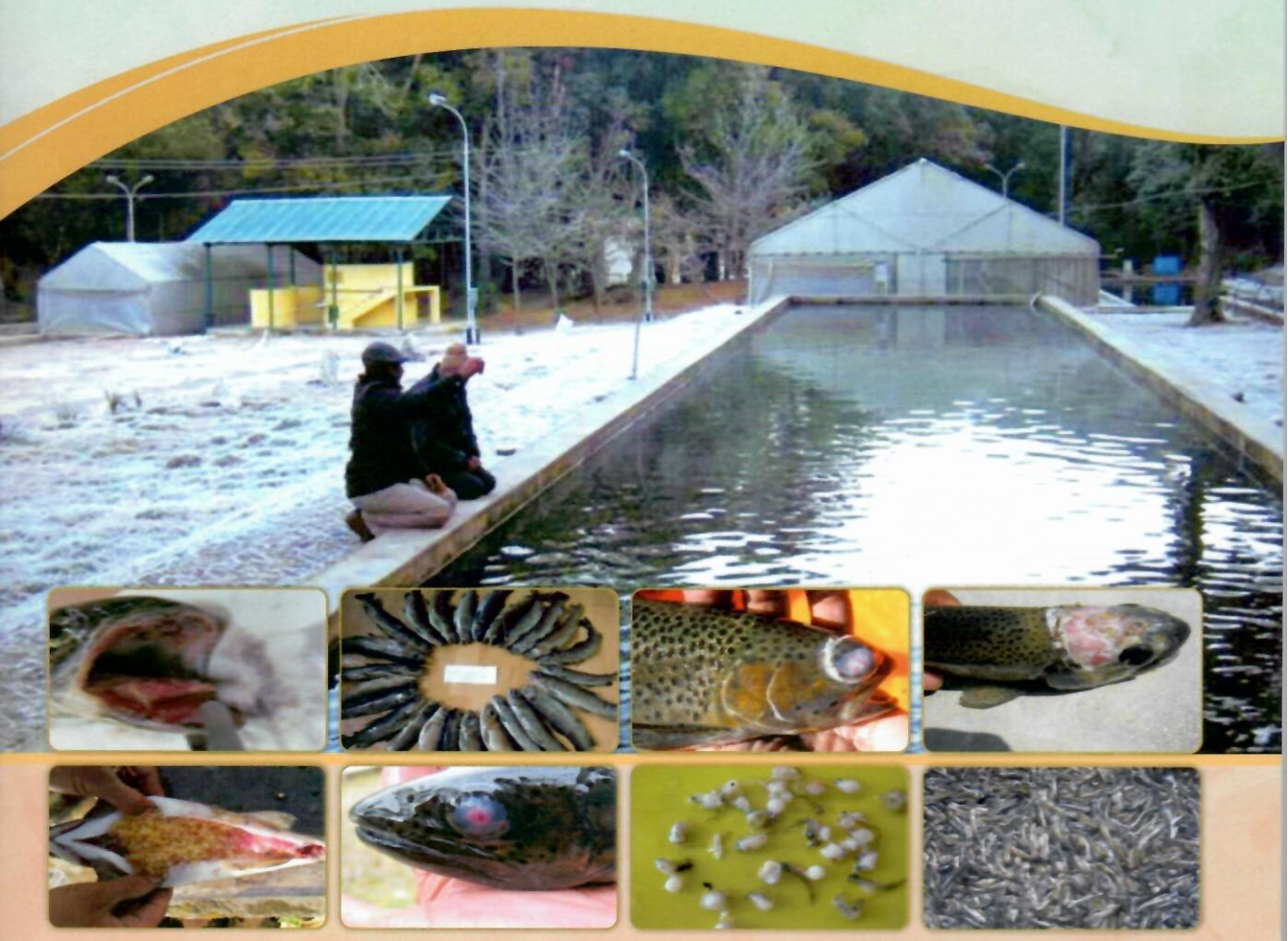
Bulletin No. 30

FIELD OBSERVATIONS ON COMMON HEALTH DISORDERS OF FARMED RAINBOW TROUT *(Oncorhynchus mykiss)*



Authored by

Suresh Chandra • S.K. Mallik • R. S. Tandel • Raja Aadil H. Bhat • Debajit Sarma

ICAR-Directorate of Coldwater Fisheries Research

Bhimtal- 263 136, Nainital, Uttarakhand

FIELD OBSERVATIONS ON

COMMON HEALTH DISORDERS OF FARMED RAINBOW TROUT

(Oncorhynchus mykiss)

Authors

Dr. Suresh Chandra, Principal Scientist

Mr. S.K.Mallik, Scientist (SS)

Mr. R. S. Tandel, Scientist

Mr. Raja Aadil H. Bhat, Scientist

Dr. Debajit Sarma, Principal Scientist

Published By

Director

ICAR-Directorate of Coldwater Fisheries Research

Bhimtal- 263 136, Nainital, Uttarakhand

Year of Publication: September, 2018

Authors

Dr. Suresh Chandra, Pr. Scientist

Mr. S.K. Mallik, Scientist

Mr. R. S. Tandel, Scientist

Mr. Raja Aadil H. Bhat, Scientist

Dr. Debajit Sarma, Pr. Scientist

Published by:

Director, ICAR-Directorate of Coldwater Fisheries Research
Bhimtal-263136, District Nainital, Uttarakhand, India

Laser typeset & Printed at:

M/s Royal Offset Printers, A89/1, Naraina Industrial Area, Phase-I, New Delhi-110 028
Mobile: 9811622258

डॉ. जे. के. जेना
उप महानिदेशक (मत्स्य विज्ञान)
Dr. J. K. Jena
Deputy Director General (Fisheries Science)

भारतीय कृषि अनुसंधान परिषद
कृषि अनुसंधान भवन-II, पूसा, नई दिल्ली 110 012
INDIAN COUNCIL OF AGRICULTURAL RESEARCH
KRISHI ANUSANDHAN BHAVAN-II, PUSA, NEW DELHI - 110 012
Ph. : 91-11-25846738 (O), Fax : 91-11-25841955
E-mail: ddgfs.icar@gov.in

MESSAGE

Himalayan states of our country are known for their difficult terrains, diverse geomorphology and small land holdings. Available land and aquatic recourses of hills could be appropriately used through technological intervention to boost the crop yield for livelihood security of hill people. Among important cultivable fish species, *Oncorhynchus mykiss,* known as rainbow trout has a good scope, high demand in both domestic and export markets and potential for improving hilly fish production.

With intensification of trout farming coupled with environmental change, farmers frequently encounter several infectious and noninfectious health problems in their culture raceway and hatcheries. Appropriate diagnosis of the disease and timely control may help in minimizing the loss. This is only possible through field oriented systematic documentation of such commonly occurring diseases. Comprehensive field observation is necessary to formulate a suitable location specific fish health management practice for the trout grower.

I appreciate and congratulate the Director and authors for their meticulous field observations on various seasonal health problems affecting life stages of rainbow trout in hatchery, nursery and culture raceways and translating these observations into a bulletin form.

I hope the information generated in this bulletin about common health problems in trout farming would be useful for farmers, extension officers, students and planners and will act as a supportive document for disease surveillance program in the coldwater region of the country.

(J. K. Jena)

FOREWORD

To understand existing fish health problems and to achieve estimated Coldwater growth of 3% in the country, it is necessary to have comprehensive knowledge of local conditions, species cultured and common health problems of economically important coldwater fish. On-field observations and documentation of health issues of coldwater fish may serve as a base material for formulating an effective health management practice.

