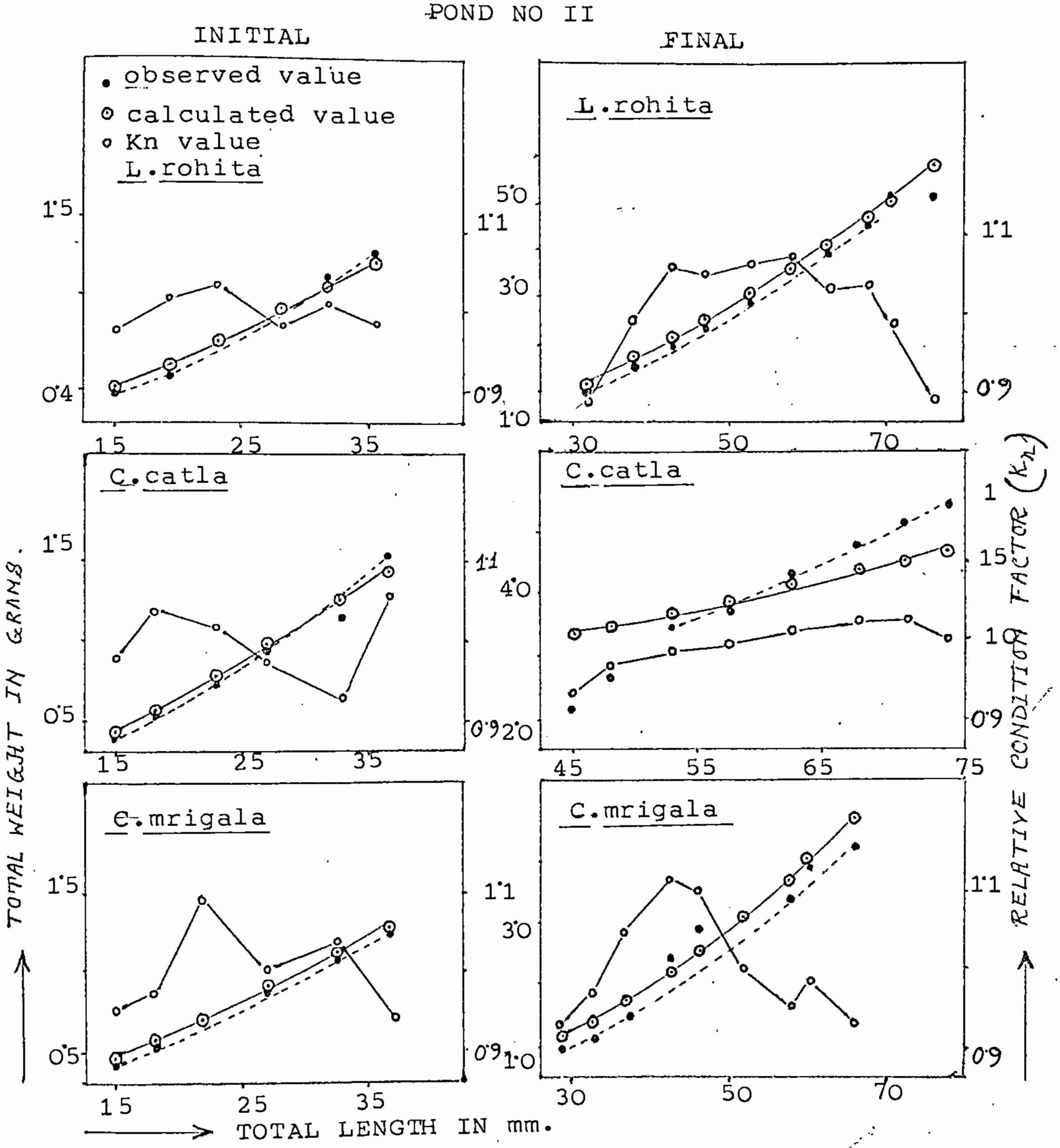


Fig.17.SHOWING INITIAL AND FINAL TOTAL LENGTH AND TOTAL WEIGHT RELATIONSHIP AND RELATIVE CONDITION FACTOR (Kn)OF CARPS FRY REARED IN POND NO II

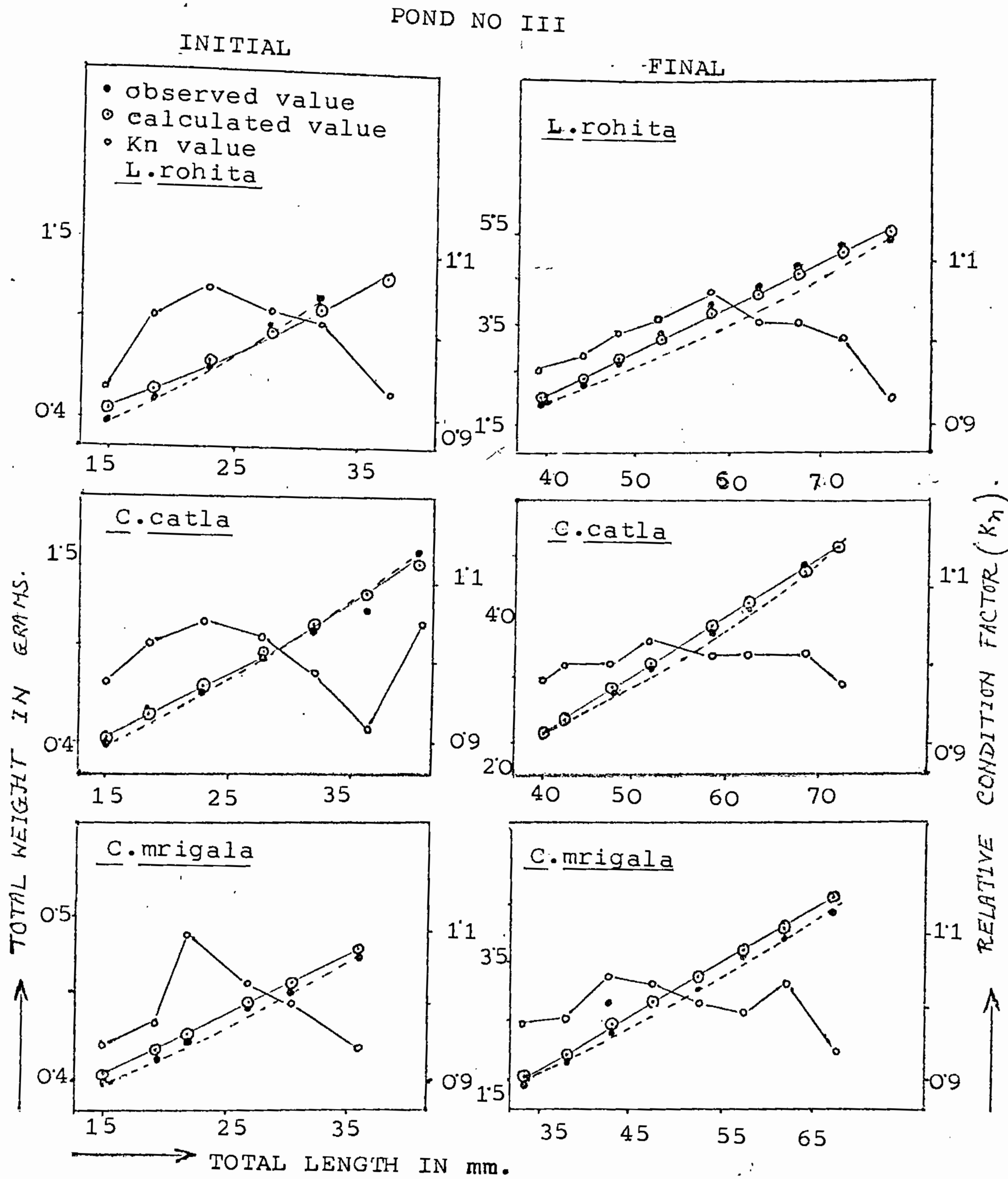


Fig.18. SHOWING INITIAL AND FINAL TOTAL LENGTH AND TOTAL WEIGHT RELATIONSHIP AND RELATIVE CONDITION FACTOR (Kn) OF CARPS FRY REARED IN POND III.

POND NO IV

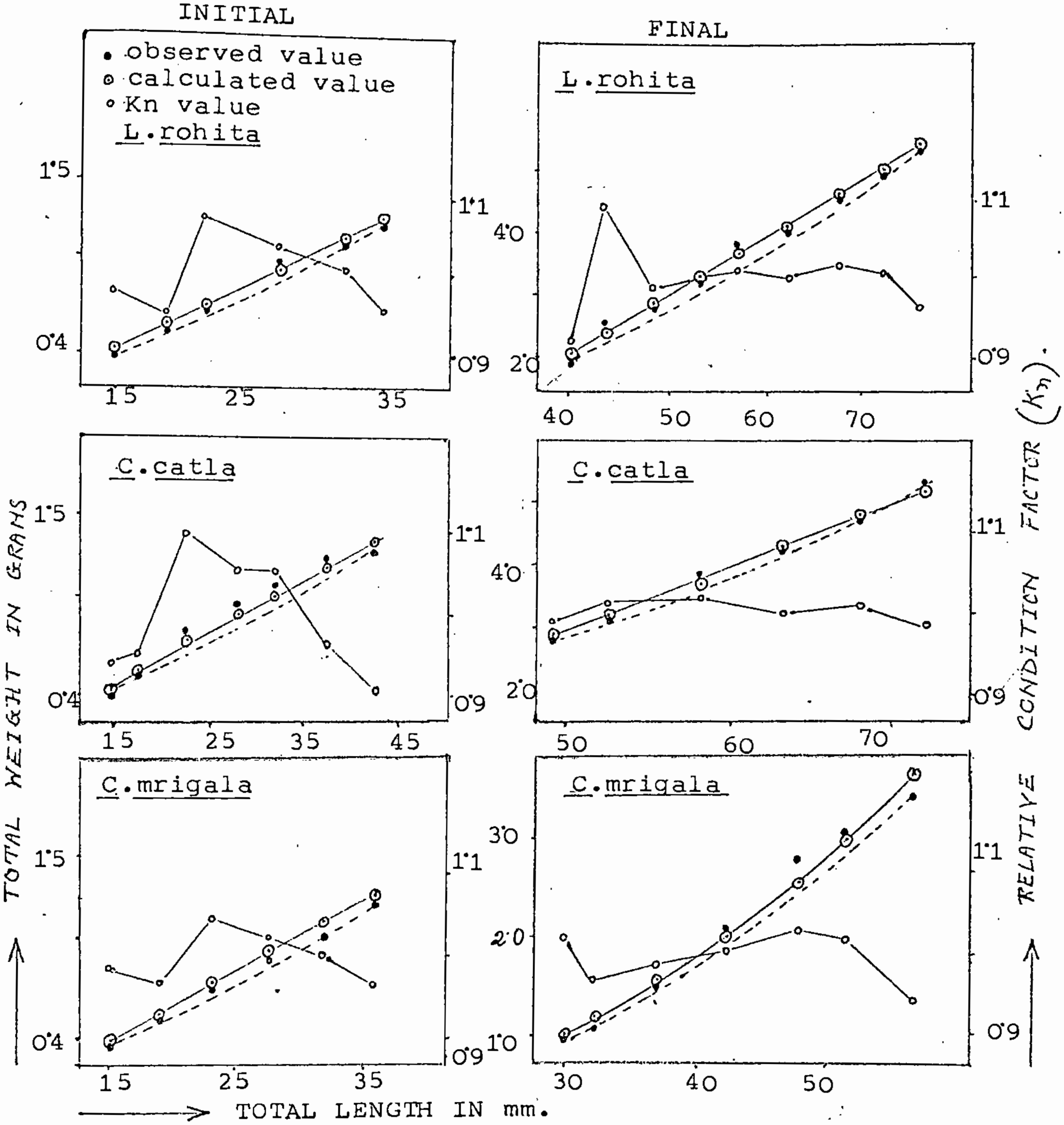


Fig.19.SHOWING INITIAL AND FINAL TOTAL LENGTH AND TOTAL WEIGHT RELATIONSHIP AND RELATIVE CONDITION FACTOR (Kn)OF CARPS FRY REARED IN POND IV.

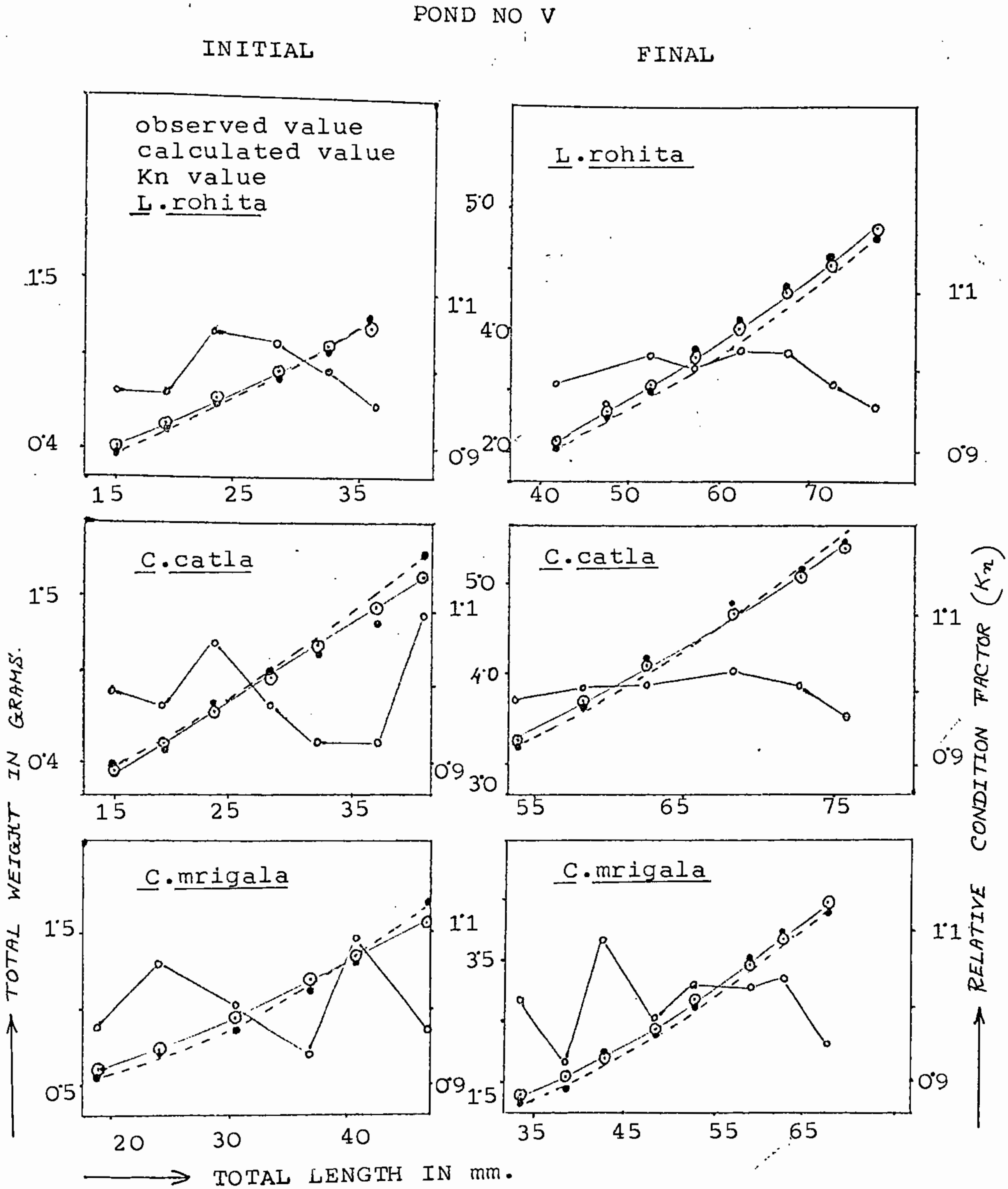


Fig.20.SHOWING INITIAL AND FINAL TOTAL LENGTH AND TOTAL WEIGHT RELATIONSHIP AND RELATIVE CONDITION FACTOR (Kn)OF CARPS FRY REARED IN POND V.

Mrigal, log w = - 4.1127 + 2.5324 log L

r = .9819

and lowest value was found in tank no.III.

Rohu, log w = - 1.9478 + 1.4005 log L

r = .9819

Catla, log w = - 1.7002 + 1.2145 log L

r = .9471

Mrigal, log w= - 2.1406 + 1.4606 log L

r = .9920.

Final observation in pond, highest " log a " and "n" value was found in case R.C.and M in pond no. V,

Rohu, log w = - 2.1386 + 1.5301 log L

r = .9910

Catla,log w = - 1.9414 + 1.4268 log L

r = .9934

Mrigal,log w = - 2.4187 + 1.6904 L

r = .9774.

The analysis of variance between total weight of three carp species and rearing ponds and tanks have been calculated. It is found from the Appendix table VII and VIII that the growth of three species differ significantly ($P < 0.01$) between species in case of fishes

Appendix table-VII : Analysis of variance of T.Wt. between carp species and tanks.

