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Bio-Stimulants in Oil Seed Crops - Its Influence on Growth, Yield and Quality

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ABSTRACT

Plant bio-stimulants influence growth, yield and quality of oil seeds. Bio-stimulants are naturally available or synthetic. They influence production and productivity of crop plants. These are substances or microorganisms or combination of both with influence on nutrients uptake, growth, yield and quality of seeds, they also protect seeds and seedlings from abiotic stress, nutrient deficiencies and enhance the seed and seedling vigour. Amino acids, fulvic acids, humic acids, seaweed extract, plant derivatives, polyphenols, beneficial fungi, beneficial bacteria, beneficial symbiosis, inorganic salts, industrial and agricultural wastes etc., these are all bio-stimulants. In India bio-stimulants are regulated under Fertilizer control order, 1985. Bio stimulants are applied as either soil or foliar application, seed treatment or seedling dip.

Keywords : Oil seed crops, Plant bio-stimulants, Abiotic stress, Regulation, Yield quality

To satisfy the food demands of the growing population, there is a need to increase production and productivity of crops. Among all crops known to man-kind, oilseed crops occupy a pivotal position by virtue of its value as the sources of edible oil in human diet and non-edible oil for bio-fuels. In world agriculture oilseeds sector has been one of the most dynamic sectors, in past three decades surpassing livestock product, growing at the rate of 4.1per cent per annum. In India almost 72 per cent of the area under oilseed production is confined to by rainfed farming, cultivated by marginal and small farmers. Due to the problems like limited appropriate technology, biotic-abiotic stresses and the lack of inputs (fertilizers, plant protection measures, quality seeds) and the stress caused due to climate change leads to the lower production and productivity in the oilseed crops (Anonymous, 2021a). In order to overcome these problems during cultivation of oilseed crops the researcher found out that one solution that is bio stimulants.

Bio-stimulants are substances or microorganism or a combination of both whose primary function when applied to plants, seeds or rhizosphere is to stimulate physiological process in plants and to enhance its nutrients uptake, growth, yield, nutrition efficiency, crop quality and tolerance to stress, regardless of its nutrient content, but does not contain pesticides or fertilizers which are regulated under the Insecticide Act, 1968 (Anonymous, 2021b). This definition is most accepted in India. Other definitions given by many scientists in their articles are; 'Materials that in minute quantities, promote plant growth' (Zhang and Schmidt, 1997). 'Bio-stimulants are materials, other than fertilizers, that promote plant growth when applied in low quantities' (Kauffman *et al*., 2007).

Agricultural experts claim to see improvements in plant growth and seed yields by using bio-stimulants. These products reduce the need of fertilizers and pesticides while maintaining excellent crop yield and seed quality.

Crop Responses to Bio-Stimulants

Bio-stimulants contain extracts and compounds that improves plant growth, development and yield. These

products appear to be an exciting breakthrough in the agricultural sector and pursuit of alternative ways for farm sustainability. A study exploring bio-stimulants and abiotic stresses in plants highlighted the several ways crops responded to bio-stimulants amid different abiotic stresses. The Findings of the study may provide some insight into the potential of bio-stimulants in keeping up with the debilitating effects of climate change on the agricultural sector (Hasanuzzaman *et al*., 2013).

Drought

Drought is the major yield-limiting stress factor and it will remain so due to increased water demands of crop land driven by rise in evapotranspiration related to climate change (Zhao and Dai, 2015 and Kim *et al.*, 2019). Drought-induced stomatal closure leads to photorespiration which accounts for up to 70 per cent of H_2O_2 generated in the leaves (Noctor *et al*., 2002). However, it is not completely harmful; crop performance requires a delicate balance between ROS generation and its detoxification (Miller *et al*., 2010). In many crops, water deficit occurs transiently and exogenous application of bio-stimulants is widely used for enhancing crop-performance under different abiotic stresses (Van *et al.,* 2017).

Salinity

Salt tolerance of plants is conferred by retention and/or acquisition of water, maintenance of ion homeostasis, protection of chloroplast functions, biosynthesis of osmotically active metabolites and specific proteins. Up regulation of antioxidant defence systems and ROS scavenging, protection against membrane damage and maintenance of structural integrity of ultrastructural organelles are also vital to achieve salt tolerance (Parida and Das, 2005 and Hasanuzzaman *et al*., 2013).

