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The Importance Role of Seaweeds of Some Characters of Plant

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ABSTRACT: Seaweeds are potentially excellent sources of highly bioactive secondary metabolites that could represent useful leads in the development of new functional ingredients. They are a large and diverse group of simple, typically autotrophic organisms ranging from unicellular to multicellular forms. Macroalgae (seaweeds) can be classified into three broad groups as red algae, brown algae and green algae, based on their pigmentation. In addition, many reports have been published regarding isolated compounds from seaweeds with various biological activities, demonstrating their ability to produce important metabolites unlike those found in terrestrial species. The main objective of this study is to evaluate the application of different concentrations of seaweed extract in enhancing the growth, yield, quality and nutrient uptake of plants grown in fields, under rain fed conditions.
Key words: Plant, Quality, Quantity, Seaweed.

INTRODUCTION

Liquid extracts obtained from seaweeds have recently gained importance as foliar sprays for many crops including various grasses, cereals, flowers and vegetable species (Crouch and Van Staden, 1994). Seaweed extracts contains major and minor nutrients, amino acids, vitamins, cytokinins, auxin and abscisic acid like growth promoting substances (Mooney and Van Staden, 1986) and have been reported to stimulate the growth and yield of plants (Rama Rao, 1991), develop tolerance to environment stress (Zhang and Schmidt, 2000; Zhang et al., 2003), increase nutrient uptake from soil (Verkleij, 1992; Turan and Köse, 2004) and enhance antioxidant properties (Verkleij, 1992). The application of seaweed extract for different crops was a great importance due to contain high levels of organic matter, micro elements, vitamins and fatty acids and also rich in growth regulators such as auxins, cytokinin and gibberellins (Crouch and Van Staden, 1994). The beneficial effect of seaweed extract application is as a result of many components that may work synergistically at different concentrations, although the mode of action still remains unknown (Fornes et al., 2002). Seaweeds are a known source of plant growth regulators (Jameson, 1993), organic osmolites (e.g. betaines), aminoacids, mineral nutrients, vitamin and vitamin precursors (Berlyn and Russo, 1990; Blunden et al., 1985). In particular, seaweed contains kahydrin, alginic acid and betaines which synergistically contribute to the efficacy of the formulation (Vernieri et al., 2006). It is a widely-researched seaweed species traditionally used as a fertilizer, a soil conditioning agent, animal feed supplement and also as a human nutritional supplement. An extract (seaweed) was shown to improve stress tolerance in a number of plant species. This was mediated by an increase in the concentration of bioactive molecules including antioxidants in the treated plants (Rayorath et al., 2009; Zhang and Schmidt, 2000). However, the effect of seaweed to improve nutritional quality of fresh produce like vegetables and fruits has not been investigated. Dynamics of modules have been investigated in a few seaweeds, mostly clonal red algae (e.g. Santos 1995; Scrosati and Servière-Zaragoza 2000) but studies relating genet competition to clone dynamics are rare (see Lazo and Chapman 1998; Viejo and Åberg 2001). Seaweeds are potentially excellent sources of highly bioactive secondary metabolites that could represent useful leads in the development of new functional ingredients (Pelegrin et al., 2008). They are a large and diverse group of simple, typically autotrophic organisms ranging from unicellular to multicellular forms. Macroalgae (seaweeds) can be classified into three broad groups as red algae, brown algae and green algae, based on their pigmentation (Dawczynski et al., 2007). These naturally growing seaweeds are an important source of food, especially in Asian countries such as China, Japan and Korea (Marsham et al., 2007, Rioux et al., 2009). In addition, many reports have been published regarding isolated compounds from seaweeds with various biological activities, demonstrating their ability to produce important metabolites unlike those found in terrestrial species (Cardozo et al., 2007). JadczukTobjasz., (2004) is a fertilizer derived from the seaweed Ascophyllum nodosum, and is a good source of nitrogen (4.2%). It also contains many amino acids, phytohormones, vitamins and polysaccharides, which improves blossoming and fruit development. However, application of seaweed extract increased chlorophyll content (Whapham et al., 1993 and Thirumaran et al., 2009). Plant fertilization using seaweed products has been practiced since antiquity in the Far East, but was not used until the century in Europe (Chapman, 1970). The beneficial effect of seaweed extract application is as a result of many components that may work synergistically at different concentrations, although the mode of action still remains unknown (Fornes et al., 2002). In recent years, use of seaweed extracts have gained in popularity due to their potential use in organic and sustainable agriculture (Russo and Beryln, 1990), especially in rain fed crops, as a means to avoid excessive fertilizer applications and to improve mineral absorption. Unlike, chemical fertilizers, extracts derived from seaweeds are biodegradable, non-toxic, non-polluting and non-hazardous to humans, animals and birds (Dhargalkar and Pereira, 2005). The main objective of this paper is to evaluate the application of different concentrations of seaweed extract in enhancing the growth, yield, quality and nutrient uptake of plants grown in fields, under rain fed conditions.

