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Research Article

A RETROSPECTIVE STUDY ON THE INCIDENCE OF FISH DISEASES AND USE OF THERAPEUTANTS IN AQUACULTURE FARMS OF MOYNA, THE 'FISHERIES HUB' OF WEST BENGAL, INDIA

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ABSTRACT: The present study depicts the disease incidences in the aqua farms of Moyna, West Bengal, India, during 2018-2020 and aqua-drugs used by farmers to combat diseases. A total of 132 fish disease incidences were reported, among which parasitic diseases were the most common (53.03%) followed by bacterial diseases (27.27%), diseases due to poor nutrition and environmental fluctuations (10.61%), and fungal diseases (9.09%), respectively. Out of the 53.03% parasitic disease incidences reported, *Argulus* (22.86%), *Dactylogyrus* (17.14%), *Gyrodactylus* (10.00%), Myxospores (10.00%), *Lernaea* (8.57%), *Ichthyophthirius* (5.71%) and *Trichodina* (4.29%) were the major disease-causing parasites. Among bacteria, *Pseudomonas* spp. and *Aeromonas* spp. were the most dominant genera encountered in diseased fish. *Labeo catla* was the most susceptible fish species followed by *Labeo rohita,* and *Cirrhinus mrigala*. Seasonal influence in disease occurrence was noticed. Monsoon and winter were favorable seasons for disease outbreaks. The influence of water quality parameters like hardness, pH, ammonia, total dissolved solids of water, and total organic carbon of sediment had a significant correlation with parasite abundance. Farmers of Moyna were observed to use a wide range of chemicals and aqua-drugs to control diseases and related problems. The majority of the fish farms of Moyna were found using feed additives and supplements (32.00%) followed by sanitizers and disinfectants (24.00%), probiotics (17.00%), anti-parasitic drugs (11.00%), antibiotics (8.00%), and other chemicals (20.00%). Lime (calcium carbonate) and zeolite along with sodium chloride, potassium permanganate, formalin, and calcium hypochlorite were extensively used as disinfectants in Moyna. Farmers being unaware of the adverse consequences of using chemicals and aqua-medicines are fully dependent on private aquaculture consultants for time-to-time advice, which may have augmented their indiscriminate use. Initiative for implementation of better management practices by creating awareness among farmers and adopting strict aquaculture policy guidelines might improve the scenario.

Key words: Aquaculture hub, Disease incidences, Seasonal influence, Species susceptible, Aqua-drugs, Water quality.

INTRODUCTION

Aquaculture has become the world's fastest-growing food-producing sector (Subasinghe *et al.* 2009). India, being the second largest country in aquaculture production in the world, has achieved a more than ten-fold increase in production from 0.37 million tonnes in 1980 to 10.79 million tonnes in 2015-16 (DAHDF 2017), with an average annual growth rate of over 6 percent. Incommensurate with this increase in production, inland aquaculture in West Bengal has emerged as a fast-growing enterprise, and thereby, West Bengal has become one of the leading states in fish production in the country. In West Bengal, the Moyna community development block of Purba Medinipur district has been involved in aquaculture activities for a long and is widely known as the 'Fisheries Hub' of West Bengal in the recent past. Physico-graphically, it is a saucer-shaped area covering 147 sq km surrounded by three rivers, *viz.* Kansai, Chandia, and Kelaghai and susceptible to flooding during the rainy season. Some parts of this block retain substantial water

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depth even in peak summer months. The area was previously used for the cultivation of the Kharif variety of paddy. With a recurrent loss in paddy cultivation due to frequent floods, farmers preferred to switch to an alternative and more profitable venture - fish farming. This transformation changed the entire agricultural and economic scenarios and now almost the entire cultivable area in the Moyna CD block, covering an estimated area of 7,500 hectares that include 4465 ponds ranging from 25 acres to 400 acres size under 200 farms are utilized for aquaculture. The total fish production in Moyna in 2019 was around 84,000 tonnes with an average production of around 12 tonnes/hectare/year (Singh 2020). The fish species cultured include rohu (*Labeo rohita*), catla (*Labeo catla*), mrigal (*Cirrhinus mrigala*), common carp (*Cyprinus carpio*), silver carp (*Hypophthalmichthys molitrix*), grass carp (*Ctenophryngodon idella*), bhetki/barramundi (*Lates calcarifer*), tilapia (*Oreochromis* sp.), magur (*Clarias batrachus*), bata (*Labeo bata*), pangas (*Pangasionodon hypophthalmus)*, koi (*Anabas testudineus*), tangra (*Mystus vittatus*) and prawn (*Macrobrachium rosenbergii*) (Ghosh 2018).

