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Sea Weed Based Liquid Fertilizer as a Source of Plant Nutrition - A Review

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A B S T R A C T

Plant nutrients are classified as major (Nitrogen (N), Phosphorus (P) and Potassium (K), calcium (Ca), magnesium (Mg) and sulfur (S). They are also enquired in relatively large amounts but are less likely to be deficient. Micronutrients [boron(B), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo) and zinc (Zn)0. Considering ill effects of chemical fertilizers and slow release of nutrients by soil applied organic fertilizers; foliar application of organically chelated micronutrient fertilizers can be an ideal option to nourish the crops by avoiding short term mineral deficiencies. Fertilizers derived from seaweeds are found to be superior to chemical fertilizers due to high level of organic matter, micro and macro elements, vitamins and fatty acids. Seaweed extracts are allowed as fertilizer for organic farming production practices whereas synthetic chemical fertilizers are prohibited for organic food production. Fertilizers derived from seaweeds are found to be superior to chemical fertilizers due to high level of organic matter, micro and macro elements, vitamins and fatty acids. Hence the review dwells on utility of sea weed as plant nutrition.

Introduction

The nutrition contains mineral nutrients, vitamins, and micronutrients, which enhance the plant growth. It can be applied as foliar spray or directly applied to the soil as an organic nutrition source. Fertilizers derived from seaweeds are found to be superior to chemical fertilizers due to high level of organic matter, micro and macro elements, vitamins and fatty acids. Seaweed extracts are allowed as fertilizer for organic farming production practices whereas synthetic chemical fertilizers are prohibited for organic food production. Now-a-days seaweed fertilizers are gaining popularity for achieving higher crop production and soil quality improvement. Seaweed extracts can be manufactured in liquid and powder form and used as fertilizers for all type of crops, grasses

and trees. Seaweed extracts on their own are unlikely to remedy a severe mineral deficiency and the appropriate element should be applied, preferably in combination with seaweed extract, to further stimulate growth. Hence, considering ill effects of chemical fertilizers and slow release of nutrients by soil applied organic fertilizers; foliar application of organically chelated micronutrient fertilizers can be an ideal option to nourish the crops by avoiding short term mineral deficiencies. In this context, an organically chelated multi-micronutrient liquid fertilizer can supply most of micronutrients at the proper growth stages like flowering, fruit setting stage.

Macronutrient formulation with seaweed extracts and growth regulators required to be formulated for optimum growth

Macronutrients

Nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), sulfur (S), magnesium (Mg), sodium (Na).

The macronutrients are consumed in larger quantities; hydrogen, oxygen, nitrogen and carbon contribute to over 95% of a plants' entire biomass on a dry matter weight basis. Micronutrients are present in plant tissue in quantities measured in parts per million, ranging from 0.1 to 200 ppm, or less than 0.02% dry weight.

Nitrogen (N)

It is required for making protein (one or more N per amino acid), Base pairs for RNA/DNA, Prosthetic groups for protein (ex.: heme group of chlorophyll), Hormones (ABA, cytokinins), Metal uptake (phytosiderophores) and transport in xylem & phloem (ex: Cu with amines), Osmoregulation (ex.: lettuce and spinach, which may accumulate 0.1 M NO_3^- in vacuoles), Chemical defences, alkaloids, misc. biochemicals (ex: mescaline, cocaine, morphine, nicotine, caffeine, quinine). Mild N deficiency will restrict plant growth, but often in a subtle manner that can only be assessed by comparison to plants grown with an adequate N supply. Moderate N deficiency will cause leaves to be light green or yellowish. Severe symptoms include necrosis (tissue death) starting at the tips of older leaves, with the tissue death developing a V-pattern down the midrib toward the base of the leaf.

Phosphorus (P)

In living organisms is most notable in the ubiquitious ATP/ADP energy transport and storage compounds. Additionally, sugar phosphates form the "rails" of the nucleic acids DNA and RNA (which N-containing bases forming the "rungs"). Phospholipids are an important constituent of membrane chemistry and phosphor proteins are essential for life functions.