The present bulletin "Field Observations on Common Health Disorders of Farmed Rainbow Trout *(Oncorhynchus mykiss)*" is an endeavor for documenting on-field observations on various health problems experienced by authors in trout farms of Uttarakhand, Himachal Pradesh and Jammu and Kashmir affecting rainbow trout growth, survival and production.

I hope and believe, this bulletin will act as a supportive document in minimizing loss occurring through various health problems in rainbow trout farms of the country.

(Debajit Sarma)
Director (Acting)

CONTENTS

Introduction

Among cultivable species, rainbow trout, *Oncorhynchus mykiss*, has a distinction of having worldwide popularity both in terms of farming as well as consumption. Owing to its excellent cultivable traits like fast growth in lower thermal regime (4-21°C), high supplementary feed acceptance, swift breeding response and good survival in high stocking density, rainbow trout is considered as an important candidate species for commercial production in Coldwater area of the country. In recent years, trout farming has gainedan impetus in hill states of India. On the other hand, this intensification of culture activities have adversely affected the growth, survival, and production of trout and potentially causing various health problems to the rearing animal. Thus farm level observations and documentation of base line data could help in effectively formulate a management practice as a preventive method to various health issues in trout farming. The present bulletin describes various disorders and disease which are generally encountered in rainbow trout farms of Uttrakhand, Himachal Pradesh and Jammu and Kashmir.

Monitoring of fish health status includes observations like sample collection, their numbers, date of collection, degree and percentage rate of infection; chronic, mild, moderate or acute, symptomatic behavior of all fish along with clinical signs, rate and time of mortality, smear from gills and other organs for detection of parasites, collection of different organs besides other relevant background data from infected ponds. Following the standard method of 2% of stock was examined in rearing raceways, while in nursery tanks 0.25% fry were examined at regular basis. Dead and moribund specimens of fry and adults were brought to the laboratory for detailed diagnosis. Length and weight of infected and normal samples were also recorded during the sampling to access the probable weight loss.

Following season wise health disorders of rainbow trout were recorded during the study conducted in various trout farms for a period of 3 years. Ocular infection that occurs round the year; dermal head necrosis in February-March; white spot disease during September-October; fungal infestations in eggs and adults, pre-spawning jumping tendency from the raceways during November-December; pre &post spawning mortality in February and deformed larval mortality in indoor hatchery in March-April.

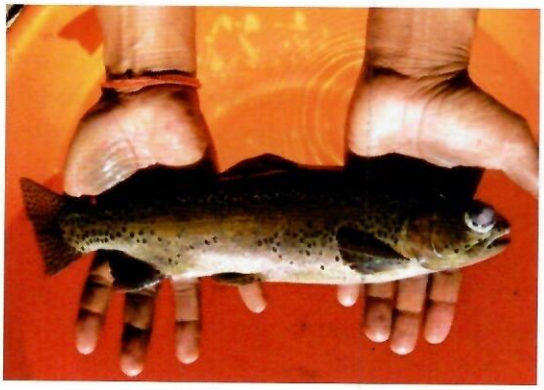
Infectious Health Disorders

1. Eye Infection in Trout

Eye infection was predominantly observed in raceways stocked with 3-4 year trout weighing 300± 50g. The average prevalence of eye infection ranged between 10-34% Initial visible symptoms is marked with appearance of red line or vascularization in periphery of lens. Gradually opaqueness develops after 2-3 months and finally single or both the eyes get putrefied, causing complete blindness of the fish. However, it has been observed that infected eye may heal while the lens is lost. In most cases the infection terminates with loss of eye ball. The water temperature during infection ranged between 15-19°C with 30-40% mortality. During winters, as the water temperature decreases, the

frequency of infection related mortality declines. In our observations, infected females were found to have poorly developed ovary during breeding seasons. Interestingly one year old trout having weight of 97-109.5 g and length of 205-225 mm were found free from infection without any external signs of disease. The eye infection showed adverse effect on growth, reproduction and survivability as infected trout were not able to compete with healthy ones for feed.

It is reported that metacercaria stage of digenetic tramatode *Diplostomum spathaceum* is also a causative agent for this kind of condition and the parasite completes its life cycle in fish eating birds, snails/cironomid larvae and fish. Cataracts among trout may also be induced by a variety of factors like nutritional, environmental, chemical or bacterial infections. In salmonids, several causes have been proposed for the development of eye infection, many of them are nutritional for example the deficiency of zinc, riboflavin, tryptophan, thiamine and methionine. Other factors associated with eye infection are rapid fluctuations in water temperature, salinity, triploid genetic constitution, Homozygosity, UV radiation, cholinesterase inhibitors and electrolytic imbalance.



Eye lens opaqueness

Different stages of eye infection

First stage of eye infection

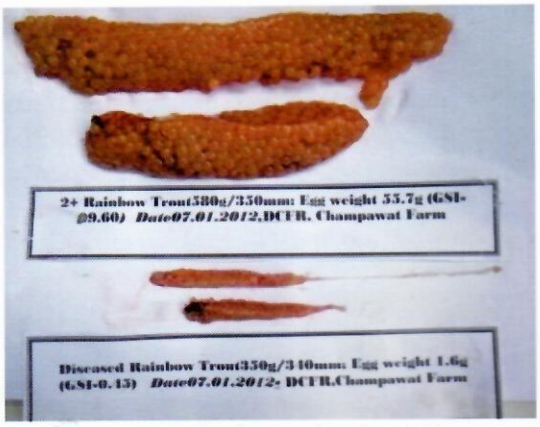
Opaqueness of eye lens in brooders

Eye opaqueness

Terminal stage of infection

Healed fish complete blindness

Dead trout specimens showing loss of eyeball



Poor ovary development in infected fish

Spread pattern of eye blindness in rainbow trout population reared at raceways

Condition Factor

Well-being of trout population and reproductive maturity was predicted by condition factor. About one hundred trout fry and thirty 2-3 yr age group trout were taken from selected rainbow trout farms. The condition factor (K) for healthy trout population was above 1.2, while for infected diseased specimens, it varied in between 0.62-1.19. Moreover, hepatosomatic index (HIS) for healthy and diseased trout (age group 3-4 yrs) ranged in between 0.89 – 1.3 and 1.15-1.17 respectively.

Emaciation in eye infected rainbow trout

Emaciation in infected Trout

Quantification of Loss Due to Eye Infection

Eye infected male and female trout exhibited a weight loss of 40-55% and 30-45% respectively before reaching the maturity. Females with acute infection did not show any sign of maturity during breeding season. Infected 4+ year male brooders did not develop jaw hook which is considered as a secondary sexual character. Absolute fecundity of a healthy female brood fish was 0.159 g eggs/g of body weight while infected trout of same age group had a fecundity of 0.108g eggs/g of body weight. The overall three year observation showed a mean reduction of 30% body weight with 50% egg loss in trout.

2. Red Mouth Disease of Rainbow Trout (RMD)

With commencement of increasing raceways water temperature from 11.0°C to 22.5°C from March, April, onwards, epidemics of a disease encountered in juveniles and adult farmed rainbow trout. At initial stage 1-2 specimens found died. However, full-fledged disease condition with large scale mortality in raceways appeared within 10-15 days period. Maximum mortality recorded during April- August with peaks in the month of June. Darkening of skin color, slow movement, typical reddening and ulceration of lower and upper jaw and mouth cavity were main distinguishing external clinical features observed in diseased specimens. A typical ulceration in lower abdominal area near anal opening and ulceration of gills and gill cartilage in advance stage of infection also found. Petechial hemorrhages in internal organs and yellowish mucoid fluid deposition in abdominal cavity has also been observed in RMD infected fishes.