DISUISSION

Seaweeds are rich and varied source of bioactive natural products and have been studied as potential biotical and pharmaceutical agents. They are used in traditional remedies in many parts of the world. Extracted substances from seaweeds have antibacterial actions and other properties include antifungal activities and growth inhibition of plants (Abdussalam, 1990; Scheuer, 1990; Rizvi and Shameel, 2003; Su et al., 1973; Burkholder and Sharma 1969). Seaweeds are also known to aid and stimulate growth of vegetables, fruits and also protect them from different pathogens and physiological hazards either in vivo or storage conditions (Washington et al., 1999). The history of seaweed utilization and the development of relevant commercial utilization processes by industry have been reviewed (Chapman and Chapman 1980; Lembi and Waaland 1988).

Vegetative growth

In most instances seaweed extracts are applied to agricultural and horticultural crops as a foliage spray; for reviews see Abetz (1980), Verkleij (1992), and Metring et al. (1990). Extensive research, therefore, has been focused on the evaluation of effects of seaweed extracts applied to established plants. However, the mode of action of seaweed extracts to beneficially influence plant growth is not completely understood. The increased growth of these crops may be due to the presence of some growth promoting substances present in the seaweed extract (Mooney and Van Staden, 1986; Blunden, 1991). In addition, the growth enhancing potential of the seaweed extract might be attributed to the presence of macro and micronutrients. Our findings coincide with those of earlier studies carried out on marigold (Aldworth and Van Staden, 1987; Russo et al., 1994) where there was an increase in vegetative growth by the application of seaweed extract. Similar results were also observed in *Cajanus cajan* (L.) Millsp. (Mohan et al., 1994) and *Vigna sinensis* L. (Sivasankari et al., 2006). Reported increased cotyledon expansion was also observed when the ached extracts of both SWS (seaweed) were applied, giving an indication that the mineral component was mainly responsible for this effect. This was not due to the presence of plant growth substances, as the concentrations of these were low because of the manufacturing process (Moller, 1996). This indicated the presence of possible inhibiting organic compound(s) in both SWS (seaweed). Similar results were reported by Blunden et al. (1968). However, alginic acid, as an ion-exchange medium, was found to compete with the plants for uptake of cations, thus reducing their potential growth primitive effects. It has a theoretical ion exchange ion exchange capacity of -515 milli-equivalents per 100g, whereas most soils have a range from 0-100 milli-equivalents per 100 g (Blunden et al., 1968). Alginic acid is present in brown seaweeds as an insoluble form, and is a structural component of cell walls (Percival and McDowell, 1990). The alginic acid content of Ascophyllum nodosum is twice as high as that in Laminaria species (Blunden et al., 1968). This could explain the twofold higher adsorption capacity of algal cell wall debris in ANS (Moller, 1996) and the reduced growth primitive effect of original ANS observed in that experiment. The enhanced plant growth effects in seaweed extract-treated plants are also correlated with auxins, gibberellins, cytokinins, precursors of ethylene and betaine and cytokinins which are present and potentially involved in enhancing plant growth responses (Crouch and Staden, 1993). On the other hand, the application of glycine betaine, a constituent of seaweed extracts, enhanced the biosynthesis of certain phenolic compounds in strawberry leaves, without affecting the concentration of others

(Karjalainen et al., 2002). This inconsistent effect on phenolic compound biosynthesis could be attributed to the different tissues used and the relatively low concentration of glycine betaine in seaweed extracts, compared with the one used in the former experiment.