Carps species	Tanks I	II	II	Total	Mean ± S.E.
Labeo rohita	23.28	12.60	10.04	45.92	15.31 ± 3.31
Catla catla	22.69	7.15	10.03	39.87	13.29 ± 3.90
Cirrhina mrigala	19.05	5.81	8.14	33.00	11.00 ± 3.33
Total	65.02	25.56	28.21	118.79	
Mean	21.67	8.52	9.40	39.60	
± S.E.	± 1.08	± 1.69	± 0.52	± 3.05	

C.F. = 1567.896 $\qquad$ SSS^2 = 27.86

TSS^2 = 363.101 $\qquad$ tss^2 = 324.35

Source of variance	Sum of square	Degrees of freedom	Mean of square	Variance ratio (F).
Between sp.	27.86	2	13.93	5.12 NS.
Between tank	324.35	2	163.175	59.62 ** ($P < 0.01$)
Residual	10.89	4	2.72	
Total	363.101	8		

LSD = 3.577 (tank)

Appendix table-VIII: Analysis of variance of Total weight between carps species and ponds.

Carps sp.	Ponds					Total	Mean ± S.E.
	I	II	III	IV	V		
Labeo rohita	22.28	33.51	33.58	33.47	31.31	154.15	30.83 ± 1.95
Catla catla	31.29	35.84	28.65	23.03	26.74	145.55	29.11 ± 1.93
Cirrhina mrigala	14.41	24.69	23.87	17.42	21.95	102.34	20.47 ± 1.76
Total	67.98	94.04	86.10	73.92	80.00	402.04	
Mean ± S.E.	22.66 ± 3.98	31.35 ± 2.77	28.7 ± 2.29	24.64 ± 3.84	26.67 ± 2.21	134.01 ± 13.09	

C.F = 10775.74 SSS^2 = 308.36

TSS^2 = 573.83 PSS^2 = 138.32

Source of variance	Sum of square	Degree of freedom	Mean of square	Variance ratio (F).
Between sp.	308.36	2	154.18	9.70 ** ($P < 0.01$)
Between ponds	138.32	4	34.58	2.18 NS.
Residual	127.15	8	15.89	
Total	573.83	14		

LSD = 4.8835.

reared in ponds. The least significant value LSD has been calculated at 1% probability is 4.88, which indicate that the mean growth (total weight) of Rohu and Catla significantly differ with Mrigal . But in case of tanks the total weight of the fishes significantly differed ($P < 0.01$) among the tanks instead of species with LSD at 1% probability in 3.58, that means average growth (total weight) in tanks 1 significantly differ with tanks II and III.

(B) Relative condition factor (kn):

Initial and final relative condition factor (Kn), condition factor for observed (K) value and calculated (K) value of R.C and M in three tanks and five nursery ponds have been shown in Tables 9,10 and 11 respectively. In tank, initial highest Kn value were found in carp species on tank II, i.e., Kn = 1.0245. In final observation highest Kn value were found in carp species of tank III, Kn = 1.0038.

In initial pond observation, lowest Kn value was found in carp species of pondI, i.e., Kn = 1.0001. Highest Kn value was found in carp species of pond no. IV, i.e., Kn =1.0028. In final pond observation highest Kn value was found in carp species of pond II, i.e., Kn =1.1034

Table no. 9 : Mean initial and final total length-weight relationship, relative condition factor (kn) and condition factor K, κ (observed & calculated) for three major carps fry reared in tanks.

Measurement	Tank replication no.	Carp species: Size group	Carp species: Total	Log TL	Log wt.	Calculated log wt.	Calculated wt	Value of Kn	Condition factor for observed (K)	Condition factor for calculate wt (k)
INITIAL MEASUREMENT	I	R-5	40	1.5660	0.1334	0.1331	1.3801	1.009	2.9214	2.9160
		C-7	40	1.4932	0.0282	0.0282	1.1445	1.0013	4.0124	4.0588
		M-5	20	1.4631	-0.0418	-0.0418	0.9519	1.0083	4.1978	4.1091
	II	R-5	42	1.4301	-0.2354	-0.2354	0.6543	1.0004	3.1053	3.1012
		C-5	40	1.3546	-0.4505	-0.4505	0.4085	1.0245	3.3566	3.262
		M-5	32	1.3486	-0.4654	-0.4657	0.3823	1.0223	3.3431	3.2597
	III	R-6	40	1.4592	-0.3335	-0.3335	0.5284	1.0217	2.0961	2.3064
		C-7	35	1.4224	-0.3329	-0.3329	0.5108	1.0029	2.0807	2.0789
		M-6	35	1.4650	-0.3846	-0.3846	0.4973	1.0025	2.4924	2.4840
FINAL MEASUREMENT	I	R-8	36	1.8108	0.4075	0.4075	2.8875	1.0025	0.9490	0.9466
		C-6	28	1.8461	0.5662	0.5661	3.7801	1.0006	1.074	1.0734
		M-6	17	1.8136	0.4802	0.4802	3.1761	1.0009	1.0976	1.0966
	II	R-7	34	1.1566	0.2210	0.2210	1.7995	1.0007	3.5655	3.5612
		C-5	35	1.5048	0.1655	0.8273	1.5392	1.0003	4.7141	4.7114
		M-4	29	1.4851	0.122	0.1525	1.4527	1.0003	5.1329	5.1339
	III	R-6	37	1.5344	0.2012	0.2012	1.6727	1.0009	4.2529	4.2519
		C-7	29	1.5025	0.1245	0.1044	1.4268	1.0038	4.8092	4.8189
		M-6	24	1.5419	0.1115	0.1115	1.3562	1.0004	3.2365	3.2343

Table no. 10 : Mean initial total length -weight relationship, relative condition factor (kn) and condition factor K, k (observed and calculated) for three major carps fry reared in nursery ponds.

Pond replication no.	Carp species: Size Group	Carp species: Total	Log TL	Log Wt.	Calculated Log wt.	Calculated wt.	Kn	Condition Factor for observed(K)	Condition factor for calculated (k)
I	R-7	175	1.4236	-0.0199	-0.0199	1.0767	1.0018	5.9646	5.9319
	C-6	102	1.3917	-0.1229	-0.1229	0.8164	1.0001	5.7621	5.7589
	M-6	48	1.3885	-0.1314	-0.1314	0.8082	1.0012	5.8379	5.7975
II	R-6	115	1.3898	-0.1166	-0.1166	0.8205	1.0002	5.9677	5.9773
	C-6	130	1.3923	-0.0828	-0.0828	0.8982	1.0011	6.3438	6.3396
	M-6	55	1.3895	-0.1055	-0.1055	0.8339	1.0016	6.2683	6.3656
III	R-6	130	1.3938	-0.1083	-0.1083	0.8345	1.0010	6.0906	6.1222
	C-7	110	1.4215	-0.0654	-0.0654	0.9408	1.0011	5.5458	5.5549
	M-6	55	1.3849	-0.1128	-0.1127	0.8259	1.0011	6.1739	6.1960
IV	R-6	137	1.3914	-0.1062	-0.1062	0.8354	1.0011	6.1460	6.1643
	C-7	83	1.4288	-0.084	-0.098	0.8881	1.0028	5.2427	5.2834
	M-6	55	1.3904	-0.1189	-0.1189	0.8206	1.0005	5.9196	5.9280
V	R-6	115	1.3917	-0.1146	-0.1146	0.8241	1.0007	5.8842	5.9153
	C-7	105	1.4256	-0.0538	-0.0537	0.9800	1.0002	5.4646	5.4505
	M-6	75	1.4674	0.0025	0.0024	1.0625	1.0013	4.4593	4.4514

Table no. 11 : Mean final total length-weight relationship, relative condition factor (Kn) and condition factor K, k (observed & calculated) for three major carps fry reared in nursery ponds.

Pond Replication no.	Carp species		Log TL	Log Wt.	Calculated Log wt.	Calculated wt.	Kn	Condition factor for observed (K)	Condition factor for calculated (k)
	Size Gr.	Total							
I	R-7	151	1.7158	0.4882	0.4239	3.1819	1.0004	2.2773	2.2768
	C-8	94	1.7697	0.5663	0.5663	3.9178	1.0047	1.8904	1.8877
	M-8	41	1.5337	0.2285	0.2286	1.7958	1.0024	5.0071	4.9885
II	R-10	101	1.7282	0.4763	0.4763	3.3768	1.0021	2.0473	2.0482
	C-9	124	1.7431	0.5842	0.5842	3.8866	1.1034	3.2799	3.1429
	M-9	42	1.6658	0.3972	0.3972	2.7502	1.0024	2.6736	2.6755
III	R-9	112	1.7545	0.5503	0.5503	3.7333	1.0006	2.0435	2.0452
	C-8	97	1.7381	0.5348	0.5348	3.5825	1.0002	2.1918	2.1926
	M-8	37	1.6963	0.4504	0.4504	2.9857	1.0006	2.4312	2.4331
IV	R-9	101	1.7527	0.5495	0.5495	3.7186	1.0012	2.0804	2.0792
	C-6	79	1.7781	0.5936	0.5935	4.0053	1.0002	1.8548	1.8549
	M-7	42	1.6234	0.2985	0.2985	2.1781	1.0005	2.7587	2.7583
V	R-8	96	1.7723	0.5732	0.5732	3.9150	1.0004	1.8841	1.8845
	C-6	84	1.8108	0.6422	0.6421	4.4567	1.0001	1.6532	1.6533
	M-8	41	1.6915	0.3992	0.3998	2.7444	1.0013	2.1832	2.1811

and lowest Kn value was found in carp species of pond no.V, i.e., Kn = 1.0001.

(C) Specific growth rate (SGR) : Yield of fishes and Mortality/survival percentage :

Table 12 presents the specific growth rate of individual species of individual tanks and ponds. From table 12 it is found that in tank I, the SGR of R.C and M as 0.6729, 1.3178 and 1.0833 respectively were better than the other tanks. The total SGR of tank I was 3.074 with mean 1.0247 ± 0.1885.

In pond, highest SGR were found in pond V, i.e., R = 0.6812, C = 0.8742 and M = 0.5903. Total SGR of pond V were 2.1457, mean 0.7152 ± 0.0837. Lowest SGR were found in Pond I, i.e., R = 0.6956, C = 0.6585 and M= 0.1442 with mean 0.4995 ± 0.1780.

Table 13 and figure 21 presents the estimated gross production (egp), calculated net production (cnp) and net yield (ny). After 94 days rearing in tanks, maximum net yield (ny) in tank I was 112.50 (37.51 ± 7.12). In ponds after 155 days rearing maximum net yield (ny) =138.96 (46.32 ± 7.36) found in pond V. Lowest net yield (ny) = 100.65 (33.55 ± 3.29) found in pond IV.

Table-12 : The specific growth rate (SGR) of carps fry and fingerlings reared in each individual tanks and ponds.

Tank and pond replication no.	Time (Days)	Carps species	Log_e Final weight Mean (±S.E)	Log_e Initial weight Mean (± S.E)	Specific growth rate (SGR)	Total Mean (±SE)	Remarks
Tank.							
I	94	*R	0.9391 ± 0.1919	0.3066 ± 0.0916	0.6729	3.074	* Satisfactory (Optimum)*
		*C	1.3036 ± 0.1039	0.0649 ± 0.1577	1.3178	1.0247 ± 0.1885	
		*M	1.1229 ± 0.1433	-0.1046 ± 0.1701	1.0833		
II	94	R	0.4642 ± 0.1646	-0.5419 ± 0.2516	-0.0827	-1.5469	NOT Satisfactory.
		C	0.3812 ± 0.1625	-1.0371 ± 0.2905	-0.6978	0.5156 ± 0.2174	
		M	0.3517 ± 0.1224	-1.0721 ± 0.2622	-0.7664		
III	94	R	0.4632 ± 0.1472	-0.7676 ± 0.2545	-0.3238	-1.6527	Not Satisfactory
		C	0.1464 ± 0.2615	-0.8855 ± 0.2602	-0.7863	0.5509 ± 0.1336	
		M	0.2567 ± 0.1409	-0.7667 ± 0.2045	-0.5426		
Pond I	155	R	1.1241 ± 0.1076	-0.0459 ± 0.2090	0.6956	1.4984	Not satisfactory
		C	1.3038 ± 0.1434	-0.2830 ± 0.1850	0.6586	0.4995 ± 0.1780	
		M	0.5261 ± 0.1366	-0.3026 ± 0.1942	0.1442		
II	155	R	1.0967 ± 0.1697	-0.2685 ± 0.1732	0.5343	1.7126	Satisfactory
		C	1.3452 ± 0.0998	-0.1906 ± 0.1882	0.7449	0.5709 ± 0.0918	
		M	0.9145 ± 0.1628	-0.2428 ± 0.1611	0.4334		
III	155	R	1.2671 ± 0.1150	-0.2498 ± 0.1699	0.6563	1.8552	Satisfactory
		C	12315 ± 0.1145	-0.1507 ± 0.1799	0.6973	0.6184 ± 0.0596	
		M	1.0371 ± 0.1320	-0.2596 ± 0.1710	0.5016		
IV	155	R	1.2652 ± 0.1131	-0.2446 ± 0.1659	0.6585	1.6823	Not Satisfactory
		C	1.3667 ± 0.0923	-0.1933 ± 0.1654	0.7570	0.5608 ± 0.1497	
		M	0.6872 ± 0.1787	-0.2737 ± 0.1801	0.2668	0	
V	155	R	1.3197 ± 0.1161	-0.2639 ± 0.1735	0.6812	2.1457	*Satisfactory (Optimum)*
		C	1.4788 ± 0.0798	-0.1238 ± 0.1950	0.8742	0.7152 ± 0.0837	
		M	0.9205 ± 0.1652	0.0056 ± 0.1530	0.5903		

* R = Rohu * C = Catla * M Mrigal.

Table-13 : The estimated gross production (egp), calculated net production (enp) and net yield (ny) of three carps fry reared in tanks and nursery ponds.

Tank/pond replication number.	Carps fry species	Estimated gross production(egp)	Calculated net production(enp)	Net yield (ny)	Total Mean (± S.E)	Remarks
Tank 1	*R	34.55	55.28	48.37	112.52	*Satisfactory (optimum)*
	*C	56.07	48.06	40.05	37.51 ±7.12	
	*M	24.10	28.92	24.10		
II	R	16.40	22.96	19.68	34.32	Not Satisfactory
	C	10.80	10.80	8.64	11.44 ±4.19	
	M	10.00	8.00	6.00		
III	R	19.86	19.86	16.55	52.90	Not Satisfactory
	C	24.57	24.57	21.06	17.63 ± 1.75	
	M	18.42	18.36	15.29		
Pond 1	R	53.13	53.13	45.54	113.93	Not satisfactory
	C	29.40	39.20	34.30	37.98 ±3.78	
	M	29.22	38.96	34.09		
II	R	29.52	49.20	39.20	122.40	Satisfactory
	C	32.40	48.60	43.20	40.80 ±1.22	
	M	30.00	45.00	40.00		
III	R	30.00	45.00	40.00	115.83	Satisfactory
	C	46.13	52.72	46.13	38.61 ±4.79	
	M	29.70	34.65	29.70		
IV	R	30.06	45.09	40.08	100.65	Not satisfactory
	C	43.47	37.26	31.05	33.55 ±3.29	
	M	29.52	34.44	29.52		
V	R	51.54	68.32	59.78	138.96	* Satisfactory (Optimum)*
	C	48.23	41.34	34.45	46.32 ±7.36	
	M	38.34	51.12	44.73		

*R = Rohu *C = Catla * M = Mrigal.

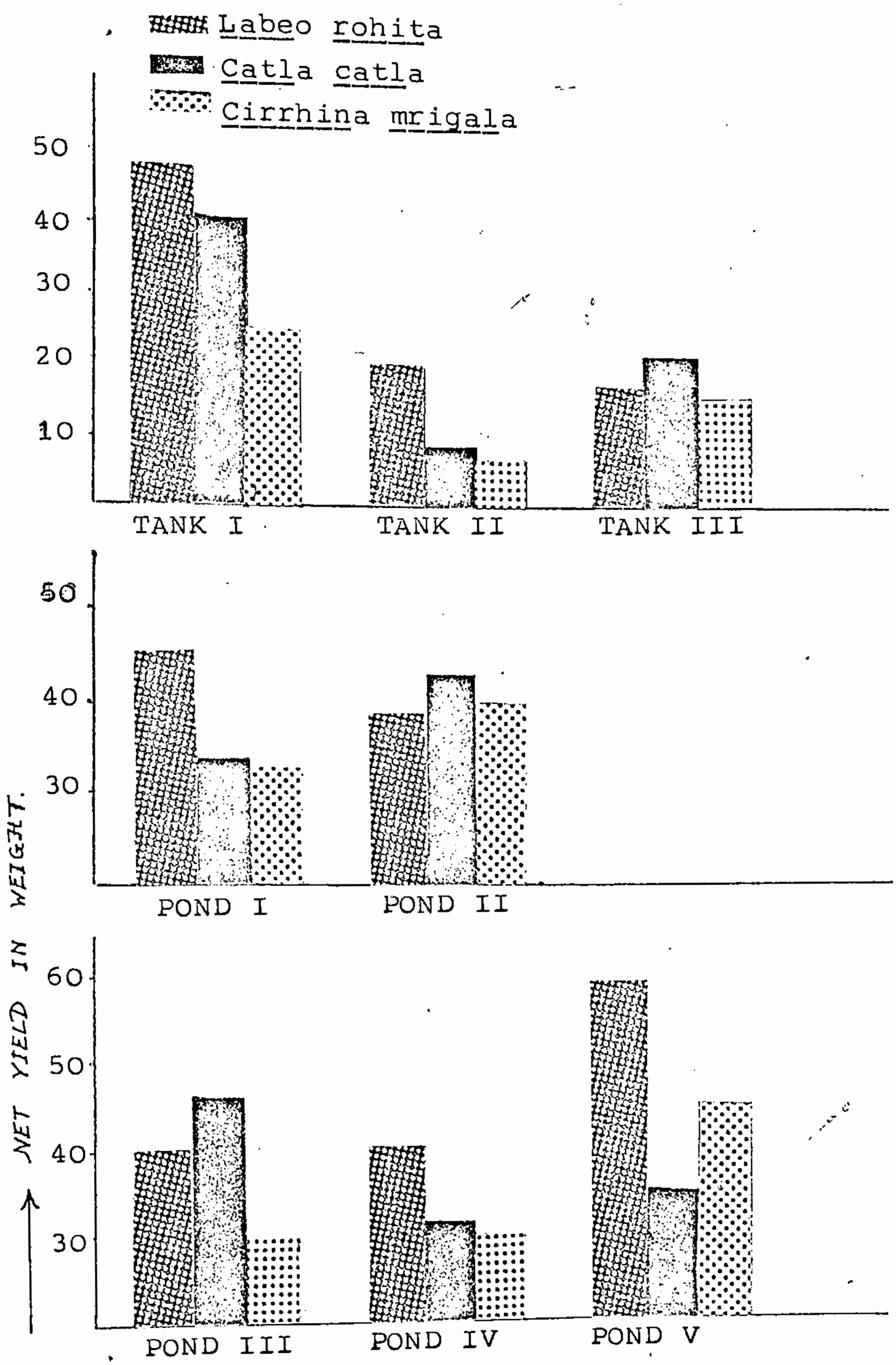


Fig.21.NET YIELD(IN WEIGHT)OF *Labeo rohita*, *Catla catla* AND *Cirrhina mrigala* IN THREE TANKS AND FIVE PONDS.

