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# Investigating the Factors Influencing Prawn Cultivation in India

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***Abstract***

*Aquaculture is a salient food production sector in India. India is the second largest country in aquaculture production, and this sector contributes 1% of India's GDP. It offers livelihood for neatly 14 million people. Among diverse aquaculture, prawn farming holds significant commercial paramount in India. The trade and commercial value of prawn farming is increasing every year, but the farmers are facing severe problems due to various disease affecting the prawns. Hence this paper aims to discuss about disease affecting the prawns, in particular, disease affecting Penaeus Monodon (P. monodon) or Tiger shrimp and Litopenaeus Vannamei (L. vannamei) or White leg shrimp, which is the majorly cultivated prawn varieties in India. Abiotic and Biotic disease are the major classification of shrimp disease. Having aware about the disease and its prevention is always the best method because uttermost diseases are having high mortality rate.*

***Keywords:*** *Aquaculture, Prawn farming, Penaeus Monodon, Litopenaeus Vannamei.*

## 1. Introduction

Prawn farming was started in Asia over centuries ago. Dr. Motosaku Fujinaga's research about Penaeus japonicas in 1934, on Japan had led the amelioration of current prawn farming (1). Now India has two different types of prawn farming, freshwater and brackish water prawn farming. Among this, brackish water prawn production surpasses over other and gives 1.6% of total export earnings (2). Brackish water prawn production includes variety of prawn species and the figure 1 shows the major prawn varieties cultivated in India. In betwixt of all this species, P. monodon and L. vannamei prevail over them in production as well as commercially. Production of P. monodon get high from early 90's but after the introduction of L. vannamei in 2008, this scenario has changed, L. Vannamei replaces P. monodon from the place of top cultivating prawn breed in India. And till date L. vannamei holds the place of top cultivating prawn breed in India followed by P. monodon. Not only in India, this scenario happened in almost all Asian countries from 2002, where farmers started cultivating L. vannamei in large numbers over P. monodon. And from 2004, L. vannamei has been the world's most cultivating shrimp species (3).



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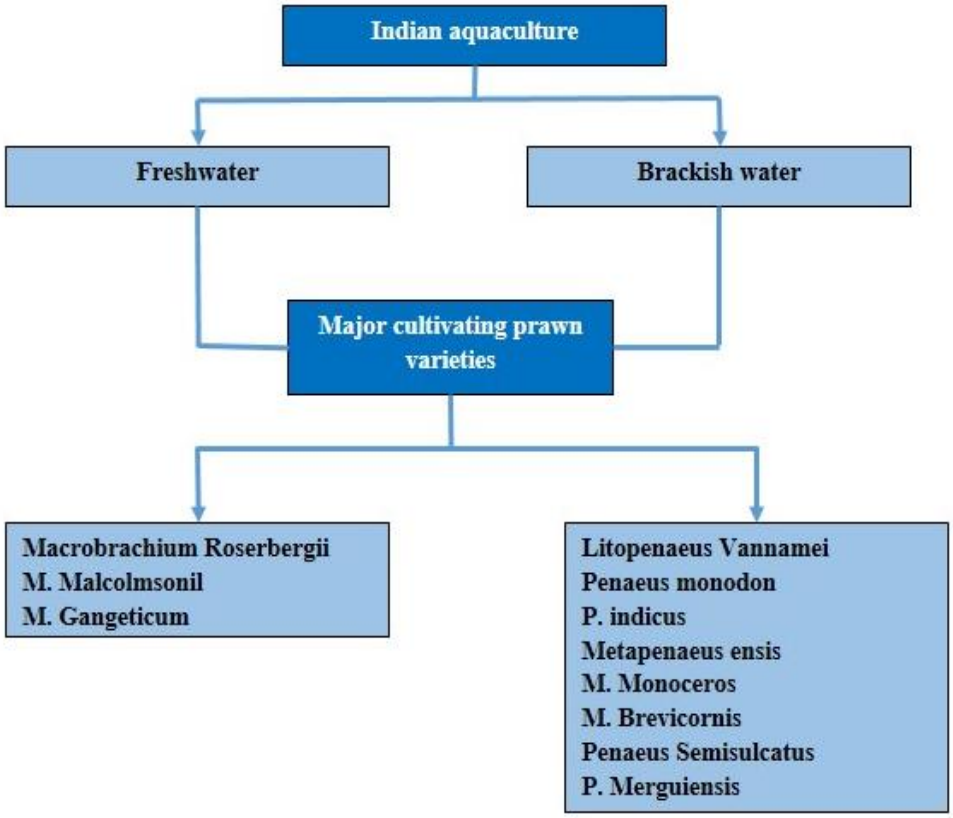


**Figure 1. Majorly cultivating prawns in India**

According to the survey of Marine Products Export Development Authority of India, total production of L. Vannamei for 2017-18 is 6,22,327 ton and P. monodon is 57,691 ton. Production of L. Vannamei and P. monodon from the financial year 2001-02 to 2017-18 is shown in figure 2 and figure 3 respectively.

