SEMINAR REPORT

Effects of Biostimulants on Vegetable Production

By

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DEPARTMENT OF VEGETABLE SCIENCE

COLLEGE OF HORTICULTURE

KERALA AGRICULTURAL UNIVERSITY

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CERTIFICATE

This is to certify that the seminar report entitled **"Effects of Biostimulants on Vegetable Production"** has been solely prepared by Nidhin Raj (2018-12-002) under my guidance and has not been copied from seminar reports of any seniors, juniors or fellow students.

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I, Nidhin Raj (2018-12-002) declare that the seminar entitled **"Effects of Biostimulants on Vegetable Production"** has been prepared by me, after going through various references cited at the end and has not been copied from any of my fellow students.

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INDEX

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

Effects of Biostimulants on vegetable production

1. INTRODUCTION

The world population which reached 7 billion in 2011 is estimated to increase to 10 billion by 2050. To feed this massive population the agriculture sector has to evolve hugely. Threats by scarcity of resources as well as climate change is affecting crop production negatively at present. Using traditional inputs only there is a limit to the production that can be achieved and various biotic and abiotic stresses that can be mitigated. So alternative methods have to be used for mitigation of these stresses and improve the agricultural production. Biostimulants offer a potentially novel approach for the regulation or modification of physiological processes in plants to stimulate growth, mitigate stress-induced limitations and to increase yield.

2. BIOSTIMULANTS

A biostimulant is a material containing substances and or microorganisms whose function when applied to plants or rhizosphere is to stimulate natural processes to enhance or benefit nutrient uptake, nutrient efficiency, tolerance to abiotic stresses and crop quality (EBIC., 2011). By extension, plant biostimulants also designate commercial products containing mixtures of such substances or microorganisms. They are able to modify some molecular processes that allow to improve water and nutrient use efficiency of crops, stimulate plant development and counteract abiotic stresses by enhancing primary and secondary metabolism. Biostimulants may be used in the form of soil preparations (powders, granules, or solutions added to the soil) or as liquid foliar application products. Biostimulants containing humic substances and nitrogen compounds are often applied directly onto the soil, whereas various types of extracts from plants and seaweed are used in the form of foliar applications. Biostimulants can be introduced into the irrigation system and taken up by plants along with water. Common forms in which these occur are ready-to-use extracts or powder to make an aqueous solution. Soil biostimulants often affect the structure of the root increasing its ability to absorb nutrients. Foliar extracts protect the plant against biotic and abiotic stresses.

Biostimulants should be applied in the morning when the stomata are open and the assimilation rate is at its peak. Biostimulants are also applied directly onto harvested fruits.

3. CATEGORIES OF BIOSTIMULANTS

The main categories of biostimulants include humic substances, protein hydrolysates and other N-containing compounds, seaweed extracts, chitosan, inorganic compounds, beneficial fungi and beneficial bacteria.

3.1.Humic substances

Humic substances (HS) are natural constituents of the soil organic matter, resulting from the decomposition of plant, animal and microbial residues and also from the metabolic activity of soil microbes using these substrates. HS are collections of heterogeneous compounds, originally categorized according to their molecular weights and solubility into humins, humic acids and fulvic acids. These compounds also show complex dynamics of association/dissociation into supra-molecular colloids and this is influenced by plant roots via the release of protons and exudates. Humic substances and their complexes in the soil thus result from the interplay between the organic matter, microbes and plant roots. Any attempt to use humic substances for promoting plant growth and crop yield needs to optimize these interactions to achieve the expected outputs. This explains why the application of humic substances – soluble humic and fulvic acids fractions – shows inconsistent, yet globally positive, results on plant growth**.** Humic substances have been recognized as essential contributors to soil fertility, acting on physical, physico-chemical, chemical and biological properties of the soil. Most biostimulant effects of HS refer to the amelioration of root nutrition. Humic substances stimulates plasma membrane H+-ATPases, which convert the free energy released by ATP hydrolysis into a trans-membrane electrochemical potential used for the import of nitrate and other nutrients. The proposed biostimulation activity of HS also refers to stress protection. Phenylpropanoid metabolism is central to the production of phenolic compounds, involved in secondary metabolism and in a wide range of stress responses. High-molecular mass HS have been shown to enhance the activity of key enzymes of this metabolism in hydroponically-grown vegetables, suggesting stress response modulation by HS.

