Plant Biostimulants, Seaweeds Extract as a Model (Article Review)

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Abstract
Plant biostimulants are classified as substances which have increased the positive effects on growth and productivity when applied to plants. Biostimulants are obtained naturally from various economically and environmentally viable sources. The plant biostimulants currently accepted include extracts of seaweed, humic substances (humin acids and fulvic acids), chitin and chitosan derivatives, amino acids, protein hydrolysates and microbes. Seaweed extracts and humic acids are widely studied for their role in plant growth-promotion, Seaweeds have been traditionally used in coastal Europe since time immemorial as fertilizers and soil conditioners. Seaweeds belong to Rhodophyta, Chlorophyta and Ochrophyta. Over the past two decades, seaweeds have been processed and marketed as seaweed extracts in various formulations for use in agriculture and horticulture. Seaweed extracts are rich in micro and macronutrients, polysaccharides, proteins, polyunsaturated fatty acids, polyphenols, phytohormones, and osmolytes. These compounds elicit multiple beneficial effects in plants, including enhanced seed germination and establishment, overall plant growth and productivity, resistance against biotic and abiotic stresses and increased post-harvest shelf life. Numerous studies of the beneficial effects of seaweed extracts on crop plants and crop production, yield and productivity have been published.

Keywords: Biostimulants, Seaweeds, Extract, Distribution, Growth, Uses, Nanoparticle.

1. Introduction
Both the biotic and abiotic factors influence the quality and quantity of the crops. Quality can be defined as a set of agronomic properties (e.g., fruit size, yield, bacterial and fungal resistance) and organoleptic properties (e.g. colour, shape, firmness) as well as nutrient and vitamin content [1]. Soil composition, extreme salinity, acidity, high and low temperatures, drought, pollution, humidity, rain, wind, or ultraviolet radiation are among the abiotic factors. Stress caused by unfavorable stimuli can significantly reduce harvest yields, as plants respond by using their energy reserves to combat stress rather than focus on yield. Biotic factors include various bacteria, fungi, or viruses which cause numerous diseases in plants. Fungal and bacterial infections may not only reduce yields, but may also cause the entire harvest to lose out. Diverse types of plant protection products are used to prevent this. In accordance with European Union guidelines [2], Chemical and mineral plant protection agents are meant to be replaced slowly by natural preparations. The cause for this is the detrimental impact on the natural world of chemical and mineral plant defense products, as well as on the safety benefits of food crops. Additionally, chemical fertilizers are blamed for certain bodies of water being eutrophised. This leads to the formation of dead zones, without living organisms. The Baltic Sea alone is characterized by the oxygen-free areas that make up around 60,000 km2 of region affected by fertilizer-related water contamination. On average, this area constitutes 3.5 per cent of the Baltic Sea catchment area [3]. The fertilizer effects have an unfavorable effect on algae, plants, animals, and people. Because man is a higher-order consumer, humans are particularly heavily exposed to the harmful effects of fertilizer compounds accumulated at lower food chain levels. Harmful fertilizer compounds may disrupt the enzymes or interfere with protein production or absorption of vitamins in the human body [3]. Modified formulations called biostimulants enhance the usage and resistance of nutrients to abiotic stress, and boost crop quality [4]. Biostimulants include microorganisms and/or organic and non-organic substances [5]. Farmers operating organic farms are now eager to utilize natural stimulants to increase the efficiency of crops [6]. Increasing consumer awareness about healthy food favors improving the importance of organic farming [7]. The stimulator eets can be multifaceted. The ects of their behaviors differ due to the form of biostimulant used and the diversity of the plants. It should be noted, however, that most have beneficial effects on crops [8].
In recent years, algae have suffered a boom, with consequent discoveries and advances in this field. Not only are algae of high ecological value but they are also of great economic importance. Possible applications of algae are very broad, including antibiotic action, biofuel processing, bioremediation, as fertilizer, as fish feed [9]. Seaweed extracts (SE) are currently widely used as plant biostimulants, which are ‘any substance or micro-organism applied to plants with the aim of enhancing nutrition and science, abiotic stress tolerance and/or crop quality, regardless of their nutrient content’ [10]. Seaweed extracts make up more than 33 percent of the global market for biostimulants and are predicted to reach a value of EUR 894 million in 2022 [11]. In addition, seaweeds or macroalgae are estimated to compromise nearly 10,000 species [12], which are mainly...
Seaweed Extracts as a Plant Growth and Production Biostimulant