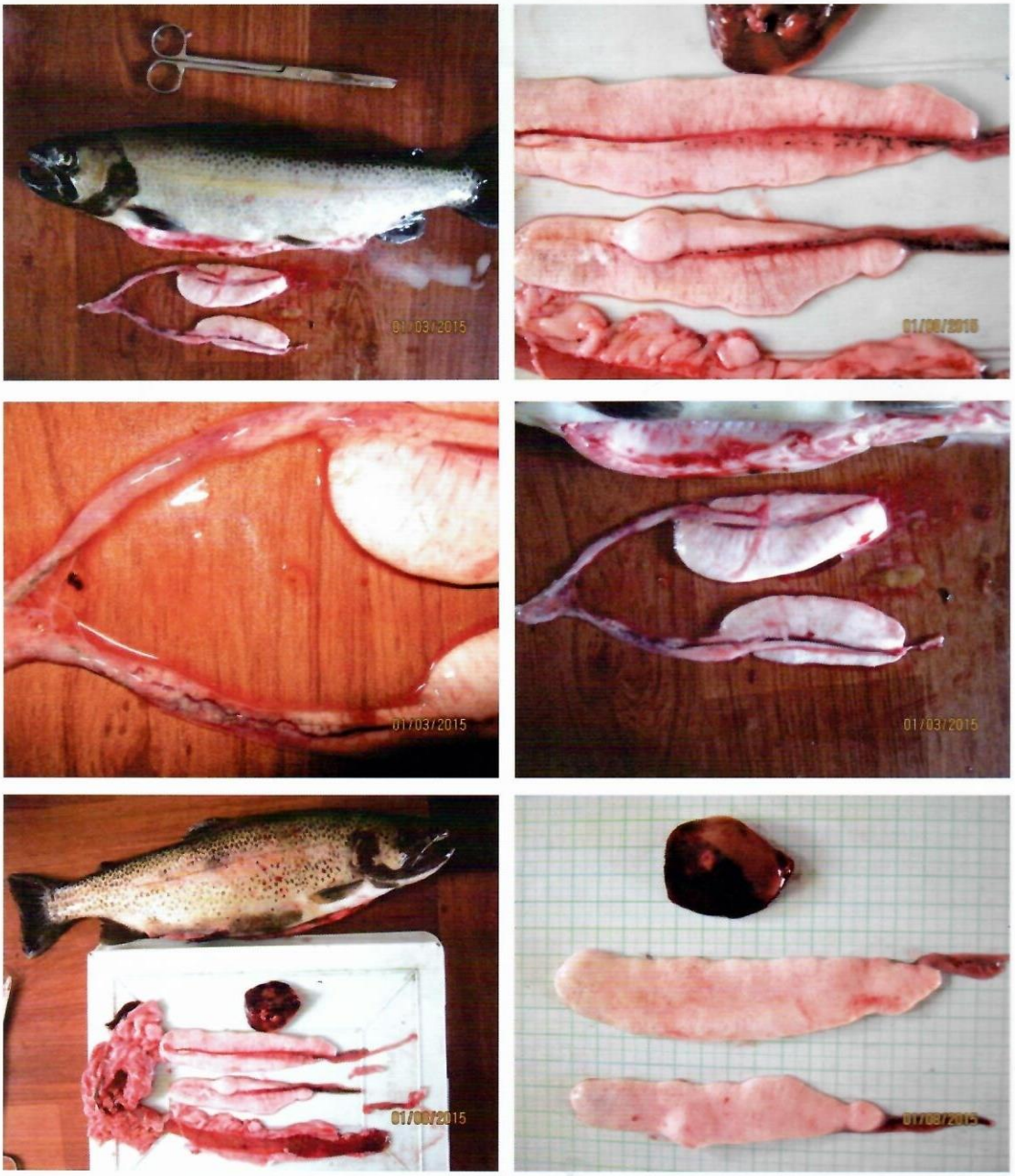
Mortality Rate: Among all health problems, mortality due to this disease varied between 06.07 - 49.47% of total diseased fishes. During the period of outbreak, total about 126 specimens reported died due to lower jaw and mouth ulceration.

SN	Name of the disease Period	OI* Nos. (%)	UTM* Nos. (%)	RMD* Nos. (%)	TFR* Nos. (%)	DN* Nos. (%)	ESMM* Nos. (%)	OT* Nos. (%)	Total Nos.
1.	April-June-	30 (2.30%)	4 (0.30%)	79 (6.07%)	2 (0.15%)	3 (0.23%)	1182 (90.92%)	0	1300
2.	July-Sept.	14 (14.73%)	0	47 (49.47%)	6 (6.31%)	3 (3.15%)	24 (25.26%)	1 (1.05%)	95
	Total	**44 (3.15%)**	**4 (0.28%)**	**126 (9.03%)**	**6 (0.43%)**	**6 (0.43%)**	**1206 (86.45%)**	**0**	**1395**

OI- Ocular Infection
UTM- Unstripped trout mortality
RMD- Red mouth disease like
TFR-Tail fin rot
DN- Dermal necrosis
ESMM- Environmental stress mediate mortality
OT- Other infection

Large scale mortality due to RMD in rainbow trout showing various symptoms

Diagnosis: Samples collected for further diagnostic investigations. Based on initial studies on epidemiology and clinical features, the outbreak found similar to enteric red mouth disease reported elsewhere from trout farms. The problem is emerging with intensification of trout farming and prolongation of warmer conditions in trout farms. Pathogenic bacterial strains responsible for the disease outbreak may inhibit in the internal organs without displaying any clinical features. Thus, apparently healthy looking fishes in rearing raceways may also act as a carrier of the disease with initiation of adverse conditions along with increase of temperature. However, lowering of water temperature in subsequent month along with antibiotics medication helped in reduction of this infection. Thermal stress and pollution in raceways acted as a predisposing factor.



Hemorrhagic testis and alimentary canal in rainbow trout mature males

RMD infected trout specimens

3. Superficial Ulceration of Head Epidermis

In many trout farms, head region of cultured trout was noticed with lesions, which leads to superficial ulcer in raceways. One the possible reason may be the pricking of rainbow trout head by predatory birds that could have resulted into wound development. Presence of claw marks over the body of trout also concurred with the above reason. Clean, transparent water with and shallow nature of raceways with crowded stock create possible chance of bird menace. Small lesions developed over the head region may be invaded by opportunistic pathogens, coupled with fluctuations in water quality parameters resulted to mortality.

Head ulceration in rainbow trout

4. Cottony White Growth in Upper Area of Caudal and Anal Fins

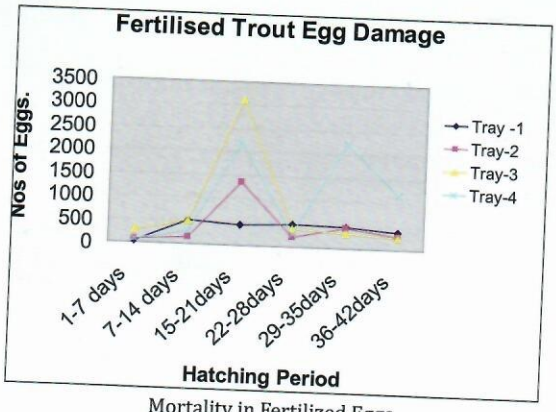
During winter season, 5-8% trout population was observed with whitening of upper area of caudal and anal fins. Aggressive feeding behavior, overstocking and handling may result in injury to fins that provide a congenial environment for certain oomycetes to cause secondary infection.