However, the diversification and intensification of aquaculture practices with improper management result in several health-related problems in culture. Disease occurrences due to infection with different pathogens including viruses, bacteria, fungi, and parasites have become a common phenomenon in fish farms of Moyna every year. Farmers spend approximately Rs. 1 lakh/ hectare/year for prophylaxis and control of fish diseases in Moyna. Organized surveillance programs to know the incidences of different diseases throughout the year are scarce. Due to the increasing fish disease problems in the fish farms of this area, monitoring and surveillance of diseases have been considered important. The passive surveillance-based study is described as one of the significant tools to ascertain the prevalence of diseases in fish. Disease incidence reports sometimes become unusable due to delayed reporting by farmers (Sahoo *et al.* 2020). Hence, timely reporting of disease occurrence is of utmost importance to develop preparedness for controlling diseases. Given this a priority, the present work was carried out to draw a current scenario of the major fish diseases and measures adopted by the farmers to combat diseases in the fish farms of Moyna, West Bengal.

MATERIALS AND METHODS

Surveillance of fish diseases and use of aqua medicines

For the surveillance of fish diseases, extensive field studies were conducted in Moyna CD block under Purba Medinipur district, West Bengal, India (Fig. 1) for a period of 33 months from April 2018 to December 2020 to collect primary data from different aquaculture farms. During the survey, farmers (n=200) belonging to 60 aqua-farms were interviewed directly about the farm, the disease prevalence, management practices, and the use of aqua-medicines as well as chemicals with a pre-tested structured questionnaire developed after Thrusfield (1995) through Participatory Rural Appraisal (PRA). Attempts were made to make statements informal, polite, and non-technical. Questionnaires were prepared in English and the respondents were interviewed in vernacular Bengali. A total of 132 questions were categorized under 04 broad groups such as (i) demography about characteristics of aquaculture, (ii) farm establishment details and general information, (iii) farming features (farm area, pond management, nursery practice, grow out culture, grow out farm productivity and profitability, feed and feeding, problems encountered, disease particulars, therapeutics and chemicals used), and (iv) machinery and equipment used in fish farming. Before starting the survey, the questionnaire was pre-tested at least two times by interviewing the targeted folks. The secondary data used for the study were collected from reports, articles, and records from the Moyna CD Block Office, different NGOs, and Fish Farmers' Co-operative Societies located at Moyna.

Diseased fish samples

The fish samples, as well as the water samples, were received from farmers of Moyna to the Regional Research Station-Rahara of ICAR-CIFA from April 2018 to December 2020. Before sample collection, awareness programs were organized to obtain diseased specimens in preferred transporting conditions. In brief, live or moribund fish samples were advised to place in a strong clean plastic bag with a minimum amount of water (not more than one-third full), oxygen packed, placed in another plastic bag, and then transported in strong cardboard, plastic or styrofoam box with insulation. Crushed ice was also suggested to be put into a separate plastic bag and placed in the box next to the fish bag if it is transported in the summer months. Freshly dead fish were advised to be kept in a small amount of water to prevent the fish from drying out, the sealed bag than to be placed on crushed ice and shipped in a well-insulated container with sufficient ice to keep the specimens cool until arriving at the laboratory. Samples were also brought from farm sites as and when reported by the farmers and noted during a visit to the farms following OIE guidelines (OIE 2013).

Parasitic samples were either preserved in 4% neutral buffer formalin (NBF) or directly studied from squash preparation of the skin, gills, and kidney tissues under the microscope. Samples from kidney, gill, and skin were collected aseptically for bacteriology in transport swabs w/ Amies w/ charcoal (HiMedia, India) for further study. Inoculums from each transport tube was streaked onto nutrient agar (NA), MacConkey agar (MA), glutamate starch phenol red agar (GSPA) with penicillin G sodium salt (100 IU/mL, HiMedia, India), and selective cytophaga agar (SCA) with neomycin sulfate (5 µg/mL) and incubated at 28^0C for 24 h. Typical colonies, based on dominance and distinct colony morphology, were randomly chosen, purified by repeated streaking on NA, and maintained on NA slants. As described by MacFaddin (1980) and Collins *et al.* (1989), a series of biochemical reactions were conducted to identify the bacteria up to the genus. For the identification of bacteria, flow charts were followed as recommended in Bergey's Manual of Determinative Bacteriology (Holt *et al.* 1994) and Lechevallier *et al.* (1980), along with some modifications added by Slepecky and Hemphill (2006), and Ugur *et al.* (2012).

Water samples

The pond water samples were collected in sterilized plastic bottles to examine the water quality parameters. Dissolved oxygen (DO), pH, and salinity were checked on the spot using a multi-parameter water testing meter (Hanna Instruments, Model: HI 9828010-01). The water temperature was measured on the spot with the help of a glass thermometer. The water quality parameters like alkalinity (phenolphthalein alkalinity and methyl orange alkalinity) and hardness (calcium hardness) were measured through standard titrimetric methods as per Boyd (1979). Total ammonia (Weatherburn *et al.* 1967) and nitrite (Shinn 1941) were measured by the phenate method and colorimetric method, respectively; Total organic carbon of sediment was measured by rapid titration method using potassium dichromate as an oxidising agent as described by Walkley and Black (1934).