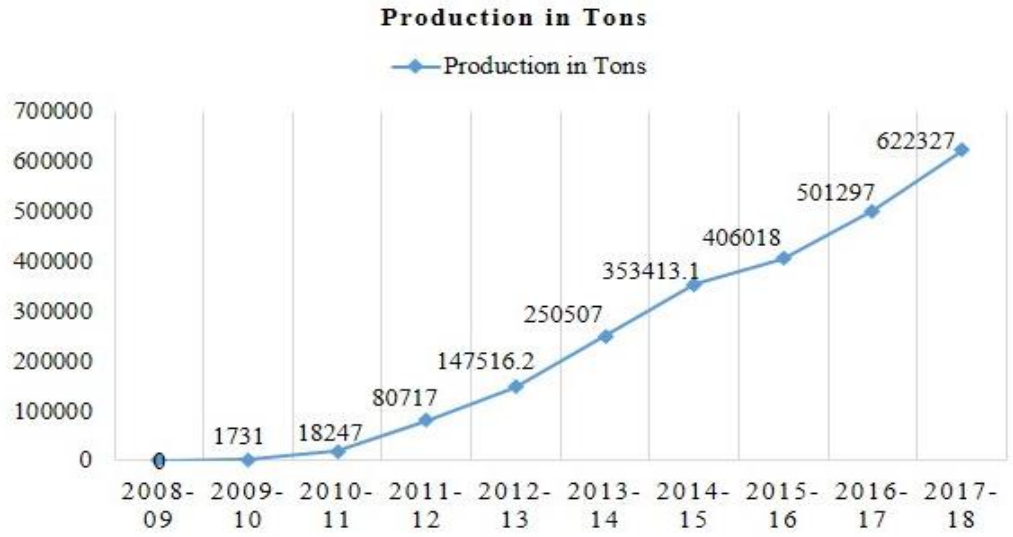


**Figure 2. Year wise production of L. Vannamei (4)**



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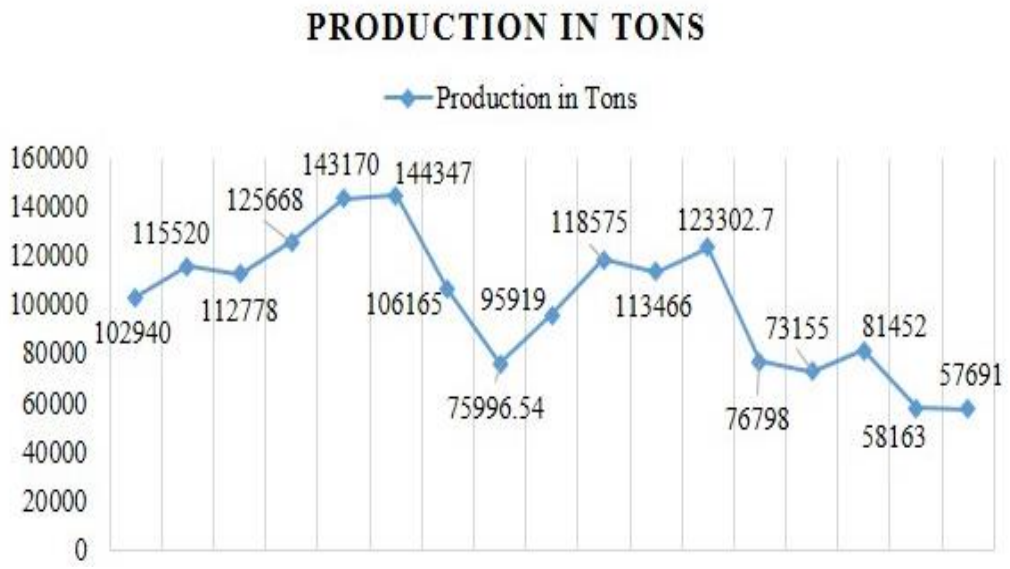


**Figure 3. Year wise production of P. Monodon (4)**

## 2. Influencing Factors in Shrimp Farming

Accomplishment of desired production level requires suitable environment in shrimp farming. Some of the parameters which play a major role in shrimp growth are site selection, quality of the water, stocking density in the pond and the most important parameter is how well the shrimps are free from disease. Because comparing to all other factors disease can give high mortality rate in shrimp farms.

### 2.1 Site selection

Site selection is the first and foremost factor to be considered for prawn farms. Site selection includes various terms as shown in figure 4.

