Unit 9: Soil and water quality parameters in aquaculture

Introduction

Maintenance of a healthy aquatic environment and production of sufficient fish food organisms (plankton) in ponds are two factors of primary importance for successful aquaculture culture operation. The nutrient status of water and soil play the most important role in governing the production of plankton organisms or primary production in fish ponds. The bottom soil governs the storage and release of nutrients to the overlying water through various chemical and biochemical processes for biological production in the environment.

1. Water quality parameters

The Physical condition of water is greatly influenced with depth, temperature, turbidity and light. These constitute the more important physical parameters on which the productivity of a pond depends.

Physical parameter

- **Depth** of a pond has an important bearing on the physical and chemical qualities of water. Depth determines the temperature, the circulation pattern of water and the extent of photosynthetic activity. In shallow ponds, sunlight penetrates up to the bottom, warms up the water and facilitates increase in productivity. Ponds shallower than 1 m get overheated in tropical summers inhibiting the survival of fish and other organisms. Generally a depth of about 2 meter is considered ideal from the point of view of biological productivity of a pond.

- **Water temperature** generally depends upon climate, sunlight and depth. That too, the intensity and seasonal variations in temperature of a water body have a great bearing upon it productivity. The temperature in fish ponds is generally less during the early hours of morning and reaches the maximum value in the afternoon showing diurnal fluctuations. Compared to the yields of fish in ponds in temperate zones, the natural water in tropical areas generally show a higher production due to more heat budget in the ponds system. A part from these, temperature plays very important role in physiological processes for breeding in fish both under natural and artificial conditions. The chemical changes in both soil and water are greatly influenced by temperature. Decrease in DO2 is directly related to increase in temperature. Fish display great variability in their tolerance to temperature. Indian major carps usually tolerate wide range of temperature and are called eurythermal.

- **The turbidity of water bodies** may be either due to suspended inorganic substances like silt, clay and planktonic organisms. Turbidity of water varies greatly with the nature of basin and inflowing sediments. Ponds with clay bottom are likely to have high turbidity

that restricts the penetration of light, therefore reduces the photosynthetic activity hence acts as a limiting factor for productivity.

- **Light** is another physical factor of importance. Availability of light energy to a fish pond greatly influences its productivity. Penetration of light is determined by turbidity which is measured optically and represents the resultant effect of several factors such as suspended clay and silt and dispersion of planktonic masses.

Chemical parameter

- **The pH of water** is defined as the logarithm of the reciprocal of hydrogen ion concentration. It may be expressed mathematically as pH=Log 1(H)+. The pH of neutral water is 7, below 7 is acidic and above 7 is alkaline. The pH of pond water undergoes a diurnal change; it is being alkaline in mid-afternoon and acidic just before day break. High yield of fish crops are usually produced in water which is just on the alkaline side of between 7.0 and 8.0. The limit above or below which pH has a harmful effect is given as 4.8 and 10.8.
- **Alkalinity or acid** combining capacity of natural freshwater ponds is generally caused by carbonate (CO3) and Bicarbonate (HCO3) or hydroxides of calcium, Magnesium, Na, K, NH4 and Fe, calcium being from the major constituent. Bicarbonate and carbonate are the major constituent of pond water and their concentrations are expressed as total alkalinity. In general, calcareous water with alkalinities more than 50ppm are most productive. Waters with an alkalinity less than 10ppm rarely produce large crops, water intermediate between these 10-50ppm may produce useful results.
- **Dissolved oxygen:** Among the chemical substances in natural water, O2 is of primary importance both as a regulator of metabolic processes of plant and animal community and as an indicator of water condition. The pond water receives oxygen mainly through (1) interaction of atmospheric air on the surface water (2) by photosynthesis. Photosynthesis, respiration and slow rate of diffusion cause a fluctuation of dissolved oxygen in water and accordingly remain optimum during morning and gradually increase to attain maximum in the afternoon and declines thereafter during night to reach minimum before dawn. It is possible that below 3.0 ppm of DO2, asphyxia from low O2 can be expected and to maintain a favorable condition for a varied warm water fish fauna, 5.5 ppm of DO2 is required. Sometimes fishes congregate near the surface for respiration in such low DO2 ponds. For average or good production ponds should have DO2 concentration above 5.5 ppm.
- **Hardness** is defined as the total of soluble Calcium and Magnesium salts present in the water medium. In most natural water, usually HCO3 anions are associated with Ca, Mg, Na and K cations. Usually bicarbonates of Ca and Mg cause temporary hardness. Permanent hardness of water is due to soluble Ca and Mg carbonates and salts of inorganic acids (CaSo4). The pond water having a hardness of 15 ppm or above are

satisfactory for growth of fish and do not require addition of lime, but water having hardness, less than 1.1ppm require liming for higher production of fish. Water having, hardness less than 5 ppm, cause slow growth, distress and eventual death of fish.

- **Dissolved Nitrogen and its compounds:** The importance of dissolved nutrients especially nitrogen is well recognized. It is an important element influencing the growth of phytoplankton in aquatic environment. As constituent of protein, Nitrogen occupies a highly important place in aquatic ecosystem. Pond having dissolved nitrogen below 0.1ppm does not indicate productive condition, while the range of 0.1-0.2 ppm an average production is expected but above 0.2ppm is considered favorable. However optimal limit of nitrogen can be in the range of 0.3-1.3ppm.

- **The phosphorus** fertility less then 0.02ppm is low productive, 0.02-0.05 ppm is fairly productive, 0.05-0.10 ppm is good productive and above 0.20 ppm excessive. Besides the absolute concentration, the ratio of nitrogen and phosphorus concentration is likely to influence aquatic productivity. Nitrogen and phosphorus are utilized for plankton growth at a ratio of 3:1 to 6:1.

Soil quality parameters

Soil plays an important role in regard to the fertility of fish ponds. Types, characteristics and chemical conditions of soil influences the pond productivity. The physico-chemical properties of pond water are more or less a reflection of the properties of the bottom soil. In this respect the major chemical factors of importance are pH, total nitrogen, total phosphorus, organic carbon, available N2 and available P.

Hydrogen ion concentration (pH)

The pH of soil depends on various factors. The release of essential nutrients at soil water interface is greatly hampered due to low pH. pH range of 5.5 is (highly acidic) 5.5-6.5 (moderately acidic), 6.5-7.5 (nearly neutral) and 7.5-8.5 (moderately alkaline) has been considered favorable for fish ponds, whereas above 8.5 is considerable highly alkaline.

Phosphorus

The importance of available phosphorus in soil for increasing productivity is well recognized. The phosphorus in soil is in both inorganic and organic forms. The organic form constitutes about 35-40% of the total phosphorus content of the soil. The available soil phosphorus (P_2O_5) below 3 mg/100gm (30ppm) as poor productivity, 3-6mg/100gm (30-60ppm) as average, above 6-12mg/100gm (60-120ppm) as high productivity and above 12mg/100gm (120ppm) as excess.

Nitrogen

Nitrogen in soil is present mostly in organic forms as amino acids, peptides and easily decomposable proteins. The conversion of complex organic forms of nitrogen to simple inorganic forms is carried out by anaerobic microbes. Hence, it is important to know available nitrogen than the total nitrogen in soil. The range of available nitrogen is 50-75mg/100gm of soil relatively more favorable for pond productivity.

Organic carbon

Compared to the mineral constituents of the soil, organic compounds are more varied and complex. Very high organic content is also not desirable for a pond soil. However, organic carbon less than 0.5% may be considered poor, 0.5-1.5% as average while 1.5-2.5% appeared to be optimal for good production.