Determination of disease incidences and use of chemotherapeutics

The disease incidences were calculated by taking an account of the occurrence of new cases of fish disease over a specified period and expressed in percentage. The seasonality in the occurrence of diseases was also ascertained in the present study. The whole year was divided into 4 major seasons i.e., summer (March-June), monsoon (July-September), autumn/pre-winter (October-November), and winter (December-February). The occurrence of diseases was recorded throughout the year. The total number of disease occurrences recorded in each season from 2018-2020 was plotted. Species-wise disease incidences were assessed by taking the percentage of the number of disease occurrences in a specific fish species out of the total disease occurrence recorded in the reporting period. The use of drugs, chemicals, and additives was obtained by determining the number of farms used out of the total number of farms surveyed (n=60) and expressed in percentage.

Data analysis

The data were assessed using descriptive and tabular statistical methods. Analysis was done by converting the raw data to meaningful results using distribution, ratio, and percentage.

RESULTS AND DISCUSSION

Incidence of fish disease in Moyna

The present study describes the occurrence of different diseases, their host preferences, and the seasonality of infections reported in fish during 2018-2020 in 60 aquaculture farms of Moyna, Purba- Medinipur, India. The samples analyzed during the study period indicated that parasites were the major disease-causing agents in the aquaculture of Moyna, which was also reported by Fagbenro *et al.* (1993), Mohan and Bhatta (2002) as well as by Hoque *et al.* (2018a) and Sahoo *et al.* (2020) in different aquaculture systems. A total of 132 disease incidences were documented during the period, of which incidences of parasitic diseases were 53.03% followed by bacterial diseases (27.27%), fungal diseases (9.09%), and other diseases (10.61%) (Fig. 2). Like present observation, Gopal *et al.* (1992) also documented different parasitic pathogens being the major disease-causing agents in fish (70.00% of cases) followed by bacteria (27.50%) and fungi (2.50%). Apart from the mixed parasitic infection (21.43%) out of the 70 cases of parasitic infections reported, *Argulus* sp. (22.86%), *Dactylogyrus* sp. (17.14%), *Gyrodactylus* sp. (10.00%), Myxosporean infection (10.00%), *Lernae* (8.57%), *Ichthyophthirius multifiliis* (5.71%) and *Trichodina* (4.29%) infections were the dominant parasites causing diseases and mortality of the fishes cultured in aquafarms of Moyna (Fig. 3). Previous studies also reported Argulosis as the main reason for production loss in other fish farms throughout the country (Gopal Rao 1988, Vineetha and Abraham 2009). The results of the present study corroborate Sahoo *et al.* (2020), who reported that parasitic diseases are the major disease-