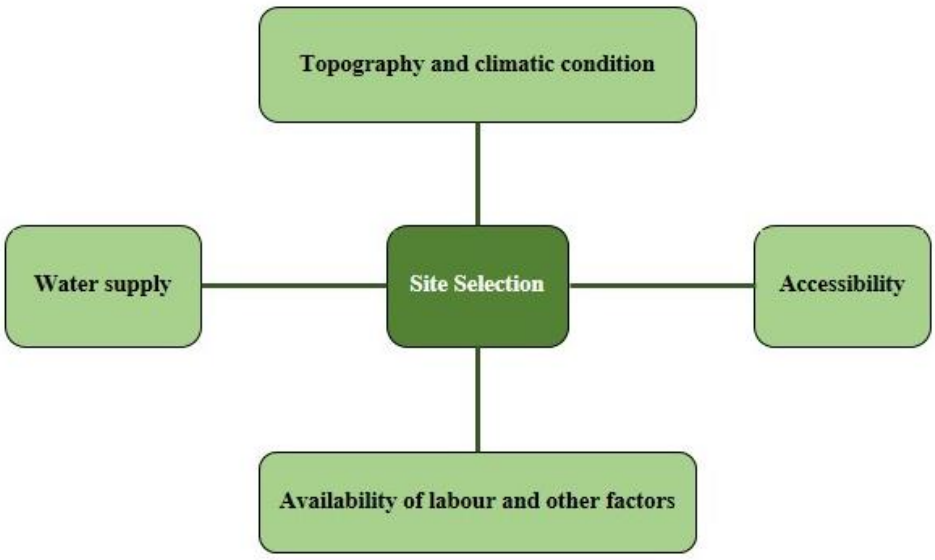


**Figure 4. Factors to be considered in site selection (5)**



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The suitable site for prawn cultivation should have acclivity of 1-3 meter above the mean sea level or it should be 1 meter raised above the highest high tide level for harvesting and drainage purpose (6). Topographic and climatic condition includes temperature, salinity and others physico-chemical parameters. And the site selection also includes other essential needs for farming practice.

### 2.2 Water quality

Water quality determines the upgradation or decline of shrimp production. Continuous monitoring and maintenance of water quality is necessary for the survival and growth of shrimp. Water quality in term includes the parameter shown in figure 5,

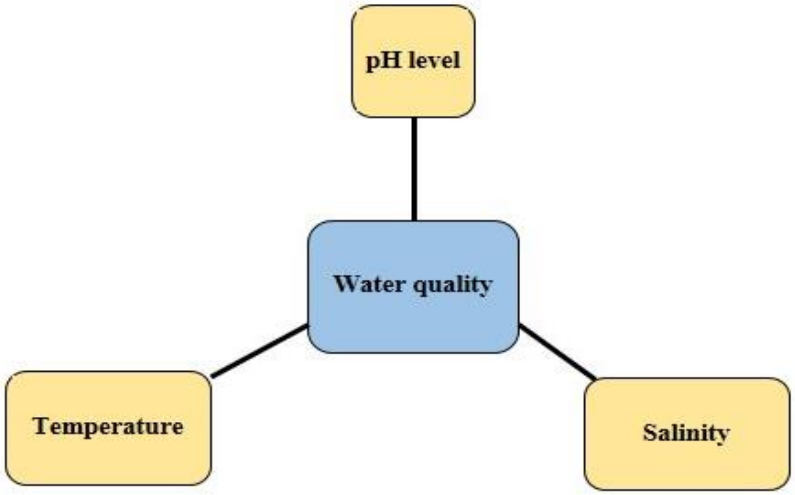


**Figure 5. Water quality parameters**

The optimum level of pH is 7.5 to 8.5 and the maximum variation in pH per day is 0.5. And the salinity variation will be 5 ppt per day (7). Generally, for maximum production temperature should between 26º - 30º C (8). Suitable temperature may vary according to the prawn variety, sufficient temperature range for L. vannamei and P. monodon is shown in table 1. In order to maintain water quality, chemicals are being used by the farmers. Chemicals and aqua-drug in shrimp farms are used for water quality management and it also used as disinfectant and antibiotics. Legitimate usage of this chemical will definitely help in maintaining water quality and also in disease prevention but improper usage will cause unwanted trouble in environment and human health (9).

**Table 1. Temperature and salinity range comparison between L. Vannamei and P. Monodon (10, 11, 12)**

| Abiotic Factors | L.Vannamei | P.Monodon |
|---|---|---|
| Temperature | 23–27°C | 26-30°C |
| Salinity | 0.5-45 ppt | 3-50 ppt |

### 2.3 Stocking density



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Stocking density means per-unit stocking amount of prawn. Three different level of stocking densities are extensive, semi-intensive and intensive (13). L. vannamei can tolerate high stocking density upto 400/$m^2$ (10). In L. vannamei farms, due to its high stocking density ammonia and nitrate are generated (Nitrogenous waste). This will severely affect the water quality (14). Various stocking density with their characteristics are discussed in table 2.

**Table 2. Stocking density in prawn culture (13, 15)**

| Stocking method | Range | Challenges |
|---|---|---|
| Extensive | Only few post larvae per square meter. | ➢ It disrupt and destruct the environment, notably mangroves<br>➢ It is unsuitable for increased population |
| Semi-intensive | 5 to 15 post larvae per hectare. | ➢ Acidification of soil<br>➢ Tourney in marketability<br>➢ Availability of feed and fertilizers |
| Intensive | 20 post larvae per square meter | ➢ Drainage facility<br>➢ Suspended solid |

### 2.4 Prawn Diseases

Prawn cultivation is the fastest growing sector around the world. India contributed 11.6% of global shrimp production in the year 2017 (16). But on other hand prawn production suffer severe slump due to various disease. And this disease causing agents are broadly categorized into Abiotic and Biotic (17). Major causing factors of abiotic and biotic disease are described in figure 6.