Seaweeds are an important component of coastal aquatic eco-systems. These include the macroscopic, multicellular marine algae commonly inhabiting the coastal regions of the world’s oceans where there are appropriate substrates. It has been estimated that about 9,000 species of macro algae are broadly classified into three main groups based on their pigmentation (e.g., Phaeophyta, Rhodophyta, and Chlorophyta; or the brown, red, and green algae). Brown seaweeds are the second most common group of around 2,000 species on the rocky coasts of temperate zones exceeding their highest biomass peaks. They are the type most commonly used in agriculture [15], and among them the most researched is the Ascophyllum nodosum (L.) Le Jolis [16]. Alongside A. Nodosum, other brown algae, such as Fucus spp., Sargassum spp., Laminaria spp. and Turbinaria spp. Are used as agricultural biofertilizers [17]. For decades, the advantages of seaweeds as sources of organic matter and nutrients for fertilizers have contributed to their use as soil conditioners ([15], [18] and [19]). About 15 million metric tons of seaweed products are produced annually [20], a substantial portion of which is used for nutrient supplements and to improve plant growth and yield as biostimulants or biofertilizers. Numerous studies have shown a wide variety of beneficial effects of marine extract applications on plants, such as early seed germination and planting, enhanced crop production and yield, increased biotic and abiotic stress tolerance, and increased post-harvest shelf-life of perishable products ([21] and [22]); Seaweed products foster root production and growth ([23] and [24]). The stimulatory effect of root growth was more pronounced when extracts were applied in maize at an early stage of growth, and the response was similar to that of auxin, an important root growth hormone [25]. By increasing root size and vigor, SWC applications reduce transplant shock in marigold, cabbage [26] and tomato seedlings [27]. Treatment with SWC increased both root: shoot ratios and accumulation of biomass in tomato seedlings by stimulating root growth [28]. On ashing this stimulating activity was lost, suggesting that the active principles in the extract of seaweed were organic in nature [29]. The root-growth-promoting behavior was observed when the extracts from seaweed were either applied to the roots or as foliar spray [29]. The concentration of kelp extract is a crucial factor in its efficacy as seen by [29] for tomato plants in which high concentrations (1:100) of seaweed extract: water impaired root growth but stimulating effects were observed at a lower concentration (1:600). In general, biostimulants are capable of influencing root growth both by strengthening lateral root structure [30] and by increasing the overall root system length [31]. The endogenous auxins as well as other compounds in the extracts could influence an improved root system [27]. Seaweed extracts improve root uptake of nutrients [28]. This results in improved water and nutrient efficiency root systems, leading to increased growth and vigor in general plants [32] and [33]. Sprinkling of Kappaphyccus extract at a rate of 15 percent with the required dose of fertilizers reported higher yield attributes such as number of panicles m-2 (507.60), filled grain panicle-1 (143.83), panicle length (28.97 cm) and 1000 grain weight (21.23 g) and thus improved grain yield (6.55 t ha-1) and straw yield (8.25 t ha-1) A 15% spray of Gracilaria sap and a recommended dose of fertilizers in rice followed. In addition, this application of only Kappaphycus sap and Gracilaria sap with the same concentration increased the absorption by grain with N and P [34]. The yield attributing rice characters such as the number of panicles hill-1 and the number of productive grains panicle-1 also increased with higher seaweed extract concentrations and the maximum value was obtained for 15 percent K sap, which was statistically equivalent to 10 concentration [35]. It has been reported that marine weed application not only improved crop growth but also helped increase the number of functional nodules as compared to control. This can be due to the presence in brown algal extracts of several cytokinins including trans-zeatin riboside and its dihydroderivatives . It has also been documented that the bioactive compounds in the Ascophyllum nodosum extract and its organic sub-fractions have impaired legume signalling processes-rhizobia, resulting in more stable nodules and an overall increase in plant growth [36]. Applications of 15 percent seaeweed extract from Kappaphycus and Gracilaria extracts are responsible for increased yield and improved green gram nutrition receiving foliar application of the aforementioned two saps. Seaweed extract application increased early growth and yield attribute properties in legume plants and The yield was 12-25 percent higher than the yield of control [37]. The application of 10 percent of Kappaphycus Alvarezi and Gracilaria edulis extracts increased the yield of black gram grain by 47.52 percent and 42.52 percent relative to control [38], respectively. Due to foliar sea weed spray) [39], the average bean yield increased by 25 per cent). [40], it was confirmed that supplementation of the prescribed dose of fertilizer with either Kappaphycus alvarezi (K sap) or Gracilaria edulis (G sap) extract at a concentration of 10 percent could be followed to boost the growth and yield of potato. They also recorded that applying both 10% G sap + RDF and 10% K sap + RDF yielded higher tuber yields of 32.88 t ha-1 and 31.30 t ha-1, respectively than power. In addition, seaweed extract sprays had significantly increased marketable yield of tuber and minimized non-marketable yields and potato damage over control. [41] corroborated similar results and maintained that seaweed extracts had a positive impact on potato plant growth and thus dramatically improved overall potato yield, both qualitatively and quantitatively [42] also concluded that seaweed extract could boost potato yields. The stages of the crop...
during which the seaweed is treated, however, play an significant role. Sprinkling of seaweed extract at an interval between 30 and 60 days after planting reported increased tuber yield,