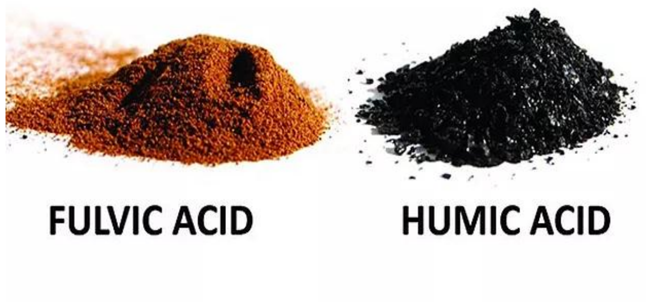


Plate 1. Fulvic acid and Humic acid

3.2. Protein hydrolysates and other N-containing compounds

Amino-acids and peptides mixtures are obtained by chemical and enzymatic protein hydrolysis from agro-industrial by-products, from both plant sources (crop residues) and animal wastes (e.g. collagen, epithelial tissues). Chemical synthesis can also be used for single or mixed compounds. Other nitrogenous molecules include betaines, polyamines and 'non-protein amino acids', which are diversified in higher plants but poorly characterized with regard to their physiological and ecological roles (Vranova *et al.*, 2011). Glycine betaine is a special case of amino acid derivative with well-known anti-stress properties (Chen and Murata, 2011).These compounds have been shown to play multiple roles as biostimulants of plant growth. Direct effects on plants include modulation of N uptake and assimilation by the regulation of enzymes involved in N assimilation and of their structural genes and by acting on the signalling pathway of N acquisition in roots. By regulating enzymes of the TCA cycle, they also contribute to the balance between C and N metabolisms. Hormonal activities are also reported in complex protein and tissue hydrolysates. Chelating effects are reported for some amino acids (like proline) which may protect plants against heavy metals but also contribute to micronutrients mobility and acquisition. Antioxidant activity is conferred by the scavenging of free radicals by some of the nitrogenous compounds, including glycine betaine and proline, which contributes to the mitigation of environmental stress. Indirect effects on plant nutrition and growth are also important in the agricultural practice when protein hydrolysates are applied to plants and soils. Protein hydrolysates are known to increase microbial biomass and activity, soil respiration and overall, soil fertility. Chelating and complexing activities of specific amino acids and peptides are deemed to contribute to nutrient availability and acquisition by roots.

3.3. Seaweed extracts

Seaweed extracts and purified compounds - laminarin, alginates and carrageenans and their breakdown product are used as biostimulants. Seaweeds act on soils and on plants. They can be applied on soils, in hydroponic solutions or as foliar treatments. In soils, their polysaccharides contribute to gel formation, water retention and soil aeration. The polyanionic compounds contribute to the fixation and exchange of cations, which is also of interest for the fixation of heavy metals and for soil remediation. Positive effects via the soil microflora are also described, with the promotion of plant growth-promoting bacteria and pathogen antagonists in suppressive soils. In plants, nutritional effects by the provision and micro- and macronutrients indicate that they act as fertilisers, beside their other roles. Impacts on seed germination, plant establishment and on further growth and development is associated with hormonal effects, which is the major causes of biostimulation activity on crop plants. Although cytokinins, auxins, abscisic acid, gibberellins and other classes of hormone-like compounds have been identified in seaweed extracts, there is evidence that the hormonal effects of extracts of the brown seaweed *Ascophyllum nodosum* are explained to a large extent by the down and upregulation of hormone biosynthetic genes in plant tissues, and to a lesser extent to the hormonal contents of the seaweed extracts themselves. Anti-stress effects are also reported on using the extracts as biostimulants.

Plate 2 : Seaweeds used for extraction of biostimulants

3.4. Chitosan

Chitosan is a deacetylated form of the biopolymer chitin, produced naturally and industrially. Poly and oligomers of variable, controlled sizes are used in the food, cosmetic, medical and agricultural sectors. The physiological effects of chitosan in plants are the results of the capacity of this compound to bind to a wide range of cellular components, including DNA, plasma membrane and cell wall constituents, but also to bind to specific receptors involved in defense gene activation, in a similar way as plant defense elicitors. Chitin and chitosan apparently use distinct receptors and signaling pathways. Among the cellular consequences of the binding of chitosan to more or less specific cell receptors, hydrogen peroxide accumulation and Ca^{2+} leakage into the cell have been demonstrated, which are expected to cause large physiological changes, as these are key players in the signaling of stress responses and in the development regulation. Agricultural applications of chitosan have been developed over the years, focusing on plant protection against fungal pathogens, but broader agricultural uses are tolerance to abiotic stress (drought, salinity, cold stress) and imparting quality traits related to primary and secondary metabolisms. It also induces stomatal closure via an ABA-dependent mechanism.

3.5. Inorganic compounds

Chemical elements that promote plant growth and may be essential to particular taxa but are not required by all plants are called beneficial elements. The five main beneficial elements are Al, Co, Na, Se and Si, present in soils and in plants as different inorganic salts and as insoluble forms like amorphous silica ($SiO_2.nH_2O$) in graminaceaous species. These beneficial functions can be constitutive, like the strengthening of cell walls by silica deposits, or expressed in defined environmental conditions, like pathogen attack for selenium and osmotic stress for sodium. Many effects of beneficial elements are reported by the scientific literature, which promote plant growth, the quality of plant products and tolerance to abiotic stress. This includes cell wall rigidification, osmoregulation, reduced transpiration by crystal deposits, thermal regulation via radiation reflection, enzyme activity by co-factors, plant nutrition via interactions with other elements during uptake and mobility, antioxidant protection, interactions with symbionts, pathogen and herbivore response, protection against heavy metals toxicity, plant hormone synthesis and signaling (Pilon-Smits *et al*., 2009)

3.6. Beneficial fungi

Mycorrhizal fungi are a heterogeneous group of taxa which establish symbioses with over 90% of all plant species. Among the different forms of physical interactions and taxa involved, the Arbuscule-Forming Mycorrhiza (AMF) are a widespread type of endo-mycorrhiza associated with crop and horticultural plants. These penetrate plant roots and form a highly branched tree-like network of roots and hyphae. This network enables the plants to extend their root system beyond the depletion zone, allowing for enhanced uptake of nutrients and water and rendering them more tolerant to drought stress. Besides improving nutrient uptake, the best-known effect of AMF is their improvement of phosphorous uptake, particularly in phosphorous-deficient soils. Fungal based products are applied to plants to promote nutrition efficiency, tolerance to stress, crop yield and product quality.