Potassium (K)

Potassium is the "universal cation" in biological systems. Only one oxidation state, soluble with all biologically significant anions (except one!) and at all pH values. Nontoxic, even at soil and plant levels far in excess of minimum requirements for optimum growth. Phloem-mobile.

Calcium (Ca)

Calcium is present in the cytoplasm at levels that would indicate that it is a micronutrient, ~0.1 µM, in order to prevent interference with the high levels of P. Nonetheless, small fluctuations in Ca levels in the cytoplasm are part of signalling mechanisms for environmental stress. Ca pumps are directed out of the cytoplasm, either to vacuoles,

where it may be precipitated as calcium oxalate, or across the plasmalemma. The function of the majority of plant Ca is structural, in the cell walls of shoots and roots.

Sulphur (S)

Most familiar function of Mg, as the central ion in chlorophyll molecule, accounts for <25% of total plant Mg. Mg in the cytoplasm is related to enzyme activation: for example, the substrate for ATPases is MgATP. Additional Mg is present in the cell wall. No toxicity to sulfate beyond salinity, S uptake beyond needs stored in part as sulfate. Deficiency symptoms are yellowing of whole plant, moderately phloem mobile. Response to S fertilizer in many crops and regions. With the reduction of sulphur at the smokestacks, agriculture may be losing the only benefit of acid rain!

Magnesium (Mg)

The most familiar function of Mg, as the central ion in chlorophyll molecule, accounts for <25% of total plant Mg. Mg in the cytoplasm is related to enzyme activation: for example, the substrate for ATPases is MgATP. Additional Mg is present in the cell wall.

Magnesium deficiencies in soils are relatively rare as far as plants are concerned, but animals fed on Mg-deficient forage may develop hypomagesameia (grass tetany). "Excess" Mg is known almost only in soils derived from serpentine or olivene, both Mg-rich rocks, in which the exchangeable Ca/Mg ratio is ~1/5 instead of the more common 4/1 to 1/1; such soils often also contain toxic, high levels of bioavailable metals, among them Ni, which together with high Mg limit the distribution of "normal" vegetation, leading to "serpentine barrens".

Sodium (Na)

Amino acids: cysteine, methionine. Organic-N/organic-S in plants typically has a 30-40:1 molar ratio.

Coenzymes and prosthetic groups, glutathionine: antioxidant and precursor to phytochelatins, alliins in allium (w/ allinase produce pungency in onions) and glycosinolates in brassica (produces isothiocynates) for chemical defenses and S storage.

Sea weed extract as plant nutrition

Seaweed contains provides following nutrition to plants:

The first records of seaweed being processed come from China in 2700 BC and have been using it for human and animal consumption ever since, Initially in the UK, agricultural use of seaweed was restricted to bulk fresh weed which was used as a manure and soil conditioner. As transport and labour costs rose and chemical fertilizers became more readily available so raw seaweed was replaced.

Auxins

These plant hormones have been identified in seaweed and more recently in extracts

Gibberellins

Gibberellin activity has been identified in seaweed extracts.

Cytokinins

Cytokinins are plant growth hormones closely involved in cell division, protein, carbohydrate and chlorophyll synthesis are also present in sea weed extract.

Betaines

Betaines are modified amino acids which have been isolated from seaweeds and which have several functions similar to those of cytokinins.

Sugars

More recently polysaccharides isolated from seaweed have been shown to stimulate the plant's natural defence mechanism (Fournier Algal polysaccharides can act as elicitors for plant defence). Finnie and Van Staden (1985). Demonstrated that tomato root response to seaweed extract was due to organic compounds and one is drawn to conclude that the major crop responses result from the action of the betaines and cytokinins although there may be further interactions with other constituents.

The field experiment conducted during the rainy (kharif) season in Indian in 2006 to study the effects of foliar applications of different concentrations of seaweed extract (prepared from *Kappaphycus alvarezii*) on nutrient uptake, growth and yield of soybean [*Glycine max* (L.) Merr.] Grown under rainfed conditions without the application of chemical fertilizers.