Enhanced phosphorus, gross soluble solids, and potato tuber protein value [43]. [35] reported an increase of 18.0 per cent in rice grain yield with either 15 per cent Kappaphycus (K) or Gracilaria (G) sap as compared to control. They recommended that the application of either 10 percent K or G sap spray concentration along with 100 percent recommended fertilizer dose is a feasible option for obtaining high yield and grain quality rice in north-eastern India region. [44] and [45] also record similar rice tests. Also recorded were the beneficial effects of the seaweed extract on wheat growth and yield) Triticum aestivum L.). Wheat grain yield increased dramatically by 19.74 percent and 13.16 percent with application of 7.5 percent and concentrations of K at 5.0 percent. Alvarezi y G. Eduis sap on power, respectively. [46] Similar results with application of K have also been reported for wheat. Extract of the alvarezi [47]. SW seaweed ibanad multi foliar application on growth and potato yield at 23.33 compared to control18.86 meg ha-1 fresh tubers yield respectively [48]. The effect of soaking the tubers + spraying the plants with algae extract AE at 200 mg L-1 showed a marked increase in the area of the leaf, Plant production and tuber content of dry matter and starch, which was compared to other treatments, while dry matter was 19.4% and starch content 13.3%, whereas control plants reported lower values of 14.9% and 9.3% respectively [49]. A novel study, a greenhouse experiment with a novel seaweed extract (SES) originating from Sargassum horneri was conducted in Shandong Province of China to investigate the effects of different doses of SES (0, 30, 60 , and 90 kg hm−2) on yields, quality, maturing time, and net returns of tomato. The results indicated that SES application significantly increased tomato yield by 4.6−6.9 percent compared to control, which is attributed to improved tomato leaf photosynthesis capacity. Tomato yields first increased and then decreased with rising dosage of SES, and SES applied at the 60 kg hm−2 dose obtained the highest yield of tomatoes. Compared to the monitor, SES increased tomato hardness by 10.2 and 19.8 percent at

3. Seaweeds: Distribution, Production and Uses

Plants are the main producers who race for this precious life on earth. They form the basic direct food for the herbivores and for the carnivores indirectly, being part of the web / chain food. They are known as Cryptogams and Phaenorogams. Once more, cryptogams are divided into Thallophyta, Bryophyta, and Pteridophyta. They are classified within Thallophyta Algae and Fungi. Most algae are aquatic, and grow in various waters. Any algae occur in soil and waters. They are the primitive group of plants that first evolved in the universe, and they are both microscopic and macroscopic, commonly called microalgae and macroalgae. Macrophytic algae found in marine environments (Seas / Oceans) are commonly referred to as seaweed . Marine algae are the major primary producers within the marine ecosystem. Macroalgae are larger, with a simple thallus structure which has no real roots and leaves. But they've got pseudo-roots called hold rhizoids / fasts. They do photosynthesis through their thallus ([51] and [50]).