Antioxidant

Bio stimulants, even those containing minerals, are not able to supply all the essential nutrients in the quantities required by plants (Schmidt et al., 2003) but may enhance root growth of plant subjected to stress possibly by increasing the antioxidant defense system (Zhang and Schmidt, 1997, 1999, 2000). The test crop under present investigation was grown under rain fed conditions, and thus it may have faced water stress conditions. Exogenous application of seaweed extract has already been shown to enhance antioxidants status of Kentucky bluegrass (Zhang and Schmidt, 1999), tall fescue and creeping bent grass (Zhang and Schmidt, 2000).

Yield

Straw yield was observed highest at 15%, which was statistically similar to 7.5, 10 and 12.5% of seaweed extract. Application of 7.5, 10, 12.5 and 15% of seaweed extract significantly increased the straw yield of soybean by 6.37, 8.76, 6.89 and 6.07% respectively over the control. The effect of the treatments on grain yield also depicted a similar trend, where highest yield was recorded with a 15% followed by 12.5% application (57.49 and 46.34%respectively) increase over control. Similarly, Rama Rao (1991) obtained increased yield and improvement in the quality of Zizyphus mauritiana Lamk. With foliar applications of seaweed extract. Further, our findings also coincide with those of earlier studiesmade byMohan et al. (1994) and Rajkumar and Subramanian (1999) who noted increased germination and enhanced seedling growth of the plants [maize (G-5), cholam (CSH-9), ragi (CO-9), kambu (KM-2) and C. cajan L. (CO-6)] by seaweed extract applications. Increases in fruit weight such as those observed in the present experiment after application of PGS have been also observed in loquat (Amoros et al., 2004). Seaweed extracts have been found to contain significant amounts of cytokinins, auxins and betaines (Blunden et al., 1997), which influence cell division during the early stages of growth along with the induction of flower formation, while they also enhance chlorophyll concentration in the leaves (Blunden et al., 1997; Schwab and Raab, 2004). Turan and Köse (2004) on grapevine, Mancuso et al. (2006) and Rathore et al. (2009) on soybean observed increases in yield as well as N, P and K with application of seaweed extract. Zodape et al. (2008), Arthur et al. (2003) on pepper and Zodape et al.(2010) on mung bean indicated that application of seaweed extract significantly increased seed yield and pod weight as well as improved nutrional values of seeds, i-e., protein and carbohydrates. Abdel Mawgoud et al. (2010) cleared that application of seaweed extract at concentrations of 1, 2 and 3 g/L increased the response of all growth parameters and yield of watermelon.

Ion Concentration

Reported by Crouch et al. (1990) who noted increased uptake of Mg, K and Ca in lettuce with seaweed concentrate application. Turan and Köse (2004), Nelson and Van Staden (1984), 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 (Mancuso et al., 2006).

Disease

The plant protective role of seaweed extract and impact on disease and quality require further evaluation under different field cropping systems. The seaweed is commercially available and some reports have indicated enhanced plant yield and health in different crops following application, although the mechanisms of action have not been determined (Norrie et al., 2002; Colapietra and Alexander, 2006). Reported Carrot plants sprayed with SW showed less disease due to Alternaria and Botrytis compared to SA and the control (Jayaraj et al., 2008). Previous reports have shown that seaweed extracts can reduce disease and promote plant growth. Pepper plants treated with an extract of the marine algae Ascophyllum had enhanced foliar resistance to Phytophthora capsici (Lizzi et al., 1998). Reported Jayaraj et al., 2008 the SW (seaweed) evaluated in carrot plants reduced leaf blights caused by Alternaria and Botrytis as effectively as the fungicide chlorothalonil.