3.7. Beneficial bacteria

Bacteria interact with plants in all possible ways (Ahmad *et al*.,2008): (i) as for fungi there is a continuum between mutualism and parasitism; (ii) bacterial niches extend from the soil to the interior of cells, with intermediate locations called the rhizosphere and the rhizoplane; (iii) associations may be transient or permanent, some bacteria being even vertically transmitted via the seed;(iv) functions influencing plant life cover participation to the bio-geochemical cycles, supply of nutrients, increase in nutrient use efficiency, induction of disease resistance, enhancement of abiotic stress tolerance, modulation of morphogenesis by plant growth regulators. With regard to the agricultural uses of biostimulants, two main types should be considered: (i) mutualistic endo-symbionts of the type Rhizobium and (ii) mutualistic, rhizospheric PGPRs (Plant Growth-Promoting Rhizobacteria). Rhizobium and related taxa are commercialised as biofertilisers, i.e. microbial inoculants facilitating nutrients acquisition by plants. PGPRs are multifunctional and influence all aspects of plant life: nutrition and growth, morphogenesis and development, response to biotic and abiotic stress, interactions with other organisms in the agro-ecosystems.

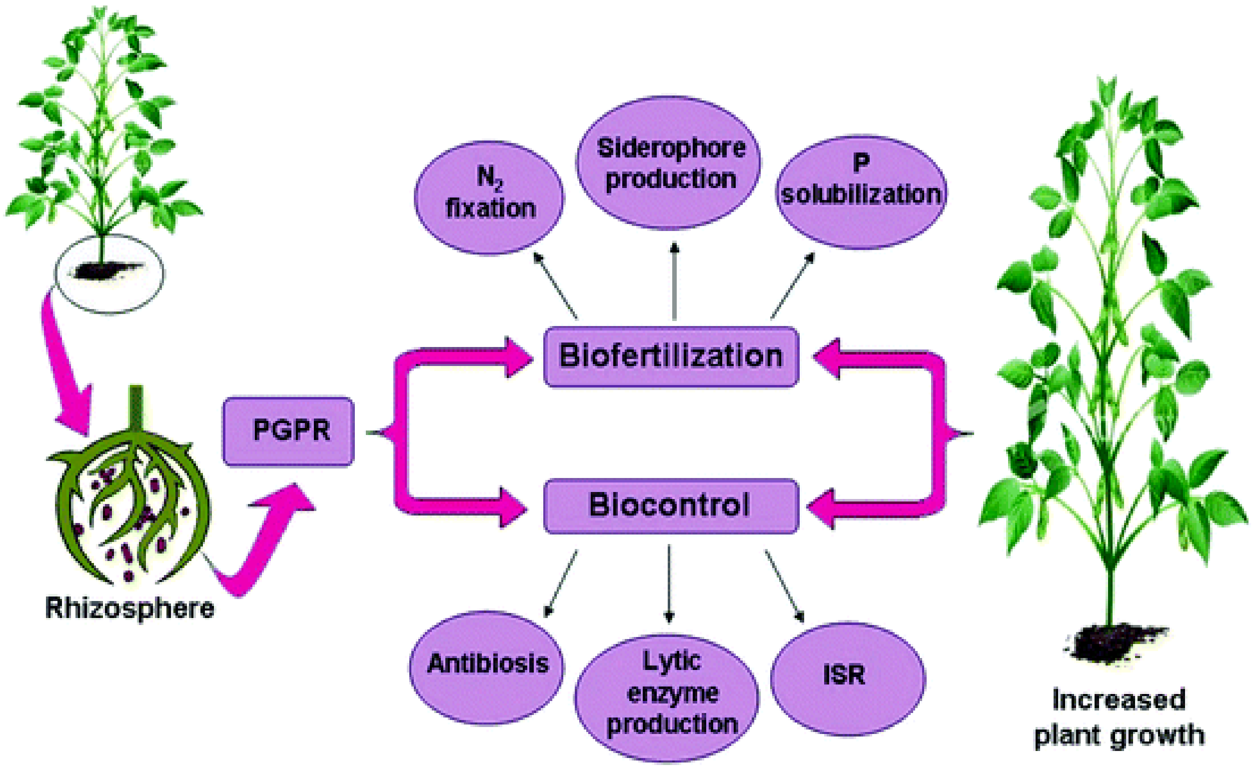


Plate 3. Functions of PGPR

4. EFFECTS OF BIOSTIMULANTS ON VEGETABLE PRODUCTION

Biostimulants improve the general health, vitality and growth of plants, protect them against infections, mitigate negative effects of abiotic stress - drought, heat, salinity, chilling, frost, oxidative, mechanical and chemical stress, increases the effectiveness of nutrient uptake, improves the mechanical properties, reduces the cracking and enhances shelf life of fruits and vegetables, increases the area and turgor of the leaf leading to an increase in the intensity of photosynthesis.. Biostimulants can affect a number of the chemical properties of fruits and vegetables, including dry mass, acidity or vitamin content. The positive effect of biostimulants is also based on increasing the content of chlorophyll in leaves and thus increasing the efficiency of the process of photosynthesis.

Biostimulants also have an influence on mechanical properties, i.e., the firmness of fruits or vegetables. Depending on the type, biostimulants may cause the stiffening of cell walls, thereby reducing their extensibility. Biostimulants that increase the flexibility of cell walls at the same time extend the shelf-life of fruits and vegetables for consumption and facilitate their storage.