Salt-affected wheat plants exhibited decreased tissue water status, disrupted ionic and hormonal homeostasis and photosynthetic performance and some other physiological disorders. Exogenous GSH (1 mM) and *Moringa oleifera* leaf extracts (MLE, 3%) in salt-treated wheat plants increased endogenous GSH attributed osmotic tolerance, stabilized membrane properties and decreased electrolyte leakage (EL). Improved tissue water status and ionic and nutrient homeostasis were maintained by GSH and MLE, additionally that also reduced ROS generation (Rehman *et al*., 2021). Advocating right dose of bio-stimulant is very crucial to avoid flow down of growth and yield parameters.

Classification of Plant Bio-Stimulant

Acids

Humic and humin substances, amino acids, fatty acids, peptides, fulvic acids, other organic acids, vitamin B comes under acids bio-stimulants group. Humic substances are naturally available substances Which are formed by decomposition of plant, animal etc., organic matter which has high water holding capacity, it influence on physiological condition of the plant, which is effective against abiotic stress and improve water holding capacity (Hasanuzzaman *et al.,* 2013). Do Rosario rosa *et al*., 2021, studied anti-stress effect of fulvic acid and seaweed extract on soybean crop and observed that bio-stimulant provided higher photosynthetic rate under adverse condition.

Extract

Seaweeds, plant derived bioactive substances, polyphenols, allelochemicals and chitosan come under extract categories of bio-stimulant. Seaweed contains numerous minerals, free amino acids and other organic matter that helps plant to overcome abiotic stress, improves photosynthetic activity etc…, (Hasanuzzaman *et al.,* 2013 and Du jardin, 2015). Application of sea weed extract of *Aschophyllum nodosum* at vegetative stage in *Brassica* variety RH 725 under both irrigated and rain fed condition improved photosynthetic rate, stomatal conductance, transpiration rate, relative water content, water potential, osmotic potential, chlorophyll fluorescence, total soluble sugar, total protein content (Goyal *et al*., 2022) this is due to presence of free amino acids, cytokinin, IAA in the seaweed extract (Sanderson *et al*., 1987 and Tay *et al*., 1985).

Chitosan obtained from deacetylation of chitin, is one of the natural nontoxic bio-stimulants (Katiyar *et al,* 2015), which is not abundant in nature and generally found in insect wing, filamentous fungi, sea creature like crabs, shrimps, crayfish etc. (No *et al*., 2002 and Gursoy *et al.*, 2018). Application of chitosan on safflower (*Carthamus tinctorius* L.) in salt condition showed positive effect in terms of morphology and biochemical parameters (Gursoy *et al*., 2020). It is due the elimination of the photo-oxidative process in the plant by the carotenoid pigments and helps to activate the antioxidant that remove the free oxygen radicle (Stahl and Sies, 2003). Betaines in seaweed extracts increases chlorophyll content and other photosynthetic pigment Whapham *et al.,* (1993) and Subha *et al.,* (2020) high doses of sea weed extracts causes negative physiological effect due to hormonal imbalance.

Micro-Organisms

Beneficial fungi (*Trichoderm*a sp.), beneficial bacteria (*Pseudomonas, Bacillus* sp.), microbial symbiosis (Arbuscular mycorrhizal fungi, plant growth promoting rhizobacteria etc.) comes under microbial group of bio-stimulants. These bio-stimulants involved in nitrogen fixation, solubilisation of minerals and provides synergistic effects and helps to plant to ease of access nutrients and increases yield (Hasanuzzaman *et al.,* 2013; Calvo *et al.,* 2014; Colla *et al.,* 2015; Rouphael *et al*., 2017 and Pascale *et al*., 2017). Reduces the demand for fertilizers and pesticides by the use of microorganisms, which are environmentally friendly. (Castiglione *et al*., 2021 and Cardarelli *et al*., 2022). In soybean, roots are naturally associated with growth promoting *Rhizobium* sp., (Pagano *et al.*, 2016). Treating canola (*Brassica napus* L.) seeds with *Trichoderma harzianum* (fungi) and *Bacillus substilis* (bacteria) gives highest percentage of germination, root length and seedling vigour index in saline condition (Somagh *et al*., 2017). Both biotic and abiotic stresses problems in plants can be overcome by seed bio-priming with *Pseudomonas, Trichoderma* sp. (Rajendra Prasad *et al.,* 2020). Some experts might categorise bio-stimulants that contain advantageous fungi as biopesticides. This contradiction can be traced back to the fact that bio-stimulants are still unofficially categorised and lack a common definition. However, certain products that contain advantageous fungi may increase seed yield by influencing the microbial activity in the rhizosphere, which may classify these products as bio-stimulants, *Trichoderma viridae* and *Trichoderma harzeanum,* etc. are a few examples.