Head ulceration in rainbow trout

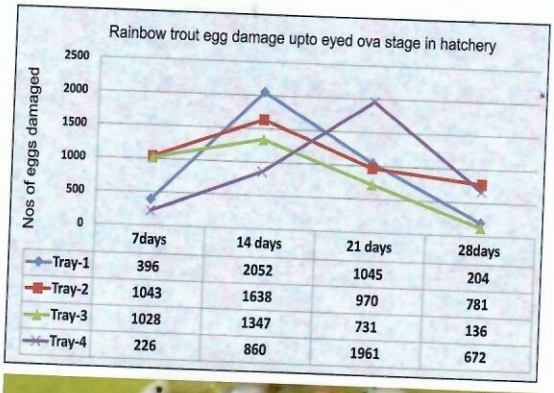
5. Infection in Fertilized Eggs

In hatchery units, egg incubation was frequently associated with incidence of *Saprolegniosis*. Longer incubation period led to development of unhygienic conditions in incubation trough along with accumulation of organic matter in inlet pipe and overhead water tank that may serve as a possible source of fungal infection in a hatchery. Fungal hyphae growing over dead eggs infect fertilized eggs, resulting in low hatching and survival rate. Change in water temperature and pH has direct correlation with fungal infestation in trout hatchery. Although, pH value doesn't vary significantly during incubation period in hatchery in present observation, but fluctuations in water temperature has caused spread of fungal infection during egg incubation. Total egg loss reported from selected hatcheries at 4.7- 8.6°C temperature for 42 day's long incubation period is presented in following table.

Head ulceration in rainbow trout



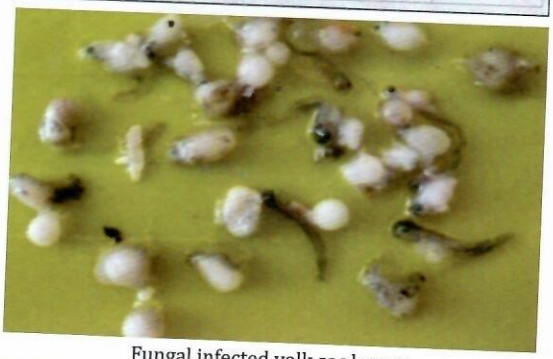
Mortality in Fertilized Eggs



	7days	14 days	21 days	28days
Tray-1	396	2052	1045	204
Tray-2	1043	1638	970	781
Tray-3	1028	1347	731	136
Tray-4	226	860	1961	672

Normal and deformed post larvae collected from selected hatcheries at different thermal regimes

S. N.	Air/ water temp °C	Normal Nos. (%)	Deformed Nos.(%)	Total larvae died
1	22.0/13.1	104 (58.75%)	73 (41.24)	177
2	23.5/12.5	73 (52.89%)	65 (48.1%)	138
3	23.0/13.0	107 (58.16%)	77(41.84%)	184
4.	21.5/13.0	103 (74.36)	35 (25.36%)	138
5..	22.0/13.5	647 (67.74%)	308 (32.25%)	955
6.	20.0/13.6	818(84.40)	152(15.60%)	970
7.	21.4/12.8	774(89.80)	88 (10.20%)	862



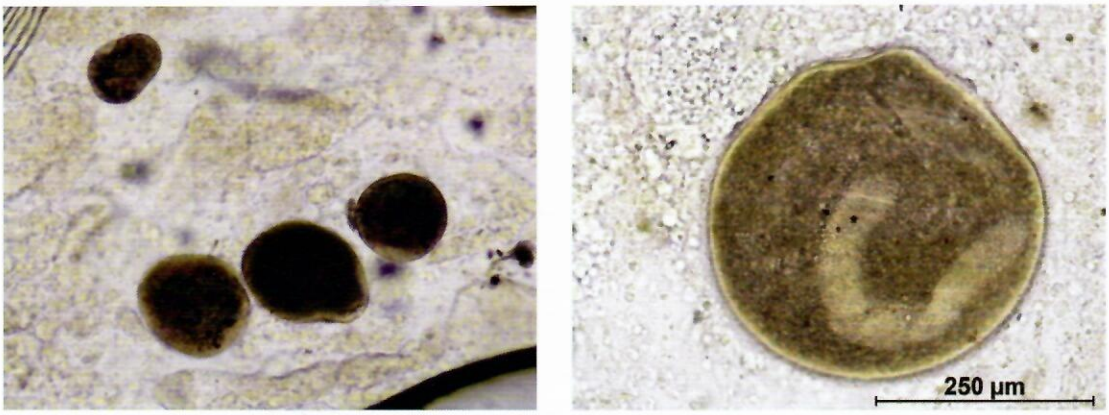
Fungal infected yolk sac larvae

Deformed and normal post larvae

6. White Spot Disease

White spot or ich disease is an ectoparasitic disease caused by ciliate protozoan, *Ichthyopthirius multifiliis*. This ectoparasitic disease is reported to occur in any freshwater fish, indicating extremely low host specificity. The infection is mainly initiated by theront (one of the developmental stage of *I. multifiliis*) with penetration in fish epithelium and is characterized by presence of white spot all over the body surface of fish. Similar observation was made in fry of rainbow trout during nursery operation with few dead specimens floating on surface of water. Infected fishes could be seen near margin of race-ways. Major loss due to white spot disease is not evident during infection however; infection of white spot disease may cause considerable mortalities in both cultured and wild fish population. It is reported that the mortality rate due to this disease might reach up to 100% leading to severe economic loss in fish farms.

Ich infected



Rainbow trout skin swab showing *I. multifillis (20 x)*

7. Whirling Disease

Causative agent of the disease is *Myxobolous cerebralis* while *Tubifex tubifex* an oligochaete that dwells in trout raceways acts as carrier. Initial whirling movement observed in 35- 40 days old trout fry with size range of 36.87± 3.79mm 38.27± 13.53mg during indoor rearing. Circular whirling movement, retarded growth, blackening of caudal area, curved tail, presence of a cyst like growth in the peduncle area and hemorrhagic gills were the clinical features recorded in infected trout fry. Besides these symptoms reports of shortening of the mandible (the lower jaw) and opercula and mouth remains open, hump develop in the back, just behind the head and tail becoming dark in color (commonly referred to as "black tail"), but internal organs generally appear healthy. Tail developing a twist or bend (seen above 17th cartilage) . Swimming in circles after 2-3 months caused by damage to the spinal cord and lower brain stem. Efforts to swim exhaust fish to the point where they eventually sink to the bottom and die. Mortality was from 0.5% to 25% and lasted till 110-125 days of rearing. The infection was found rainbow trout specific. The infection declined with decrease of temperature in last week of September.

Died trout fry

Tail twisting and blackening

Rainbow trout juveniles showing black tail

Spinal curvature in Rainbow trout

Rainbow trout fingerlings showing clinical signs of whirling disease

Non Infectious Disorders

Among non infectious health problems, pre-spawning jumping tendency of trout in race-ways was recorded during November and December while pre and post spawning mortality in brooder during February. In March-April deformed larval mortality in indoor hatchery was recorded. Mortality in un-stripped trout brooders was recorded during March-September while aggressive non- selective feeding behavior and incidences of dissolved oxygen deficiency was common during April-June when six major non-infectious health troubles observed during the period.

8. Loss Due to Brooder's Jump

Small brooders (weighing 400-550g) attaining firstmaturity exhibit pronounced jumping tendency to come out of the race-ways as compared to bigger one (weighing 600-1200g). We have reported about 1% loss of stock due to brooder's jump.