Needless to say, in the light of recent new knowledge provided by molecular techniques, the taxonomic classification of algae is still the subject of constant changes and controversy [53], [54] indicates that there are about 36,000 recognized algae species which constitute only about 17 per cent of current species. According to Dring (55), over 90 percent of marine plant species are algae and about 50 percent of the plant group's global photosynthesis is derived from algae [54]. Thus each second molecule of oxygen that humans inhale is produced by an alga, and each second molecule of carbon dioxide that they exhale is reused by an alga [56]. Uses of these marine aquatic plants otherwise known as weeds (Marine algae) had not been well understood in earlier days. Thus the name of these marine plants / weeds was given as “Seaweeds.” Now, the aquatic plant benefits (sea algae) have been well studied in various ways, and are being used in human life today. The name "Seaweeds" is now common with scientists and people and hence the name "Seaweeds" is difficult to modify. But some scientists use the term ‘Marine Plants’ here and there in scientific literature, and yet the term ‘Seaweeds’ is widely accepted. More important than the name, it is the use and many applications of these seaweeds. Seaweeds grow naturally in seawater, and their growth is greater where there is adequate nutrition and sunlight. Earth has 71 per cent of marine water and harbors an enormous number of marine plants. Marine plants include phytoplankton, cyanobacteria, seaweeds and sea grasses, and the coastal community is known among these seaweeds for a better livelihood option ([57]). Seaweeds grow in shallow or near-shore waterways of sea, estuaries and even in brackish waters wherever dead corals, rocks, stones, pebbles and any other suitable substrates are accessible for attachment. They are also one of the marine resources which are renewable and economically valuable ([58] and [59]). [60] and [61] examined the advantages of seaweed for human well-being in which the use of seaweed as human food , animal feed, crop manure, antibiotics and phycocolloids (agar, alginate and carrageenan) were included.

4. Effect on plant defense system against biotic factors

Several reports have shown that SWE induce protection against fungal, bacterial, and viral pathogens in plants. Defense response occurs after perception of signal molecules, called elicitors, derived from pathogens or from the host plant [62]. SWE polysaccharides can act as elicitors of plant defense responses and enhance resistance against pathogens. Early study of Featonby-Smith and van Staden [63] showed that SWE reduced root damage from nematode Meloidogyne incognita
predation in tomatoes whether applied to the foliage or as a soil drench. SWE did not reduce the abundance of nematodes in the soil but lowered their number inside the roots. According to [64] SWE in the soil reduced the number of galls and juveniles of M. incognita and decreased the infestation of tomato plants by root-knot nematodes. Application of Spathoglossum variable, Melanothamnus afaqhusainii, and Halimeda tuna extracts can suppress rotting fungi Rhizoctonia solani and Fusarium solani on tomato roots as well as nematode’s galls on roots and nematode’s penetration in roots [65]. SWE of different brown algae species reduced necrotic lesions induced by A. solani. Ulva lactuca extracts induced the expression of systemic wound response genes. Caulerpa sertularioides, Padina gymnospora, and Sargassum liebmannii extracts were involved in the other, unidentified mechanisms[62] . Ascophyllum nodosum enhanced foliar resistance to Phytophthora capsici in pepper [66]. SWE, applied as a soil drench to pepper plants, reduced Verticillium wilt of pepper through improving plant fitness and increasing resistance to pathogens [67]. Spathoglossum variable, Stoekeyia indica, and Melanothamnus afaqhusainii extracts showed significant suppressive effect on root rotting fungi Fusarium solani and root knot nematode Meloidogyne incognita in eggplant [68]. Due to their effects as plant protectants, algal extracts represent an alternative tool for disease and pest control in Solanaceae crops [69].