Other Bio-Stimulants

Inorganic salts of Al, Si, Na, Se, Co (beneficial elements) like chlorides, carbonates, silicates, phosphates which are not only essential elements but also benefits to plants as promote growth and improve physiological condition of plants which enhance abiotic stress resistance (Pilon-smits *et al*., 2009). Industrial, agricultural waste, manures, vermicompost and sewage waste act as bio-stimulants (Yakin *et al*., 2016 and Xu *et al*., 2018) Polypeptides, oligopeptides, amino acids present in hydrolysed protein rich waste components act as bio-stimulant (Schaafsma, 2009).

They are many reasons for failure of oil seed crops, among these most prominent ones are abiotic stress, lack of availability of nutrients, low quality seeds used for sowing purpose and environmental pollution. To overcome these problems one of the solution is application of bio-stimulants. It can be applied as soil inoculant, seed treatment, transplanting tip and foliar spray.

Silient Features of Bio-Stimulants

Diverse Nature of Bio-stimulants

Both non-living substances and living microorganisms are involved. They can be organic or inorganic molecules, can be single compounds (such as glycine betaine) or groups of compounds of natural origin whose composition and bioactive components are not fully characterised (such as seaweed extracts). However, synthetic compounds should not be excluded, especially if certain plant growth regulators are included within bio-stimulants (for instance, nitro-phenolates are described and sold as 'bio-stimulants', Pryzybysz *et al*., 2014). Microbial inoculants may contain a single strain (such as *Bacillus subtilis*) or a

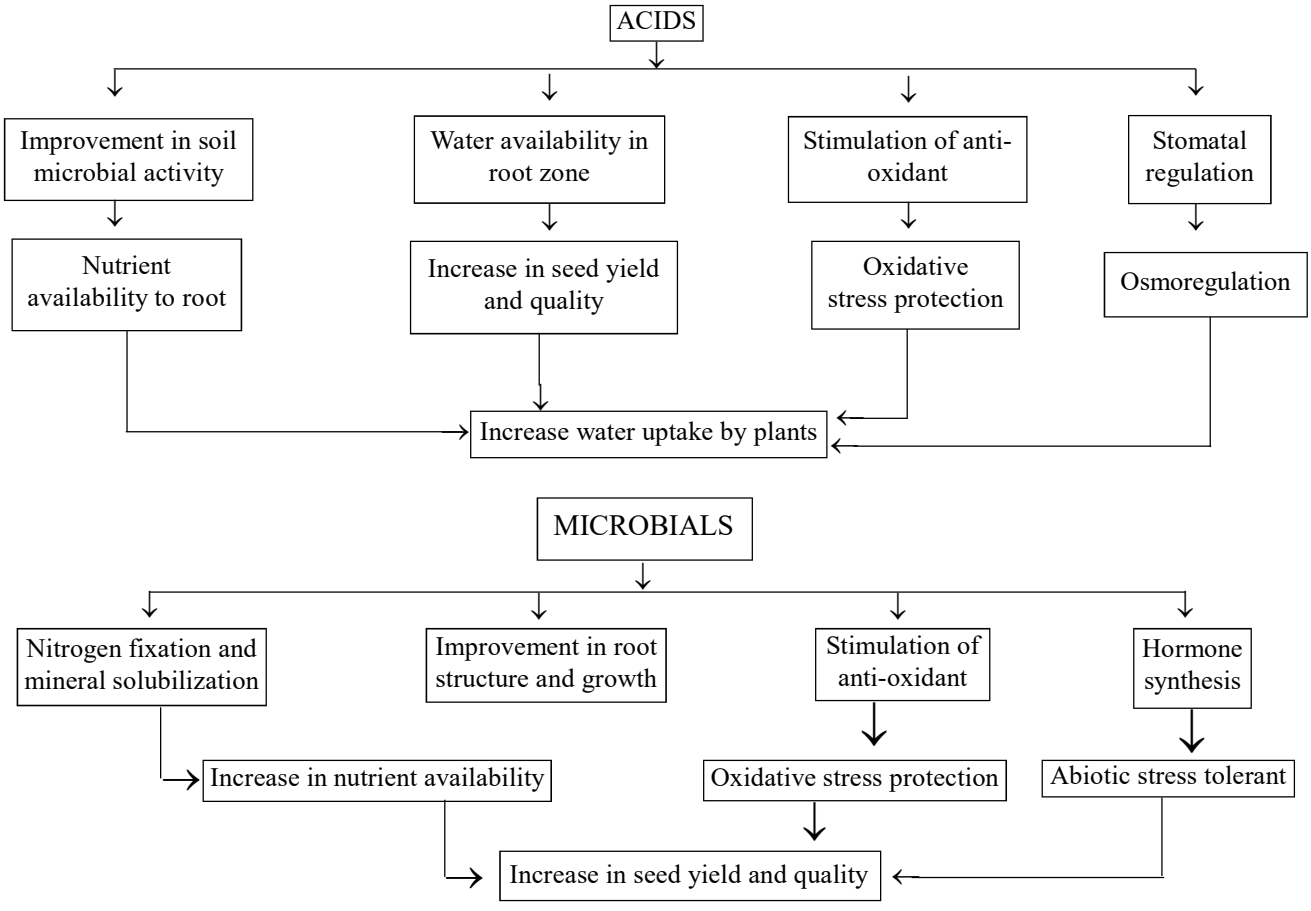
combination of microorganisms that exhibit additive or synergistic effects (such as a number of commercially available products) (Du Jardin, 2015).