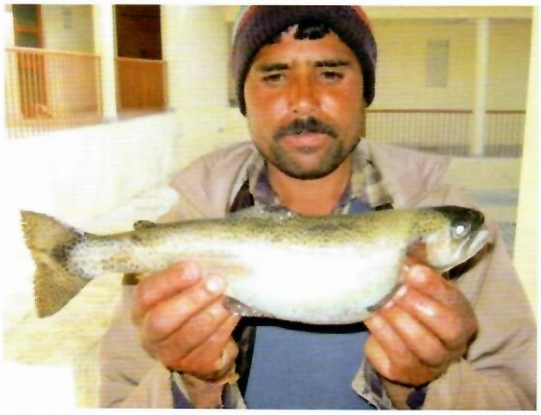
9. Breeding Stress Mediated Mortality

Breeding stress due to mishandling during brooder selection and improper stripping practice exerting pressure on abdominal region that causes mortality of male and female brooders during seed production. Loss of protective mucous layer and injury due to stripping

makes a way for opportunistic bacterial pathogens and secondary fungal infection. Breeding trial of trout is generally held during December to January. Female brooders suffer 15-20% of post stripping mortality, which is less as compared to male (5-8%).

10. Mortality of Unstriped Female Rainbow Trout

Mortality of female brooders with swelling of body cavity and reddish vent is marked during February-September. Autopsy of died female showed presence of dead and putrefied eggs in the abdominal cavity. Development of new ovary (3.48-3.64g) is also observed in died female. Compared to peak maturity when gonadosomatic index (GSI) varies from 18-25% in female trout, GSI in died unstripped female trout varies from 2.38-19.18%. It may be a condition of oocyte atresia that inhibits the absorption rate of matured eggs, gradually ovarian follicle get ruptured and eggs start putrefying inside body cavity .



Trout with swollen abdomen

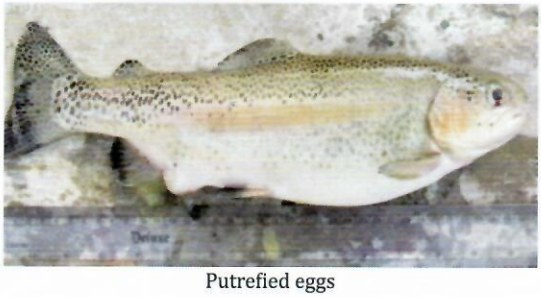
Swelling of genital opening

Putrefied eggs in body cavity

Died unstripped female with swollen abdomen

Swelling of genital opting

Putrefied eggs in abdomen



Putrefied eggs

11. Non-Selective Aggressive Feeding Behavior

Feeding behavior of trout reveals that they are voracious in nature and engulf everything, whatever they find in rearing race-ways. They compete with themselves, become aggressive during feeding and exert rapid reflex action to receive feed or any other matter that seems like feed particulates. Sometimes, this action leads them to swallow up indigestible substances like wooden sticks, stone, pebbles, cemented block and plastic polythene etc. As a result, stomach becomes swollen. This incidence is well recorded in trout race-ways during our observation. Distinct broaden blood capillaries over the outer surface of alimentary canal are observed due to choking of alimentary canal by indigestible substances. In few cases, lower alimentary canal gets completely blackened, exhibits enlarged blood capillaries in the area and finally it results in fish kill.

Intake of fibre

Entrance of fiberup to anal opening

Presence of wooden sticks in alimentary canal

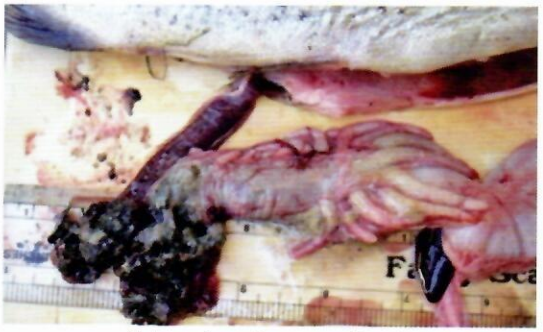
Wooden sticks in alimentary canal

Presence of stones Alimentary canal

Presence of stones Alimentary canal

Enlarged swollen stomach and alimentary canal with a concrete block

Enlarged swollen stomach and alimentary canal with a concrete block



Enlarged swollen stomach and alimentary canal with a concrete block

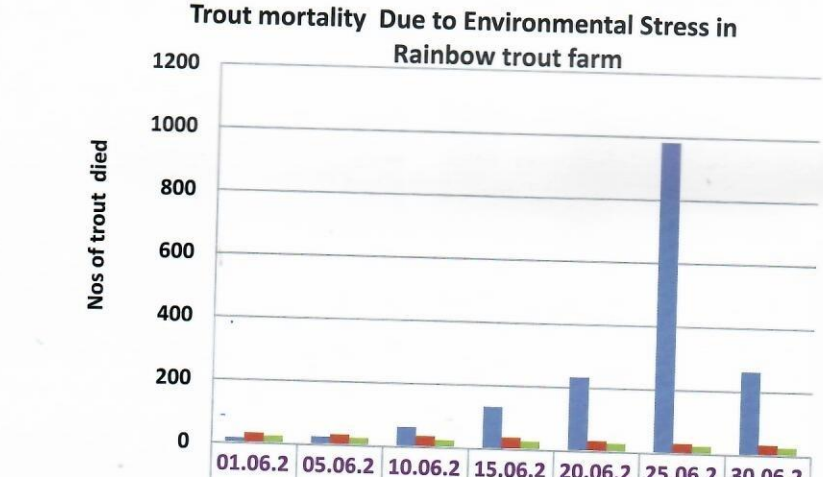
Enlarged swollen stomach and alimentary canal with a concrete block

12. Large Scale Rainbow Trout Mortality Due to Environmental Stress in Summer Months

More than two year old rainbow trout being reared in 30x5m (150sqm) raceways at various organized rainbow trout farms located at an altitude of 1620 msl were assessed. The stocking density varied between @ 8-12fish/sqm (150-250g). Mass mortality of trout was recorded in the month of June-July and predisposing factor/factors for mass kill was investigated in detail.

Post larval mortality

Post larval mortality



	01.06.2012	05.06.2012	10.06.2012	15.06.2012	20.06.2012	25.06.2012	30.06.2012
Nos of trout died	14	23	60	130	231	982	260
Air Temperature	29.5	30.5	32.5	35	31.6	29.6	31
Water Temp.	20.7	20.6	21.1	24	23.5	22.1	22

Trout Mortality due to Oxygen depletion

Fry and adult trout mortality

Adult and Juvenile Rainbow Trout Loss Due to Various Health Disorders in a Trout Farm

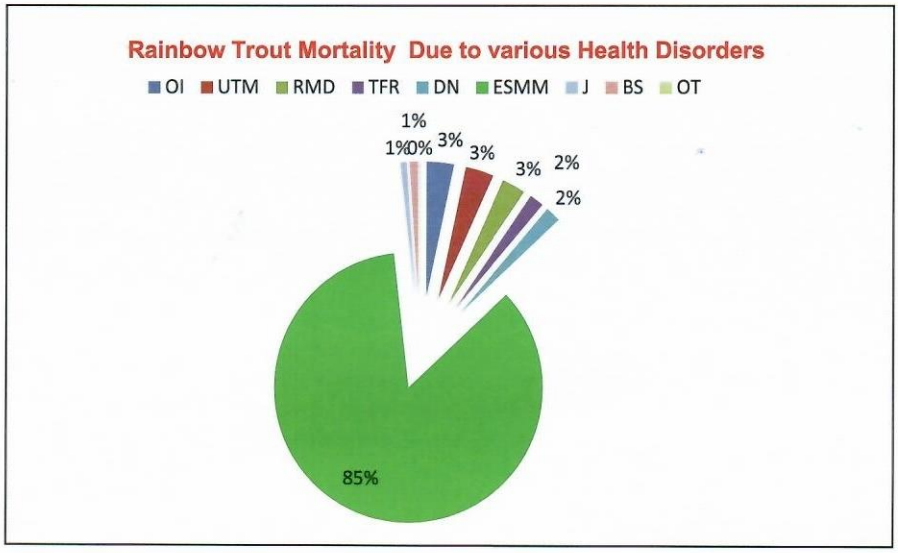
S.N.	Period	OI	UTM	RMD	TFR	DN	ESMM	J	BS	OT	Total
1.	July-Sept.	29	45	10	0	0	470	0	0	3	557
2.	Oct-Dec.	14	1	0	0	0	0	0	0	3	18
3.	Jan-March	0	0	0	0	0	0	0	18	0	18
4.	April-June	30	4	79	2	3	1182	0	0	0	1300
5.	July-Sept.	14	0	47	6	3	24	0	0	1	95
	Total	87	50	136	8	6	1676	0	18	7	1988