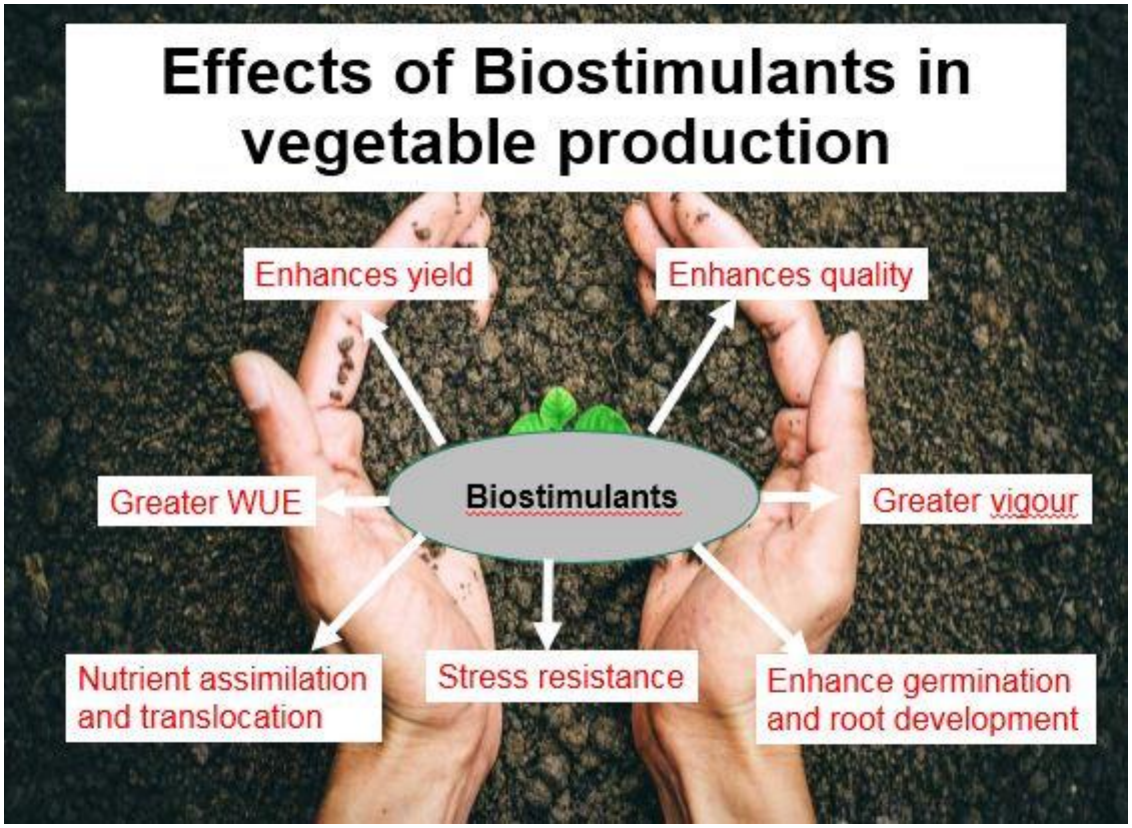


Plate 4 : Effects of biostimulants in vegetable production

Table 1. PGPR application in vegetable crops

PGPR spp/strain	Crops	Effect on plant growth	References
Rhizobium spp, *Mesorhizobium, Bradyrhizobium, Sinorhizobium*	Broccoli, carrot, lettuce	Increased yield, enhanced macro and micronutrient uptake	Yildrim *et al.*(2011), Bhagat *et al.* (2014), Ghosh *et al.* (2015)
Azotobacter spp, *Azospirillum* spp	Cucumber, lettuce	Increased germination percentage, length and weight of roots, improved vigour index	Fascigllone *et al.* (2012), Mangmang *et al.* (2015)
Pseudomonas fluorescens, P. putida	Broccoli, cucumber, lettuce	Increased yield, enhanced nutrient uptake, increased mineral content	Kohler *et al.* (2009), Dursun *et al.* (2010), Tanwar *et al.* (2014)

Achromobacter xylosoxidans, Stenotrophomonas maltophilia	Cucumber, potato	Increased plant height, dry weight, fruit yield, tuber dry matter	Egamberdieva *et al.* (2011), Dawwam *et al.* (2013)
Bacillus subtilis, *B megatherium,* *B cereus,* *B amyloliquefaciens*	Cucumber, pepper	Induced systemic tolerance to drought stress, increased root and shoot weight and their length	Wang *et al.* (2012), Kokalis- Burelle *et al.*(2002), Lim and Kim (2013)

Table 2. Responses of vegetables to biostimulant application

Crop	**Biostimulant**	**Plant response**	**Reference**
Broccoli	Seasol®	Increased leaf area, stem diameter and biomass	Mattner *et al.* (2013)
Broccoli	Goemar BM86®	Increased yield and content of macro and micronutrients	Gajc-Wolska *et al.* (2013)
Carrot	Aminoplant®	Influenced carrot productivity and chemical composition of the roots	Grabowska *et al.* (2012)
Endive	Goemar Goteo®	Leaves synthesized more rutoside and astragalin	Gajc-Wolska *et al.* (2012)
Lettuce	Actiwave®	Increased yield and energy use efficiency	Amanda *et al.* (2009)
Spinach	Aminoplant®	Lowered dry matter content in leaves, positively influenced	Kunicki *et al.* (2010)

		nitrate reductase activity	
Tomato	Radifarm®	Stimulated root growth and induced a more favourable root/shoot ratio	Vernieri *et al*. (2002)
Potato	Seaweed extract	Improvement in growth, yield and tuber quality of potato	Haider *et al*. (2012)

Table 3. Use of biostimulants in vegetable disease management

Product	**Source**	**Crop**	**Disease targets**
Vacciplant ®	Brown algae, *Laminaria digitata*	Tomato	Bacterial spot, grey mould, *Phytophthora* blight, anthracnose
		Brinjal	*Phytophthora* blight, powdery mildew
		Cucurbits	*Phytophthora* blight, powdery mildew
		Leafy vegetables	Downy mildew, grey mould
		Cabbage	Downy mildew, grey mould
Elexa®	Chitosan based natural product	Cucurbits	Downy mildew, powdery mildew
		Cucurbits	Downy mildew
Milsana ®	Alcoholic extract from giant knotweed	Cucumber	Powdery mildew