Table-14 : The mortality of fry and fingerlings at different stocking rates in tanks and ponds.

Tank and pond replication no.	Date of stocking	Stocking rate	Species with no. of per tank/pond	Date of harvesting	Survival per tank/pond No.	Survival per tank/pond Percentage	Mortality of three species	Percentage Average mortality
Tank								
I	16-6-84	100	* R - 40	29-9-84	36	90.00	4	10.00
			* C - 40		28	70.00	12	30.00
			* M - 20		17	85.00	3	15.00
II	10-7-84	114	R - 42	11-10-84	34	80.95	8	19.05
			C - 40		35	87.50	5	12.50
			M - 32		29	90.62	3	9.38
III	"	110	R - 40	"	37	92.50	3	7.50
			C - 35		29	82.86	6	17.14
			M - 35		24	68.57	11	31.43
Pond								
I	"	324	R - 175	11-12-84	151	86.28	24	13.72
			C - 101		94	93.07	7	6.93
			M - 48		41	85.42	7	14.58
II	"	300	R - 115	"	101	87.83	14	12.17
			C - 130		124	95.38	6	4.62
			M - 55		42	76.36	13	23.64
III	"	295	R - 130	"	112	86.15	18	13.85
			C - 110		97	88.18	13	11.82
			M - 55		37	67.27	18	32.73
IV	"	275	R - 137	"	101	73.72	36	26.28
			C - 83		79	95.18	4	4.82
			M - 55		42	76.36	13	23.64
V	"	295	R - 115	"	96	83.48	19	16.52
			C - 105		84	80.00	21	20.00
			M - 75		41	54.67	34	45.33

* R = Ruhu, * C = Catla, * M = Mrigala.

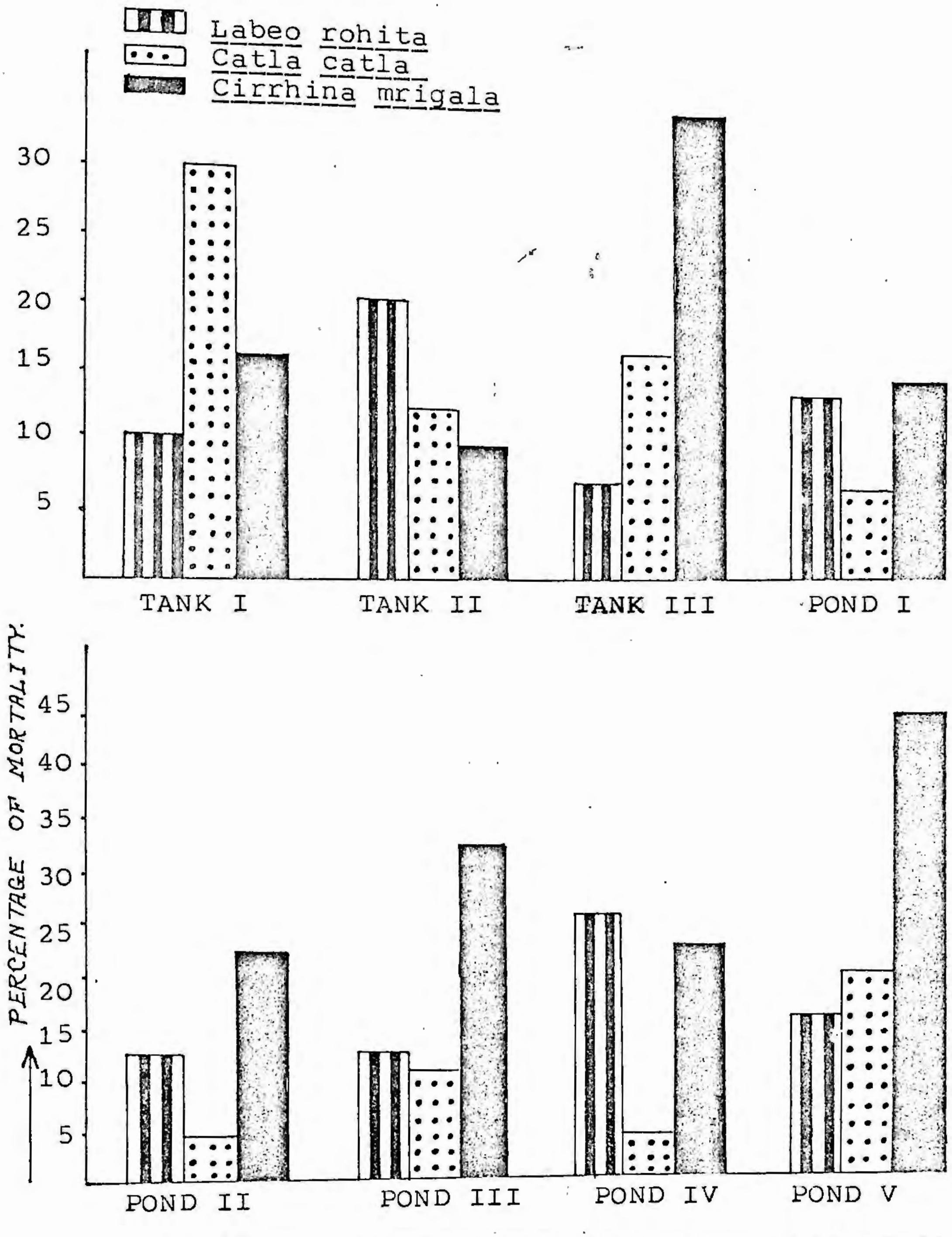


Fig.22. MORTALITY PERCENTAGE OF *Labeo rohita*, *Catla catla* AND *Cirrhina mrigala* IN THREE TANKS AND FIVE PONDS.

Table 14 and figure 22 presents the mortality of fry and fingerlings at different stocking rates in tanks and ponds. Percentage of average mortality was high in tank III i,e., 7.5%,17.14% and 31.43%in R,C and M respectively. Low mortality percentage occure in tank no II i.e., 19.05%, 12.5% and 9.38% in R,C and M respectively.

In pond percentage of average mortality was high in case of R.C and M of pond V i.e., 16.52%, 20.0% and 45.33% respectively. And low in Pond I i.e., 13.72%, 6.93% and 14.58% for R,C and M respectively.

DISCUSSION

Successful rearing of the young carp fry released in nursery ponds is the most important fundamental problem in carp culture in our country.

Shafi and Quddus (1974) showed that the length weight relationship of carp *Catla catla* were highly significant and Islam *et al*.,(1978) reported that *T. nilotica* (L.) showed significant curvilinear relationship between total length and body weight. Hile (1936) and Martin (1949) observed that the value of the regression coefficient "n" usually lies between 2.4 and 4.0. Only an ideal fish maintain the shape n=3. In the vast majority of instances, it has been found that the cube law is not obeyed and "b" is less or more than 3.0 (Le Cren, 1951). It is evident in the present study that the carp species do not follow the cube law exactly and that the value of "n" is less than 3.0, which is also observed by Shafi and Quddus (1974) *Hilsa ilisa* and Quddus *et al*., (1987) on *Labeo rohita*.

The condition factor, also known as the ponderal index or the coefficient of condition, expresses the condition of fish, such as the degree of wellbeing, relative robustness, plumpness or fatness in numerical terms. The factor is also used as an adjunct to age and growth studies (Thompson, 1959) to indicate the suitability of an environment for a species by comprising the values of a given locality with those for a region. This factor is not constant in a great majority of organisms (Doha, 1970). In nature it has been found to vary in an individual, species or a population. It fluctuate periodically with seasons of the year which may be due, among others, to spawning and rebreeding of reproductive system. The value of the factor also varies to some extent with the seasonal changes in appetite and general condition. (Doha and Dewan,1967). Quddus et al.,(1987) observed in the work on Labeo rohita that weight increases comparatively at a higher rate in case of lower length that in case of bigger length.

In the present study the condition factor has been calculated and found a variable result from 1 to 5 in tanks and 5 to 6 in ponds. Determination of the condition factor helps in the convertion of length into weight and vice versa. generally, the specific gravity or density of a fish does not change significantly in its life time. Now one can make fairly accurate determinations of the length and corelate it with the weight, then value of the condition factor, whether it varies or remains constant, will show at once whether there has or has not been a tendency to alternation in the general form or, in other words, a difference in the rates of growth in different direction (Thompson, 1959). In the present study the condition factor in the tank rearing fry widely varied whereas the factor for the fry reared in the ponds is more or less the same for three species, studied.

Interrelationship of population density and individual growth of fish has been studied by Vass-van-ovan (1957) ;Islam et al.,(1978); Hasan et al.,(1982) and Quddus et al.,(1987).

According to Jhingran, (1982),growth of fish depends on the feed available in the cultured medium, both natural and artificial. The average specific growth rate (SGR) attained in three tanks SGR = 2.0912 ± 0.493 and the average specific growth rate attained in five nursery ponds SGR = 1.7788 ± 0.1079 is comparable to that represented by (SGR = 1.3) Sadler and Lynum (1986).

The percentage of the mortality of the stocked fish was fairly low in all the tanks and ponds used in the present study for Rohu and Catla fry which indicates that mortality of those species under the experimental conditions was not as such influenced by stocking densities. But in case of Mrigal in the ponds higher percentage of mortality was observed. However, a direct relationship between stocking rates and mortality was observed. Predation has been recognised by Soong (1951) as the main factor contributing to mortality of fry. Wright and Giles et al., (1986) also reported that the intraspecific predation is an important cause of mortality of pike fry, as suggested by Kipling and Frost (1970) and Craig and Kipling (1983). In the present study since effective measures were taken to prevent predation and poaching of the fry and fingerlings, low rate of mortality was achieved. High percentage of servival of the fry have also been observed by Laksman et al. (1971) in composite culture of Indian major carps and exotic fish of India.

The growth rate of all three species was higher in the ponds than that of the tanks. The growth was the lowest in the tanks may be due to the shortage of food and space per fish. This agrees with the findings of Nakamura et al. (1954); Alikunhi (1957); Kawamoto et al., (1957).

Among three species, catla fingerlings showed a higher growth potential in all the ponds which is in agreement with the observation of Jhingran (1968) and Khan and Jhingran (1975) and Akand (1986).

Maximum specific growth rate SGR= 0.7152 $\pm$ 0.0837 was obtained in pond V, where the stocking rate was 295 (R - 115, C - 105, M - 75) with net yield (ny) = 138.96.

In present work the results indicate that out of three tanks and five nursery ponds maximum production potential in respect of population density are found in tank no. I and pond no. V. Thus the population density as observed in tank no I and pond no. V is acceptable.

CHAPTER -III

EFFECT OF AGRO CHEMICAL (INORGANIC FERTILIZERS) ON THREE MAJOR CARP FRY AND FINGERLINGS, e.g. *Labeo rohita*, *Catla catla* AND *Cirrhina mrigala* : MORTALITY RATE, BEHAVIOUR AND DIFFERENT PHYSICO-CHEMICAL FACTORS.

INTRODUCTION

Chemical fertilization contribute greatly to agricultural production through increases in yield, yet their accumulation in the ecosystem is building up gradually, portending long term effects on the acquatic ecosystem. Irrespective of the mode of contamination of the fresh water environment, various chemicals have a multitude of undesirable and chronic effects on various non terget organisms in the system. Both inorganic and organic fertiligers are used in fish ponds for increased fish production. For many purposes, inorganic fertilizers are believed to be superior to organic fertilizers. The nutrient elements from inorganic fertilizers dissolve more readily in water and consequently produce their effect at once (Akand, 1986). Moreover inorganic fertilization of ponds with N-P-K fertilizers were found to be more economical than feeding with mustard oilcake (Parameswaran et al., 1971).

Considerable information are available about the application of inorganic fertilizers in the fish ponds (Swingle and Smith, 1938; Krugel and Heinrich, 1939; Hasler and Einsele, 1948; Lessent, 1967; Koyama et al., 1968; Okubo et al.,1968). But there is no report available on the use of inorganic fertilizers in the fish ponds of

Bangladesh, with the result that the recommended does of pond fertilization is extrapolated form the results derived from elsewhere and hit or miss works in Bangladesh and its neighbouring countries.

So, the present study was undertaken to find out the effects of three inorganic fertilizers viz, Urea, Triple-supperphosphate and Murate of potash (hereinafter called U, TSP, and MP respectively) on the tolerance range, mortality and behaviour of fry and fingerlings of three major carps, Labeo rohita, Catla catla, Cirrhina mrigala and also the chemical changes of water due to fertilization.

MATERIALS AND METHODS

Collection of fry and fingerlings :

The experiment was conducted for a period of three months (May to July,1988) in laboratory. The carpfry were procured from Co-operative Fisheries Farm, Meher-chandi, Rajshahi. After collection they were brought to the laboratory in an stainless steel pot and released in an earthen tub (1440 mm x 300 mm) with 11 litre water for acclamatization and stocking . The size of the fry were 12 mm to 95 mm in total length and weighed as 0.85 gms. to 7.90 gms. Only the normal fry were used for experiment.

Preparation of experimental tub :

Twelve earthen tubs, each having the capacity of 11 litre water were procured from the local market and placed in the laboratory. They were filled in tap water and kept 7 days before begining on the investigation.

Preparation of doses :

U,TSP and MP were collected from local Bangladesh Agriculture Development Corporation Dealer. Standard doses were worked out as follows : For each of the fertilizer, eight glass beakers (600 ml) were taken with 500 ml tap water in each. Then U and TSP was dissolved at the rate of 1 gm in one beaker, 2gm in another and thus by increasing at the rate of 1 gm upto 8 gms in the last beaker. But in case of MP, 0.1gm to 0.45 gms of fertilizer with an increase of 0.05 gms between them were used to dissolve in eight beakers having 500 ml. of tap water in each. (Table-15)

After tolerence tests the standard doses ere made in the tubs each having 11 litre tap water as follows :

U : 66 gms in 11 litre of tap water.

TSP: 22 gms in 11 litre of tap water.

MP: 9 gms in 11 liter of tap water.

Another treatment was made with mixture of three fertilizers i.e. U, TSP, MP (hereinafter called UTM) as

UTM: 12 gms of U + 8 gms of TSP + 2.25 gms of MP in 11 litre of tap water.

Stocking density :

In each treatment 12 tubs were used having different densities of fry in them . For the purposes three tubs were used by keeping 15 fry in each, three tubs having 20 fry and three tubs were used by keeping 25 fry in each. With each treatment of fertilizers another set of 4 tubs

Table no. 15: Showing the tolerence of Urea (U), Triple-Superphosphate (TSP) and Murate or Potash (MP) by carp fry for preparation of doses.