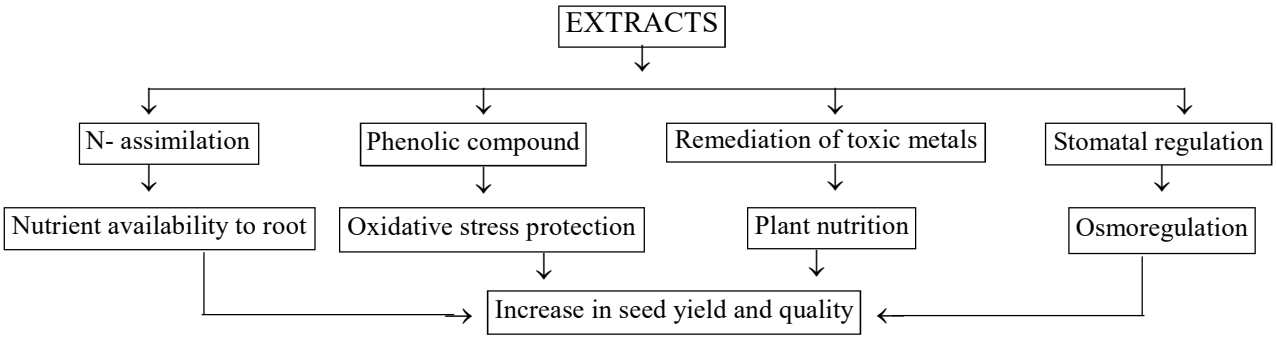
The Physiological Functions are Diverse

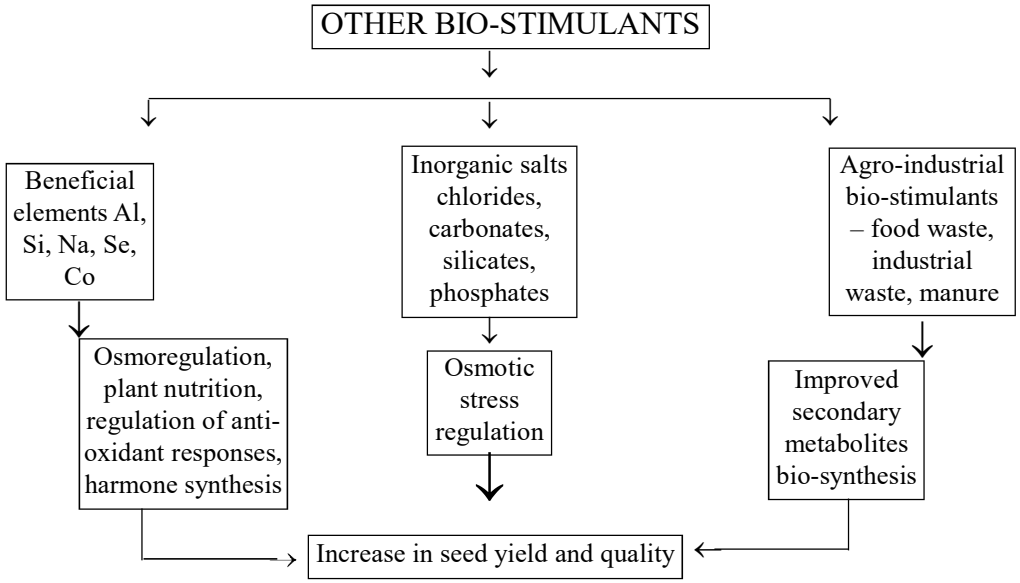
The prevention of photodamage to the photosynthetic machinery or the beginning of lateral roots are examples of physiological activities. Cellular mechanisms, such as antioxidant's capacity to scavenge reactive oxygen or the enhanced production of auxin transporters, etc., support certain functions. The collective term for the 'modes of actions' of the bio-stimulants is physiological processes and the underlying cellular mechanisms. Finally, these mechanisms of action provide an explaination for the agricultural activities of bio-stimulants, such as greater resistance to abiotic stress (which results in oxidative stress) or increased nitrogen use efficiency (which depends on the foraging ability of roots and consequently, on lateral root density). The functions of agriculture may eventually result in gains for the economy and the environment, such as increased agricultural production, fertilizer cost savings, improved crop product quality and profitability and improved ecosystem services (Du Jardin, 2015).

Bio-Stimulants help Converge Agricultural Functions

They improve nutritional effectiveness, resistance to abiotic stress and/or seed quality attributes. Qualities include things such grain protein content, shelf life, and nutritional value. Any definition of bio-stimulants should be based on these convergent activities. Many of the previously mentioned bio-stimulants (such as chitosan, laminarin, some PGPRs, etc.) are also effective at stimulating the response of pathogens to elicitors and plant gene regulators (Du Jardin, 2015).