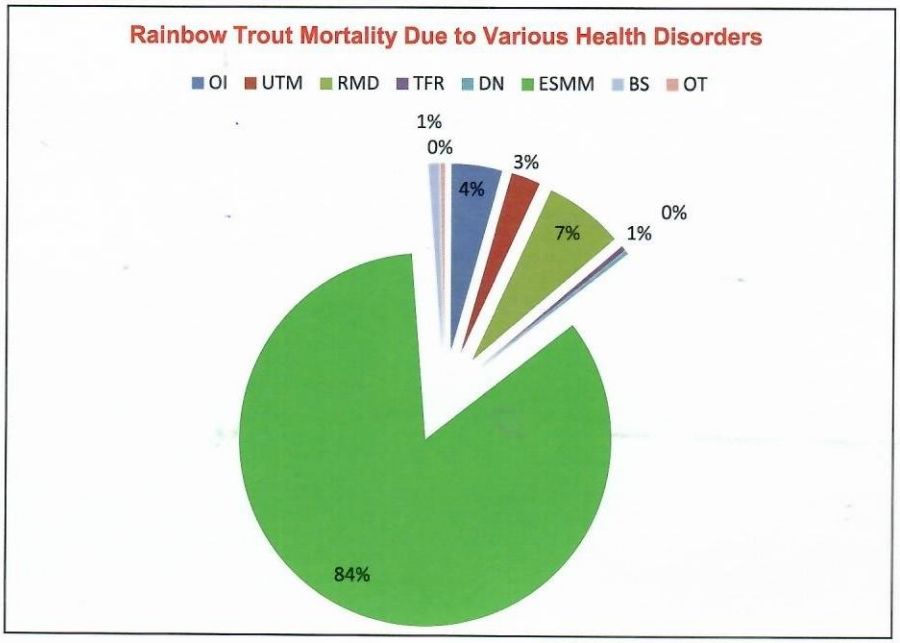
Physico-chemical Parameters of Rearing Raceways/Tanks, Champawat

SN	Month	Air Temp. In °C		Water Temp. In °C		pH		Hardness (ppm)		Dissolved Iron (ppm)		Nitrate (ppm)		Chloride (ppm)	
		min	max	min	max	min	max	min	max	min	max	min	max	min	max
1.	July-Sept, 2011	17.5	27.0	16.5	22.0	-	-	-	-	-	-	-	-	-	-
2.	Oct-Dec. 2011	5.0	22.0	2.0	18.0	-	--	-	-	-	-	-	-		-
3.	Jan-March 2012	5.5	22.5	3.0	15.5	7.0	9.1	25	75	0.0	0.5	0.0	0.2	20	90
4.	April-June 2012	14.5	35.1	12.0	26.5	7.0	9.5	25	50	0.0	0.2	0.0	0.3	20	110
5.	July-Sept. 2012	16.5	25.5	16.8	26.0	7.0	9.4	25	50	0.0	0.3	0.0	0.2	10	100
6.	Oct-Dec. 2012	6.0	24.0	4.0	19.4	7.0	9.1	25	25	0.0	0.5	0.0	0.3	10	60
7.	Jan-March 2013	0.0	19.0	2.2	15.1	6.8	9.1	25	50	0.1	0.5	0.0	0.02	20	60
8.	April-June 2013	16.5	29.5	10.8	26.5	6.5	9.4	25	75	0.0	0.6	0.0	0.02	20	80
9.	July-Sept. 2013	19	27	17.2	21.5	6.7	9.2	10	25	0.1	0.5	0.0	0.03	10	60

Contribution of Various Health Problems in Rainbow Farms

During the period under report total 4351adult/juveniles trout specimens died due to various health problems in culture raceways nurseries and hatcheries. The specimens were examined in laboratory to ascertain probable cause of death. Based on the results, these problems were grouped into four major categorizes i.e. Environmental stress (ESMM), mortality due to ocular (eye) infection(OI), un-stripped female trout kills (UTM) and other health problems (O).Contribution of these problems is depicted in following pie diagram.





Annual Fish Health Calender of Rainbow Trout Farms

S. N.	Month	Syndrome/ Diseases	Major symptological features	Percent infection	%Mortality range Of infected trout/ eggs
1.	January-March	(i) Injury & asphyxiation	(i)Jumping of brooders, surfacing	0.8-1.2	90-100
		(ii)Fungal infections in stripped female brooders	(ii) & (iii) Whiting of fins/mouth region, eggs, change of egg colour	15-25	20-25
		(iii)Fungal infestations in eggs during incubation		20-30	100
2.	April-June	(i)Mortality of non-striped female brooders	Abdominal & genital swelling of abdomen, putrefied eggs	8-12	80-100
		(ii) Ocular Infection	(ii) Reddening, opaqueness with different degree of eye infection in one or both eye with mortality	10-40	30-40
		(iii) Dermal necrosis of head	(iii) Ulceration of head region		
		(iv) Mass fry and adults mortality due to environmental stress	(iv) Surfacing, irritant behavior , change of body coloration	3-4	60-70
		(iv) Red mouth disease	(iv) Reddening of jaw area and mouth; Deep lower abdominal ulceration	50-80 (total five Occasions)	40-60
					90-100
				8-10	
3.	July-September	(i) Ocular infestation in 3-4+year old trout	(ii) Reddening, opaqueness of eye with mortality	25-30	30-35
		(ii)Mortality of non-striped female brooders	(ii)Abdominal swelling	8-12	80-100
		(iii) Mortality due to non-selective feeding habit	(iii) Swelling or normal looking		
		(iv) Red mouth disease	(iv) Reddening of jaw area and mouth; Deep lower abdominal ulceration	1-2	95-100
				5-6	80-90
4.	October-December	(i) Ocular infestation in 3-4+year old trout	(i)Eye opaqueness	15-18	15-20
		(ii) Ich disease in fry	(ii)White minute spots over body	1-2	10-15
		(ii) Tail & fin rot	(iii) Damage of fins		
		(iv) Jumping behaviour	(iv)Mouth open,	5-6	0-3
				0.8-1.2	90-100

13. Treatment and Control of Common Health Disorder

Selection of Chemotherapeutic Agents

While choosing a treatment following important criteria should be taken into consideration

- Fish Species to be treated
- Age group of the fishes
- Economics
- Detail about critical tolerance limits, toxicity of the medicine/chemical

Methods of Treatment

In order to effectively control Diseases, desired dose of therapeutics could be given in following ways

Flush Treatment

- Higher concentration of chemical is added at the inlet or incoming water site and allowed to pass through the tank
- Uniform distribution of chemical depends on the flow of water.

Dip Treatment

- Higher concentration of chemicals/ disinfectants used
- Adopted in treatment of small size fishes in controlled condition
- Duration of exposure is very less 1-3min
- Advantage of this method is large population can be treated at small doses of medicines.