Name of fertilizer	Observation no,	Density of fry	Fertilizer in gms.	Mortality rate and time of exposure				Behaviour and total gain.
				10 AM	11 AM	12 PM	1 PM	
UREA	1	4	1	Normal	Normal	Normal	Normal	Normal, 4 survive
	2	4	2	Normal	Normal	Normal	Normal	Normal, 4 survive
	*3	4	3	Normal	Normal	Normal	Restless	Normal, 4 survive
	4	4	4	Normal	Restless	1 died	Restless	1 restless and 2 normal
	5	4	5	Normal	Restless	1 died	1 died	Restless, 2 survive
	6	4	6	Normal	Restless	2 died	Restless	Restless, 2 survive
	7	4	7	Normal	1 died	Restless	2 died	Restless, 1 survive
	8	4	8	Normal	Restless	1 died	3 died	Nil
TSP	*1	4	1	Normal	Normal	Normal	Restless	Normal, 4 survive
	2	"	2	Restless	Restless	1 died	2 died	1 survive
	3	"	3	1 died	2 died	1 died	Nil	Nil
	4	"	4	Restless	1 died	1 died	2 died	Nil
	5	"	5	2 died	2 died	Nil	Nil	Nil
	6	"	6	3 died	1 died	Nil	Nil	Nil
	7	"	7	4 died	Nil	Nil	Nil	Nil
	8	"	8	4 died	Nil	Nil	Nil	Nil
MP	1	"	0.10	Normal	Normal	Normal	Normal	Normal, 4 survive
	2	"	0.15	Normal	Normal	Normal	Normal	Normal, 4 survive
	3	"	0.20	Normal	Normal	Normal	Normal	Normal, 4 survive
	4	"	0.25	Normal	Normal	Normal	Normal	Normal, 4 Survive
	5	"	0.30	Normal	Normal	Restless	Restless	Restless, 4 survive
	6	"	0.35	Normal	Restless	Restless	Restless	Restless, 4 survive
	7	"	0.40	Normal	Restless	Restless	Restless	Restless, 4 survive
	*8	"	0.45	Normal	Restless	Restless	1 died	Restless, 3 survive

* Acceptable dose

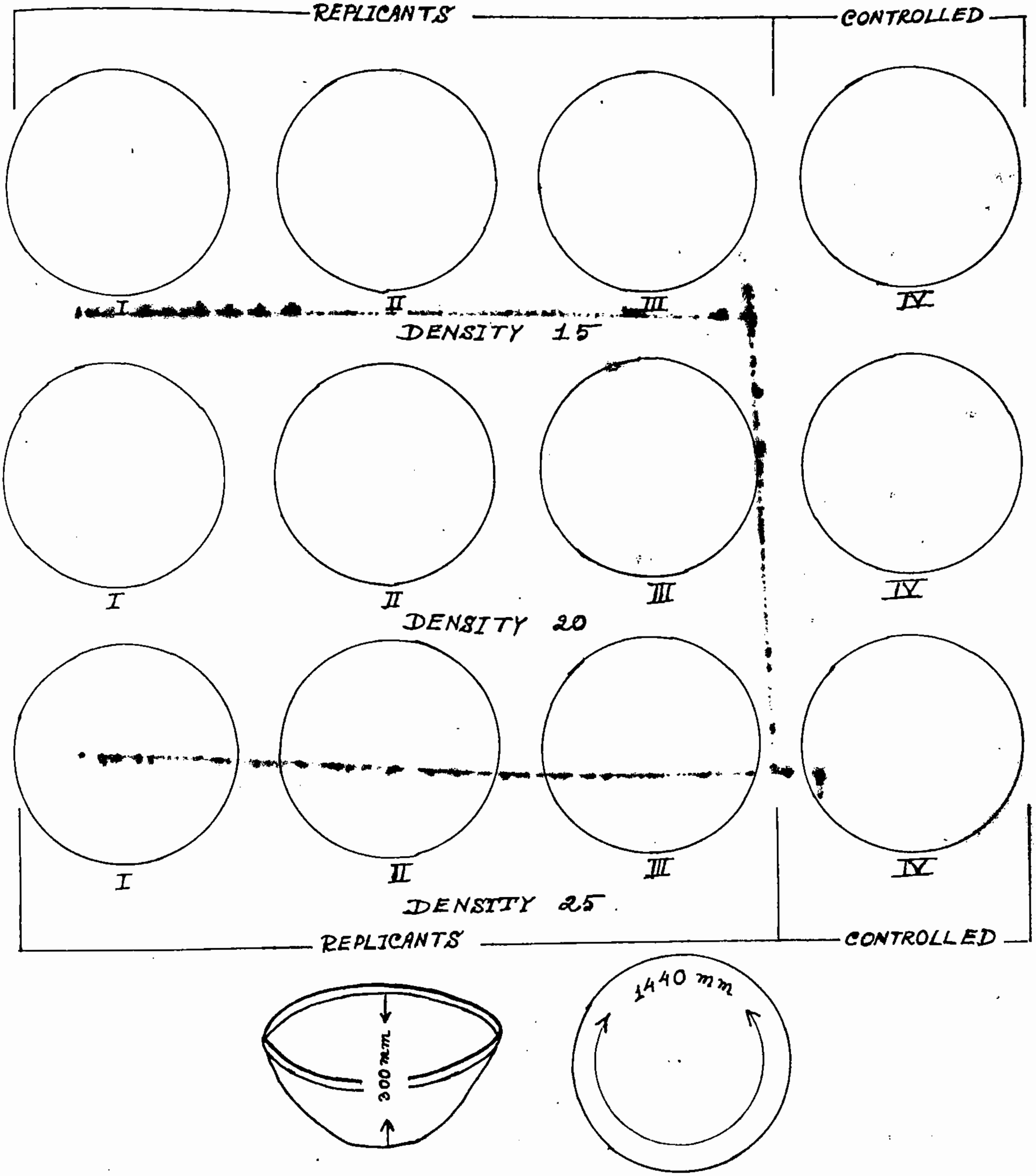


Fig.23 :Arrangement of earthen tubs used in the experiments for the effects of agro-chemicals on three major carps fry.

VIEW OF EXPERIMENTAL EARTHEN TUBS

PLATE V

were also kept control having only 11 litre water with different density of fry stated as above(Fig.23).

The ratios of carps fry of Rohu, Catla and Mrigala (hereinafter called R,C and M respectively) were used as

R : C : M = 7 : 5 : 3 in 15 density,

R : C : M = 10: 6 : 4 in 20 density and

R : C : M = 12: 8 : 5 in 25 density.

In case of U, another set of experiment with 30 and 40 densities of fry were studied having same experimental design and ratios.

Observations were made carefully on mortality and behaviour of fry were recorded constantly for seven days with two hours interval between two observations. Water qualities were recorded daily twice, once in the morning at 7 A.M. and once in the evening at 5 P.M. with water quality cheker (WQC-2A-TOA) total length and weight of dead fry were recorded immediately after death and preserved in 5% formalin.

RESULTS AND OBSERVATIONS

(A). Mortality and Behaviour of Fry and Fingerlings :

i) Urea :

The behavioural response of the carp fry towards dissolved urea was largely dependent on concentration and length of exposer. Decreased aerial excursions and opercula movement was observed as immediate response of fish towards the pollutant. The body weight also decreased in increasing concentration of urea.

Within 18 hours of urea exposure changes in physical behaviour has been demonstrated with excitations, looping and bending of the body jerky movements, tendency to remain at the water surface, anesthetic condition, loss of equilibrium and protrusion of eye ball. Ultimately fry reached to the bottom of the tubs, moving their operculum and mouth and finally died.

Abdomen of the fry were swollen before death, bodies were highly slimy and did not became stiff even after 8 hours of their death. During 7 days experiment it was observed that the survival capacity of fry was larger in case of higher density while it was least in lower density. Daily mortality rate of carp fry in urea on different density were shown in table 16 and the rate of survival in figure 24.

Table-16 : Showing daily mortality rate of carp fry and fingerlings on different density after applying urea during 7 days experiment.

Experimental dates.	Daily mortality rate in percentage on urea.																			
	Fry density-15				Fry density-20				Fry density-25				Fry density-30				Fry density-40			
	Replicants			Cont.	Replicants			Cont.	Replicants			Cont.	Replicant			Cont.	Replicants			Cont.
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
11.7.88	6.66	66.66	06.66	-	15.00	15.00	-	-	04.00	12.00	04.00	-	06.66	-	-	-	02.50	-	-	-
12.7.88	60.00	100.00	73.33	-	55.00	60.00	45.00	-	12.00	28.00	32.00	-	16.00	03.33	06.66	-	15.00	05.00	05.00	-
13.7.88	86.66	-	80.00	-	60.00	85.00	75.00	-	40.00	52.00	88.00	-	26.66	10.00	13.33	-	20.00	10.00	07.50	-
14.7.88	93.33	-	-	-	-	-	80.00	-	56.00	-	96.00	-	30.00	13.00	20.00	-	-	-	-	-
15.7.88	-	-	-	-	-	-	-	-	64.00	56.00	-	-	36.66	20.00	23.33	6.60	25.00	12.50	15.00	-
16.7.88	-	-	-	-	-	-	-	-	68.00	-	-	-	-	-	-	-	30.00	15.00	-	-
17.7.88	-	-	-	-	-	-	-	-	-	-	-	-	50.00	-	26.66	10.0	37.50	17.50	17.50	-
Total	6.6	0	20.00	100.00	40.00	15.00	20.00	100.00	32.00	44.00	04.00	100.00	60.00	80.00	73.30	90.00	62.50	82.50	82.50	100.00
Gain	1	Nil	9	15	8	3	4	20	8	11	1	25	18	24	22	27	25	33	33	40

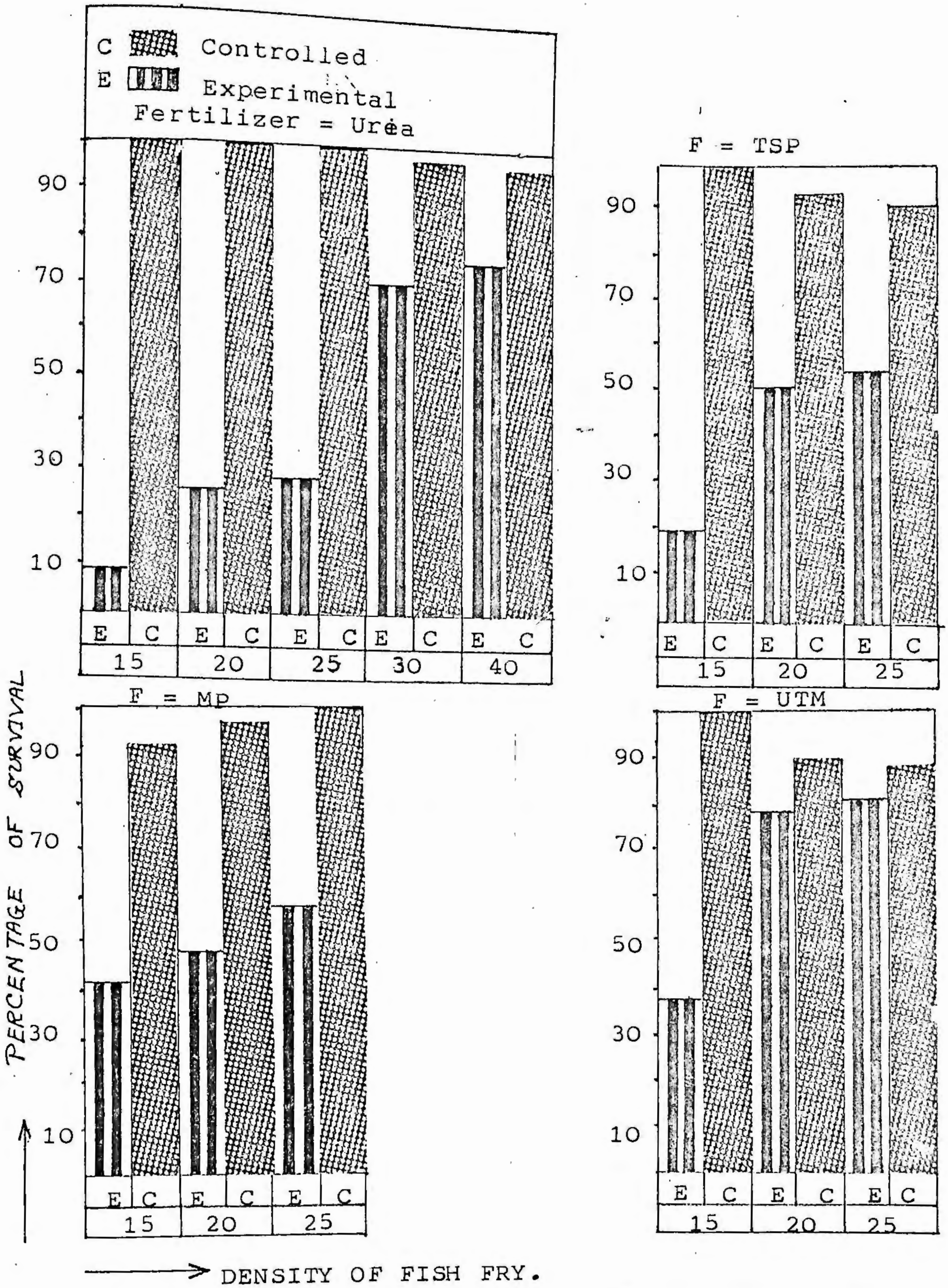


Fig. 24 Percentage of servival in experimental and controlled condition applying fertilizer Urea, TSP, MP and U+T+M (UTM) in different density of fish fry (three replicants and one control in each density).

From table 16 it is evident that the survival rate was highest in controlled tubs. The rate decrease in all treated tubs but in thin density the mortality rate was higher.

ii) <u>Triple Super Phosphate (TSP)</u> :

The behavioural response of the carp fry towards TSP was also extremely dependent on concentration of fertilizer.

After application of TSP, tub water became turbid, whitish in colour . Fry became restless immediately after releasing TSP and begun swimming on the surface of the water tried to jump outside of the tub. Operculum of all the fry raised within few minutes. Fry became anesthetic and reached at the bottom of the tub and within 18 hours about 75% of the fry died indensity 15. Catla fry were comparatively disturbed, died earlier than Rohu and Mrigal fry. After 17 to 18 hours a thick white layer sediment stored at the bottom of the tub., and a thin white membrane was formed on the upper surface of the water. Behaviour of the rest fry slowly became normal and the rate of mortality abruptly decreased.

Fry which were about to die after 20 to 22 hours, gradually revive to their normal condition. Daily mortality of carp fry at different densities in TSP solution has been

Table No. 17 : Shows daily mortality rate of carp fry and fingerlings on different density after dissolving TSP during 7 days experiment.

Experimental dates	Daily Mortality Rate in Percentage in TSP											
	Fry density -15				Fry density-20				Fry density- 25			
	Replicants			Contr.	Replicants			Contr.	Replicants			Cont
	1	2	3	4	1	2	3	4	1	2	3	5
13-7-88	86.66	80.00	40.00	-	55.00	30.00	25.00	-	64.00	28.00	48.00	-
14-7-88	-	86.66	53.33	-	60.00	-	-	-	-	-	-	-
15-7-88	100.00	-	60.00	-	75.00	35.00	35.00	-	76.00	-	52.00	-
16-7-88	-	-	-	-	-	-	-	-	-	-	-	88.0
17-7-88	-	-	66.00	-	-	-	-	-	-	-	-	-
18-7-88	-	-	-	-	-	-	-	-	-	-	-	-
19-7-88	-	-	-	-	-	-	-	05.00		-	-	-
Total	Nil	13.33	33.33	100.00	25.00	65.00	65.00	95.00	24.00	72.00	48.00	92.00
		2	5	15	5	13	13	19	6	18	12	23

presented at table-17 and rate of survival in fig. 24. It may be observed from table-17. In density 15, out of 45 in experimental three tubs seven fry were alive. In density 20, out of 60 fry in 31 fry (Rohu 22 + Catla 5 + Mrigal 4) were alive. In control tub one fry died in the seventh day remaining 19 were alive. In density 25 , out of 75 fry 41 were alive (Rohu 24 + Catla 12 + Mrigal 5). In control tab, two fry were died in the fourth day, remaining 23 were alive. In this case 25 density shows the better result.

iii) Murate of Potash :

Behavioural response of the carp fry and fingerlings towards MP was more or less dependent on concentration and length of exposure.

After dissolving MP, water colour changed to slightly reddish in colour. Fry were normal, swim freely upto 24 hours, then some fry were restless, whirrling in the water, then try to jump outside the tub water. Lastly they loss the equilibrium of their body and lie down at the bottom and died after 10 -15 minutes.

Rohu and Mrigal fry and fingerlings were very sensitive in case of MP but Catla fry were more resistant. After 24 hours reddish sediment appeared in the bottom of the

Table no. 18 : Shows daily mortality rate of carp fry and fingerlings on different density after applying MP during 7 days experiment.

Experimental dates.	Daily Mortality Rate in Percentage in MP											
	Fry density-15				Fry Density-20				Fry density-25			
	Replicants			Contr.	Replicants			Contr.	Replicants			Contr
	1	2	3	4	1	2	3	4	1	2	3	4
16.7-88	20	-	26.66	-	15	-	5	5	16	8	4	-
17.7.88	53.33	13.33	33.33	-	30	45	15	-	44	12	24	-
18.7.88	60	33.33	40	13.33	40	-	30	-	48	-	32	-
19.7.88	66.66	-	-	-	65	-	-	-	-	-	-	-
20.7.88	73	-	46.66	-	75	-	40	-	56	20	36	-
21.7.88	-	-	-	-	-	-	-	-	-	-	-	-
22.7.88	86.66	-	53.33	-	-	-	-	-	60	-	44	-
Total Gain.	13.33	66.66	46.66	86.66	25.00	55	60	95	40	80	56	100
	2	10	7	13	5	11	12	19	10	20	14	25

tub, and fry gradually became normal in behaviour and mortality rate decreased.