	(*Reynoutria sachaliensis*)		
		Tomato and chilli	Powdery mildew
ChitoPlant ®	Chitosan based product	Tomato, Potato	Powdery mildew
		Cucurbits	Downy mildew

5. MODE OF ACTION OF BIOSTIMULANTS

The modes of action of biostimulants is largely unknown due to the heterogeneous nature of raw materials used for production and the complex mixtures of components contained in biostimulant products which makes it almost impossible to identify the exact component responsible for biological activity. To understand further about the mechanisms of biostimulant action we have systematized the stages of biostimulants action on plants after their application: (1) penetration into tissues, translocation and transformation in plants, (2) gene expression, plant signaling and the regulation of hormonal status, (3) metabolic processes and integrated whole plant effects.

1. Penetration into tissues, translocation and transformation in plants

The penetration of amino acids and peptide based biostimulants into plant tissues has been investigated using radiolabelled amino acids and mathematical modeling. The components of a biostimulant preparation of animal origin, labeled with ^{14}C proline and glycine, were shown to penetrate rapidly into treated leaves and where subsequently distributed to other leaves. The penetration of protein hydrolysates into a plant tissue occurs via diffusion of protein molecules through membrane pores and is energy-dependent. Biostimulants must have a good solubility in water or other suitable solvents. This is important for sufficient penetration of active ingredients into internal structures of treated plants.

2. Gene expression, plant signaling and the regulation of hormonal status

Many biostimulants have been shown to induce genes and benefit productivity only when plants are challenged by abiotic and biotic stress. The bioactive compounds in some biostimulants are proposed to display signaling activity in plants or induce signaling pathways. Various amino acids and peptides function as signaling molecules in the regulation of plant growth and development. Proteins may also contain hidden peptide sites, “cryptides” or “crypteins” in their amino acid sequence, which may have their own biological activities. Amino acid based biostimulants are readily absorbed and translocated by plant tissues and once absorbed, they have the capacity to function as transport regulators, signaling molecules, modulators of stomatal opening, and may detoxify heavy metals. Animal based lipid soluble fractions, have also been observed to produce an auxin-like response (Kauffman *et al*., 2007), while sugars, sucrose, and its cleavage products (hexoses), are also known to act as signaling molecules through regulation of gene expression and by interaction with other hormone signals including auxins. Amino acids, glycosides, polysaccharides and organic acids contained in many biostimulants act as precursors or activators of endogenous plant hormones.

3. Metabolic processes and integrated whole plant effects

Biostimulants improve plant productivity through increased assimilation of N, C, and S, improved photosynthesis, improved stress responses, altered senescence, and enhanced ion transport. The protective effect of many biostimulants against biotic and abiotic stresses has been associated with a reduction of stress-induced reactive oxygen species, activation of the antioxidant defense system of plants, or increased levels of phenolic compounds.

6. ORGANIC PREPARATIONS AS BIOSTIMULANTS

Different organic preparations such as panchagavya, jeevamrutham, dashagavya, fish amino acid, egg amino acid and vermiwash are found to have biostimulant effect in vegetables. Foliar application of panchagavyam or vermiwash at two weeks interval stimulates growth and increases yield in cowpea. In solanaceous crops, okra and amaranth, foliar or soil application of vermiwash @ 500 l/ha at 7 to 10 days interval increases yield.

6.1. Drumstick leaf extract as a biostimulant

Leaves of drumstick plant contains zeatin (5 – 200 µg/g) which is a naturally occurring cytokinin. Application of drumstick leaf extract was found to increase vegetative growth, nutrient uptake, yield and fruit quality in vegetables. It also reduces the adverse effect of heavy metals, salinity, drought, high temperature and gamma rays.

Plate 5. Commercial biostimulants

Plate 6. Organic preparations used as biostimulants

7.CASE STUDIES

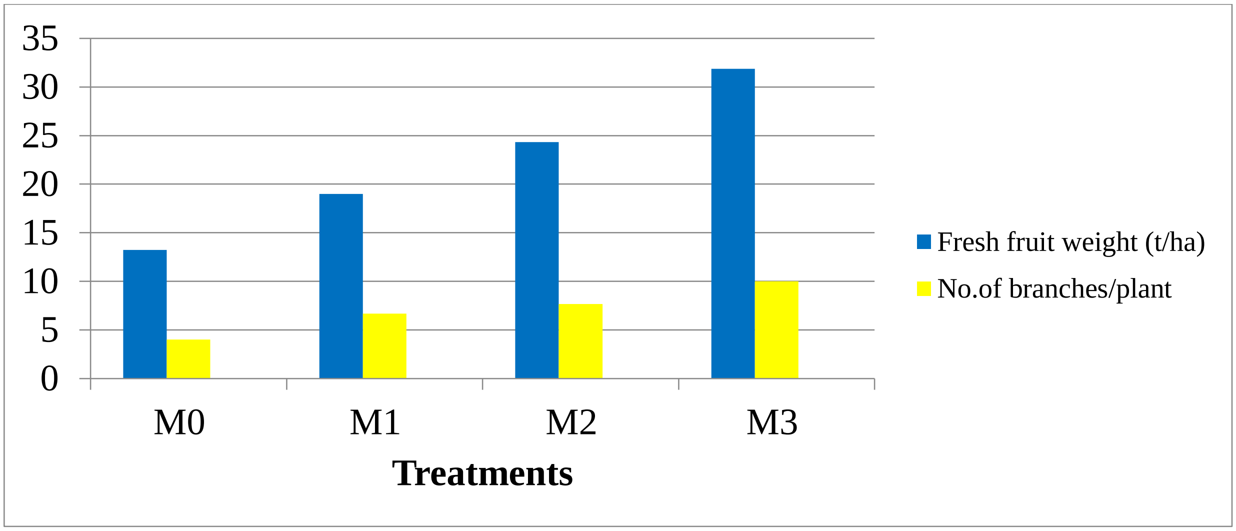
7.1. Effect of drumstick leaf extract on growth and yield of tomato cv. Rodade