Economic and Environmental Benefits

Bio-stimulants are cheaper than fertilizers and pesticides, they are eco-friendly and prevent environmental pollution (Du Jardin, 2015).

Methods of Application of Bio-Stimulants

Bio-stimulants used in the form of soil preparation as powders, granules, liquid form or solution added to soil (Kocira *et al*., 2018a). Humic acid substances and nitrogen compounds are often applied to the soil. (Drobek *et al*., 2019). Bio-stimulants can be introduced in irrigation system and taken up plants along with water and can also be used for foliar application. One such example is Kelpak SL (Sea weed extract) sprayed on *Phaseolus vulgaris* L. (Kocira *et al*., 2018a). Bio-stimulants can be applied as seedling dip and also as seed treatment before sowing. The foliar application of bio-stimulants from sewage sludge increased the level of micro and macronutrients in the leaves of maize (Tejada *et al*., 2016). Foliar application of sea weed extract from *Ecklonia maxima* increased chlorophyll and carotenoid concentration in *Brassica oleracea* (Rengasamy *et al*., 2016). Increase in volume of bio-stimulants decreased seed vigour in case of soybean as reported by Brzezinski *et al*., 2017.

Mode of action of Bio-stimulants (Hasanuzzaman *et al.,* 2013)

Extraction Methodology of Biostimulant

Conventional Extraction Techniques

The first step in separating polysaccharides from the algae is extraction. As a result, certain procedures have been used to provide the right circumstances for easily drawing out the necessary component from the cell walls of diverse species of algal biomass. In the