Fruit quality

The treatments with PGS did not exhibit any significant effect on the fruit juice TSS content or on the TA or their ratio (TSS: TA). This is in agreement with the effect of applied glycine betaine and cytokinine like compounds (found in seaweed extracts) in strawberry (Rohloff et al., 2002) and phenothiol on loquat fruit, where it increased fruit size without affecting its TSS and TA (Amoros et al., 2004). On the other hand, the application of glycine betaine, a constituent of seaweed extracts, enhanced the biosynthesis of certain phenolic compounds in strawberry leaves, without affecting the concentration of others (Karjalainen et al., 2002). Many researchers have found positive relationship between the biochemical analysis and the taste panel, especially concerning the sweetness of the fruits and their TSS (Azodanlou et al., 2003). Gajewski et al. (2008) on Chinese cabbage revealed that application of Goteo (an organic mineral fertilizer which contains algae extract Ascophyllum nodosum with addition of phosphorus) increased yield, marketable heads as well as vitamin C content compared to the untreated cabbage whereas; slightly higher nitrate content was noted.

CONCLUSION

These results shown the mode of action of seaweed extracts to beneficially influence plant growth is not completely understood. The increased growth of these crops may be due to the presence of some growth promoting substances present in the seaweed extract. Application of seaweed extract significantly increased the straw yield. An extract (seaweed) was shown to improve stress tolerance in a number of plant species. This was mediated by an increase in the concentration of bioactive molecules including antioxidants in the treated plants.

REFERENCES

Abdel-Mawgoud AMR, Tantawy A, Magda S, Hafez M, Hoda A, Habib M. 2010.Seaweed extract improves growth, yield and quality of different watermelon hybrids Research Journal of Agriculture and Biological Sciences, 6(2): 161–186.

Abdussalam S. 1990. Drugs from Seaweeds. Journal of Medical Hypothesis, 32(1): 5-33.

Abetz P. 1980. Seaweed extracts: Have they a place in Australian agriculture or horticulture? The Journal of the Australian Institute of Agricultural Science 46, 23-29.

Aldworth SJ, Van Staden J. 1987. The effect of seaweed concentrates on seedling transplants. South African Journal of Botany 53, 187–189.

Amoros A, Zapata P, Pretel MT, Botella MA, Almansa MS, Serrano M. 2004. Role of naphthalene acetic acid and phenothiol treatments on increasing fruit size and advancing fruit maturity in loquat. Sci. Hort. 101:387–398.

Arthur GD, Stirk WA, Van Staden J. 2003. Effect of seaweed concentrates On the growth and yield of three varieties of Capsium annuum , South. Afr. J Bot, 69: 207 -211.

Azodanlou R, Darbellay C, Luisier JL, Villettaz JC, Amado R. 2003. Quality assessment of strawberries (Fragaria species). J. Agric. Food Chem. 51:715–721.

Berlyn GP, Russo RO. 1990. The use of organic biostimulants to promote root growth. Belowground Ecol. 2:12–13.

Blunden G, Challen SB, Woods DL. 1968. Seaweed extracts as fertilizers. Journal of the Science of Food and Agriculture 19:289-293.

Blunden G, Challen SB, Woods DL. 1968. Seaweed extracts as fertilizers. Journal of the Science of Food and Agriculture 19, 289-293.

Blunden G, Gordon SM, Smith BE, Fletcher RL. 1985. Quaternary ammonium compounds in species of the Fucaceae (Phaeophyceae) from Britain. Eur. J. Phycol. 20:105–108.

Blunden G, Jenkins T, Liu YW. 1997. Enhanced leaf chlorophyll levels in plants treated with seaweed extract. J. Appl. Phycol. 8: 535–543.