(Culver *et al*., 2012)

A study was conducted to find out the effect of drumstick leaf extract on growth and yield of tomato cv. Rodade. The treatments were;

- M0 – Control
- M1 - Drumstick leaf extract sprayed at 2 weeks ATP
- M2 - Drumstick leaf extract sprayed at 2 & 4 weeks ATP
- M3 - Drumstick leaf extract sprayed after every 2 weeks up to physiological maturity

Fig.1. Effect of drumstick leaf extract on growth and yield of tomato cv. Rodade



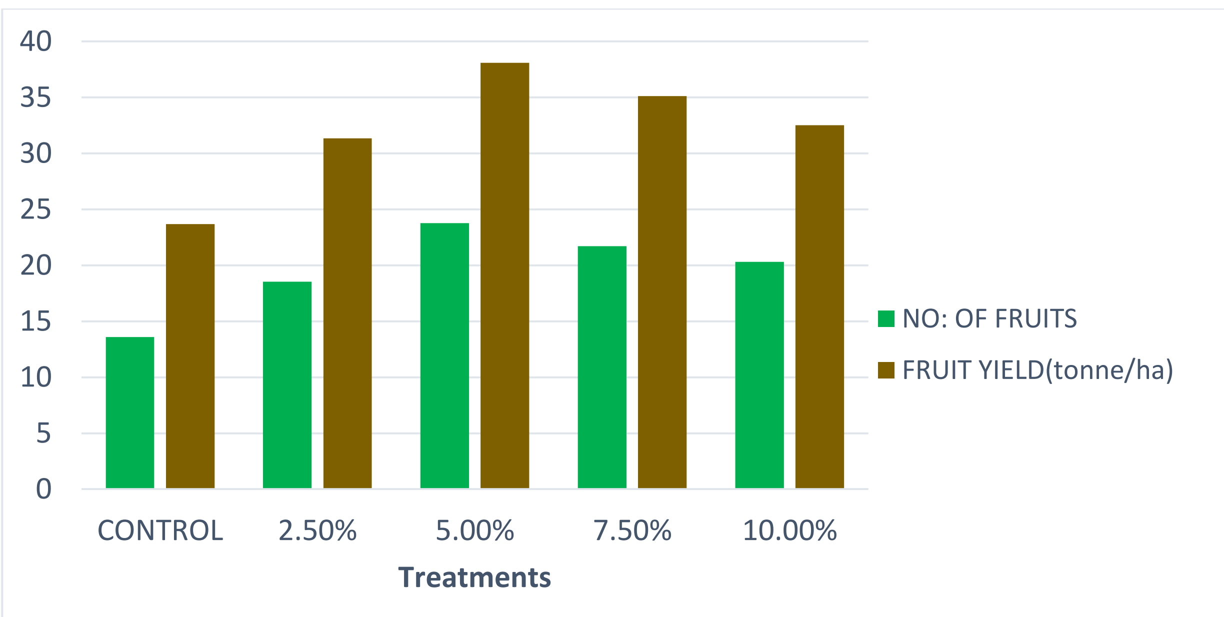
It was found that drumstick leaf extract sprayed after every 2 weeks up to physiological maturity showed significant increase in yield in terms of fresh fruit weight and number of fruits per plant.

7.2. Foliar application of seaweed sap as biostimulant for enhancement of yield and quality of tomato (*Lycopersicon esculentum* Mill.)

Aim: To study the effect of *Kappaphycus alvarezii* (seaweed) sap on growth and yield of tomato

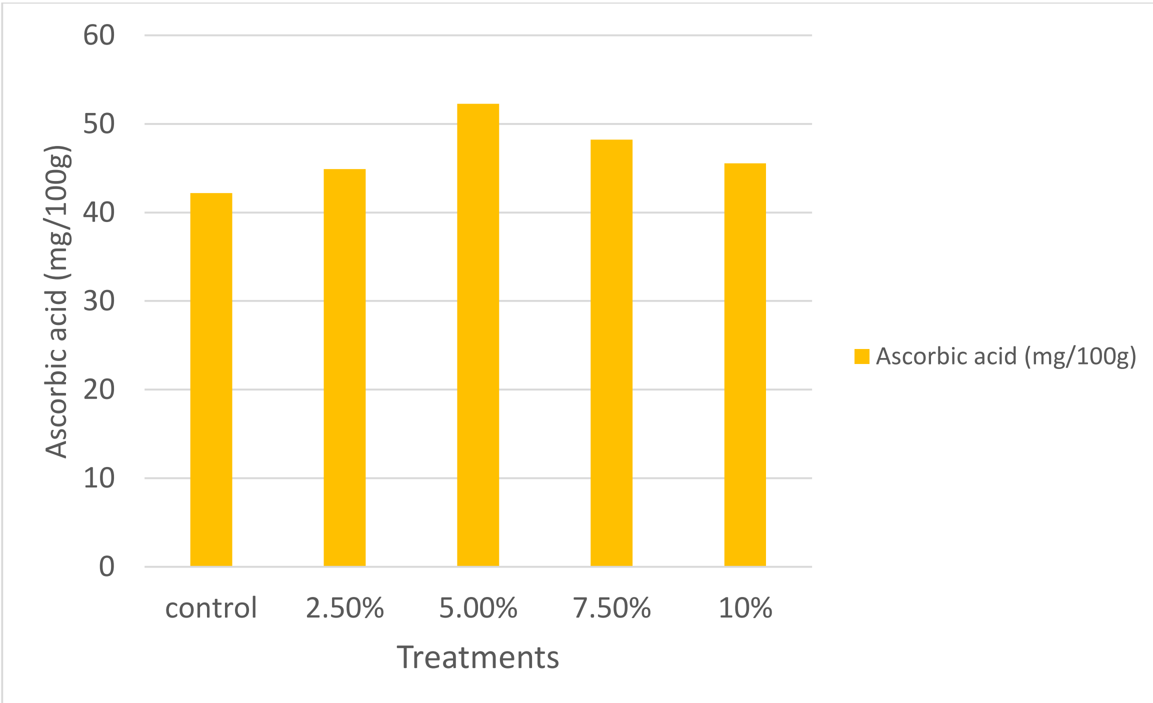
- *Kappaphycus alvarezii* - 2.5, 5.0, 7.5, and 10.0%
- Two foliar applications of *K. alvarezii* sap
- 7 days before flowering
- 7 days after flowering