Bath Treatment

- Employed in small experimental tanks under controlled conditions and after adding chemical/medicine left for specified time
- The fishes are kept under observation and as soon as fish shows stress symptoms, either fresh water is added or fishes are taken out from the tanks and released in freshwater

Treatment for Ich Disease

The theront stage of ichis most susceptible to therapy and thus drugs must remain at therapeutic levels for a sufficient time to ensure that all parasites have passed through this stage. For example, during the first day when a chemical is added to the water to kill Ich, only a certain percentage of Ich organisms will be susceptible to the chemical. Two days later many of the surviving Ich organisms, which were embedded in the skin, will be entering the vulnerable stage of their life cycle; chemical treatment on this day will kill these susceptible organisms. In order to catch all the Ich organisms in a "treatable" stage, from three to seven treatments are be needed

- Using formalin in large ponds at a rate of 15-25 mg/l is effective in treating Ich, but can be

cost prohibitive, two to four applications made on alternate days should be used. Formalin removes oxygen from the water, so it is critical to monitor oxygen levels during treatment and be prepared to supply supplemental aeration if levels drop below 5 mg/l.

- Dip treatment in 2-3% salt solution for 1-2 minute.
- Potassium permanganate is sometimes used successfully to treat Ich. Treatment rates of 2 mg/l should be repeated on alternate days; two to four applications are recommended. Success using Potassium permanganate is low
- Pond water with a hardness of 40-50 mg/l, use less than 0.25 mg/l of copper sulphate. For water with a hardness of 50-90 mg/l use 0.5 mg/l. For hard water with a hardness value of between 100-200 mg/l use 1 mg/l. Treat on alternate days, with two to four applications necessary. Regardless of water hardness, treatments should be reduced by one-half during the third, and fourth treatment. Copper sulphate should not be used when water hardness is above 200mg/l and below 40 mg/l.
- Probably the easiest treatment in indoor systems for Warm water species is to raise the water temperature to 85°F(30°C) for three weeks. Since Ich is a Coldwater protozoan, raising the temperature will kill the free-swimming (theronts) forms before they have a chance to reinfect the fish.
- Another treatment in raceways involves increasing the flow rates as high as possible while still permitting the fish maintain their position in the raceway. The increased flow flushes away the free-swimming forms before they have a chance to settle to the bottom and attach.

Prevention and Control of Whirling Disease

- Disinfectants can be used to kill the spores at the bottom of the tanks & ponds & to sanitize mud.
- Spores present in soil can be killed in two days when their is no fish by treating it with 25% unslaked lime @ 380g/m2.
- UV radiations is effective against spores of M. cerebralis
- M.cerebralis spores where decreased in fish fed with furazolidone
- Proguanil in the diet also reduce spore production & alleviated lesions
- Toltrazuril was effective against all stages of myxosporea except mature spores
- Feed 5 mg Fumagillin /kg of body weight /day for 42 days
- Thinning of stock and providing balanced diet to infected fishes.

Superficial Ulceration of Head Epidermis

Farmed fish, when exposed to UV-B in clear water,develop changes in the epidermis very similar to thoseseen experimentally. Lesions are normally on the mostexposed areas, namely, the head, dorsal fin, pectoral fins,dorsum and tail.Increasing the water depth, covering the raceways with tarpaulin, decreasing the stocking density of fish are some strategies which can minimize the chances of epidermal lesions in rainbow trout raceways.

Eye Disease

- Praziquantel is very effective against againstmetacercariaewith elimination of 100% of *Diplostomumspathaceum* via either bath ororal treatment.
- Use of praziquantel@ 300 mg/Kg body weight of fish.
- Bath treatment in praziquantel @ 1 mg/l for 9 hours or 10mg/l for 1 hour.
- The most common and sustainable method is to prevent the parasite from completing its life cycle by removing the intermediate host present in aquatic environment/fish pond.
- Eye lesions due to UV radiation can be treated by increasing the water depth, covering the raceways with tarpaulin, decreasing the stocking density of fish.
- Balanced feed should be given to fish to avoid chances to eye disease.

Red Mouth Disease

Red-mouth disease in Rainbow trout can be treated with sulfa drugs. The common method is to feed Sulmet at the rate of 8 grams per 100 pounds of trout. This treatment may be followed for 6 days. Another variation of the sulfa treatment combines sulfamerazine and sulfaguanidine: 12 grams of sulfamerazine and 6 grams of sulfaguanidine per 100 pounds of trout for 3 days, then a reduced dosage of 6 grams of sulfamerazine and 4 grams of sulfaguanidine for 7 days.

Infection in Trout Eggs

This disinfection protocolmay be applied to newly fertilised or eyed trout eggs. However newly fertilised eggs should be allowed to commence hardening prior to undergoing the disinfection protocol. Although there is a considerable margin of safety for hardened eggs, the disinfection protocol is not recommended for unfertilised ova or during fertilisation. It is essential that the pH of the iodophore solution is maintained between 6 and 8.

To disinfect salmonid eggs the following protocol should be applied:

- Rinse in pathogen-free 0.9% to 1.1% saline (30-60 seconds) to remove organic matter
- Immerse in an iodophore solution containing 100 ppm available iodine for a minimum of 10 minutes. The iodophore concentration should be monitored to ensure effective levels are maintained. The ratio of eggs to iodophore solution should be a maximum of 1:4.
- Rinse again in pathogen-free 0.9% to 1.1% saline for 30-60 seconds and then finally hold in pathogen-free water.

All rinsing and disinfection solutions should be prepared using pathogen free water. Iodophore solutions may be buffered using sodium bicarbonate (NaHCO3) if the pH is low.

Chemicals used to treat Water mold infection in fish and eggs

Chemicals/treatment	Application	Dose
UV radiation	Water Treatment	-
Ozone treatment	Water Treatment	-
Sodium Chloride	Egg	20 g L-1 2-3 h seawater flushes

Chemicals/treatment	Application	Dose
Formalin	Egg and Fish	150-300 mg L-1 100 mg L-1
Copper Sulphate	Egg and Fish	0.006 and 0.01 ppm
Hydrogen peroxide	Egg and Fish	250-500 mg L-1 for 15 min on alternative day
Bronopol(Pycez)	Egg	20-100 mg L-1 Bath/flush treatment daily
Peracetic acid	Egg	4-10 mg L-1

Basic Management Measures for Rainbow Trout Fishes Reared in Raceways

- Close watch should be kept on incoming water sources and maximum care should be taken to prevent the entry of extraneous materials in rearing facilities or raceways in order to avoid the loss of trout.
- Raceways should be covered with tarpaulin and incoming water should be filtered before allowing it to enter in raceways.
- Do and temperature should be kept at optimum level to avoid any mortality.
- Brooders should be properly handled during stripping to avoid sloughing of mucus layer.