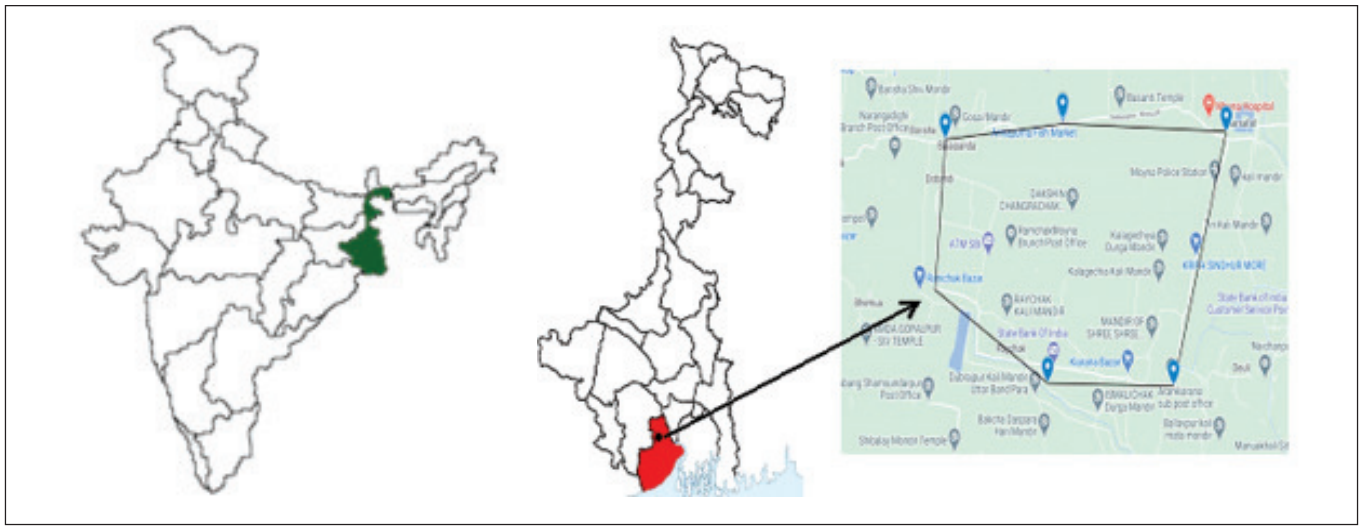

Fig. 1. Study area

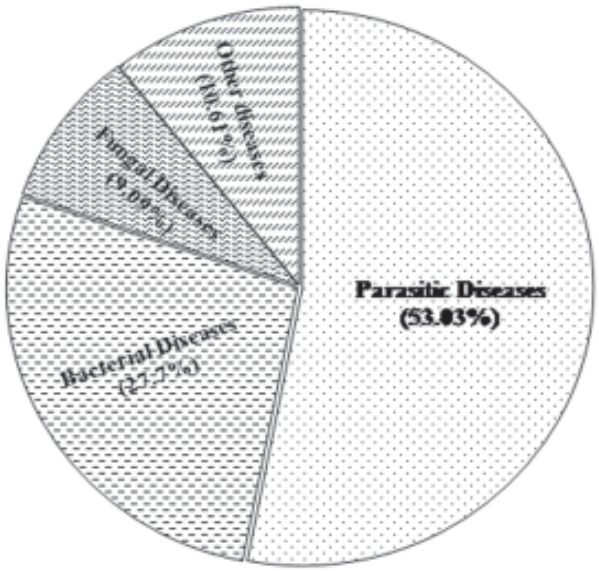

Fig. 2. Incidences of fish diseases in Moyna.

causing agent in freshwater aquaculture farms of Eastern India.

Bacterial diseases are considered key concerns in fish production. *Pseudomonas* spp. (n=12) was found as the dominant bacterial genus causing disease and associated mortalities. *Pseudomonas* spp. was isolated from gills causing discoloration and necrosis and from the skin causing hemorrhages and ulcers. In fish farms of Moyna, 30.56% of bacterial diseases were found to be caused by *Aeromonas* spp. (n=11). Similarly, Vineetha and Abraham (2009) reported that *Pseudomonas* spp. and *Aeromonas* spp. were the frequently encountered bacterial species in fishes of Andhra Pradesh. Aeromoniasis was also described as a major threat affecting IMC farming in India (Sahoo *et al.* 2008). Apart from pseudomonads and aeromonads, other bacterial pathogens causing diseases and fish mortality were *Klebsiella* (n=3), *Edwardsiella* (n=4), and *Flavobacterium* (n=2) (Fig.4.). In the present study,

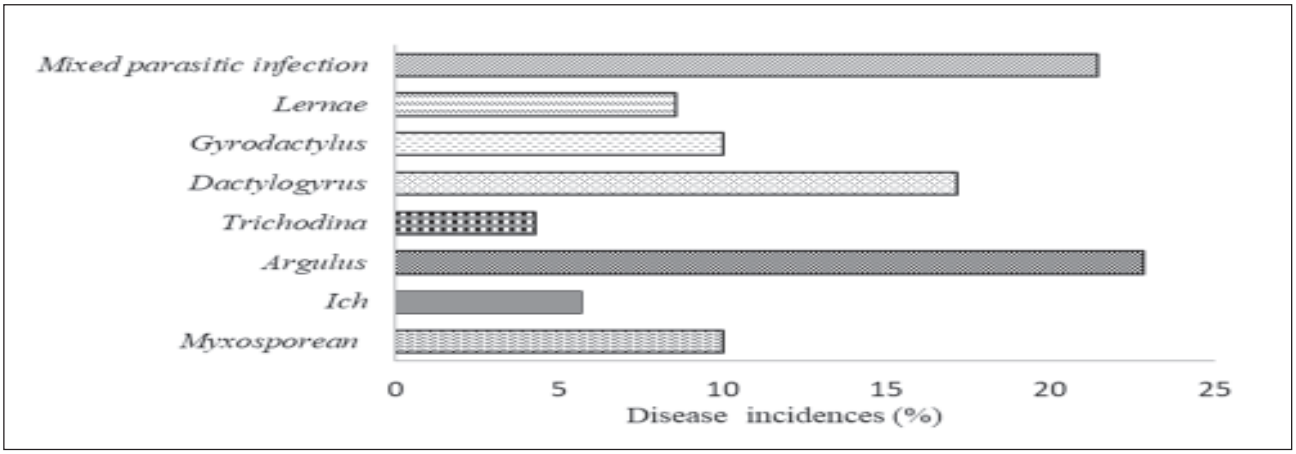

Fig. 3. Incidences of different parasitic diseases in Moyna.