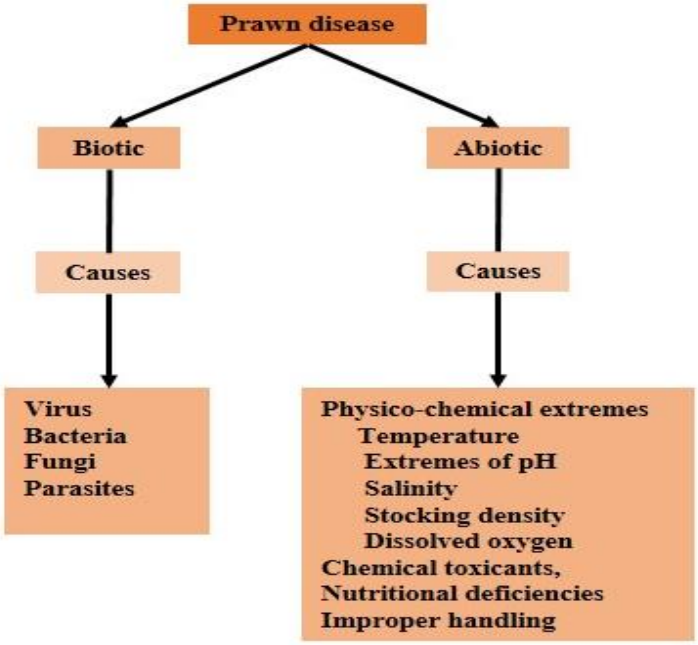


**Figure 6. Classification of prawn disease**



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Prawn diseases are not causing any health disorder in human but it is a crucial problem for prawn farmers and also to our economy (3). In 2001, Global aquaculture alliance took a survey which admits 80% of the shrimp production loss is due to biotic disease and 20% is due to abiotic and other unknown factors (13). During the period 2006-08, loss nearly 1000 crores (INR) were occurred due to prawn disease in India (18).

## 3. Abiotic Disease

Abiotic diseases getting occurred in shrimp due to external factors like temperature, water quality of the pond (including pH level, dissolved oxygen content) and maintenance of the pond. Some of the abiotic diseases affecting cultured prawns are shown in figure 7.

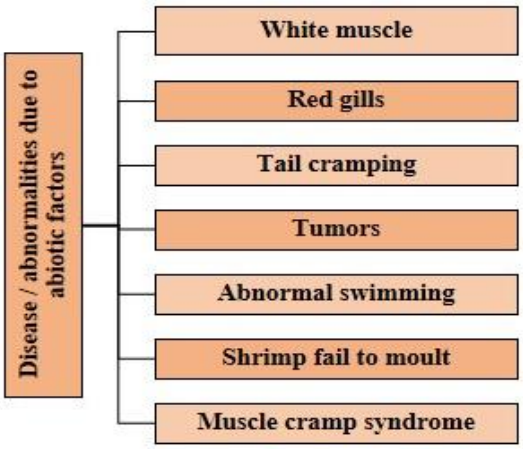


**Figure 7. Abiotic diseases**

Efficient shrimp growth needs suitable external factors. When there is instability in environmental conditions it will lead to various abiotic disease. Some of the vastly affecting abiotic diseases are discussed below.

**Table 3. Causes and characterization of abiotic disease of prawn**

| Disease / abnormality | Causes | Characteristics |
|---|---|---|
| White muscle | Extreme pond temperature and Heat stress | Opaque white muscle |
| Red gills | Stress | Colour of the gill become abnormal |
| Tail cramping | High temperature and Salinity | Impairments in prawn |
| Tumors | Genetic disorder and Chemical pollution | - |
| Abnormal swimming | Deficient water quality | Abnormal prawn behaviour |
| Muscle cramp syndrome | Less amount of dissolved oxygen | Muscle whitening |



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### 3.1. Disease due to high pond temperature and stress

Temperature plays a major role in shrimp growth, its metabolism and also in feeding the shrimp. For L. vannamei, temperature and shrimp size are inversely proportional because small shrimp require temperature nearly 30$^{o}$C and large shrimp need 27$^{o}$C (10).

#### 3.1.1. White muscle disease

When pond temperature reaches extreme range than its suitable condition, white muscle disease (WMD) occurs (19). First occurrence of WMD was in Guodeloupe in 1995 (18). In India. WMD was first reported from the freshwater (M.rosenberjii) prawn farms of Tamilnadu and Andhrapradesh in 2001(20). Appearance of white opaque muscle in shrimp body is the clinical sign of this disease (19). The mortality rate was ranged from 30% to 100% within one year(November 2001 to December 2002).

#### 3.1.2. Red gill disease

Clinical sign of this disease is, gill colour turns into red from pink. This abnormal colour change in prawns is due to stress (19). Continuous monitoring and proper maintenance of the pond's environmental condition is the only way to avoid stress (19).

#### 3.1.3. Tail cramping

Prawns with stringent bent tail shows that they are having this abnormality. Primary cause of tail cramping disease is unusual salinity and temperature (21). This abnormality can be treated by providing proper water exchange in order to reduce the temperature and salinity (19).

### 3.2 Disease/abnormality due to deficient water quality and chemical pollution

Prawns are being easily affected by poor water quality and it leads to their mortality (22). Term water quality is judged by the parameters like pH, dissolved oxygen level, ammonia, water colour and water odour (6). Chemical has been used in prawn farms as disinfects, therapeutants, antibiotics, etc., Misuse of this chemical products are known as chemical pollution and it lead to prawn disease (23).