Daily mortality rate of carp fry and fingerlings in percentage in MP on different density has been given in table 18 and rate of survival in fig. 24. According to table 18 in density 15, out of 45 fry 19 were alive (Rohu 8 + Catla 9 + Mrigal 2). In control tub 2 fry were died in the fourth day, remaining 13 were alive. In density 20 , out of 60 fry , 28 fry were survived (Rohu 6 + Catla 14 + Mrigal 7). In control tub 1 fry died in first day , remaining 19 were alive. In density 25, out of 75, 44 were alive (Rohu 16 + Catla 20 + Mrigal 8). In control tub, all fry were alive.

iv) <u>Urea + Triple Super Phosphate + Murate of Potash(UTM)</u>

Behavioural response of carp fry and fingerlings towards mixed fertilizer e.g. UTM was also dependent on concentration and time of exposure. After application of mixed fertilizer water became turbid and slightly whitish in colour. Fry became restless immediately after releasing fertilizer. Opercular movement of the fry remarkably high Some fry try to jump outside of the tub, then after being anesthetic reached at the bottom of the tub. Mortality rate was high on first, second and third days. More or less all fry were affected on mixed fertilizer.

Table No.-19 : Shows daily mortality rate of carp fry and fingerlings on different density after applying mixed fertilizer (U+TSP+MP) during 7 days experiment.

Experi-mental dates	Daily Mortality Rate Percents on Urea + TSP +MP											
	Fry density-15				Fry density-20				Fry Density-25			
	Replicants			Contr.	Replicants			Contr.	Replicants			Contr.
	1	2	3	4	1	2	3	4	1	2	3	4
16.7.88	13.33	26.66	26.66	-	5	15	20	-	12	8	4	-
17.7.88	20	33.33	-	-	10	-	25	-	16	-	8	-
18.7.88	-	-	-	-	-	-	-	-	-	-	-	4
19.7.88	-	-	-	-	-	-	-	-	-	-	12	-
20.7.88	26.66	-	-	-	-	-	30	10	-	-	-	12
21.7.88	33.33	46.66	46.66	-	20	20	35	-	24	-	16	-
22.7.88	53.33	66.66	66.66	-	30	25	40	-	28	12	-	-
Total Gain	46.66 7	33.33 5	33.33 5	100 15	70 14	75 15	60 12	90 18	72 18	88 22	84 21	88 22

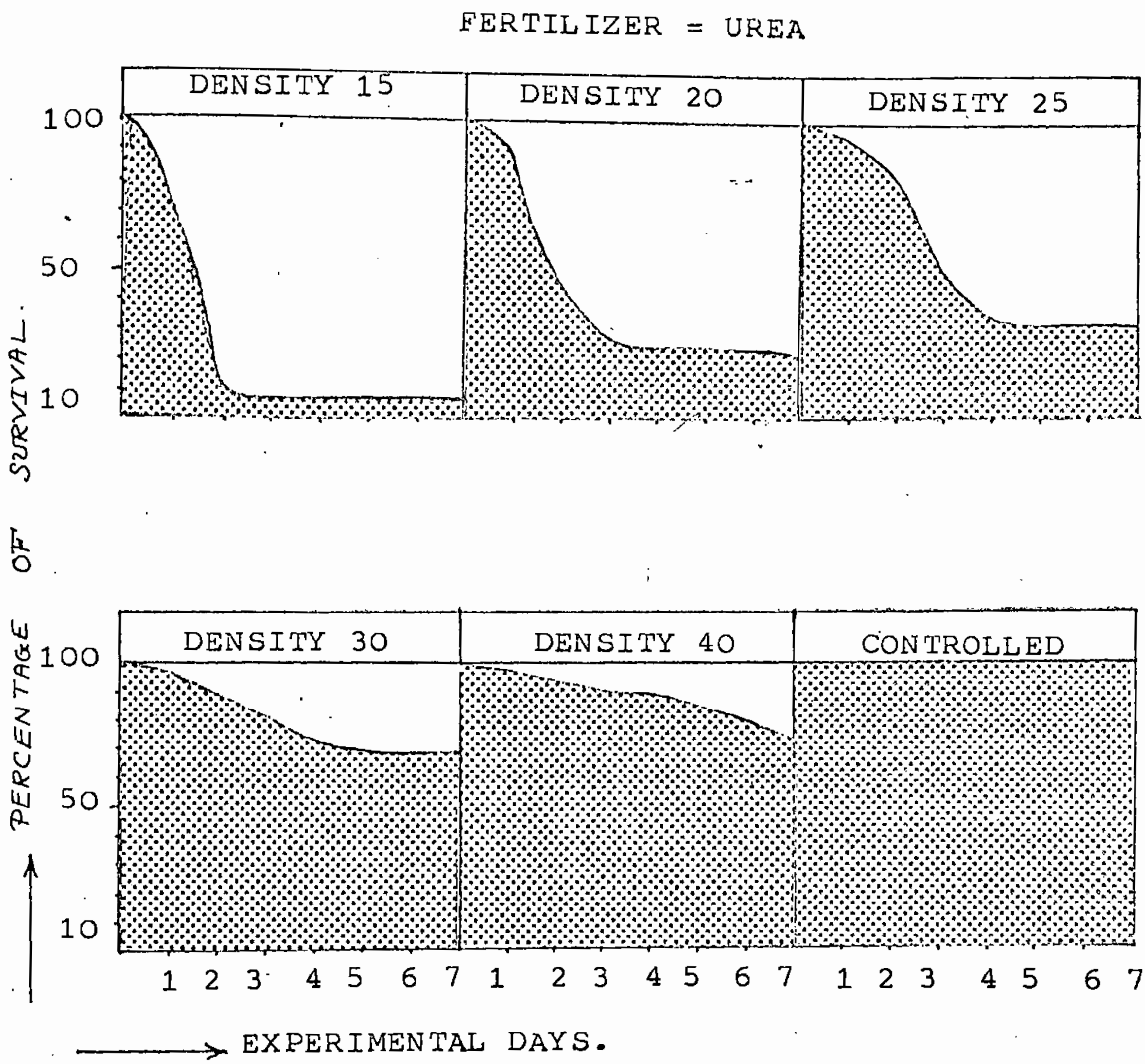


Fig.25. Percentage of mortality in different density of fish fry applying fertilizer Urea on seven days duration (three replicants and one control in each density).

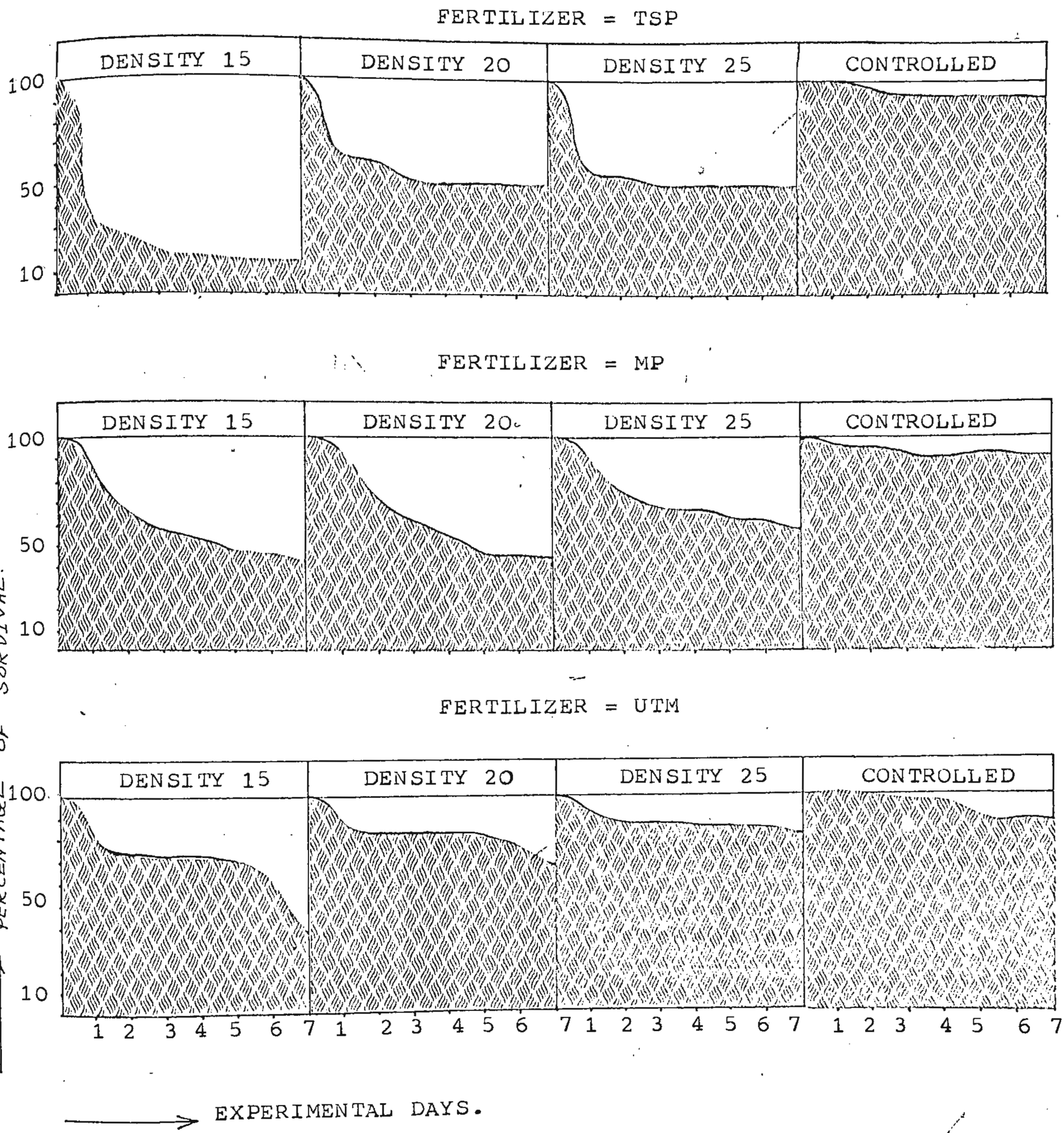


Fig.26. Percentage of mortality of different density of fish fry applying fertilizer TSP.MP and UTM on seven days duration. (three replicants and one control in each density).

Daily mortality rate in percentage and rate of survival are shown on table 19 and figure 24.

In density 15, out of 45 fry, 17 were alive (Rohu 7 + Catla 9 + Mrigal 1). In control tub all 15 fry were alive.

In density 20, out of 60 fry 41 were alive (Rohu 10 + Catla 15 + Mrigal 7). In control tub 2 fry died in the fourth day, remaining all were alive.

In density 25, out of 75 fry , 62 were alive (Rohu 32 + Catla 19 + Mrigal 11). In control tub one fry died in the third day and two fry died in the fifth day, remaining 22 fry were alive.

Daily rate of survival in percentage applying fertilizer Urea, TSP and MP are shown on fig.24 , daily rate of mortality applying Urea in fig.25 and TSP , MP and UTM in fig. 26

(B) Physico-chemical factors of water (water qualities):

The water qualities, viz., pH, temperature, dissolved oxygen and turbidity at different treated and control water were taken and presented in table 20 for U, table 21 for TSP, table 22 for MP and table 24 for UTM.

Table-20 : Showing the water quality due to dissolved urea at differen t densities of fry and fingerlings.

Fry density	Day	pH	Temperature °C	Dissolved oxygen in ppm.	Turbidity in ppm.
15	1	7.15	28.50	1.03	105.66
	2	6.53	27.80	1.13	127.50
	3	6.36	30.50	0.56	118.30
	4	6.42	26.50	1.00	107.00
	5	7.05	28.70	3.40	82.00
	6	7.07	30.20	2.30	117.70
	7	7.02	28.00	1.75	99.70
Mean		6.80	28.60	1.59	108.27
± S.E.		0.32	1.28	0.905	13.79
20	1	7.48	30.50	1.21	105.00
	2	7.00	27.30	1.95	135.16
	3	6.20	30.50	0.90	126.83
	4	6.75	26.60	3.75	111.50
	5	6.55	28.50	2.32	79.00
	6	7.10	29.50	2.05	114.70
	7	6.95	28.00	1.50	86.70
Mean		6.83	28.70	1.95	108.41
±S.E.		0.40	1.42	0.86	18.72
25	1	7.03	31.62	2.08	109.16
	2	7.96	28.66	1.13	126.66
	3	6.16	30.50	0.98	138.16
	4	6.20	28.50	2.40	56.16
	5	6.80	28.60	1.90	82.50
	6	6.80	29.50	1.90	86.83
	7.	6.91	28.00	2.05	109.16
Mean		6.83	29.34	1.78	101.23
± S.E.		0.56	1.20	0.48	25.98
30	1	7.40	30.50	3.53	107.33
	2	7.90	31.30	4.81	110.83
	3	7.45	28.60	3.10	92,66
	4	6.86	28.50	2.68	87.16
	5	6.78	27.40	3.70	83.16
	6	5.35	28.50	3.05	83.66
	7	6.86	28.00	2.83	87.16
Mean		6.94	29.02	3.39	93.14
±S.E.		0.75	1.28	0.67	10.53

Continued

Table 20 continued

Fry density	Day	pH	Temperature °C	Dissolved oxygen in ppm.	Turbidity in ppm.
	1	8.60	31.20	4.21	100.83
	2	7.28	30.50	5.75	103.16
40	3	6.61	28.40	2.98	97.50
	4	6.08	28.40	2.86	81.66
	5	6.88	27.50	3.03	83.00
	6	6.86	28.50	2.38	85.66
	7	6.61	28.00	2.98	97.56
Mean		6.99	28.93	3.46	92.77
±		0.74	1.27	1.07	8.35
	1	7.54	30.20	3.65	89.70
	2	7.74	28.90	3.33	114.50
Control	3	7.52	29.50	2.89	104.40
	4	6.89	28.50	3.48	85.80
	5	7.25	28.60	3.17	90.20
	6	7.07	29.10	2.73	94.40
	7	7.74	28.00	2.53	92.40
Mean		7.39	28.97	3.11	95.91
±S.E.		0.31	0.67	0.38	10.46

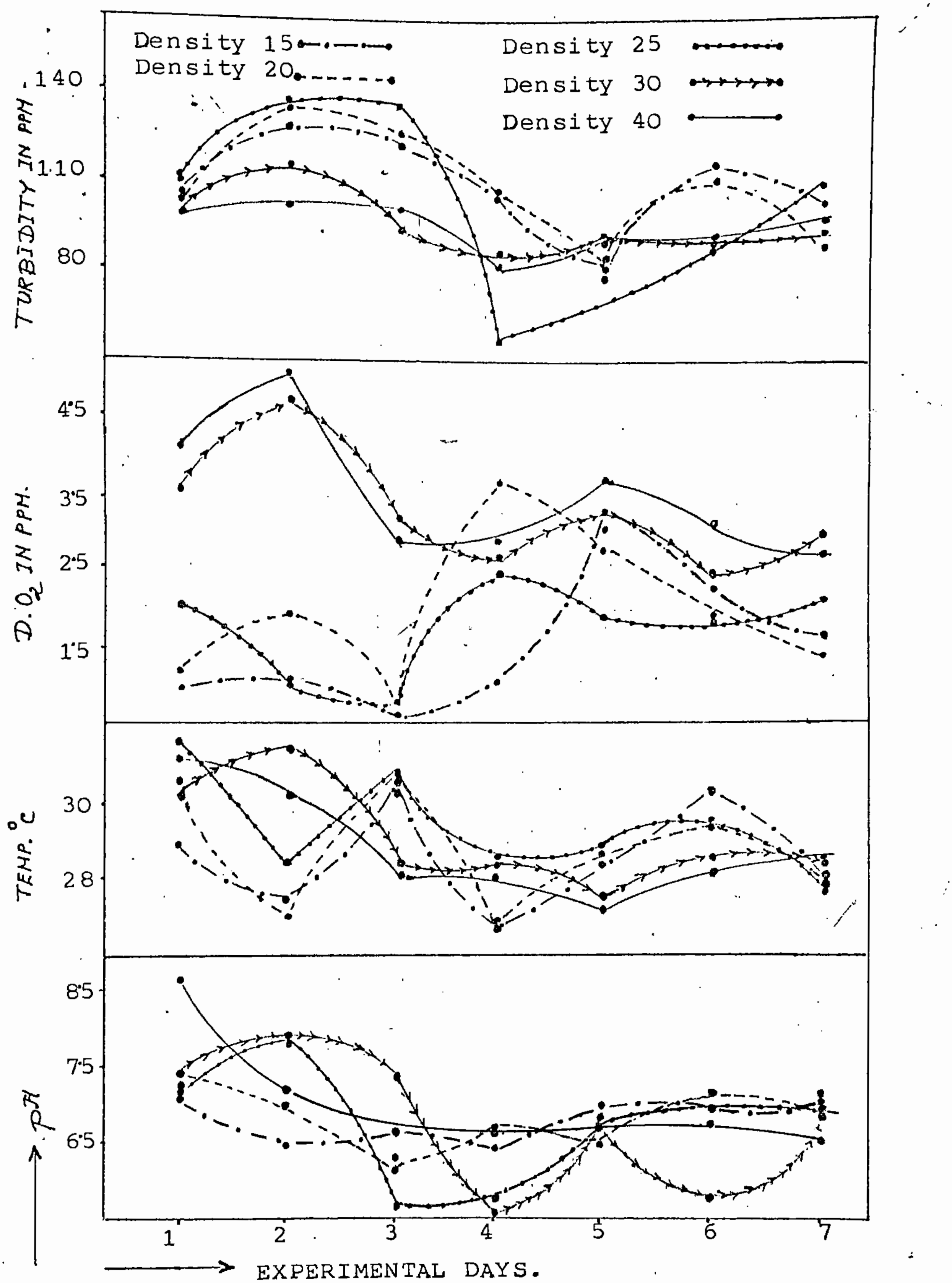


Fig.27 Daily estimation of pH, temperature, dissolved oxygen and turbidity after releasing urea in water.

i) Hydrogen ion concentration (pH):

It was observed that with the addition of fertilizers in tap water the pH value decreased slightly. It is evident from tables 20-24 that the control water in which no fertilizer was mixed, was more or less alkaline. But with the addition of fertilizers the water slightly changed into acidic.