5. Seaweeds and New Technologies
5.1 Seaweed nanoparticles, Green Synthesis and Application
The underwater surfaces of marine environments are populated by a wide variety of living species, from bacteria to invertebrates [70]. Bio fouling is harmful growth and aggregation of bacteria, plants and animals on a natural surface or other artificial structures long exposed to water. It is still one of the big unanswered issues impacting the shipping industry at present. Nanoparticles were added to cover the ships and other artificial structures within the ocean to solve this consisting problem. However, to reduce the side effect and gradual poisoning of chemically derived nanoparticles, the present generation has focused on the biosynthesized nanoparticles for coating and is trying to solve this consisting problem of living organism accumulation. Nanoparticles are used for different fields of use for their special characteristics. In general, the noble metals Gold, Silver and Platinum Nanoparticles are widely applied to various fields such as toothpaste preparation, various biomedical applications, and pharmaceutical applications. Gold (red colloidal) had likewise been reported to have revitalization therapeutic applications in India and China; gold nanoparticles had drug distribution and diagnostic uses. Nanoparticles have multiple uses in different fields [71].

5.2 Biosynthesis of Nanoparticles in Gold
Biosynthesis of Gold Nanoparticles is done through Fucus spiralis, a single step reduction of aqueous chloroaurate ions. The biosynthesized gold nanoparticles vary in form and range from 5-40 nm in size [72]. This research also shows that the shape and sizes of biosynthesized gold nanoparticles depend on pH values, reduction period and also the coagulation rate of crystal growth [72]. The single cell protein (Spirullina platensis) uses nanoparticles to biosynthesize silver (7-16 nm), gold (6-10 nm) and bimetallic (17-25 nm) which show the biosynthesis and nanopart size. depend on temperature and reduction duration [73]. The presence of Cds in phytoplankton Phaeodactylum tricornutum is biosynthesized by the CdS Nanocrystallites. Sargassum wightii’s aqueous solution applied to the extracellular biosynthesis of mono-disperse and shape-specific gold nanoparticles [73]. The Fucoidans, Cladosiphon okamuranus o-fucoidan and Kjellamaniella crassifolia t-fucoidan use to biosynthesize the gold nanoparticles. Both synthesize nanoparticles in spherical and 8-10 nm sizes but well mono-disperse linear polymer and t-fucoid synthesize less dispersed branched polymer [74]. Gold Nanoparticles are synthesized by the extracellular polysaccharides of dried Sargassum wightii [73]. Similar study shows that Sargassum wightii also depends on temperature, pH and reduction duration for the biosynthesis, stability of biosynthesized nanoparticles, shape and sizes of gold nanoparticles. The processing of gold Nanoparticles varies with improvements in nitrate reductase, pH, and temperature [75]. The various forms such as square, rectangle and triangle and 60 nm gold nanoparticles synthesize Turbinaria conoides from brown seaweed and inhibit the growth of Streptococcus sp., Bacillus subtilis, and Klebsiella pneumoniae [76]. Dictyota bartayresiana’s aqueous extract synthesizes 548-564 nm gold nanoparticles confirming the presence of amine, poly phenol, and carboxylic group. It has greater inhibitory action than generic antifungal medications against Fusarium dimerum and Humicola insulans. The Nanoparticles 53-67 nm of metallic gold synthesize with the Padina gymnospora aqueous extract [77].

5.3 Silver Nanoparticular Biosynthesis
Hypnea musciformis biosynthesized water extract Silver nanoparticles is both antibacterial and antifungal [78]. Kumar reported that biosynthesized silver nanoparticles in Sargassum tenerrimum had pathogenic inhibitory activity involving human MTCC [79]. Gelidiella acerosa biosynthesized Silver Nanoparticles allegedly displayed antifungal activity rather than clotrimazole [80]. Ulva lactuca’s biosynthesized Silver Nanoparticles allegedly had antimicrobial activity [81]. Silver Nanoparticles’ interesting biosynthesis is done by 63.7 per cent to 56.0 per cent of the metals silver ions including Codium capitatum water extract. No use of a chemical solution in this synthesis, so it is absolutely environmentally friendly [82]. Turbinaria conoides aqueous extract biosynthesizes the 96 nm spherical Silver Nanoparticles and these biosynthesized Silver
Nanoparticles are highly toxic to the growth of some human pathogenic bacteria such as Bacillus subtilis (MTCC3053) and Klebsiella planticola (MTCC2277) [83]. Padina tetrastromatica synthesizes the 14 nm spherical Silver Nanoparticles, which also have antimicrobial activity [84]. Sargassum polycystum biosynthesizes 5-7 nm Silver Nanoparticles, the methanol extract that activates inhibitory potential against some human pathogens. Padina tetrastromatica’s biosynthesized circular, polydispersed silver nanoparticles and fatty acid extract had anticancer action against the MCF line of breast cancer cells ([85] and [86]). Shiny has recently clarified the spherical 25-40 nm Padina gymnospora antibacterial Silver Nanoparticles and even hospital surgical wound dressing [87].