Chemical pollution causes tumors in shrimp body. Tumors are nothing but an unusual growth of muscle. Some case, tumors affect the shrimp due to genetic factors (19). Dearth of water quality is the leading reason for abnormal shrimp behaviour. Aberrant prawn swimming, throng of prawn in edge of the pond is the symptoms show that the water quality is poor (19). Stress due to diminished amount of dissolved oxygen leads to muscle cramp syndrome and gives high mortality in cultured prawns (20). Shrimp with necrotic muscle tissue (24) and whitened tail muscle (25) shows the clinical signs of muscle cramp syndrome.

## 4. Biotic Disease

Disease caused by living agents are categorized as biotic disease and they are listed in figure 8.



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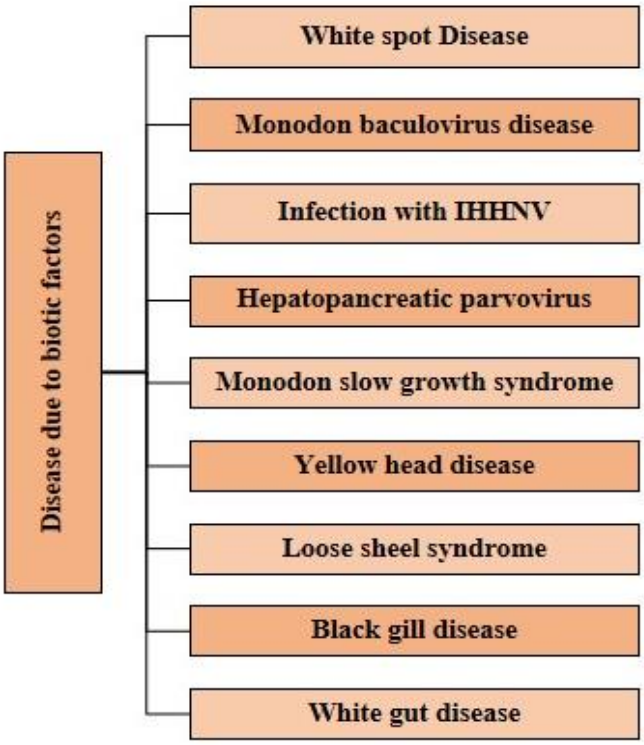


**Figure 8. Biotic disease**

Comparing with other reason, biotic disease cause more mortality in shrimp. Also it is the major reason behind economic loss (17). Major disease causing agents are virus, bacteria, fungi and parasites (26). Severe pandemic was happenned in mid of 1990 and during the year 2009-2015 by virus and bacteria respectively (27). From 1970, various viral pathogen has been discovered (28). Table show the prominent disease in Indian prawn culture with their causative agent and symptom,

**Table 4. Prominent biotic diseases in India's prawn culture**

| Disease | Cause | Clinical sign |
|---|---|---|
| White spot disease | White spot syndrome virus | ➢ Reddish discoloration of body and appendages<br>➢ The presence of calcified white spots on the exoskeleton |
| Monodon baculovirus disease | Monodon Baculovirus or P. monodon singly enveloped nuclear polyhedrosis virus (PmSNPV) | ➢ Lethargy<br>➢ Reduced growth rate<br>➢ Reduced feed intake |
| Infection with IHHNV | Infectious hypodermal and haematopoietic necrosis virus | ➢ Deformed rostrum |
| Hepatopancreatic parvovirus disease. | Hepatopanceatic parvovirus | ➢ No specific clinical signs |



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| | | |
|---|---|---|
| Monodon slow growth syndrome | Laem-singh virus | ➢ Size variation<br>➢ Dark discoloration |
| Yellow head disease | Yellow head virus | ➢ A pale body<br>➢ Yellowish discoloration of the cephalothorax |
| Loose shell syndrome | Bacterial infection<br>Poor soil and water quality | ➢ Loose shell<br>➢ Soft muscle<br>➢ Condensed melanized hepatopancreas |
| Black gill disease | Fusarium | ➢ Melanization in gill tissue (Black gill) |
| White gut disease | Vibriosis | ➢ Reddening of the body<br>➢ Floating white feces strings |

## 5. Taxonomy of Biotic Diseases

### 5.1. Viral disease

#### 5.1.1. White spot disease

White spot syndrome virus (WSV) is the causation of white spot syndrome or white spot disease (WSD) (29). This virus belongs to the family Nimaviridae, genus Whispovirus and it is a double stranded DNA virus (29). Size of WSV is 80-120 nm length and 250-380 nm diameter (30). Here, both vertical and horizontal transmissions are possible (31). Fujina, a province of China was the first place to report WSD in 1992. In India during 1994, WSD affected the places between Visakhapatnam (in Andhrapradesh) and Sirkali (in Tamilnadu) in the farms of P. monodon (30).

At the period of 1990 overall prawn producing Asian countries faced severe economic loss (approximately $ 6.0 billion) due to White spot disease (32). WD is highly infectious and produces 80-100% mortality within 3-10 days (26). Nearly, economic loss due to WSD in one year is equal to one tenth of the world's prawn production (33). It shows symptoms like reddish discolouration of body and loss of cuticle (34). Worst economic loss is happening due to WSD, because it gives high mortality rate within short span of time and still there is no treatment available for this disease (5).