Fig 2. Effect of treatments on yield of tomato



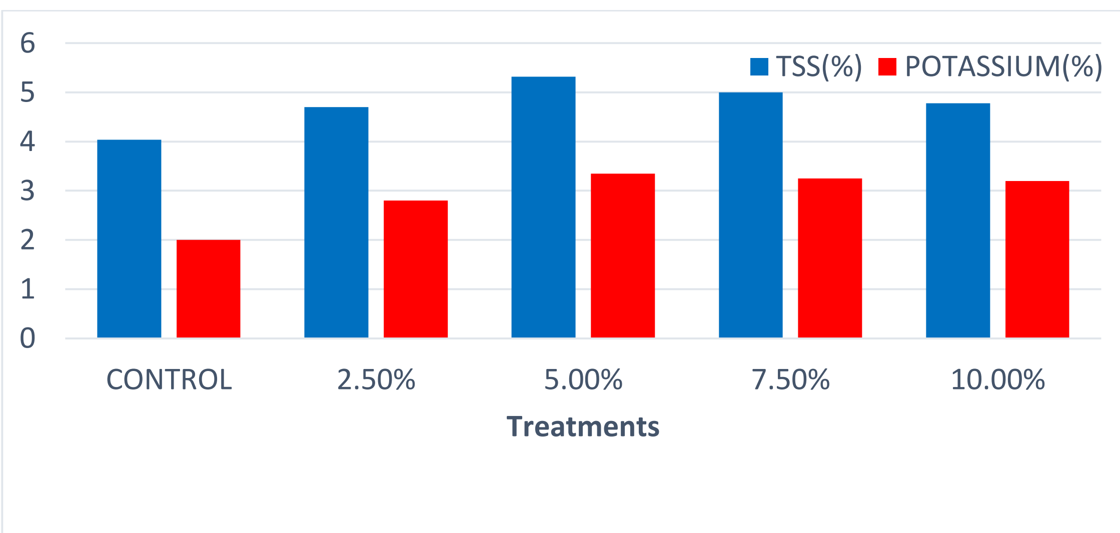
The foliar application of *K. alvarezii* sap has resulted in an increase in yield in all concentrations. Maximum increase in fruit yield (60.9%) over control in plants was observed on application of 5.0% seaweed sap.

Fig 3. Effect of treatments on Ascorbic acid content of fruit



The foliar application of seaweed sap showed increase in ascorbic acid by 23.81% over control.

Fig.4. Effect of treatments on Total Soluble Solids(TSS) and potassium content of fruit



The foliar application showed 23.81% increase in ascorbic acid content and 67.5% potassium content over control.

8. BIOSTIMULANT LEGISLATION

The European Union was first to introduce guidelines for the production and use of biostimulants. The European Biostimulants Industry Council (EBIC) provides guidance on regulatory issues to producers, stakeholders, public policy makers, and the general public. It is the ultimate authority regarding biostimulants in the whole of Europe. In India at present no regulations are there. Recently ICAR has set up a team to evaluate the biostimulant market in the country. It is a positive step towards forming the regulatory framework in the country.

9. TOXICOLOGICAL CONCERNS

Most compounds are natural products of terrestrial and aquatic ecosystems. They are applied at very low concentrations and are generally regarded as safe. It is proposed to position these as eco-friendly products for sustainable agriculture. However, most compounds are not subjected to rigorous toxicological screening and there exists the potential for the persistence of human pathogens in materials of animal origin. There are chances for the synthesis of novel compounds of unknown function or toxicology during the manufacturing which may be harmful. So proper legislation and monitoring need to be present for the manufacture and use of these compounds to ensure safety.