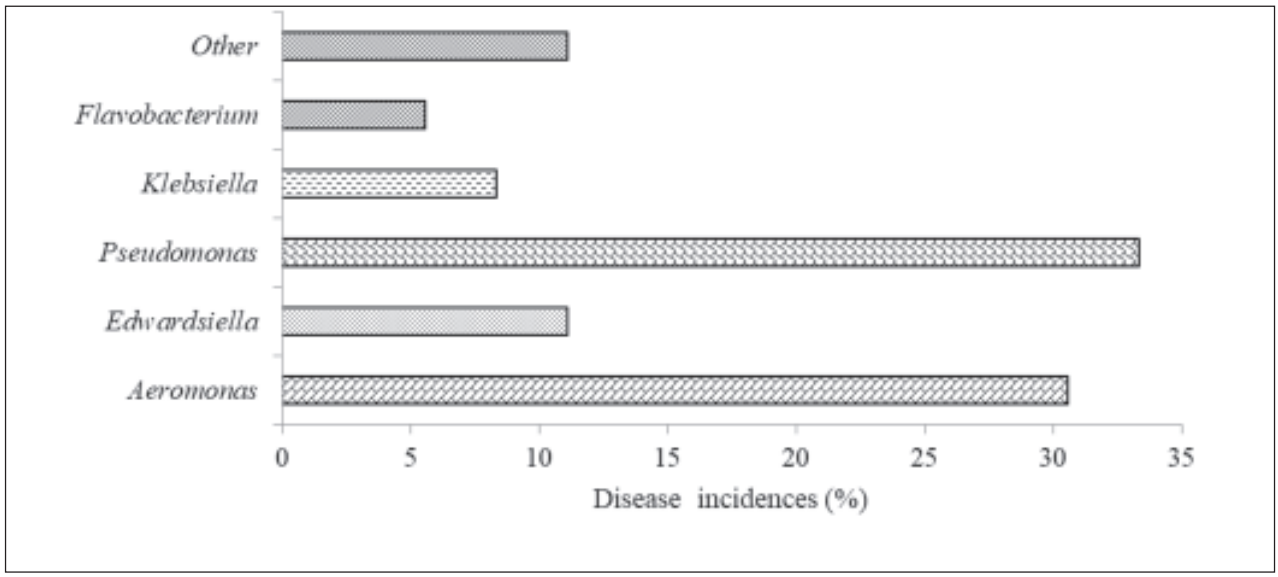

Fig. 4. Incidences of different bacterial diseases in Moyna.

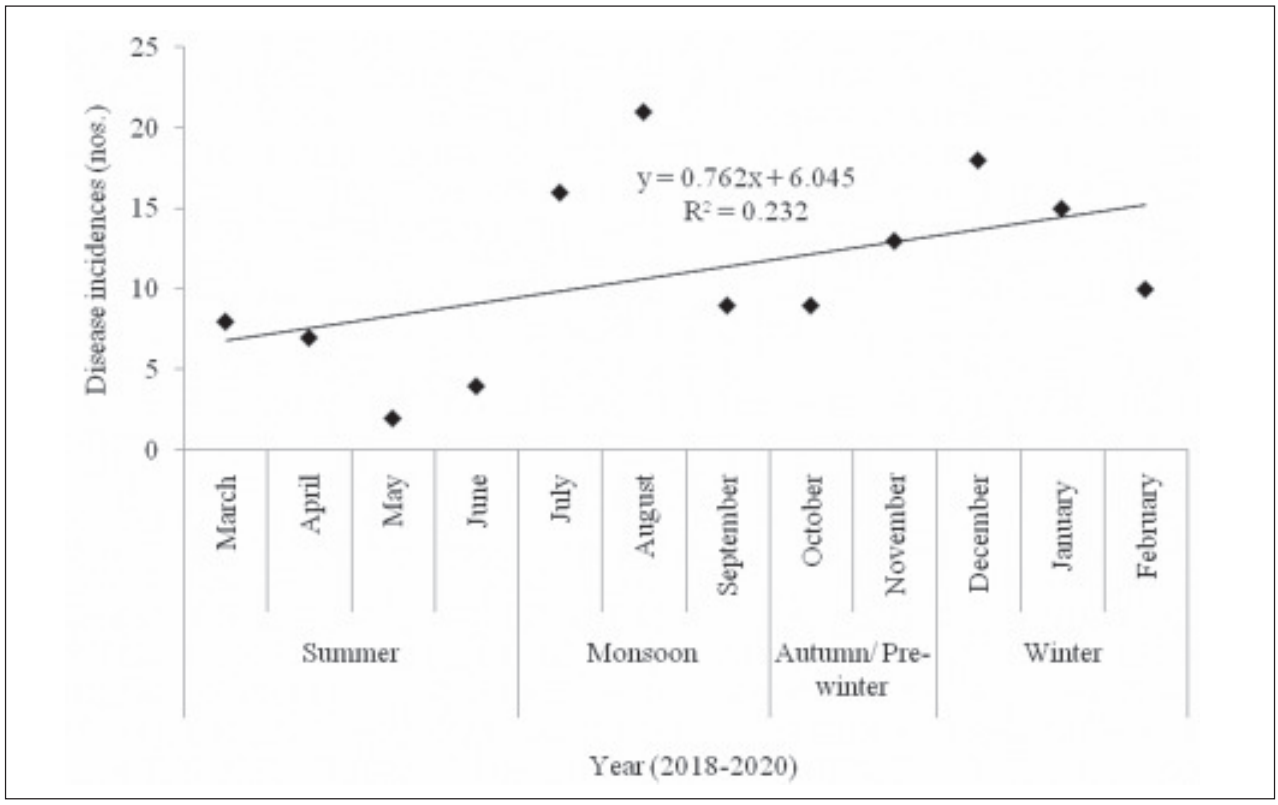

Fig. 5. Seasonal variations in incidences of diseases.