#### 5.1.2. Monodon baculovirus disease

This disease occur in shrimp due to Monodon Baculovirus (MBV) belongs to the family Baculoviridae (29). It is a circular, double stranded DNS (35). This virus exists in size of 265-324 nm length and 42-77nm diameter (30). First occurrence of this disease was happened on Taiwan, 1981 (22). It mainly affects P. monodon. MBV is an infectious disease and involves horizontal transmission between shrimps (31). Even though Monodon Baculovirus disease does not cause any mortality, it will reduce the growth rate of shrimp, which is a salient problems in production and cause economic loss (31, 35).

#### 5.1.3. Infection with IHHNV

Infectious Hypodermal and Haematopoietic Necrosis virus is the causative agent of Infection with Infectious Hypodermal and Haematopoietic Necrosis virus. It is a single-stranded DNA virus, it comes under parvoviridae family, genus Penstyidensovirus (28). It is icosahedral in shape with diameter ranges 22-23nm (28). IHHNV was first reported at 1981 in Penaeus stylirostris with high mortality rate but in case of P. monodon and L.



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vannamei this virus does not cause any mortality (18). Infected prawn become weak and shows reduced growth with clinical signs of deformed rostrum (20). Transmission of this disease occurs in two ways, one is horizontal transmission, it takes place through contaminated water, and another one is vertical transmission which is through infected eggs (36).

#### 5.1.4. Hepatopancreatic Parvovirus Infection

Hepatopancreatic Parvovirus causes this Hepatopancreatic Parvovirus infection. This virus belongs to the family Parvoviridae. It is a double-stranded DNA virus, icosahedral in shape and 22 nm in size (30). It supports both vertical and horizontal transmission (37). This virus was first discovered in Singapore (28). No specific symptoms for Hepatopancreatic parvovirus infection but it slow down the growth rate of shrimp (28).

#### 5.1.5 Monodon slow growth syndrome

Laem-singh virus (LSNV) is found to be the causative agent of Monodon slow growth syndrome (22). This virus is from Luteoviridae family. LSNV is an non-enveloped virus which is icosahedral in shape with 27 nm of size (28). Monodon slow growth syndrome was first discovered in 2001, at Thailand, where one-month old shrimps faced unusual slow growth without an proper reason, then laem-singh virus was said to be its reason on 2006 (30). Tremendous reduction in prawn growth is the effect of this disease (28).

#### 5.1.6. Yellow Head Disease

Yellow Head Virus (YHV) is the causing agent of yellow head disease. YHV is a Rod shaped, enveloped virus of size 40-50 nm length and 150-200 nm diameter and it exist in the family of Ronivirdae (28). Thailand was the first country to become the victim of yellow head virus in 1991 (32). Prawns become pale in colour and yellowish cephalothorax are the clinical signs of YHD (28). P. monodon and L. vannamei are the common host of this disease. YHD is highly lethal as it gives 100% prawn death rate in 3-5 days (34).

### 5.2. Bacterial Disease

#### 5.2.1. Loose shell syndrome disease (LSSD)

LSSD is a bacterial disease but there is no clear knowing about its causative agent (38). LSSD causing high mortality in prawns next to white spot syndrome disease and occurrence of this disease is increasing every year (38). Prawns farms of India facing this disease since 1998, especially in P. monodon farms (39). Affected prawns have soft and thin exoskeleton with lethargic movement and they were spongy in texture (26).

#### 5.2.2. White gut disease

White gut disease is due to Vibrio bacteria. This disease also known by the name White feces syndrome (18). Symptoms of this disease are reddening of the body and floating white feces, this disease can be observed after 50-60 days of post larvae's stocking (18, 40), This bacteria affect the prawn by entering into its cuticle through wounds, cracks and through feed intake (40). Mortality rate due to this disease would increase if the shrimps are under any stress (20).

### 5.3. Fungal Disease



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### 5.3.1. Black gill disease

Black gill disease occurrence in shrimp is due to the species Fusarium (41). Other environmental factors like lower dissolved oxygen level, high stocking density and pollution may also cause black gill disease (26). Shrimp's gill turn into black colour and indicates the occurrence of black gill disease (14). This disease cause mortality in shrimp because, the fungi affect the gill and block the respiration of the shrimp (41). Treatment of this disease involved maintaining proper environmental conditions and once if the indication of this disease found, water of the pond should get changed frequently and more aerators should be provided for the shrimps (20).

## 6. Discussion

Prawn farming has been carried out in India since many decades ago and the dominance of this industry is increasing Indian economy every year. But at the same time, this sector also suffers severe economic loss due to various factors which were discussed above. Disease which are being the crisis to Indian prawn farms has been reviewed in this paper and most of this disease are not having any proper clinical solutions yet. Hence the only way to avoid the economic losses due to this disease are to prevent them and detect them in prior if it occurs.