In dissolve urea the pH of water slightly increased with the increased in fry densities . It was 6.8,6.83, 6.83, 6.94, 6.98 in urea treatment water at 15,20, 25,30 and 40 density of fry. In case of TSP it was 7.6, 7.04 and 6.83 at 15,20 at 25 densities of fry , whereas it was 7.29, at control. When MP dissolved in tap water the pH value decreased with respect to control and it was 6.86, 6.85, 6.87 and 7.28 at treated water at 15.20 and 25 densities and control respectively. And in case of UTM, it was 6.73, 6.75, 6.61 and 7.46 at treated water of 15.20 and 25 fry densities and in control respectively

ii) Temperature in °C :

It was observed that fertilizer of water had no effect on water temperature. The mean water temperature at dissolved urea solution was 28.8 at 15 fry density, 28.7 at 20 fry density and 29.34 at 25 fry density., Table-21 : Showing the water quality due to dissolved TSP at different densities of fry and fingerlings.

Fry density	Day	pH	Temperature °C	Dissolved oxygen in ppm	Turbidity in ppm.
15	1	7.06	29.50	0.35	108.66
	2	5.75	27.50	1.45	127.00
	3	7.46	31.50	2.26	109.16
	4	7.06	29.50	2.55	125.66
	5	7.05	28.50	2.47	127.00
	6	6.87	29.50	3.62	105.00
	7	8.20	27.50	2.40	91.50
Mean		7.06	29.07	2.16	113.43
±		0.68	1.29	0.94	12.59
20	1	6.88	29.50	0.40	140.83
	2	6.15	28.50	2.01	130.50
	3	7.00	31.50	2.78	118.00
	4	6.75	29.50	2.63	115.83
	5	6.50	28.50	2.05	120.83
	6	8.00	29.20	2.13	117.16
	7	8.06	27.50	2.61	88.66
Mean		7.05	29.17	2.09	118.83
± S.E.		0.67	1.15	0.75	14.87
25	1	6.25	29.50	0.38	177.17
	2	6.86	28.50	2.01	122.00
	3	6.78	31.00	2.55	120.33
	4	6.71	29.50	1.85	95.50
	5	6.75	29.00	1.91	118.16
	6	6.85	28.50	2.13	98.83
	7	7.66	27.50	3.86	83.33
Mean		6.84	29.07	2.09	116.47
± S.E.		0.39	1.02	0.95	28.23
Control	1	7.18	29.66	2.78	115.66
	2	7.03	28.33	3.71	115.33
	3	6.88	31.16	3.45	97.33
	4	7.73	29.50	3.58	111.16
	5	7.18	28.83	3.25	93.33
	6	7.41	28.33	3.83	91.33
	7	7.68	27.50	2.86	72.00
Mean		7.29	29.04	3.35	99.45
± S.E.		0.29	1.10	0.38	14.70

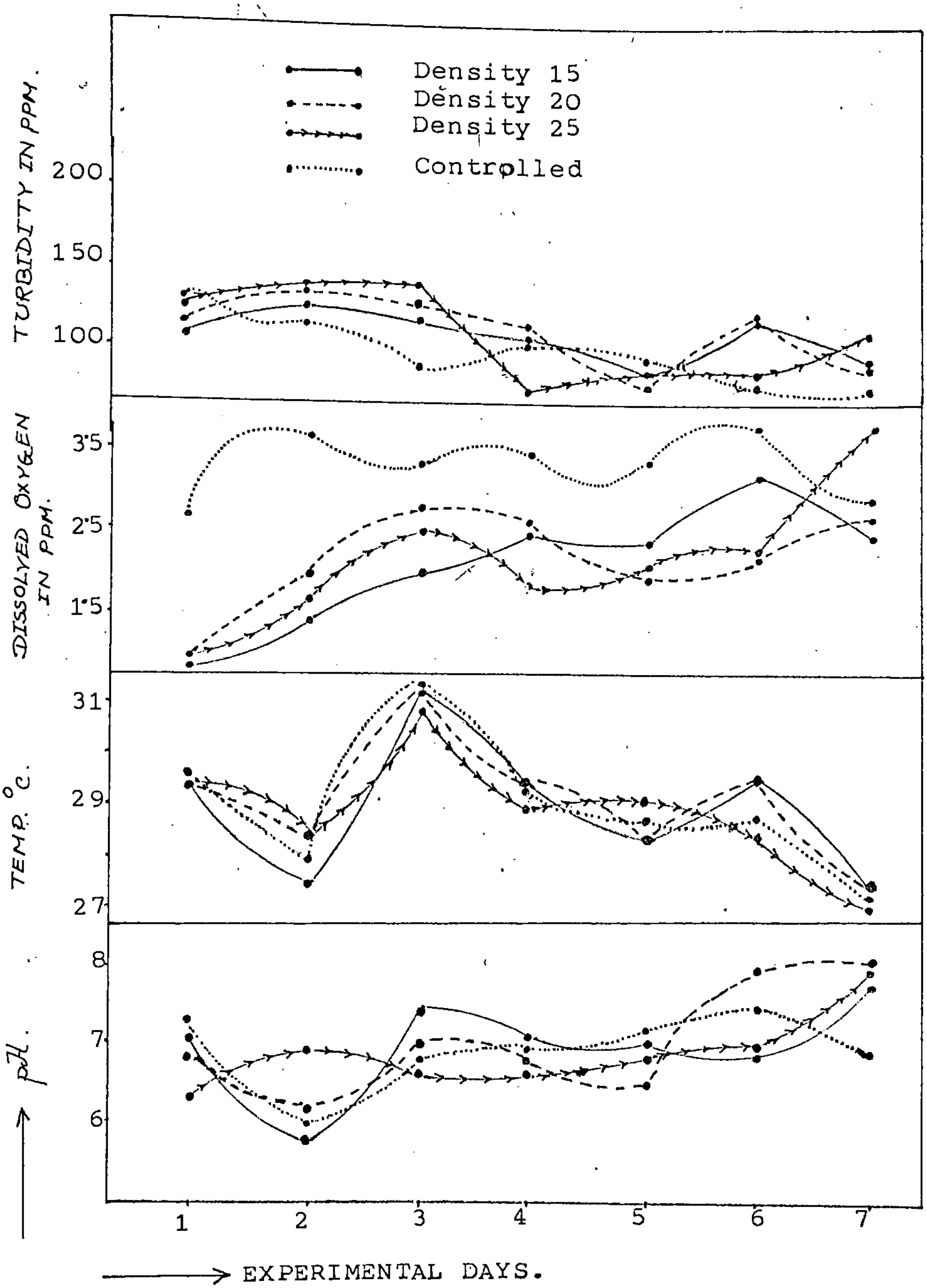


Fig.28. Daily estimation of pH, temperature, dissolved oxygen and turbidity after releasing TSP in water.

28.97 at 30 fry density 28.92 at 40 fry density, whereas it was 28.97 at control. In case of TSP it was 29.07, 29.17, 29.07 and 29.04 at 15,20,25 and control respectively, In case of MP water temperature was 28.96, 29.02, 28.83 and 28.84 at 15.20 , 25 fry densities and at control respectively. At UTM treated water, temperature was 28.48, 28.47, and 28.56 at 15.20 and 25 fry densities respectively against 27.96 at control.

iii) Dissolved oxygen (DO_2) in ppm.

It was observed that in urea treatment, dissolved oxygen in the water gradually decreased upto fourth day, then again increased. It was also observed that due to increased in density of fry , dissolved oxygen also increased . It was 1.33 ppm, 1.73 ppm 1.77 ppm, 3.38 ppm and 3.46 ppm at 15,20,25,30 and 40 fry densities respectively against 3.11 ppm in control.

In case of TSP, on the first day in all treated tubs, the DO_2 decreases on first day and from the second day a gradual increase took place (table-21). DO_2 in ppm was recorded as 2.16, 2.08, 2.09, and 3.35 ppm at 15,20, and 25 densities respectively and in control.

Table-22 : Showing the water quality due to dissolve MP at different densities of fry and fingerlings

Fry density	Day	pH	Temperature °C	Dissolved oxygen in ppm	Turbidity in ppm
15	1	8.05	31.50	5.41	106.33
	2	7.08	29.50	3.33	117.00
	3	6.71	27.50	2.40	101.33
	4	6.50	30.20	4.45	115.50
	5	7.03	30.50	5.85	118.60
	6	6.63	27.60	5.73	110.50
	7	6.03	26.50	5.93	87.66
Mean		6.86	29.04	4.73	108.13
±S.E.		0.58	1.72	1.29	10.12
20	1	6.80	30.50	3.51	107.50
	2	7.98	28.50	3.16	105.60
	3	7.06	28.80	2.88	119.50
	4	6.58	30.20	4.66	121.66
	5	6.69	30.80	5.33	106.66
	6	7.28	28.00	6.01	99.16
	7	5.60	26.80	6.08	89.66
Mean		6.86	29.09	4.51	107.11
±S.E.		0.67	1.36	1.24	10.25
25	1	6.81	31.50	3.88	111.50
	2	7.08	29.20	4.26	100.60
	3	6.88	27.20	3.25	115.30
	4	6.90	29.50	4.50	123.50
	5	7.00	30.30	5.30	92.00
	6	7.45	27.50	6.31	95.33
	7	5.98	27.20	6.10	86.50
Mean		6.87	28.91	4.80	103.53
± S.E.		0.41	1.55	1.06	12.53
Control	1	7.81	30.80	5.48	97.83
	2	6.98	29.20	4.33	118.33
	3	7.98	27.80	4.20	105.83
	4	6.83	29.30	5.76	109.33
	5	7.15	30.30	5.21	97.00
	6.	7.75	27.80	6.23	99.00
	7	7.91	26.70	6.56	93.66
Mean		7.48	28.84	5.39	102.99
± S.E.		0.45	1.37	0.82	8.01

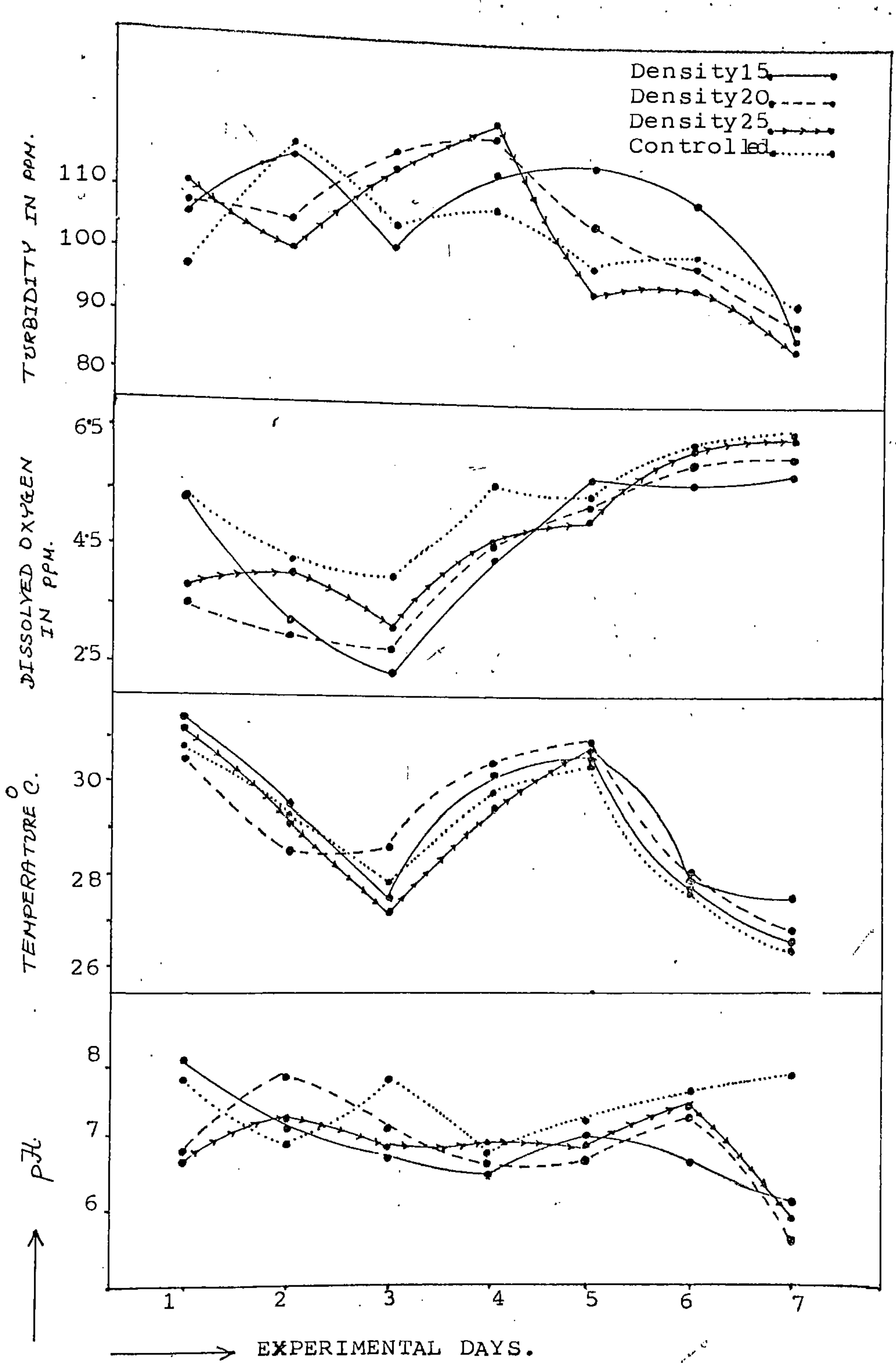


Fig. 29. Daily estimation of p^H, temperature, dissolved oxygen and turbidity after releasing MP in water.

In case of MP a similar trend like U was notices, i.e. DO_2 gradually decreased upto third day of treatment and then a gradual . increase was noticed. It was 4.72 ppm, 4.51 ppm, 4.37 ppm and 5.39 ppm at 15,20 and 25 fry densities and in control.

But in UTM treated tubs, DO_2 decreased upto second day and then a steady rise of DO_2 noticed (table-24). It was 3.84 ppm, 3.62 ppm, 3.79 ppm and 4.97 ppm at 15.20, 25 fry densities and in control .

iv) Turbidity in ppm :

Regarding turbidity of water, it was found that in U-treatment tubs maximum turbidity was noticed on the second day and then a gradual decrease in turbidity took place. It was 108.27, 108.41, 101.23, 93.13 and 92.19 at 15,20,25,30 and 40 fry densities and 95.91 in control tubs.

When TSP dissolved in tubs it was found that the solution became turbid and whitish in colour and gradually from second day the turbidity decreased. At 15,20,25 fry densities it was 113.42, 118.85, 116.47 respectively and 99.44 in control.

Table -23 : Showing the water quality due to dissolve UTM at different densities of fry and fingerlings.