traditional way of extracting algal polysaccharides, the extraction medium is often used hot water, acids, alkalis or a mixture of these. In order to produce polysaccharides with the fewest contaminants, the pre-treated algal biomass is exposed to various solvents for a set amount of time at a particular temperature (He *et al*., 2018). The oligosaccharides and polysaccharides produced after extraction using these solvents is dependent on species. As an example, fucoidan, alginate and laminarin, which together make up 43.57 per cent of the total polysaccharide, were extracted from the algae *Durvillaea potatorum* using 0.05 M HCL at 60°C for 3 h (Abraham *et al*., 2019). Despite the fact that conventional methods yield some polysaccharide from algal biomass, they are not always practical due to a number of factors, including long extraction times with little polysaccharide production, the need for high purity solvents and their excess evaporation, manual handling, issues with the management of heat-labile compounds and environmental risks from contaminating organic compounds (Ray *et al*., 2020). Hence, numerous creative and fruitful unconventional extraction methods have been devised to counteract the downside of these traditional procedures. These conventional techniques are regarded as 'green' and eco-friendly since they adhere to the requirements established by the U.S. Environmental Protection Agency (EPA). Reduced chemical use, environmentally friendly processing conditions, low water use, high energy efficiency, reduced solvent use, cost effectiveness, higher efficacy, reduced by-product generation and use of green solvents like deep eutectic solvents are merely some of the important advantages of these traditional methods. According to Meksi *et al*. (2017) these solvents have advantages including low vapour pressure, great thermal characteristics, a wide variety of liquids, good solubility, low cost, eco-friendliness, and excellent reusing ability.

Non-Conventional Extraction Techniques

Several methods are approved namely, Supercritical Fluid Extraction Method, Ultrasound Assisted Extraction, Pressurized Liquid Extraction, Microwave Assisted Extraction, Enzyme Assisted Extraction methods.

Influence of Bio-Stimulnats on Growth of Oil Seed Crops

Algal extract (*Aschophyllum nodusum)* act as bio-stimulant which showed effect on growth and development of soybean. Plants receiving 500 ml/ha bio-zyme crop plus + half of recommended NPK maintained 30 per cent greater number of trifoliate at 60 DAS, Number of nodules per plant by 14.20 per cent, fesh weight of nodules by 25.12 per cent, dry weight of nodules by 17.51 per cent, more than control (recommended dose of fertilizer), (Tandon and Dubey, 2015). *A. nodosum* extract contain cytokinin, IAA, amino acid, vitamins (Sanderson *et al*., 1987 and Tay *et al*., 1985), due to presence of cytokinins, auxins in sea weed extract (Strik *et al*., 2004), this plant hormone stimulates axillary bud growth by cell division and cell elongation (Taiz *et al*., 2017), which potentially affect plant height. Albrecht *et al*. (2011) investigated the effects of a growth regulator including auxin, gibberellin, and cytokinin on soybean crops and found that it had a beneficial effect up to a specific concentration. According to the authors hormonal imbalance caused by large doses results in detrimental physiological effects.

Double spraying of terra sorb complex (0.5 %) improved number of pods per plant by 32 %, number of seeds per plant by 38% compared to control in soybean (Kocira, 2019). It is due to application of terra sorb complex which contain free amino- acid, which works like Gibberllic acid (Colla *et al*., 2014). By application of extract of *Achophyllum nodosum* which containing free amino acids on soybean increased in number of pods and seeds (Kocira et al., 2018b). Similarly, foliar application of red algae (*Kppaphycus alvarezii*) extract influenced the number of pods and seeds (Rathore *et al*., 2009). The increase in height of the first pod by application of terra sorb complex (Kocira 2019), similar results can be noticed by application of polyphenols (Kozak et al., 2008).

By application of humic acid (8 ml/L) observed superior in plant height (118.07 cm), number of branches (6.67) and number of leaves per plant (37.73) in forage cowpea. Yield parameters like forage yield by (13.91 %), pod length by 43.4 per cent, number of

pods per plant by (33.9 %), 100- Seed weight (10.2 %) greater than control in forage cowpea (Hassanen *et al*., 2020). It was attributed to the effect of foliar application of humic acid in enhancing the photosynthetic assimilation in plant (Sebastiano *et al*., 2005). Foliar treatment of humic acids resulted in reater accumulation of N, P and K (%) in plants (Gad *et al*., 2012). Humic acid, a commercial chemical made up of 44-58 per cent carbon, 42-46 per cent oxygen, 6-8 per cent hydrogen and 0.5-4 per cent nitrogen, along with other distinct elements, improved soil fertility and increased the availability of nutrients (Larcher, 2003). This may be the reason for promoting growth and development of plants.