## REFERENCES

[1] George W. Chamberlain, "History of shrimp farming", Global Aquaculture Advocate, **(2011)**, pp. 1-7.
[2] "Development of Shrimp Aqua Culture", Agro and Food Processing, Government of Gujarat, Vibrant Gujarat 2017, **(2017)** January 10-13, pp. 1-18.
[3] T.W. Flegel, "Detection of major penaeid shrimp viruses in Asia, a historical perspective with emphasis on Thailand", Aquaculture, vol. 258, no. 1-4, **(2006)**, pp. 1-33.
[4] The Marine Products Export Development Authority, Ministry of Commerce & industry, Government of India. URL: https://www.mpeda.gov.in/MPEDA/index.php#
[5] Fisheries, TNAU Agritech Portal, Government of Tamilnadu. URL: http://agritech.tnau.ac.in/fishery/fish_shrimps.html
[6] KAU Agri-infotech Portal, Centre for e-Learning, Kerala Agricultural University. URL: http://www.celkau.in/Fisheries/CultureFisheries/Shrimps/siteselction.aspx
[7] Dr. R. Saraswathy, Dr. P. Kumararaja, Dr. N. lalitha, Dr. M. Muralidhar and Dr. S.V. Alavandi, "Soil and water quality management for Shrimp farming", Ciba Extension Series No. : 53, ICAR-Central Institute of Brackishwater Aquaculture, Indian Council of Agricultural Research.
[8] Endhay K. Kontara, "Shrimp Culture Management Techniques", Report of the Training Course on Shrimp Culture, **(1987)**, December 2-19.
[9] Mishra SS, Choudhary P, Debbarma J, Sahoo SN, Barua A, Giri BS , Swain P, Das R1, Das BK, Rathod R, Sahu A, Patil PK, "Status of Aqua-medicines, Drugs and Chemicals Use in India: A Survey Report", HSOA Journal of Aquaculture & Fisheries, vol. 1, no. 1, **(2017)**.
[10] Hisham A. Abdelrahman, Asheber Abebe, Claude E. Boyd, "Influence of variation in water temperature on survival, growth and yield of Pacific white shrimp Litopenaeus vannamei in inland ponds for low-salinity culture", Aquaculture research, vol. 50, no. 2, **(2019)**, pp. 658-672.
[11] Arun Shanker, Chitra Shanker, "Abiotic and Biotic Stress in Plants",**(2016)**, pp. 101-120.



ISSN: 2233-7857 IJFGCN

[12] P. Soundarapandian, S. Sankar, "Effect of Probiotics on the Survival and Production of Black Tiger Shrimp Penaeus monodon (Fabricius)", International Journal of Zoological Research, vol. 4, no. 1, **(2008)**, pp. 35-41.
[13] "Operating Procedures For Shrimp Farming", Global Shrimp OP Survey Results and Recommendations, Global Aquaculture Alliance, **(2006)**, pp. 1-169.
[14] M.Kumaran, P.Ravichandran, M.Muralidhar, K.Ambasankar, Subhendu.K.Otta, A.Panigrahi, D.Deboral Vimala, T.Ravisankar, J.Ashok Kumar, PR.Anand, Johnson Paul and K.K. Vijayan. "Frequently Asked Questions (FAQs) Pertaining to Penaeus vannamei Shrimp Farming", ICAR - Central Institute of Brackishwater Aquaculture (Indian Council of Agricultural Research), (2016), pp. 1-32.
[15] Elvira A. Baluyut, "Aquaculture Systems and Practices: A Selected Review", FAO, **(1989)**.
[16] By Darryl E. Jory, "Current production, challenges and the future of shrimp farming ", Global Aquaculture Advocate, **(2018)**.
[17] Subramaniyan Manivannan, Subhendu K. Otta, Indrani Karunasagar, Iddya Karunasagar, "Multiple viral infection in Penaeus monodon shrimp postlarvae in an Indian hatchery", Diseases of Aquatic Organisms , vol. 48, no. 3, **(2002)**, pp. 233-236.
[18] Mishra SS, Das R, Choudhary P, Debbarma J, Sahoo SN, Giri BS, Rathod R, Kumar A, Mishra CK and Swain P, "Present status of Fisheries and Impact of Emerging Diseases of Fish and Shellfish in Indian Aquaculture", Journal of Aquatic Research and Marine Sciences, vol. 1, no. 1, **(2017)**, pp. 1-22.
[19] Ritesh V. Borichangar , "Study of Tiger Shrimp (Penaeus monodon, Fabricius, 1798) Culture: Pond Design, Operation and Management in Diu", Bhavnagar University, BHAVNAGAR, **(2008)**.
[20] Gunalan B, Soundarapandian P, Anand T, Kotiya Anil S, Nina Tabitha Simon, "Disease Occurrence in Litopenaeus vannamei Shrimp Culture Systems in Different Geographical Regions of India", International Journal of Aquaculture, vol. 4, no. 4, **(2014)**, pp. 24-28.
[21] Baticados, M.C.L., Cruz-Lacierda, E.R., de la Cruz, M.C., DuremdezFernandez, R.C., Gacutan, R.Q., Lavilla-Pitogo, C.R., Lio-Po, G.D., "Diseases of penaeid shrimps in the Philippines", Aquacultur- Extension Manual No. 16, Aquaculture Department Southeast Asian Fisheries Development Center, **(1990)**.
[22] Srijit Chakravarty, Shivendra Kumar, Satya Prakash, "Back to the Basics: Biomimicry in Shrimp Farming", International Journal of Current Microbiology and Applied Sciences, vol. 7, no. 5, **(2018)**, pp. 2172-2184.
[23] Nils Kautsky, Patrik Ronnback, Michael Tedengren, Max Troell, "Ecosystem perspectives on management of disease in shrimp pond farming", Aquaculture, vol. 191, no. 1-3, **(2000)**, pp. 145-161.
[24] Siripong Thitamadee, Anuphap Prachumwat, Jiraporn Srisala, Pattana Jaroenlak, Paul Vinu Salachan, Kallaya Sritunyalucksana, Timothy W. Flegel and Ornchuma Itsathitphaisarn, "Review of current disease threats for cultivated penaeid shrimp in Asia", Aquaculture, vol. 452, **(2016)**, pp. 69-87.
[25] Saengchan Senapin, Kornsunee Phiwsaiya, Warachin Gangnonngiw, Timothy W Flegel, "False rumours of disease outbreaks caused by infectious myonecrosis virus (IMNV) in the whiteleg shrimp in Asia", Journal of Negative Results in BioMedicine, vol. 10, no. 10, **(2011)**, pp. 1-5.
[26] V. Venkateswarlu, P.V. Seshaiah, P. C. Behra, "A Study on Diseases Affecting Litopenaeus vannamei Farming in Coastal Districts of Andhra Pradesh, India", International Journal for Research in Applied Science & Engineering Technology, vol. 7, no. 7, **(2019)**, pp. 1301-1306.
[27] Timothy W. Flegel, "A future vision for disease control in shrimp aquaculture", Journal of the World Aquaculture Society, vol. 50, no. 2, **(2019)**, pp. 1-18.