members of Enterobacteriaceae such as *Proteus, Morganella* and *Enterobacter* were also isolated from diseased fish. Abdel-Latif and Sedeek (2017) also reported Enterobacteriaceae in cultured *Oreochromis niloticus* cause disease and mortality. In Moyna, 10.61% of diseases and associated mortality were reported due to poor environment and nutrition. Shefat (2018) also documented that poor water quality, nutrition, or immune system is related to stress and leads to major disease outbreaks and high mortality in fish.

Seasonality in the occurrence of disease

The occurrence of diseases was recorded throughout the year, however, monsoon followed by winter was found to be the most favorable seasons for disease outbreaks in aquaculture farms of Moyna (Fig. 5). Total of 46 disease

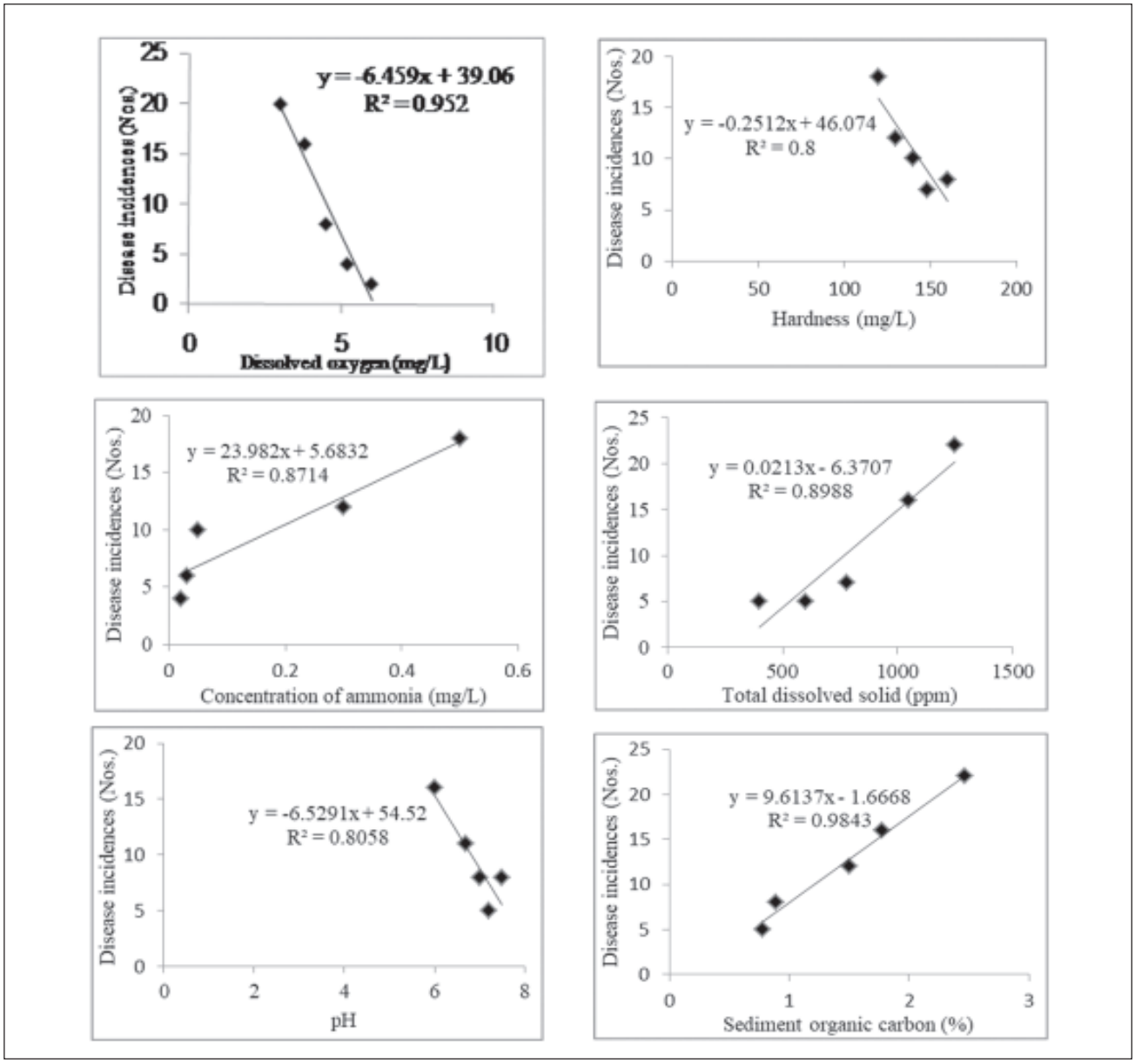

Fig. 6. Correlation of water quality parameters associated with incidence of parasitic diseases at Moyna.