Blunden G. 1991. Agricultural uses of seaweeds and seaweed products. In: Guiry, M.D., Blunden G. (Eds.), Seaweed Resources in Europe: Uses and Potential. John Wiley and Sons, Chichester, pp. 65–81.

Burkholder PR, Sharma GM. 1969. Antimicrobial agents from the sea. Lloydia 32:466-483.

Cardozo KHM, Garatini T, Barros MP, Falcao VR, Tonon AP, Lopez NP. 2007. Metabolites from algae with economical impact. Comp Biochem Physiol C;146:60–78.

Chapman VJ, Chapman DJ. 1980. Seaweeds and their uses, 3rd edn. Chapman and Hall, London, p 334.

Chapman VJ. 1970. Seaweeds and their uses. Methuen & Co. Ltd., the Camelot Press Ltd., London, UK.

Colapietra M, Alexander A. 2006. Effect of foliar fertilization on yield and quality of table grapes. Acta Hortic. (ISHS) 721:213–218.

Crouch IJ, Beckett RP, Van Staden J. 1990. Effect of seaweed concentrates on the growth and mineral nutrition of nutrient stress lettuce. Journal of Applied Phycology 2: 269–272.

Crouch IJ, van Staden J. 1993. Evidence for the presence of plant growth regulators in commercial seaweed products. Plant Growth Regulatur. 13:21–29.

Crouch IJ, Van Staden J. 1994. Commercial seaweed products as bio stimulants in horticulture. Journal of Home and Consumer Horticulture 1, 19–76.

Dawczynski C, Schubert R, Jahreis G. 2007. Amino acids, fatty acids and dietary fibre in edible seaweed products. Journal of Food Chem; 103:891–9.

Dhargalkar VK, Pereira N. 2005. Seaweed: promising plant of the millennium. Science and Culture 71, 60–66.

Fornes F, Sánchez-Perales M, Guadiola JL. 2002. Effect of a seaweed extract on the productivity of 'de Nules' Clementine mandarin and navelina orange. Botanica Marina 45, 486–489.

Gajewski M, Katarzyna G, Bobruk J. 2008.The influence of Goëmar Goteo biostimulator on yield and quality of two Chinese cabbage cultivars. Conference of biostimulators in modern agriculture "vgetable crops". Warsaw pp 23-27.

JadczukTobjasz E. 2004. Goemar BM 86® w uprawie truskawki. OWK 7: 26.

Jameson PE. 1993. Plant hormones in the algae. In: Round, F.E., Chapman, D.J. (Eds.), Progress in Phycological Research. vol. 9. Biopress Ltd., Bristol, UK, p. 239.

Jayaraj JA, Wan M, Rahman Punja ZK. 2008. Seaweed extract reduces foliar fungal diseases on carrot. Crop Protection 27 :1360– 1366.

Karjalainen R, Lehtinen A, Keinanae M, Julkunen-Tiito R, Hietaniemi V, Pihlava JM, Tiilikkala K, Jokinen K. 2002. Benzothiadiazole and glycine betaine treatments enhance phenolic compound production in strawberry. Journal of Acta Horticulture. 567: 353–356.

Lembi C, Waaland JR. 1988. Algae and human affairs. Cambridge University Press, New York, p 590.

Lizzi Y, Coulomb C, Polian C, Coulomb PJ, Coulomb PO. 1998. Seaweed and Mildew: what does the future hold? Encouraging laboratory results. Phytoma, The defense of plants 508:29–30

Mancuso S, Azzarello E, Mugnai S, Briand X. 2006. Marine bioactive substances (IPA extract) improve foliar ion uptake and water tolerance in potted Vitis vinifera plants. Advances in Horticultural Science 20:156–161.

Marsham S, Scott GW, Tobin ML. 2007. Comparison of nutritive chemistry of a range of temperate seaweeds. Food Chem; 100:1331–6.