Padina gymnospora synthesizes the 25-40 nm silver spherical nanoparticles with inhibitory activity against Bacillus cereus and Escherichia coli which has a medicinal application for wound dressing in hospitals [87]. Some seaweed Caulerpa pelteta (green), Hypnea Valencica (red) and Sargassum marioycystum (brown) biosynthesize various forms such as spherical, triangular, rectangular, radial and 96-110 nm spheres Zinc Nanoparticles at pH 8 and 80 °C temperature. The biosynthesized nanoparticles of zinc contain reactive oxygen species that exhibit antibacterial activity against Streptococcus mutans, Vibrio cholerae, M. Luteus, Neisseria gonorrhea and Klebsiella pneumoniae [88]. The biosynthesized Silver Nano content from Sargassum longifoliums aqueous extract, brown seaweed, has antifungal efficacy against Candida albicans, Aspergillus fumigatus and Fusarium sp. S. Longifolium may be due to its bio-component, owing to its size and spherical shape [89]. The surface area of the nano-sized materials has been increased to protect the fungal growth area [90]. The positively charged silvernano-materials bind through electrostatic attraction and can impede fungal growth within the fungal growth region with the current negatively charged particles [91]. Positively charged silver ions may be attached by electrostatic attraction to negatively charged microbial cell membranes [91]. Silver nanoparticles have high permeability due to their smaller size and create proton leakage that helps to transfer the ROS through the membrane ([92] and [93]). Silver nanoparticles inhibit conidial fungal germination, and have reasonable potential to inhibit fungus-producing spore [94]. The insulin deficiency is causing clinical diabetes syndrome. Colpomenia sinuosa’s biosynthesizes of silver nanoparticles have antidiabetic potential that inhibits the development of α-glucosidase and α-amylase enzymes responsible for the production of diabetes [95]. Halymenia poryphyroides synthesizes of 34-80 nm of colloidal silver nanoparticles have a strong efficacy against Salmonella typhi, Klebsiella pneumoniae. Staphylococcus aureus, Proteus vulgaris and Salmonella typhi [96]. Cubic shape 18-90 nm and biosynthesized 20-90 nm Silver nanoparticles have aqueous extracts of Turbinaria ornata, and antimicrobial and antifungal activity of Padina tetrastromatica. There are carbonyl groups, aromatic alcohols, amines and hydroxyl groups in the Nanoparticles [97].