outbreaks was documented during monsoon, which may be due to the sharp fall in water alkalinity, hardness, chloride concentration, and fluctuating pH from the higher summer values due to dilution during rainy season triggering the disease outbreak (Das and Das 1993). In winter, the decrease in water temperature along with a weak immune system plays a significant role in higher disease incidences (Kalita *et al.* 2019, Vineetha and Abraham 2009, Sahoo *et al.* 2020).

Species-wise disease incidence

In Moyna, the highest disease incidences were reported in cattle, followed by rohu. The present study corroborates the observations of Vineetha and Abraham (2009), Khatri *et al.* (2009), and Sahoo *et al.* (2020) who noticed that catla was the most susceptible to infectious diseases followed by mrigal and rohu. The reason may be due to the surface feeding habit and more commonly vulnerable to water temperature fluctuations leading to weakening immunity as reported by Sahoo *et al.* (2020). Moreover, disease incidences were also reported in *Pangasionodon*, *Oreochromis, Clarias*, *Mystus,* and *Anabas* on farms of Moyna apart from exotic and minor carp (Table 1). Diseases of fungal origin (*Saprolegnia* spp.) were mainly recorded in catfish such as *Clarias* sp., exotic carp such as *Hypophthalmichthys*

Fig. 7. Common drugs and chemicals used in aquaculture farms of Moyna.

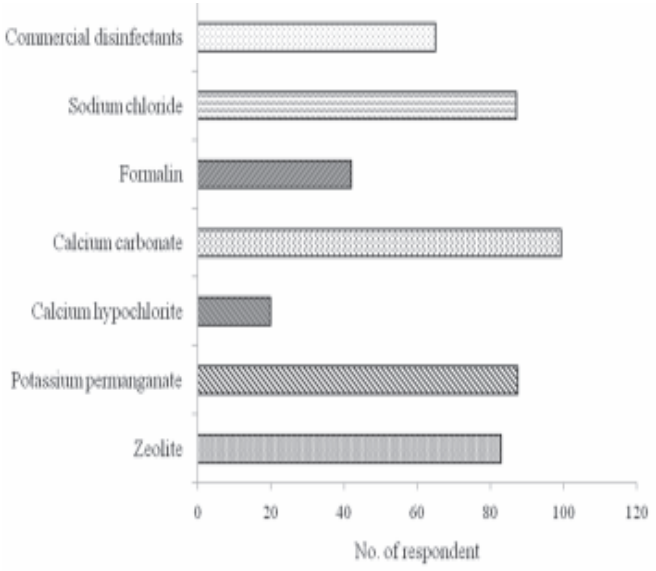

Fig. 8. Disinfectants used in aquaculture farms of Moyna.

molitrix, and minor carps such as *Puntius* sp., whereas parasitic and bacterial diseases occurred irrespective of species. Environmental, nutritional (vertebral column deformities), and viral-like (Papillomas) disease incidences have been enlisted in other diseases reported here.

Influence of water quality on the incidence of parasitic diseases

The water quality parameters like dissolved oxygen, hardness, pH, ammonia, total dissolved solids, and total organic carbon of sediment in the fish parasite-infested farms were examined. Most of the parameters studied (pH 6.88±0.57, dissolved oxygen 4.50 ±1.17 ppm, hardness 139.60±15.51 ppm, total ammonia 0.18±0.21 ppm, total dissolved solids 816.00±340.63 ppm, and total organic carbon of sediment 1.49±0.69%) were in sub-optimal levels imparting stress to fish. The relation between the water quality parameters and the parasitic disease incidence was investigated by multiple linear regression analysis (Fig.6) and dissolved oxygen, hardness,

Table 1. Summary of fish species specific disease incidences at Moyna (2018-2020).

Fish species	Disease incidences (nos.)				
	Bacterial	Parasitic	Fungal	Other	Total
Rohu (Labeo rohita)	08	18	NR	02	28
Catla (*L. catla*)	05	25	NR	01	31
Mrigal (*Cirrhinus mrigala*)	03	09	NR	01	13
Exotic carps	02	06	03	02	13
Minor carps	01	04	04	NR	09
Pangas (*Pangasianodon hypophthalmus*)	06	02	NR	NR	08
Nile Tilapia (*Oreochromis niloticus*)	03	NR	NR	NR	03
Magur (*Clarias* sp.)	02	04	03	01	10
Tangra (*Mystus* sp.)	04	02	NR	02	06
Koi (*Anabas* sp.)	02	NR	02	05	11

*NR- Not recorded.

pH, ammonia, total dissolved solids of water, and total organic carbon of sediment had a significant correlation with parasite abundance ($p < 0.05$).

