

Application of Biostimulants in Aquatic Plants: A New Growth Engines in Integrated Aquaculture Systems

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Today aquaculture has changed their production way in another upgraded version of culture. It's not only focus only fish culture also gives attention to growing plant components in different integrated based systems (Aquaponics, IMTA units, biofloc-linked wetlands). One of the specific essential tools for enhancing this plant side is the biostimulant- a category of compounds which don't feed plant directly but instead switch on the plants self physiological machinery to grow better, immunity to tolerance stress and utilize nutrients more effectively.

Definition of Biostimulant

A biostimulant is type of substance or microorganisms implied to plants that boost nutrition efficacy, stress resistancy or quality traits beyond of its nutrient components. Common categories contain:

- Seaweed extracts
- Protein hydrolysate and amino acids component
- Humic acids
- Beneficial microbes
- Chitosan and other biopolymers

In land based agriculture these components are already categorised under mainstream. In aquaculture linked plant cultivation namely duckweed plantation, azolla mats, aquaponic vegetable beds, seaweed rafts are a newer but fast growing idea in this field.

Connection of Biostimulant with Aquaculture Systems

In an integrated multitrophic aquaculture systems, the extractive plant namely duckweed, azolla, macrophytes, seaweeds perform dual function such as absorbing nitrogen and phosphorous from fish waste while also becoming a harvestable crops. The substances or components which make these plants grow faster or help to absorb nutrients more effectively has a compounding benefit such as cleaner water and more biomass. These are describing below:

▪ Smooth Nutrient Uptake, Cleaner Water

Several biostimulant such as humic acids and microbial inoculants develop root and frond which enhances the surface area available for nitrogen and phosphorous absorption, In Azolla and duckweeds plantation, this translates into water that clears of ammonia and nitrate faster help to directly reducing stress on the fish or shrimp sharing the same water body.

▪ Higher Production Rate

Utilization of seaweed specific biostimulant can stimulate cell division and elongation through natural plant hormones such as auxins and cytokinins present in the extract. Proper application of biostimulant in aquaponics or floating macrophytes cultivation can noticeably increase harvestable biomass over a growing cycle.

▪ Stress Tolerance

Sometimes aquatic plants are suffered by fluctuating ammonia spikes, temperature swings and variables of light especially in outdoor systems. Biostimulant namely Chitosan and amino acid formulations help plants to activate antioxidant defences, reducing the shock of these fluctuations and maintain the biofilters function stable even during poor water quality days.

▪ Better Nutritional Quality of the Harvest

For Aquaponics type systems, where plant directly used as human or animal feed there biostimulant have been linked to improved protein content, antioxidant levels and mineral density adding different value beyond simple biomass.

Practical Implications Points for Farmers

- **Dose issues:** Biostimulant function at very low concentrations; over implication rarely upgrades results and makes unnecessary cost.
- **Combine, don't replace:** Biostimulant generally act as supplement not substitute so take them as an efficiency booster not a fertilizer replacement.
- **Match to system type:** Seaweed extracts suitable in floating macrophytes and aquaponic systems; microbial inoculants suitable for root zone crops in gravel or media based beds; humic acid can bloom well duckweed plants or Azolla in open ponds.
- **Monitor water quality alongside plant response:** Since these plants are also acting as biofilters, any change in their growth performances affect their nutrient stripping capacity-track both plant biomass and water parameters also,

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