6. Application of nanoparticles made of gold and silver in various fields

The low-resistance gold nanoparticles are used for flexible electronics, and the gold nano-particulate is used for flexible electronic inks; nano rod is useful for electronic devices and is also used for rapid biomedical testing. The gold-silica nano-shells kill cancer cells; the gold nanoparticles boost the use of thiol in decorative coatings, the thermosetting gold nanoparticles exhibit novel esthetic effects, the use of gold nanoparticles for pollution control and even some chemical synthesis [72]. Nanoparticles uses for drug delivery, antibacterial and viral agent, genetic disorder detection, bio-sensing, labeling of biological applications, and sequencing of DNA and gene therapy because of special chemical reactivity and unique physical properties. Polysaccharides extracted from brown seaweed are used as anti-peptic-ulcer, anti-coagulant, anti-inflammatory, anti-aging, anti-cancer, whitening agent, and anti-viral agent [98]. Silver nanoparticles show enormous applications in drug delivery [99], wound healing [100], sensor applications ([101] and [102]) cosmetics [103], textile industry and also used antimicrobial agents in paint [104]. Due to their antimicrobial actions in food pathogens such as Staphylococcus aureus and Escherichia colli, Klebsiella mobilis, Bacillus subtilis, Klebsiella pneumoniae, Pseudomonas aeruginosa, Silver Nanoparticles were actively involved in the medical sciences ([105] and [106]). Meningitis causative microbe Cryptococcus neoformans [98], Staphylococcus aureus resistant to methicillin, Staphylococcus epidermidis resistant to methicillin, Streptococcus pyogenes and Salmonella typhi and strong antifungal activity against Candida albicans, Aspergillus niger, Penicillium citrinum and Aureobasidium pullulans were isolated from kitchen drainage synthesis wastage suspension [101]. The Nanoparticles of gold, silver and platinum noble metal used for the preparation of toothpaste, also used for the preparation of pharmaceutical and medicinal goods. Biosynthesized from Rhizophora apiculata, the eco-friendly spherical shaped (15 nm) Silver Nanoparticles had a high antibacterial activity compared to gentamicin and chloramphenic [107]. Research has shown gold nanoparticles to be useful for the treatment of breast cancer [108]. Corallina officinalis gold nanoparticles from the red seaweed have a cytotoxic impact on breast cancer MCF-7 [109].

7. The use of anti-foulants

The gold biosynthesized nanoparticles have antibiofilm activity against the common marine biofilm forming bacteria such as A. Salmonella sp. hydrophila And ... And S. Liquefaciens [110]. Seaweed crude extracts such as Sarconema furcellatum, Sargassum wightii, and seaweed Siringodium isoetifolium, Cymodocea serrulata have anti-microfouling activity against microfoulers such as antibacterial activity of 7±0.16 to 13±0.26 mm; 50-300 μg / ml anti-microbial, LC50 133.88 μg / ml; P<0.001 Artemia cytotoxicity and anti-crustacean activity; micro-fouler mortality increase with increased concentration of
extract of crude seaweed [111]. Because of the existence of some essential functional groups such as aliphatic (fatty acid), amide I and II (NH2), amino, phosphoryl, hydroxyl and carbonyl, the mangrove extract Rhizophora apiculata, Rhizophora mucronata and Avicennia marina show stronger antifouling activity against certain fouling bacteria such as Bacillus sp., Cytophaga sp., flavobacterium sp. And those of Pseudomonas sp. Halimeda macroloba, Ulva reticulate and Sargassum wightii, close to sea grass extract Halodule pinifolia, Cymodocea serrulata also exhibits the lowest anti-foulant activity than mangrove extract [112]. South China Sea grass Enhalus acoroides chemical constituents and anti-feedant, antibacterial , and anti-larval behaviors. Including four flavonoids, eleven pure compounds were obtained, and five steroids. Among these compounds were three flavonoids anti-feeding Spodoptera litura second-star larvae, two flavonoids had antibacterial activity against many marine bacteria, and one flavonoid had significant anti-larval activity towards Bugula neritina larvae [113]. The crude ethyl acetate extract of Ulva fasciata induced biosynthesized crystalline, circular, poly-dispersed size range 28-41 nm Silver Nanoparticles had inhibitory activity14.00±0.58 mm against Xanthomonas campestris pv. malvacearum [114].

Conclusion
It is important to note that many crop systems react differently to plant biostimulants, and that positive effects are recorded mainly under regulated laboratory or greenhouse conditions and in specific crop species. The crops that have been studied most widely within commercial agricultural production systems and have been shown to respond positively to biostimulant materials are row crops and cereals. Specific drug compositions (often containing several forms of biostimulants or macro or micronutrient additions), specific farming methods, and various environmental factors further complicate their usage. Seaweed extracts derived from marine algae, which contain a wide variety of macronutrients and microelement nutrients and organic components such as growth hormones, amino acids , vitamins, betains, cytokinins and sterols, have played an significant role in the production of an environmentally sustainable seed planting program. In general, extracts of seaweed can induce changes in the physiological / biochemical process associated with plant nutrient uptake and growth in agriculture.

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