10. CONCLUSION

Biostimulants are preparations of natural origin that support the pro-ecological cultivation of vegetables and fruits. Although for several years a positive effect of biostimulants has been widely reported, they are rarely introduced into standard cultivation technologies. This is connected with the insufficient knowledge of farmers on functions and usage of biostimulants what results in a fear of an increase in the cost of cultivation and a reduction in the quality and quantity of plants. The market requires the development of preparations with a broad spectrum of functionality, which is easy to apply and has the possibility of combination with other agents. The use of biostimulants on a commercial scale would limit the amount of mineral fertilizers introduced into the environment, thus reducing the pollution of soils, water, and air. This is especially important in the case of global warming. Global agriculture accounts for an average of 21% of the global greenhouse effect, of which around 13% is concerned with the effect of chemical fertilizers. The newly developed technologies of bio-preparations may constitute a significant contribution to environmental protection, but primarily they are closely linked with sustainable agricultural and horticultural production with the aim of obtaining cheap, easily available, and high quality food. The effect of biostimulants depends on many factors, from the raw material and the process as a result of which they arose to the plant varieties, application method, and climate. The positive effect of consortia of microorganisms and plant hydrolysates on growth and yield of crops plants should be particularly emphasized. It is also important to increase the antioxidant potential of plants treated with biostimulants containing algae. A positive impact on crop quality and performance, no negative or harmful impact on people, animals, or the environment, increased biodiversity of beneficial microorganisms, and improvement of soil properties are the main advantages of biostimulants. For these reasons, biostimulants are among the hot topics in agriculture and still require detailed research.

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12. DISCUSSION:

12.1. What are the major processes through which biostimulants are produced?

The processes used in the production and preparation of biostimulants are highly diverse and include cultivation, extraction, fermentation, processing and purification, hydrolysis, and high-pressure cell rupture treatment (Table 4). In some instances, a biostimulant product may also contain mixes of components derived from diff erent sources and production methods

12.2. Are biostimulants cost effective?

Many biostimulants are produced through industrial processes which are complex and involving costly raw materials, machinery, etc. Hence cost of these at present are comparable to other inputs such as pesticides. But as the demand is increasing large scale production of these can be made possible and hence production cost can come down making these products less costly.

12.3. What are the uses of chitosan in humans?

Chitosan is used for treating obesity, high cholesterol, high blood pressure. It is also used for issues caused by kidney failure, including high cholesterol, "tired blood" (anemia), loss of strength and appetite, high phosphorous levels (hyperphosphatemia), and trouble sleeping (insomnia).

12.4. Can biostimulants be used in crops other than vegetables?

Biostimulants find wide application in crops other than vegetables such as banana, rice, maize, wheat, etc. In wheat, biostimulants have been found to control nematode attack. It was also found to increase the yield and quality of fruits in banana. The anti-oxidant content was also found to be increased.

12.5. Which are the major suppliers of biostimulants in India?

UPL (India), Apple agro, Biogold, AR bio organic**,** etc are the major companies supplying biostimulants in India. The world leaders in this sector are BASF (Germany), Isagro (Italy), Valagro (Italy), Bayer (Germany), Italpollina (Italy), Koppert Biological Systems (Netherlands), Acadian Seaplants (Canada), etc.

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COLLEGE OF HORTICULTURE, VELLANIKKARA
Department of Vegetable Science
VSC 591: Masters Seminar

Name	: Nidhin Raj	Venue	: Seminar Hall
Admission no.	: 2018-12-002	Date	: 28-11-2019
Major advisor	: Dr. P. Anitha	Time	: 9:15 am

Effects of biostimulants on vegetable production

Abstract

The world population, which reached 7 billion in 2011, is estimated to increase to 10 billion by 2050. To feed this massive population the agriculture sector has to evolve hugely. At present, scarcity of resources and climate change are majorly affecting the crop production. Using traditional inputs, there is a limit to the production that can be achieved and various biotic and abiotic stresses that can be mitigated. Biostimulants offer a novel approach for the regulationof physiological processes in plants to stimulate growth, mitigate stress-induced limitations and to increase yield.

According to EBIC (European Biostimulants Industry Council, 2011), a biostimulant is a material containing substances and or microorganisms whose function, when applied to plants or rhizosphere is to stimulate natural processes to enhance or benefit nutrient uptake, nutrient efficiency, tolerance to abiotic stresses and crop quality.

The main categories of biostimulants include humic substances, protein hydrolysates, seaweed extracts, chitosan, inorganic compounds, beneficial fungi and beneficial bacteria (Du Jardin, 2012). These include products of both living and non-living origin. Biofertilisers are considered as a sub category of biostimulants.

Biostimulants have various effects on vegetable production. They improve the general health, vitality and growth of the plants, protect them against infections, mitigate negative effects of abiotic stresses (drought, heat, salinity, chilling, frost, oxidative, mechanical and chemical stresses), increase the effectiveness of nutrient uptake, improve the mechanical properties, reduce cracking and enhance shelf life of fruits and vegetables and increase the area and turgor of the leaf leading to an increase in the photosynthesis (Rayorath *et al.*, 2008). Through increased root foraging capacity and enhanced nutrient use efficiency, they lead to higher crop yields, reduced uses of fertilisers and reduced losses to the environment

(Kolomaznik *et al*., 2012). Traditional organic preparations also have biostimulant effects on vegetables. These include panchagavya, jeevamrutha, fish-amino acid, egg-amino acid, vermiwash, *etc*. Extracts of moringa leaf also acts as a biostimulant and is found to increase growth and yield of vegetables by 10-20 per cent (Culver *et al*., 2012).

Biostimulants act on vegetables through gene expression, production of signalling molecules and regulation of hormones. Their protective actions on plants are by reduction of stress induced ROS (Reactive Oxygen Species), activation of antioxidant defense system and increased levels of phenolic compounds (Shubha *et al*., 2017).

Using biostimulants on a large scale is definitely instrumental in increasing the production as well as productivity of vegetables. To an extent it also answers the problems related to indiscriminate use of chemical inputs. Hence, biostimulants can definitely play a vital role to ensure sustainability and to satisfy the food needs of human population.

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