Influence of Bio-Stimulants on Yield of Oil Seed Crops.

Double spraying of higher concentration bio-stimulants (amino acids) on soybean increased yield by 25 per cent compared to control (Kocira, 2019). Due to terra sorb complex contain free amino-acids which helps to increase in yield (Colla *et al*., 2014). Krawczuk *et al.* (2021) observed that foliar spray of bio-stimulants with two different nozzles, the highest yield obtained with use of nozzles API 2003 by 11.35 per cent compared with nozzle 6MS03C in soybean. Similarly, the effect of foliar application of fertilizers on maize crop using with different nozzle studied by Alheidary *et al*., 2020.

Application of biozyme (*Aschophyllum nodusum*) along with half recommended NPK led improved in yield (3.277 t/ha) compared to control (Tandon and Dubey, 2015). It is because of effect of *A. nodosum* extract that contained cytokinin, IAA, amino acid and vitamins (Sanderson *et al*., 1987 and Tay *et al*., 1985). Due to presence of auxins and cytokinins in seaweed extract that stimulates growth and development of higher number of reproductive structures like flowers. Auxin promote growth of pollen tubes (Aloni *et al*., 2006) and reproductive structure such as flowers and fruits, while cytokinins act in cell division, takes initiation in translocation of photoassimilates and nutrient mobilization to sinks (Fageria *et al*., 2006 and Buchanan *et al*., 2015).

Influence of Bio-Stimulants on Seed Quality of Oil Seeds

Cotton seeds treated with bio-stimulants showed higher N content in plant compared to control (Silva *et al.,* 2016). Due to Mo present in bio-stimulant around 23.54 per cent which helps in nitrate reductase (Gelain *et al.,* 2011). Similarly, K level increased in bio-stimulants treated seeds compared to control (Silva *et al*., 2016). *Trichoderma virens* of different strains used for soybean seed coating showed significantly increased in root and shoot length (cm) and weight (g) compared to control (Yusnawan *et al*., 2019). Different species of *Trichoderma* influence the growth of crops (Lee *et al*., 2016). Increasing root length helps to deep root penetration which is correlated with drought resistance (Mastouri *et al.,* 2010). *Trichoderma* spp. produces secondary metabolites which works like auxin on growth of plants (Vinale *et al*., 2008). Due to the application of seaweed extract, increased germination rates and seedling vigour have also been noted in the case of green gram (Venkataraman and Mohan, 1997) and cowpea (Sivasankari *et al*., 2006). Because seaweed extract contain growth-promoting compounds such auxin and gibberellins, phenyl acetic acid (Sivasankari *et al*., 2006) and micronutrients (Layek *et al*., 2014), seaweed extract boost seedling vigour and germination percentage when used in low concentration. Reduction in germination percentage at higher concentrations of seaweed extract, was due to inhibition of germination by presence of high salts concentration at seaweed extract. Salt stress induced inhibition of seed germination, seedling growth and metabolic processes were observed in maize (Azevedo *et al*., 2004).

Factors Contributing to Expansion of Bio-Stimulants Market in World

- Rising global population and food demand
- Increase in sustainable crop yield
- Minimize abiotic stress
- Sustainable Agriculture
- Eco-friendly
- Government grants and funding
- NGOs, Governmental bodies accepted performance of bio-stimulant

- Popularity of natural and organic ingredient-based agriculture
- Cost-effective products

Shortcomings of Bio-Stimulants

- Selection of plant components which have high bio-stimulant effective compounds is tedious and time consuming
- Protocol for extraction is laborious
- Lack of awareness among farmers
- Till 2021 there were no legal norms
- Technical challenges like blending of more than one bio-stimulants
- Shorter shelf life

Bio-Stimulants Regulation in India (Anonymous, 2021b)

Amendment in the Fertilizer (Control) Order, 1985 for inclusion of Bio-stimulant, in clause 2(h) the term bio-stimulant is defined. Definition of Bio-stimulant is compounds, substances and products including microorganisms whose functions when applied to plants/ seeds/ rhizosphere is to regulate and enhance a cropsphysiological processes independent of the products nutrient contents to improve input use efficiency, growth, yield, quality and/or stress tolerance. The bio stimulants may include products of plants /animals or microbial origin. The primary function of the products should be other than that for pesticidal use and Nutrient source. Heavy metal and other contaminants if any, may be within the prescribed limits given under clause 20 C as below.