Metiing B, Zimmermann WJ, Crouch I, Vn Staden J. 1990. Agronomic uses of seaweed and microalgae. In: Akatsuica, I. (ed.): Introduction to Applied Phycology, pp. 589-627, SPB Academic Press, The Hague, the Netherlands.

Mohan VR, Venkataraman Kumar V, Murugeswari R, Muthuswami S. 1994. Effect of crude and commercial seaweed extract on seed germination and seedling growth in Cajanus cajan L. Phykos 33, 47–51.

Moller M. 1996. Effects of seaweed suspensions on seed germination and seedling growth of barley (*Hordeum vulgar*~ L.) and lettuce (Lactuca sativa L.). PhD Thesis, The University of Edinburgh.

Moller M.1996. Effects of seaweed suspensions on seed germination and seedling growth of barley *(Hordeum vulgar*~ L.) and lettuce (Lactuca sativa L.). PhD Thesis, The University of Edinburgh.

Mooney PA, Van Staden J. 1986. Algae and cytokinins. Journal of Plant Physiology 123, 1–2.

Nelson WR, Van Staden J. 1984. The effect of seaweed concentrates on the growth of nutrient-stressed, greenhouse cucumbers. Journal of Horticultural Science 19:81–82.

Norrie J, Branson T, Keathley PE. 2002. Marine plants extracts impact on grape yield and quality. Acta Hort. (ISHS) 594:315–319.

Pelegrin Y, Robledo D, Chan-Bacab MJ, Ortega-Morales BO. 2008. Antileishmanial properties of tropical marine algae extracts. Fitoterapia; 79:374–7.

Percival E, Mcdowell RH. 1990. Algal polysaccharides. In: DEY, P. M. and J. B. lliRBORNE (eds.): Methods in plant biochemistry, Vol. 2, Carbohydrates, pp. 523-547, Academic Press, London, UK.

Rajkumar I, Subramanian SK. 1999. Effect of fresh extracts and seaweed liquid fertilizers on some cereals and millets. Seaweed Research and Utilization 21: 91–94.

Rama Rao K. 1991. Effect of seaweed extract on Zyziphus mauratiana Lamk. Journal of Indian Botanical Society 71, 19–21.

Rama Rao K. 1991. Effect of seaweed extract on Zyziphus mauratiana Lamk. Journal of Indian Botanical Society 71: 19–21.

Rathore SSR, Chaudhary GN, Boricha A, Ghosh BP, Bhatt ST, Zodape J, Patolia S. 2009. Effect of seaweed extract on the growth, yield and nutrient uptake of Soybean (Glycine max) under rainfed conditions.South African Journal of Botany75:351-355.

Rayorath P, Benkel B, Hodges DM, Allan-Wojtas P, Mackinnon S, Critchley AT. 2009. Lipophilic components of the brown seaweed, Ascophyllum nodosum, enhance freezing tolerance in Arabidopsis thaliana. Planta, 230:135–147.

Rioux LE, Turgeon SL, Beaulieu M. 2009. Effect of season on the composition of bioactive polysaccharides from the brown seaweed Saccharina longicruris. Photochemistry; 70:1069–75.

Rizvi MA, Shameel M. 2003. Biological activity and element ology of benthic algae from Karachi coast. Pak. J. Bot. 35(5): 717-729.

Rohloff J, Fiskaa Hagen S, Iversen T. 2002. The effect of plant biochemical regulators on strawberry production in field trials under drip irrigation management at 5 locations in Norway. Journal of Acta Horticulture. 567:463–466.

Russo RO, Beryln GP. 1990. The use of organic biostimulants to help low inputs. Journal of Sustainable Agriculture 1, 9–42.

Russo RO, Poincelot RP, Berlyn GP. 1994. The use of a commercial organic biostimulant for improved production of marigold cultivars. Journal of Home Consumer and Horticulture 1, 83–93.

Santos R. 1995. Size structure and inequality in a commercial stand of the seaweed Gelidium sesquipedale. Marine Ecology Progress Series, 119:253–263.