Fry density	Day	pH	Temperature °C	Dissolved oxygen in ppm.	Turbidity in ppm.
15	1	6.60	29.60	2.31	129.00
	2	7.06	30.00	1.63	121.00
	3	6.31	28.20	2.91	106.30
	4	6.86	27.50	4.18	98.50
	5	6.06	28.50	4.30	106.60
	6	7.21	28.20	5.73	94.00
	7	7.06	27.50	5.88	93.00
Mean		6.74	28.50	3.85	106.92
±S.E.		0.39	0.90	1.52	12.64
20	1	6.65	29.50	0.83	133.80
	2	6.83	29.80	1.16	124.16
	3	5.75	28.20	3.06	100.33
	4	7.03	28.30	4.31	103.16
	5	5.88	28.70	4.43	101.00
	6	7.38	27.50	5.73	93.00
	7	7.16	27.30	5.83	92.00
Mean		6.67	28.47	3.62	106.78
± S.E.		0.58	0.87	1.88	14.78
25	1	6.96	29.10	0.81	135.50
	2	6.90	29.50	1.73	125.33
	3	6.03	27.60	3.41	100.66
	4	6.11	29.60	3.25	110.33
	5	6.61	29.20	5.23	94.16
	6	7.00	27.70	6.01	90.83
	7	6.70	27.30	6.10	89.83
Mean		6.62	28.57	3.79	106.66
± S.E.		0.37	0.92	1.92	16.56
Control	1	7.91	29.20	3.05	106.00
	2	7.78	29.80	3.26	100.30
	3	7.58	27.80	4.95	88.16
	4	7.08	28.50	4.93	90.00
	5	7.45	27.50	5.98	93.33
	6	6.90	27.30	6.25	91.16
	7	7.56	26.80	6.38	90.16
Mean		7.47	28.13	4.97	94.16
± S.E.		0.34	1.00	1.27	6.06

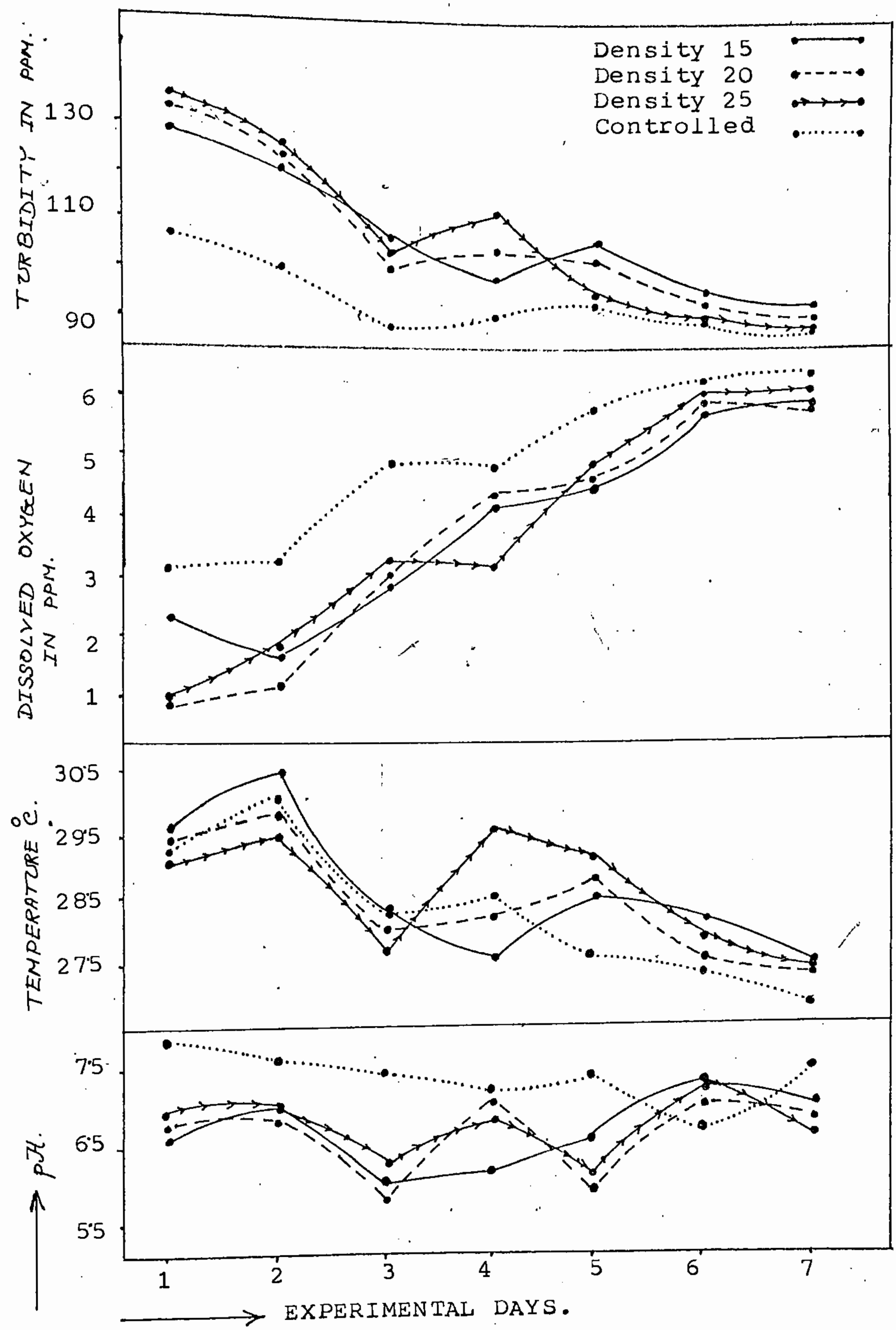


Fig. 30. Daily estimation of pH, temperature, dissolved oxygen and turbidity after releasing UTM in water.

In case of MP treated tubs a similar trend was noticed as TSP. Turbidity of water was 108.13, 107.10, 103.53 at 15,20 and 25 fry densities against 102.99 in control. In UTM treated tubs the turbidity of water was 106.91, 106.77, 106.66 and 99.15 at 15,20 and 25 fry densities respectively and in control (table 24).

Estimation of pH, Temperature, DO_2 and Turbidity are shown on fig.27,28,29 and 30 for Urea,TSP,MP and UTM respectively.

DISCUSSION

In the experiment it was observed that the high concentration of fertilizer in water the fry became at first very much swift sweemer and gradually motionless morbid and died. This was due to high concentration of inorganic salt in the water, Sah *et al*.,(1988) observed the effect on N-fertilizers on the mortality and behaviour of an air breathing fish *Channa punctatus* and recorded a similar trend.

Using organic fertilizer on fish population Kakand Pathak (1966) observed toxicity of Lindane to tawes, tilapia and carps.

Fish generally grew faster in neutral or alkaline waters than in acidic condition (Frost and Brown,1967). There are however relatively few studies which indicate whether this is due to a direct pH effect or other factors associated with it. In the present investigation it was found that in all treated tubs, pH decreases. In field studies from low pH water have shown variable growth responses of fish including increased growth ascribed to reduced competition for food following declining in fish stocks (Jensen and Snekvik, 1972; Almer *et al*.,1974).

It was observed that the increased or decreased of DO_2 was inversely related to the rise or fall of water temperature and moderate during rest of the period. It was also interesting to note that in increased density of fry, DO_2 increased. This was due to that in increased density the water became more saturated with air and have DO_2 increased with respect to low fry densities.

The water temperature was more or less similar in all tubs. Khaleque and Islam (1983) reported that the temperature of shallow and small piece of water closely followes the air temperature with small variation only in amplitude and time.

In the present experiment it was found that the tub water temperature a bit lower or higher than air temperature which in agreement with the above findings.

S U M M A R Y

SUMMARY

Approximately, over 10 million people of Bangladesh derive their livelihood from fisheries and related activities. Fisheries are second to agriculture in the overall agrobased economy of the country and contributes about 3.6 percent to Gross Domestic Product (GDP). Fish accounts for about 6 percent of the per capita protein intake of the people. For the last few years, the country is experiencing a considerable and gradual increase in the amount of foreign currency earned through exporting of fish and fishery products.

However, despite its potential, fish production from inland waters in Bangladesh is estimated to have declined substantially. Consequent to the decline in fish production from inland waters, and increase in population, fish consumption per capita per day has dropped from 33g. in 1963-64 to about 21g. in 1985, a decrease of 12 g/person/day. As a result animal protein is very low in the everyday diet of our people. It has been estimated that the population would reach 137.9 million by the year 2005. Even to maintain a per capita supply of fish at the current level production would have to increase to 1.1 million tons by 2005, an increase of 39 per cent over the present day production (The Bangladesh Observer).

Inland fish production comes mainly from ponds, reservoirs, rivers, beels and flood plains. Much stress has been given on production of quality fish seeds but the important and critical inputs on population density for increasing the growth rate in production of fish from inland waters has long been ignored. Considering the expected growth in culture of fisheries in the coming years, there is a need for assessing the likely demand of the knowledge of optimum population density of fish in a specific waterbody.

From the past experience it has now become convincingly clear that the lack of such knowledge cannot do much of development work required in the fisheries sector for increased production.

The present study was carried out on the optimum population density of the three major carps fry in the nursery ponds regarding (a) their growth effect in water quality(b) their population density and growth effect in the water body and (c) the effects of agro-chemicals on three major carps fry and fingerlings and the following results have been observed :

A) Growth-effect : Comparative study on physico-chemical factor and morphometric relationship with different density:-In order to get result of the optimum density of three major carps fry in nursery pond, a comparative study has been carried out on the growth rate of the fry on an exact time after releasing them in different ponds and tanks at different ratios. In the course of study different physico-chemical character of water of tanks and ponds has been compared and the following result was observed :

Monthly variation of physical condition i.e.,hydrogen ion concentration (pH), dissolved oxygen in ppm, temperature in 0^{o} centigrade and turbidity in ppm were in tank I

in tank I,pH = 7.38 $\pm$ 0.43

$D.O_2$ = 2.29 $\pm$ 0.48

Temp. = 29.88 $\pm$ 0.63

Turbidity = 210.00 $\pm$ 30.57.

tank II , pH = 7.59 $\pm$ 0.30

$D.O_2$ = 3.69 $\pm$ 0.62

Temp.= 29.3 $\pm$ 1.23

Turbidity= 147.5 $\pm$ 34.43

and tank III,pH = 7.28 $\pm$ 0.51

$D.O_2$ = 3.16 $\pm$ 0.50

Temp.= 28.93 $\pm$ 1.04

Turbidity=120.5 $\pm$ 14.29.

Mean monthly variation physical condition of pond water were found as follows :

Pond I, pH = 7.38 $\pm$ 0.30

$D.O_2$ = 3.22 $\pm$ 0.54

Temp. = 27.25 $\pm$ 1.88

Turbidity= 178.58 $\pm$ 28.79

Pond II, pH $= 7.44 \pm 0.31$

$D.O_2 = 3.13 \pm 0.25$

Temp$= 26.83 \pm 2.02$

Turb.$=171.25 \pm 25.59$

Pond III, pH $= 7.42 \pm 0.31$

$D.O_2 = 3.03 \pm 0.57$

Temp.$=26.83 \pm 1.99$

Turb.$= 128.25 \pm 10.17$

Pond IV, pH $= 7.38 \pm 0.27$

$D.O_2 = 3.09 \pm 0.48$

Temp.$= 26.67 \pm 1.94$

Turb.$= 163.75 \pm 24.87$

and Pond V, pH $= 7.45 \pm 0.20$

$D.O_2 = 3.41 \pm 0.92$

Temp.$=27.00 \pm 1.89$

Turb.$=149.33 \pm 20.09$

ii) The analysis of variance of TL between carp species and tanks showed significance difference ($F = 141.38$, $P < 0.001$) with LSD = 19.857. In SL, ($F = 89.325$, $P < 0.001$) with LSD = 21.389. And in case of BD ($F = 22.829$, $P < 0.01$) with LSD = 4.70.

In Ponds, analysis of variance between carp species in TL showed significance difference ($F = 37.81$, $P < 0.001$) with LSD at 0.1% level of significance as 10.465. In case of SL ($F = 32.47$; $P < 0.001$) with LSD at 0.1% level of probability as 10.82. And in case of BD i.e. ($F = 65.95$, $p < 0.001$) with LSD = 1.033 at 0.01% level of probability.

Regression coefficient and correlation of carps fry and fingerlings reared in tanks and ponds were worked out and following results were found. Tank, initial and final results in case of Rohu was

$y = -1.7033 + 0.7531\,x$; TL/SL. $r = 0.8823$ and

$y = -3.2453 + 0.8576\,x$; TL/SL. $r = 0.9235$.

$y = 1.7847 + 0.1502\,x$, $r = 0.5845$; TL/BD and

$y = 0.7858 + 0.1830\,x$, $r = 0.5692$; TL/BD.

respectively . In case of Catla, ie.,

$y = -7.1341 + 0.9206\,x$, $r = 0.9611$; TL/SL

$y = -6.4323 + 0.9289\,x$, $r = 0.9289$; TL/SL

$y = -2.5480 + 0.1372\,x$, $r = 0.7609$; TL/BD

$Y = 7.5698 + 0.1240\,x$, $r = 0.4640$; TL/BD respectively.

In case of Mrigal i.e.,

$y = -7.0720 + 0.9229\,x$, $r = 0.9449$; TL/SL.

$y = -4.0300 + 0.8853\,x$, $r = 0.8837$; TL/SL.

$y = 1.2137 + 0.1640\,x$, $r = 0.7415$; TL/BD

$y = 0.2519 + 0.2200\,x$, $r = 0.7671$; TL/BD, respectively.

Initial and final regression coefficient and correlation values of carps fry reared in tank II was as follows :-

In case of Rohu,

$$y = -1.6359 + 0.8286\,x,\; r = 0.9444\;;\; TL/SL.$$

$$y = -7.8126 + 1.0255\,x,\; r = 0.9701\;;\; TL/SL.$$

$$y = -0.4791 + 0.2637\,x,\; r = 0.7656\;;\; TL/BD.$$

$$y = 1.4623 + 0.2202\,x,\; r = 0.6793\;;\; TL/BD.$$

In Catla,

$$y = -3.1506 + 0.8728\,x\; r = 0.9410\;;\; TL/SL$$

$$y = -1.5214 + 1.0117\,x, r = 0.9020\;;\; TL/SL.$$

$$y = 0.2880 + 0.2561\,x,\; r = 0.7925\;;\; TL/BD.$$

$$y = 1.3525 + 0.2420\,x,\; r = 0.5396\;;\; TL/BD.$$

And in Mrigal,

$$y = -3.8819 + 0.9121\,x,\; r = 0.9474\;;\; TL/SL.$$

$$y = -4.6529 + 0.9219\,x,\; r = 0.9455\;;\; TL/SL.$$

$$y = 0.0685 + 0.2463\,x,\; r = 0.7247\;;\; TL/BD.$$

$$y = -4.0939 + 0.3711\,x, r = 0.8653;\; TL/BD.$$

In tank III, in case of Rohu, initial and final values were

$$y = -2.1497 + 0.8916\,x,\; r = 0.9887\;;\; TL/SL$$

$$y = -6.6683 + 0.9935\,x,\; r = 0.9658\;;\; TL/SL.$$

$$y = 1.0334 + 0.1786\,x,\; r = 0.7373\;;\; TL/BD.$$

$$y = -2.0346 + 0.3189\,x,\; r = 0.8056\;;\; TL/BD \text{ respectively.}$$

In Catla,

$y = -3.7243 + 0.9276\ x\ , r = 0.9856$; TL/SL.

$y = -3.9147 + 0.9188\ x,\ r = 0.9712$; TL/SL.

$y = 0.5925 + 0.1913\ x,\ r = 0.8707$; TL/BD.

$y = -0.9567 + 0.2810\ x,\ r = 0.8393$; TL/BD respectively.

In Mrigal,

$y = -5.3174 + 0.9800\ x,\ r = 0.9783$; TL/SL.

$y = -3.6458 + 0.9028\ x,\ r = 0.9807$; TL/SL.

$y = -0.7696 + 0.2507\ x,\ r = 0.7986$; TL/BD.

$y = -2.4184 + 0.3044\ x,\ r = 0.8354$; TL/BD respectively.

Initial and final regression coefficient and correlation values of carps fry and fingerlings reared in nursery ponds were as follows :

Pond I, Rohu,

$y = -\ 4.2210 + 0.9376\ x,\ r = 0.9525$; TL/SL.

$y = -\ 6.5965 + 0.9187\ x,\ r = 0.9249$; TL/SL.

$y = 0.6142 + 0.1886\ x,\ r = 0.6207$; TL/BD.

$y = -\ 6.6979 + 0.9483\ x,\ r = 0.9686$; TL/BD.respectively.

In Catla,

$y = -4.0742 + 0.9284\ x,\ r = 0.9798$; TL/SL

$y = -3.7275 + 0.9088\ x,\ r = 0.9571$; TL/SL.

$y = -0.8096 + 0.3104\ x,\ r = 0.8654$; TL/BD.

$y = 0.3051 + 0.1919\ x,\ r = 0.7617$; TL/BD.respectively.

In Mrigal,

y = -5.3634 + 0.9852 x, r = 0.9877 ; TL/SL.

y = -5.0077 + 0.9004 x, r = 0.9827 ; TL/SL.

y = -0.5171 + 0.2999 x, r = 0.8945 ; TL/BD.

y = 2.0164 + 0.2195 x, r = 0.8903, TL/BD.respectively.

Pond II, In case of Rohu,

y = -5.3283 + 0.9819 x , r = 0.9807 ; TL/SL.

y = -6.6979 + 0.9483 x , r = 0.9630 ; TL/SL.

y = -3.0502 + 0.3649 x , r = 0.7673 ; TL/BD.

y = 3.3123 + 0.1557 x, r = 0.7980 ; TL/BD.respectively.

In Catla,

y = -4.9922 + 0.9553 x, r = 0.9710 ; TL/SL.

y = -5.3702 + 0.9394 x, r = 0.9563 ; TL/SL

y = -0.7679 + 0.3025 x, r = 0.8795 ; TL/BD.

y = 0.0422 + 0.1933 x, r = 0.8018 ; TL/BD.respectively.

In Mrigal ,

y = -4.7778 + 0.9577 x, r = 0.9927 ; TL/SL.

y = -7.8578 + 0.9797 x, r = 0.8851 ; TL/SL.

y = 0.2617 + 0.2838 x, r = 0.8894 ; TL/BD.

y = 2.2115 + 0.1508 x, r = 0.8774 ; TL/BD respectively.

Pond III, In case of Rohu,

y = -5.1746 + 0.9757 x , r = 0.9909 ; TL/SL.

y = -7.5513 + 0.9724 x , r = 0.9793 ; TL/SL.

$y = -0.7507 + 0.3152\,x,\ r = 0.8129$; TL/BD.

$y = 1.3717 + 0.1756\,x,\ r = 0.8546$; TL/BD.respectively.

In Catla,

$y = -4.7811 + 0.9650\,x,\ r = 0.9897$; TL/SL.

$y = -8.3437 + 0.9847\,x,\ r = 0.9950$; TL/SL.

$y = -0.0864 + 0.2701\,x,\ r = 0.8261$; TL/BD.

$y = -0.4291 + 0.1974\,x,\ r = 0.9276$; TL/BD respectively.

In Mrigal,

$y = -4.4487 + 0.9496\,x,\ r = 0.9815$; TL/SL.

$y = -7.9616 + 0.9767\,x,\ r = 0.9937$; TL/SL.

$y = -0.2617 + 0.2838\,x,\ r = 0.8894$; TL/BD.

$y = 2.2115 + 0.1508\,x,\ r = 0.8774$; TL/BD.respectively

Pond IV, In case of Rohu,

$y = -5.1983 + 0.9757\,x,\ r = 0.9885$; TL/SL.