Details of fish disinfectants / chemicals used in aquaculture

Name	Type if treatment	Total quantity required	Use
Potassium Permanganate ($KMnO_4$)	Pond treatment 2-3 ppm Bath treatment 500-1,000 ppm (1-2 min)	20-30 kg /ha-m 25-50 g in 50 L	General bactericide against external parasites Against fungal infections
Acriflavin	Bath treatment 500 ppm (20 min)	10 g in 20 L	Fish egg Disinfectant Against bacterial Infection
Sodium chloride	Bath treatment 2-3 % (1-2 min)	2-3 kg in 100 L	Againest wound infections Bactricide Fungicide Ectoparasitecide
Bleaching power (Active ingredient 30%)	Pond treatment @25-60 ppm	750-1000 kg/ha-m	Pond disinfectant complete disinfectant for nets and hatchery equipment
Lime Calcium oxide	Pond treatment	250 kg/ha-m	Pond disinfectant
Calcium Carbonate	Pond treatment	250 kg/ha-m	Pond disinfectant

Name	Type if treatment	Total quantity required	Use
Formalin	Pond treatment 15-25 ppm	150-250 L/ha-m	Parasiticide and against protozoan infections
	Dip treatment 250 ppm(1h)	5 ml in20 L	Parasiticide and against protozoan infections infection
*Copper sulphate	Pond treatment 0.1 ppm	10 kg/ha-m	Bectericide
	Dip treatment 500 ppm (1-2 min)	25 g in 50L	Bectericide
*Malachite green	Pond treatment 0.15 ppm	1.5 kg/ha-m	Fungicide Parasiticide
	Dip treatment 0.25 ppm	12.5 mg in 50 L	Fungicide Parasiticide
Malathion 50%	Pond treatment @ 0.25 ppm (3 doses)	5L/ha-m	Against *Argulus, Ergasilus* and other parasites
Butox	Pond treatment	70-75mL/ha-m	Against *Argulus, Ergasilus*
Methylene blue	Bath @3 ppm (30 min)	3 g in 1,000 L	Parasiticide specifically for Ichthiophthiriasis
Picric acid	Bath @ 10 ppm (1 h)	100 g in 1,000 L	Against black spot disease
Acetic acid	Dip treatment @ 5% (2-3 min)	1 L in 20L	Parasiticide and Bactericide
*Malachite green + Formalin	Prolonged bath for 2-3 h @ 0.05 ppm+50 ppm	50 mg +50 mL in 1,000 L	Against Dactylogyus, Gyrodactylus and other treamatodes
Oxytetracylin	With feed @ 70 mg /kg body weight (10 d)	70 g for 1,000 kg	Bactericide ,against aeromonad disease and EUS caused by Gm-ve bacteria
Chloramphenicol	With feed @ 50 mg /kg body weight (10 d)	55 g for 1,000 kg	Bactericide ,against aeromonad disease and EUS caused by Gm-ve bacteria
Chlorotetracylin	With feed @ 55 mg /kg body weight (10 d)	55 g for 1,000 kg	Against diseases caused by Aeromonas and pseudomonas

* Chemicals avoided in fish farm due to their harmful effects

Good Management Practices for Trout Farming

Healthy Trout Seed Stocking

- Fish seed should be collected from a certified hatchery or from a reliable source.
- Apparently healthy looking uniform size of fishes should be preferred for stocking in ponds/ tanks.
- Prior to stocking of fish seed in nurseries or grow out tanks/raceways, proper quarantine measures should be adopted.

Maintaining Appropriate Stocking Density

- Before deciding the stocking density, resources like water flow and fish feed availability for the whole culture duration should be evaluated.
- For calculating the carrying capacity of a fish rearing facility, culture system, species and intensity of farming should also be considered.
- Carrying capacity of a fish ponds/ tanks/raceways should not be exceeded.
- Exotic carp species juvenile's 20-50 g size should be stocked @5-10/sq with regular monthly exchange of some tank/pond water to maintain congenial environment, free of algal blooms and low Dissolved Oxygen.
- With water flow range of 40-50L/min, 50-150 rainbow trout larvae/sqm should be stocked in nurseries.
- In grow out raceways, stocking density of 4- 5g fry in should be maintained @ 25-50 fry/m^3 with water flow rate of 200-250 L/min.
- The stocking density could be increased with higher water flow rate, quality and feed availability.
- Regular grading of trout in 2-5 g, 10-20 g, 50-60 g and >100 g size should be done to avoid cannibalism.

Feeding

- Locally farm made balance feed should be preferred for feeding the farmed fishes.
- Pelleted trout feed should contain 35-45 % protein and 16-22% fat
- In fish farming utmost management of food and feeding schedule not only help in reducing the cost of production but also help in reducing the pollution in the raceways/cement tanks.
- Use proper feeding rate either over-feeding or starving the fishes leads to lowering of survival and fish production.
- Feed being used should be stored properly in dry condition avoiding from dampness.
- Shelf-life of prepared pelleted feed is very short therefore, should be used within 2-3 months.
- Feeding rate during nursery operations should be 10-15% of total body weight of fish.
- For growing table size trout and carps, feeding rate should be maintained @ 5-2% of the total body weight of stocked fishes.

Cleaning of Raceways/Tanks

- Removal and cleaning of trout raceways at regular intervals (20-30 days) should be carried out.
- Frequency of raceway cleaning depends on the season and quality of incoming water.
- During summer and rainy season, trout raceways should be cleaned more frequently then winter months.
- During winter months, minimum handling of fishes helps in keeping away fungal infection.
- Care should be taken while shifting the trout in other raceway
- Maximum flow of water should be maintained in hapas fixed during the cleaning and spreading of trout is also equally important
- Placing trout for longer duration in a crowed condition induces stress and injury, weaker fishes suffers more and therefore, cleaning work should be finished within shortest period.
- During cleaning of raceways, a flush of potassium per magnate($KMnO_4$) solution before filling freshwater should be given.

Water Parameter Monitoring

- Daily visit should be made to farm for observing the behavior of stocked fishes, water flow, algal bloom, morning surfacing etc
- Monthly or during abnormal situations, water quality should be analyzed and should be recorded in a register.
- During rainy season, filtration or sedimentation of incoming water should be undertaken to minimizing the sand concentration in flowing water.
- Prevent the accumulation of organic debris, nitrogenous wastes (ammonia and nitrite), carbon dioxide, and hydrogen sulfide. Maintain appropriate pH, alkalinity, and temperature.
- Maintain dissolved oxygen levels above 5 mg/L. Sub-optimum levels of dissolved oxygen, may not immediately be lethal to fishes, but, may stress fish resulting to fish kills with prolongation of condition.
- Maintain optimum water conditions while harvesting, hauling, and handling the stocked fish.
- During transportation of seed, salt (0.3 to 1.0 percent) maybe used in the transport water to minimize osmotic stress and bacterial infection of freshwater fish. Ice may be added to the water during hauling to prevent an increase in water temperature which reduces the ability of the water to hold oxygen and increases the metabolic rate and resulting oxygen demand.
- Considering the insatiable feeding habit of rainbow trout it is, therefore necessary to keep a close watch on incoming water sources and maximum care should be taken to prevent the entry of extraneous materials in rearing facilities or raceways in order to avoid the loss of trout.
- Thermal/ Oxygen sensitivity during summer months is found highest in fry followed by juveniles and adults rainbow trout.

- Based on the Oxygen demand, in aseries of raceways, the fry should be reared in row first followed by juveniles in second row and adults in third row.

Regular Examination of Incoming Water

- Fortnightly or monthly sampling of important water parameters like Temperature, Dissolved Oxygen (DO), ammonia, hardness and pH should be undertaken to provide a favorable environment.
- Water quality parameters should be in normal range. Do >5ppp, unionized ammonia <0.01ppm, pH 7.0 - 8.5ppm, temperature range for trout 4-21°C and carps 5-32°C.
- Discharge water of trout /carp farm should be properly filled and purified before releasing in to open aquatic systems.

Reduction of Physical Stress:

- Use captures methods that minimize physical injury and stress.
- When possible, use knitted mesh nets rather than knotted nets to reduce injury and scale loss
- Speed and gentleness when handling fish are of utmost importance.
- Minimize the number of times the fish are lifted from the water, and work as quickly as possible when transferring fish.
- Harvest, handle, and transport fish at times when fish are least susceptible to stress and infection.
- Transport and holding tanks should be large enough to allow complete freedom of movement of fish and have no sharp corners or edges that might injure the fish.

ICAR-Directorate of Coldwater Fisheries Research
Bhimtal- 263 136, Nainital, Uttarakhand