New Provision 20 C May be Included 20 (C) Specification in Respect of Bio-Stimulants

i) Not withstanding anything contained in this Order, the central Government shall specify the name, active ingredient (s), name of the crop and name of manufacturer / importer and method of analysis for determination of various components, claim benefit(s) of the Bio-stimulant in Schedule VI of the Fertilizer control order.

ii) Bio- stimulants notified under sub-clause (a) shall be under any of the following category
   - Botanical extracts, including seaweed extracts
   - Bio-chemicals
   - Protein hydrolysates and amino acids
   - Vitamins
   - Cell free Microbials products
   - Antioxidants
   - Anti-transpirants
   - Humic & fulvic acid and their derivations

iii) No person shall manufacture/import any Bio-stimulant unless it is notified under the above said clause and conform to the standard set out in the said notification and it contains no traces of Insecticide.

iv) Every Person desiring to manufacture/import any Bio-stimulant shall apply to the Controller fertilizer in Form R for its notification and such manufacturer shall submit along with application the following data/details relating to product.

a) Chemistry

- Source (natural extracts of plant/microbe/ animal / synthetic)
- Chemical composition (chemical analysis from GLP/NABL accredited lab)
- Physical and Chemical properties of active ingredients and adjuvants, if any.
- Method of analysis conforming to the specifications.
- Shelf-life claim.

Heavy metal	Quantity in mg/kg (max.)
Cadmium	5
Chromium	50
Copper	300
Zinc	1000
Lead	100
Arsenic	10

Ref. (Anonymous, 2021b)

b) Bio- efficacy Trials

Agronomic Bio-efficiency trials be conducted at National Agriculture Research System (SAU and ICAR) at 3 different doses for minimum one season from 3 locations.

c) Toxicity

Name of the Institute need to be indicated from where the manufacturer of Bio-stimulant should obtain certificate in respect of this.

d) Heavy metal limit prescribed

e) The sample of the product along with an Affidavit by the manufacturer /importer on non-judicial stamp paper stating that the product is not laced with pesticide (> 0.01ppm).

v) The Heavy metals of the product present in the product shall not exceed the following maximum limit prescribed for various metals, namely

vi) No Bio-stimulant shall contain any pesticides beyond a permissible limit of 0.01ppm. Label and leaflet requirements- new provision may be included in FCO

In Clause 21 the following sub clause shall be inserted, namely - (ab) The word 'Bio-Stimulant' must be prominently displayed on any container that contains any bio-stimulant and it must only have the information that the Controller may from time to time specify in this regard, unless it is prohibited by law.

Under the above said clause Notification : The Controller under above said notification notify for following particulars for printing of particulars on the bags of Bio-Stimulant. If it is in small pack then a separate leaf let shall be placed in the bag.

- Name of the manufacturer/importer
- Name of the marketer, if any
- Name of the bio-stimulant (brand name or trade mark under which the bio-stimulant is sold) and its active ingredient(s) and its percentage content
- Use recommendations (dosage, crops, label expansion as applicable)
- Precautions/storage conditions
- Net content
- Batch number and date of manufacturing/ repacking
- Expiry date
- The label shall be so affixed to the containers that it cannot be ordinarily removed.
- The label to be affixed or attached to the package shall be printed in English/ Hindi/ regional language
- Maximum Retail Price of the product
- Label claim of the product
- New provision- Under clause 38, a separate CFC for Bio-stimulant with following members shall be constituted under the chairmanship of Agriculture Commissioner with following other members:
- DG Health Services,
- ADG(NRM), ICAR,
- Head Plant Physiology, IARI,
- Head Chemical Division, IARI,
- Deputy Secretary / Director (INM) - Member Secretary.

Schedule

A. Specification of Bio Stimulant

B. Tolerance limit

C. Sample draw

D. Methodology of testing

Application of bio-stimulants on crops could influence on growth and yield attributes resulting in higher yield and improve in quality. Meanwhile bio-stimulants are cheaper than fertilizers and are eco-friendly in nature, use of bio-stimulants could minimize hazardous effect caused by fertilizers and pesticides like water pollution, contamination of food, dangerous for birds and other animals etc.

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