$y = -7.7622 + 0.9767\,x,\ r = 0.9959$; TL/SL.

$y = 0.2141 + 0.2645\,x,\ r = 0.8356$; TL/BD.

$y = -0.7277 + 0.1965\,x,\ r = 0.8658$; TL/BD respectively.

In Catla,

$y = -5.7834 + 0.9887\,x,\ r = 0.9945$; TL/SL.

$y = -8.9821 + 0.9942\,x,\ r = 0.9742$; TL/SL.

$y = 0.3159 + 0.2509\,x,\ r = 0.8965$; TL/BD.

$y = 0.3452 + 0.1772\,x,\ r = 0.8241$; TL/BD respectively.

In Mrigal,

$y = -5.6013 + 0.9887\,x, r = 0.9945$; TL/SL

$y = -8.6699 + 0.9897\,x, r = 0.9919$; TL/SL

$y = 0.0623 + 0.2675\,x, r = 0.9285$; TL/BD

$y = 0.0911 + 0.2093\,x, r = 0.7955$; TL/BD respectively.

And in Pond V, In case of Rohu,

$y = -5.2381 + 0.9722\,x, \; r = 0.9926$; RL/SL.

$y = -7.9847 + 0.9796\,x, \; r = 0.9938$; TL/SL.

$y = 0.4427 + 0.2703\,x, \; r = 0.8649$; TL/BD.

$y = 2.0921 + 0.1487\,x, \; r = 0.7577$; TL/BD.

In Catla,

$y = -5.7644 + 0.9919\,x, \; r = 0.9964$; TL/SL.

$y = -8.0111 + 0.9809\,x, \; r = 0.9924$; TL/SL.

$y = 1.8827 + 0.2262\,x, \; r = 0.8591$; TL/BD.

$y = -0.2814 + 0.1856\,x, \; r = 0.8272$; TL/BD respectively.

And in Mrigal,

$y = -5.5551 + 0.9824\,x, \; r = 0.9948$; TL/SL.

$y = -6.0734 + 0.9366\,x, \; r = 0.9261$; TL/SL.

$y = 1.7756 + 0.2270\,x, \; r = 0.8070$; TL/BD.

$y = 1.0017 + 0.1700\,x, \; r = 0.7808$; TL/BD respectively.

(B) Population density and growth effects :

Total length and total weight relationship, relative condition factor (Kn), condition factor for observed weight (K), and for calculated weight (k), specific growth rate (SGR), estimated gross production (egp), calculated net production (cnp), net yeild (ny) and mortality of fry and fingerlings at different stocking rates in tanks and ponds were worked out and the following results was observed in species wise and tank/pond wise-

In tank I, initial results, in case of Rohu were found as follows :

log TW = -1.4037 + 0.9814 log TL, r = 0.9431, Kn = 1.0009, K = 2.9214, and k = 2.9160 and in final, log TW = -4.3376 + 2.6204 log TL, r = 0.9804, Kn=1.0025, K = 0.9490, and k = 0.9466.

In Calta, Log TW = -1.8653 + 1.2681 log TL, r=0.9819, Kn =1.0013 K = 4.0124 and k = 4.0588 found initially and finally it was log TW = -3.1059 + 1.9891 log TL, r =0.9793, Kn=1.0006 K = 1.0740, and k = 1.0734 and in Mrigal, initally log TW = -1.8140 + 1.2112 log TL, r=0.9513, Kn =1.0083 K=4.1978 and k = 4.1091 and finally log TW =-4.1127 + 2.5324 log TL, r=0.9819, Kn=1.0009 K = 1.0976, and k = 1.0966.

Tank II, initial results of Rohu were,

log TW =-2.9952 + 1.9298 log TL, r=0.9970, Kn=1.0004, K=3.1053 and k = 3.1012 and it was finally,

log TW =-2.2128 + 1.5539 log TL, r=0.9912, Kn=1.0007, K = 3.5655, and k = 3.5612.

Initially, in case of Catla,

log TW =-2.8822 + 1.7952 log TL, r=0.8554, Kn =1.0245, K = 3.3566 and k = 3.2620 and finally

log TW = -2.1238 + 1.5213 log TL, r =0.9958, Kn =1.0003, K =4.7141 and k = 4.7114.

Initially in case of mrigal,

log TW =-2.8476 +1.7663 log TL, r=0.8417, Kn =1.0223 K =3.3431, and k = 3.2597. finally,

log TW =-1.8968 + 1.3799 log TL, r=9886, Kn=1.0003, K=5.1329 and k = 5.1339.

In tank III, initial and final results found in case of Rohu were as follows :

log TW =-3.0636 + 1.8744 log TL, r =0.8673, Kn=1.0217 K=2.0961, and k=2.3064, finally it was

log TW=-1.9478 + 1.4005, log TL, r= 9821, Kn=1.0009, K=4.2529 and k=4.2519. In Catla , initally,

log TW =-2.8460 + 1.7304 log TL, r=0.9879, Kn=1.0029 K=2.0807 and k =2.0789, it was finally

log TW =-1.7002 + 1.2145 log TL, r=0.9471, Kn=1.0038, K=4.8092, and k =4.8189. And in Mrigal, initially, it was log TW = -2.5284 + 1.4985 log TL,r =0.9717,Kn=1.0025,K=2.4924 and k= 2.4840. Finally, it was,

log TW = -2.1406 + 1.4606 log TL,r=0.9920, Kn=1.0004, K=3.2365 and k = 3.2343.

In five nursery ponds following results were found

Pond I, in Rohu, initially it was

log TW = -2.0976 + 1.4594 log TL,r=0.9865,Kn=1.0018, K=5.9646 and k =5.9319, finally,

log TW =-2.0298 + 1.4675 log TL,r=0.9899, Kn=1.0004, K=2.2773 and k=2.2768.

In Catla, initial values were ,

log TW =-1.9907 + 1.3421 log TL,r=0.9991, Kn=1.0001, K=5.7621 and k =5.9319.

and final values were,

log TW =-2.4129 + 1.6834 log TL,r=0.9348,Kn=1.0047 K = 1.8904 and k = 1.8877 In Mrigal initially and finally it was,

log TW =-2.0024 + 1.3475 log TL,r=0.9863, Kn=1.0012, K=5.8379 and k =5.7975.

log TW = -1.5581 + 1.1649 log TL,r=0.9624, Kn=1.0024 K=5.0071 and k = 4.9885, respectively.

Pond II, inital and final values were found in case of Rohu were as follows :

log TW = -1.9766 + 1.2664 log TL, r= 0.9973, Kn=1.0002

K=5.9677 and k =5.9773.

log TW =-2.7915 + 1.8909 log TL, r=0.9834, Kn=1.0021,

K=2.0473 and k=2.0482, respectively.

In Catla, initial and final values were

log TW = -1.9283 + 1.3257 log TL, or=0.9880, Kn=1.0011

K=6.3438, k = 6.3396. and

log TW -0.9358 + 0.6863 log TL, r= 0.8453, Kn=1.1034,

K =3.2799 and k =3.1429.

In Mrigal,

log TW = -1.6571 + 1.1166 log TL, r=0.9760, Kn=1.0016

K = 6.2683, k = 6.3656 and

log TW = -2.4187 + 1.6904 TL, r = 0.9774 Kn = 1.0024,

K= 2.6736 and k =2.6755.

Pond III, in case of Rohu,

log TW =-1.7321 + 1.1651 log TL, r=9853, Kn=1.0010,

K=6.0906 and k = 6.1222.

log TW = -2.0608 + 1.4882 log TL, r=0.9898, Kn=1.0006

K=2.0435, k = 2.0452, initial and final respectively.

In Catla,

log TW =-1.9052 + 1.2943 log TL, r=0.9887, Kn=1.0011

K=5.5458, k =5.5549 , and

log TW =-2.0610 + 1.4935 log TL, r=0.9972, Kn=1.0002,

K=2.1918, and k = 2.1926 inital and final respectively.

In Mrigal

log TW = -1.8633 + 1.2640 log TL, r=0.9804, Kn=1.0011, K=6.1739 and k = 6.1960, Again

log TW = -2.1599 + 1.5388 log TL, r=0.9910, Kn=1.0006, K = 2.4312, k = 2.4331 initial and final respectively.

Pond IV, initial and final values incase of Rohu, Catla and Mrigal were as follows :

log TW =-1.7517 + 1.1826 log TL, r= 0.9844, Kn=1.0011, K =6.1460 and k= 6.1443.

log TW = -1.9652 + 1.4348 log TL, r=0.9773, Kn=1.0012 K=2.0804 and k = 2.0792 in Rohu.

log TW =-1.7172 + 1.1431 log TL, r=0.9664, Kn=1.0028, K=5.2427 and k = 5.2834.

log TW =-2.0854 + 1.5061 log TL, r=0.9932, Kn= 1.0002, K=1.8548 and k = 1.8549 in Catla,

log TW = -1.9123 + 1.2899 log TL, r=0.9941, Kn=1.0005, K = 5.9196 and k = 5.9280

log TW = -2.8502 + 1.9396 log TL, r=0.9952, Kn=1.0005 K=2.7587 and k=2.7583 in Mrigal.

In pond V, inital values of Rohu were

log TW = -1.8836 + 1.2711 log TL, r=0.9912, Kn=1.0007 K = 5.8842, k = 5.4505 . Final values were

log TW =-2.1386 + 1.5301 log TL, r=0.9910, Kn=1.0004, K = 1.8841 and k = 1.8845 . In Catla initial values were log TW = -2.0401 + 1.3933 log TL, r=0.9827, Kn =1.0002 K=5.4646, k=5.4505 and finally

log TW =-1.9414 + 1.4268 log TL, r=0.9934, Kn =1.0001, K=1.6532 and k=1.6533. In Mrigal initial values were

log TW =-1.8468 + 1.2603 log TL, r=0.9782, Kn =1.0013 K=4.4593 and k=4.4514. Final values were,

log TW =-2.8319 + 1.5105 log TL, r= 0.9869, Kn=1.0013 K=2.1832 and k =2.1811 .

In tank I, the specific growth rate (SGR) of R=0.6729 C.=1.3178 and M=1.0833. In tank II, SGR of R=-0.0827, C=-0.6978 and M=0.7664 and tank III, the SGR of R=-0.3238, C=-0.7863, and M=-5426.

In pond I SGR of R=0.6956, C=0.6586 and M=0.1442.
Pond II, SGR of R=0.5343, C=0.7449 and M =0.4334,
Pond III, SGR of R=0.6563, C=6973 and M=0.5016.
Pond IV, SGR of R=0.6585, C=0.7570 and M=0.2668.
and in Pond V, SGR of R = 0.6812, C=0.8742 and M=0.5903.

Net yeild found in tank I = 112.52 (37.51 ± 7.12), tank II =34.32 (11.44 ± 4.19) and in tank III =52.90 (17.63 ± 1.75) pond I =113.93 (37.98 ± 3.78), Pond II= 122.4(40.80 ± 1.22), pond III =115 (38.61 ± 4.79), pond IV = 100.65 (33.55 ± 3.29) and in pond V = 138.96(46.32 ± 7.36).

Percentage of average mortality of R.C and M. in tank I =10 ;30 and 15 respectively. It was tank II in R=19.05, C =12.50 and M=9.38 and in tank III, R =7.50, C =17.14

and in M =31.43. Again percentage of average mortality in pond I, R = 13.72, C =6.93 and M = 14.58. Pond II, R=12.17, C=4.62 and M = 23.64. Pond III, R = 13.85, C = 11.82 and M = 32.73. Pond IV, R = 26.28, C = 4.82 and M = 23.64 and in pond V, R= 16.52 , C = 20.00 and M = 45.33.

(C) Effect of agro-chemicals (inorganic fertilizers)on three major carps fry and fingerlings.

The experiment was conducted for a period of three months (May to July 1988). Twelve earthen tubs each having the capacity of 11 litre water were used for the experiment. Three inorganic fertilizers viz, Urea,Triple superphosphate and Murate of potash were used. Mortality and behavioural responses of the carps fry and fingerlings were observed.

a (i) Urea : The behavioural response of the carps fry towards dissolved urea was largely dependent on concentration and length of exposure . The survival capacity of fry was larger in case of higher density while it was least in lower density. In thin density the mortality rate was higher. In density 15 (total 45 fry in three replicants) four fry survived. In density 20 (total 60 in three replicants) 20 fry survived. In density 25 (total 75 in three replicants) 20 fry survived. In density 30 (total 90 in three replicants) 64 fry survived . And in density 40 (total 120) 91 fry survived.

(ii) Triple super phosphate (TSP): Behavioural response of carp fry towards TSP was extremely dependent on concentration of fertilizer. Catla fry died earlier than Rohu and Mrigal fry. In density 15 (out of 45 in three replicants) seven fry survived . In density 20 (out of 60 fry in three replicants) 31 fry survived. In density 25 (out of 75 in three replicants) 36 fry survived.

(iii) Murate of Potash (MP) : Behavioural response of the carp fry and fingerlings towards MP was more or less dependent on concentration and length of exposure. Rohu and Mrigal fry were very sensitive but catla fry were more resistant. In density 15 (out of 45 in three replicants) 19 fry survived. In density 20 (total 60 fry in three replicants) 28 fry survive. In density 25 (total 75 in three replicants) 44 fry survived.

(iv) Urea + TSP + MP (UTM) :- Behavioural response of carp fry and fingerlings towards UTM was also dependent on concentration and time of exposure. More or less all fry were affected on mixed fertilizer. In density 15 (total 45 in three replicants) 17 were alive. In density 20 (total 60 fry in three replicants) 41 were alive. In density 25 (total 75 fry in three replicants) 62 were alive.

(b) Physico-chemical factors of water (Water qualities):

Hydrogen ion concentration (pH) , temperature, dissolved oxygen and turbidity at different treated and control water were taken.

(i) Hydrogen ion concentration (pH) :- In dissolved urea the pH of water was 6.80 ± 0.32, 6.83 ±0.40, 6.83 ± 0.56, 6.94 ± 0.75 and 6.99 ± 7.4 in 15, 20,25, 30 and 40 density respectively . It was 7.39 ± 0.31 in control tub. In dissolved TSP, the pH of water was 7.06 ± 0.68, 7.05 ± 0.67 and 6.84 ± 0.39 in 15, 20 and 25 density respectively. It was 7.29 ± 0.29 in control tub. In dissolved MP, the pH value of water was 6.86 ± 0.58 , 6.86 ± 0.67 and 6.87 ± 0.41 in 15, 20 and 25 density respectively . It was 7.48 ± 0.45 in control tub. In dissolved UTM, it was 6.74 ± 0.39, 6.67 ± 0.58 and 6.62 ± 0.37 in 15, 20 and 25 density respectively. It was 7.47 ± 0.34 in control tub.

(ii) Temperature :- In Urea treated tubs, the temperature was 28.6 ± 1.28 , 28.7 ± 1.42 , 29.34 ± 1.20, 29.02 ± 1.28, and 28.93 ± 1.27 in 15, 20, 25,30 and 40 density respectively. It was 28.97 ± 0.67 in control tub. In TSP treated tubs, it was 29.07 ± 1.29, 29.17 ± 1.15 and 29.07 ± 1.02 in 15,20 and 25 density respectively. It was 29.04 ± 1.10.in control tub. In dissolved MP, the temperature was 29.04 ± 1.72, 29.09 ± 1.36 and 28.91 ± 1.55 in 15,20 and 25 respectively.

It was 28.84± 1.37 in controlled. In UTM, the temperature was 28.5 ± 0.90, 28.47 ± 0.87, 28.57 ± 0.92 and 28.13 ± 1.00 in 15, 20,25 and controlled tub respectively.

iii) Dissolved oxygen (DO_2) : In dissolved Urea, DO_2 was 1.59 ± 0.90 , 1.95 ± 0.86 , 1.78 ± 0.48, 3.39 ± 0.67 , 3.46 ± 1.07 and 3.11 ± 0.38 in 15, 20, 25, 30 and 40 and in controlled tub respectively . In TSP , it was 2.16 ± 0.94, 2.09 ± 0.75, 2.09 ± 0.95 and 3.35 ± 0.38 in 15, 20, 25 and controlled water respectively. In MP, it was 4.73 ± 1.29, 4.51 ± 1.24, 4.80 ± 1.06 and 5.39 ± 0.82 in 15, 20, 25 and controlled water respectively . In UTM , it was 3.85 ± 1.52 3.62 ± 1.88, 3.79 ± 1.92 and 4.97 ± 1.27 in 15, 20, 25 and in controlled water respectively.

iv) Turbidity : In dissolved Urea the turbidity was 108.27 ± 13.79, 108.41 ± 18.72, 101.23 ± 25.98, 93.14 ± 10.53 92.77 ± 8.35 and 95.91 ± 10.46 in 15, 20, 25, 30 and 40 density and controlled tub respectively. In TSP, it was 113.43 ± 12.59 118.83 ± 14.87, 116.47 ± 28.23 and 99.45 ± 14.70 in 15, 20, 25 density and controlled tub respectively. In MP, it was 108.13 ± 10.12, 107.11 ± 10.25, 103.53 ± 12.53 and 102.99 ± 8.01 in 15, 2o, 25 density and controlled tub respectively. In UTM, the turbidity was 106.92 ± 12.64, 106.78 ± 14.78, 106.66 ±16.56 and 94.16 + 6.06 in 15, 20, 25 density and controlled tub respectively.

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