The foliar spray was applied twice at seven concentrations (0; 2, 4, 8, 12 and 16% v/v) of seaweed extract. Foliar applications of seaweed extract significantly enhanced yield parameters. The highest grain yield was recorded with applications of 15% seaweed extract, followed by 12.5% seaweed extract that resulted in 57% and 46% increases respectively compared to the control. The maximum straw yield was also achieved with 15% seaweed extract application. Improved nutrient uptake (N, P, K and S) was also observed with seaweed extract applications. Thus, under rainfed soybean production, foliar applications of sea weed extract could be a promising option for yield enhancement.

In the study conducted by Anna Kocira *et al.*, (2013), the application of Ecklonia maxima extract (Kelpak SL – a water soluble concentrate) was optimized and its impact on yield, nutraceutical and nutritional potential of *Phaseolus vulgaris* L. (var. Aura and Toska) was measured. During the growing season, 0.2% and 0.4% solution of Kelpak SL was applied by single and double spraying of plants. These four treatments with Kelpak SL were compared with the control, where no bio stimulator was applied. Kelpak SL treatments stimulated the yield of both cultivars studied. The application of its maxima extract had no effect on the content of starch, free sugars or proteins in seeds of either of the tested cultivars there is a growing interest in using cultivation methods such as natural biostimulants, which improve yield without any negative effects on plant quality. Such a strategy allows for increasing biomass production, but also induces the natural resistance of plants, as well as improves nutraceutical quality of plant food (Vallad and Goodman, 2004; Zodape *et al.*, 2010; Kavipriya *et al.*, 2001; Złotek and Wo´ jcik, 2014).

The use of the seaweed extract increased significantly N, P and K uptake by grains at higher concentrations (7.5% and above) and reached maximum at 12.5%, 15% and 15% application rate respectively compared with control (Rathore, 2009). Sulphur uptake by grains was significantly increased at 10%. And above levels of seaweed extract applications. Highest P uptake by straw was observed (Crouch *et al.*, 1990; Turan and Köse, 2004; Nelson and Van Staden, 1984; Mancuso *et al.*, 2006). Noted increased uptake of Mg, K and Ca in lettuce with seaweed concentrate application (Turan and Kose, 2004). And Mancuso *et al.*, (2006) also

observed increased uptake of N, P, K and Mg in grapevines and cucumber with application of seaweed extract. The presence of marine bioactive substances in seaweed extract improves stomata uptake efficiency in treated plants compared to non-treated plants. Bio stimulants, even those containing minerals, are not able to supply all the essential nutrients in the quantities required by plants but may enhance root growth of plant subjected to stress possibly by increasing the antioxidant defence system (Zhang and Schmidt, 1999; Zhang and Schmidt, 2000; Zhang *et al.,* 2003). In addition to proper mineral fertilization, bio stimulants can enhance the effectiveness of fertilizers as well as nutrient utilization from soil (Frankenberger and Arshad, 1995). To evaluate the use of foliar fertilization to increase the productivity of Egyptian agriculture in the case of Zn-, Mn- and Fe-deficiency, field trials in different regions (Nile Delta, Middle and North-West Egypt) with relevant crops at those locations (Alexandarina clover, Faba bean, Soya bean, Bush bean, Wheat, Maize, Cotton, Potato, Rice, Grape, Orange) were conducted from 1981/81 till 1984. The used foliar fertilizers (Zn-Chelate, Zn-Mn-Fe-Chelate-Mix, Wuxal suspensions, Wuxal liquid, Fetrilon combi, Metalosate) caused yield increases between 1 and 51% compared to the untreated check. With the exception of Faba bean and Orange, where Zn-Chelate resp. Chelate-Mix gave the best results, the compound foliar fertilizers with the formula N-Zn-Mn-Fe and N-P-K-Mn-Fe (Wuxal suspensions and Wuxal liquid) produced the highest yields.

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