ISSN: 2233-7857 IJFGCN

[28] Mohammedsaeed Ganjoor, "A Short Review on Infectious Viruses in Cultural Shrimps (Penaeidae Family)", Fisheries and Aquaculture Journal, vol. 6, no. 3, **(2015)**, pp. 1-11.
[29] Muhammad Meezanur Rahman, "Differences in virulence between white spot syndrome virus (WSSV) isolates and testing of some control strategies in WSSV infected shrimp", Thesis for obtaining the degree of Doctor in Veterinary Sciences, Department of Virology, Parasitology and Immunology, Ghent University, **(2007)**.
[30] G. M. Tandel, K. Riji John, M. Rosalind George, M. J. Prince Jeyaseelan, "Current status of viral diseases in Indian shrimp aquaculture", Acta virologica, vol. 61, **(2017)**, pp. 131-137.
[31] Dr. C. P. Balasubramanian, Dr. Shyne Anand, Dr. Kannappan S, Biju I.F., "Training Manual on Recent Advances in Farming of Pacific White Shrimp, Penaeus vannamei", CIBA-TM Series 2018-No.14, **(2018)**, pp. 1-126.
[32] Iddya Karunasagar, Lahsen Ababouch, "Shrimp Viral Diseases, Import Risk Assessment and International Trade", Indian Journal of Virology, vol. 23, **(2012)**, pp. 141–148.
[33] Bipul K. Dey, Girsha H. Dugassa, Sheban M. Hinzano and Peter Bossier, "Causative agent, diagnosis and management of white spot disease in shrimp: A review", Review in Aquaculture, **(2019),** pp. 1-44.
[34] Caroline H. Seibert, Aguinaldo R. Pinto, "Challenges In Shrimp Aquaculture Due To Viral Diseases: Distribution and Biology of The Five Major Penaeid Viruses and Interventions to Avoid Viral Incidence And Dispersion", Brazilian Journal of Microbiology, vol. 43, no. 3, **(2012)**, pp. 857–864.
[35] K. V. Rajendran, M. Makesh, I. Karunasagar, "Monodon Baculovirus of Shrimp", Indian Journal of Virology, vol. 23, no. 2, **(2012)**, pp. 149-160.
[36] "Infection with infectious hypodermal and haematopoietic necrosis virus", OIE - Manual of Diagnostic Tests for Aquatic Animals, **(2019)**.
[37] Muhammed P. Safeena, Praveen Rai, Indrani Karunasagar, "Molecular Biology and Epidemiology of Hepatopancreatic parvovirus of Penaeid Shrimp", vol. 23, no. 2, **(2012)**, pp. 191-202.
[38] Sheikh AftabUddin, Wali Ullah Roman, Chowdhury Kamrul Hasan, Musfiq Ahmed, Hafizur Rahman & Mohammad Abdul Momin Siddique, "First incidence of loose-shell syndrome disease in the giant tiger shrimp Penaeus monodon from the brackish water ponds in Bangladesh", vol. 46, no. 1, **(2017)**, pp. 210-217.
[39] Vardi Venkateswarlu, Chenji Venkatrayulu, "Prevalence of disease problems affecting shrimp Litopenaeus vannamei farming in Andhra Pradesh, India", International Journal of Fisheries and Aquatic Studies, vol. 7, no. 5, **(2019)**, pp. 275-279.
[40] Venkateswara Rao Annam, "Vibriosis in Shrimp Aquaculture", **(2015)**, pp. 1-9.
[41] Naresh Kumar Dewangan, Ayyaru Gopalakrishnan, Daniel Kannan, Narayanasamy Shettu, Ramakrishna Rajkumar Singh, "Black gill disease of Pacific white leg shrimp (Litopenaeus vannamei) by Aspergillus flavus", Journal of Coastal Life Medicine, vol. 3, no. 10, **(2015)**, pp. 761-765.



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