Scheuer PJ. 1990. Some marine ecological phenomena: Chemical Basis and Biomedical Potential Science, 248:173-177.

Schmidt RE, Ervin EH, Zhang X. 2003. Questions and answers about biostimulants. Golf Course Management 71: 91–94.

Schwab W, Raab T. 2004. Developmental changes during strawberry fruit ripening and physico-chemical changes during postharvest storage. In: Dris, R., Jain, S.M. (Eds.), Production Practices and Quality Assessment of Food Crops, 'Quality handling and Evaluation', vol. 3. Kluwer Academic Publishers, Netherlands, pp:341–369.

Sivasankari S, Venkatesalu V, Anantharaj M, Chandrasekaran M. 2006. Effect of seaweed extracts on the growth and biochemical constituents of Vigna sinensis. Journal of Bioresource Technology 97:1745–1751.

Su KL, Abul-Hajj Y, Staba EJ. 1973. Antimicrobial effects of aquatic plants from Minnesota. Lloydia. PMID: 4576314 [PubMed - indexed for MEDLINE]. 36(1): 80-7.

Thirumaran G, Arumugam M, Arumugam R, Anantharaman 2009. Effect of sea weed liquid fertilizer on growth and pigment concentration of Cyamopsis tetrogonolaba L Taub. Am- Euras. J. Agron., 2 (2): 50 -56.

Turan K, Kose M. 2004. Seaweed extract improve copper uptake of Grapevine (Vitis vinifera) Act Agric Scand , B, Soil Plant Sci , 54:213- 220.

Verkleij FN. 1992. Seaweed extracts in agriculture and horticulture: a review. Biological Agriculture and Horticulture 8, 309–324.

Verkleij FN. 1992. Seaweed extracts in agriculture and horticulture. Journal of Biological Agriculture and Horticulture 8, 309-324.

Vernieri P, Borghesi E, Tognoni F, Serra G, Ferrante A, Piagessi A. 2006. Use of biostimulants for reducing nutrient solution concentration in floating system. Acta Hortic. 718:477–484.

Viejo RM, Åberg P. 2001. The effects of density on the vital rates of a modular seaweed. Marine Ecology Progress Series, 221:105–115.

Washington WS, Engleitner S, Boontjes G, Shanmuganathan N. 1999. Effects of fungicides, seaweed extract, tea tree oil and fungal agents on fruit rot and yield in strawberry. Aust. J. Exp. Agric., 39: 487-494.

Whapham CA, Blunden G, Jenkins T, Wankins SD.1993. Significance of betaines in the increased chlorophyll content of plants treated with seaweed extract Appl Phycology, 5: 231 -234.

Zhang X, Ervin EH, Schmidt ER. 2003. Plant growth regulators can enhance the recovery of Kentucky bluegrass sod from heat injury. Journal of Crop Science 43, 952–956.

Zhang X, Schmidt RE. 1997. The impact of growth regulators on the α- tocopherol status in water-stressed Poa pratensis. International Turfgrass Society Research Journal 8, 1364–1371.

Zhang X, Schmidt RE. 1999. Antioxidant response to hormone containing product inKentucky bluegrass subjected to drought. Journal of Crop Science 39: 545–551.

Zhang X, Schmidt RE. 2000. Hormone-containing products' impact on antioxidant status of tall fescue and creeping bentgrass subjected to drought. Crop Science, 40:1344–1349.

Zodape ST, Kawarkhe VJ, Patolia JS, Warade AD. 2008. Effect of liquid seaweed fertlizer on yield and quality of okra *(Abelmoschus esulentus* L.) Journal of Scintific and Industrial Research Vol. 67, December , pp. 1115 – 1117.

Zodape ST, Mukhopadhyay S, Eswaran K, Reddy MP, Chikara J. 2010. Enhanced yield and nutritional in green gram (*Phaseolus radiata* L) treated with seaweed(Kappaphycus alvarezii)extract Jornal of Scientific and Industrial Research Vol. 69, pp. 468 -471.