Higher incidences of parasites were observed in organic matter-rich water with low dissolved oxygen (3.00 - 4.50 ppm) and acidic pH (6.00 - 6.50) which in turn enhanced the secondary pathogen, particularly bacteria. Similar observations were made by Nayak *et al.* (1999), who reported outbreak of fish diseases in *Carassius auratus*, grown in an environment with a higher organic load, low oxygen, and high ammonia. In the present study, the majority of the parasitic diseases were reported in the water bodies with high ammonia (0.05 - 0.50 ppm), low level of dissolved oxygen (3.00 - 4.50 ppm), high total dissolved solids (1050.00 -1250.00 ppm), the high organic carbon in sediment (1.78% - 2.47%) causing extreme stress, which in turn may have promoted infestation of different parasites in fish. The coefficient of determination (R2) values for the estimated functions varied from 0.80 to 0.98, which implies that 80.00% to 98.00% variation in the incidence of parasitic infection in the farms of Moyna was related to suboptimal water quality. Banu and Khan (2004) also reported a significant correlation between Physico-chemical parameters and the incidence of parasites in fish ponds in Bangladesh. The present observations were also in parity with Athithan (2008) and Chidambaram *et al.* (2013) who reported water quality parameters directly affect fish health, causing stress and resulting in the death of fish.

Use of aqua-medicine and chemicals

Aquaculture farmers of Moyna reported the use of a wide range of chemicals, insecticides, and antimicrobial agents to control the occurrence of fish disease. The aqua-medicines, drugs, and chemicals used were categorized into different groups, *viz.,* feed additives and nutritional supplements, probiotics, sanitizers and disinfectants, anti-parasitics, antibiotics, and others (fertilizers, growth promoters, water quality improvement products, antiseptics, and pesticides) (Fig. 7). Out of 60 farms surveyed, 32% farms (n=19) reported use of feed additives and supplements, 24% farms (n=14) used sanitizers and disinfectants, 17% farms (n=10) used probiotics, 11% farms (n=7) used anti-parasitics, 8% farms (n=5) used antibiotics as well as other chemicals. Similarly, the use of aqua-medicines, drugs, and chemicals was reported in Andhra Pradesh, Chhattisgarh, Jharkhand, and Odisha (Mishra *et al.* 2017). The expansion of intensive fish culture has led to the higher application of drugs and chemicals in Moyna. Also, soil treatment with inorganic fertilizers was reported from 20 farms, and both organic and inorganic fertilizers from 28 farms out of the 60 farms surveyed in Moyna. The use of only organic fertilizers was found minimal might be due to meager availability. Lime (calcium carbonate) and zeolite were the most common chemicals used in Moyna. Also, sodium chloride, potassium permanganate, formalin, and calcium carbonate were reported to be used as disinfectants in aquaculture farms of Moyna apart from using other commercial products. Joshua *et al.* (2002) also reported the use of similar disinfectants in shrimp hatcheries in India. In Moyna, calcium carbonate, potassium permanganate, sodium chloride, formalin, calcium hypochlorite, and commercial disinfectants were frequently used chemicals (Fig.8). Although the practice of using antibiotics and antimicrobials in aquaculture is unjustified, they are widely used as therapeutic and prophylactic purposes. Inadequate knowledge of the farmers on the use of aqua drugs has led to the rampant use of these products in Moyna. Moreover, aqua-medicines are observed to be marketed in the name of "feed-additives". Fish farmers of Moyna were found highly dependent on private aquaculture consultants or representatives of feed or chemical suppliers for timely advice for a better harvest of crop and disease management, which was also reported by Mishra *et al.* (2017) in other states of India. Even the farmers in this region were provided feed "on-loan a basis" by the private dealers and allowed to make payments post-harvest of the crop. Farmers being unaware of the quality and problem of using aqua-medicines and formulations are fully dependent on the aquaculture consultants, which may have augmented the indiscriminate use of aqua-medicines in Moyna. The traditional knowledge in fish health management may be adopted in aquafarms along with modern scientific technologies which may lower the tendency of the farmers to use commercial chemotherapeutics (Hoque *et al.* 2018b). Knowledge of stressors and their impact on fish may also play a major role in minimizing stress-induced mortality (Hussan *et al.* 2017).

CONCLUSION

The fish disease is one of the major causes of concern in the growth of freshwater aquaculture of Moyna CD block. The present study established a comprehensive and clear trend about occurrences of diseases in different seasons during 2018-2020 in the freshwater aquaculture hub of West Bengal. The establishment of better management practices (BMPs) for Moyna CD Block is

critical. A better understanding of the status of disease prevalence, disease prevention and control technologies, adoption of profitable biosecurity programs, and implementation of farm-level BMPs are strategic for sustainable fisheries production in the study area.

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