INNSPUB

International Journal of Biosciences | IJB |
ISSN: 2220-6655 (Print), 2222-5234 (Online)
http://www.innspub.net
Vol. 13, No. 1, p. 27-35, 2018

RESEARCH PAPER OPEN ACCESS

Impact of organic fertilizers on strawberry production grown in soilless media

Saman Chughtai*, Nadeem Akhter Abbasi, Khalid Mahmood Qureshi, Abdul Ahad Qureshi, Usman Shoukat Qureshi

Department of Horticulture, PMAS Arid Agriculture University, Rawalpindi, Pakistan

Key words: Strawberry, Proline, Amino acid, Humic acid, Seaweed extract

http://dx.doi.org/10.12692/ijb/13.1.27-35 Article published on July 15, 2018

Abstract

Fragaria ananassa Duch (Strawberry) is economically very important member of family Rosaceae, is extensively consumed all over the world. With advanced awareness about hazardous effects of chemical fertilizers, agrochemical industries are also focusing on organic sources for providing organic plant products that are processed and originated either from pure natural animal collagen that derives excellent constituents such as glycine, proline and hydroxyproline via advanced hydrolysis process; or originated by plant debris through process of fermentation. Humic acid and seaweed extracts are also other organic sources that have bio-regulatory effects on plants, which help to improve plant growth by increasing the leaf chlorophyll content, enhancing nutrients uptake and hormonal effects. The research was conducted at PMAS-Arid Agriculture University during years 2014- 2015 and 2015-2016. 'Chandler' variety is grown in peat moss using organic fertilizers amino acid (animal based), amino acid (plant based), humic acid and seaweed extract at 3, 0.2, 2, 4 ml/L respectively. Results were analyzed using RCBD. The results showed that among all treatment applied, plant based amino acid increased all parameters including vegetative (plant biomass, number of leaves and leaf area), reproductive (number of fruit and total yield) and fruit quality (total soluble solids, titratable acidity and total sugars) followed by animal based amino acid, during two growing years. Humic acid and seaweed extract showed non-significant effect during two years study.

* **Corresponding Author:** Saman Chughtai ✉ sc33_hort@hotmail.com

Introduction

There is a tremendous increase in strawberry cultivation by farmers due to high demand by consumers and consequently high profit. One of the major problems in arid and semi-arid regions is soil situation as low fertility, deprived physical, chemical type and natural properties (Campbell and Beckett, 1988). In conventional farming, farmers apply chemical fertilizers to increase productivity of their crops (Nilsson, 1979; Bengt and Martensoon, 2003). The Pakistani soils are characterized by near to the ground contents of organic matter due to which above all fertility condition is not sufficient to offer the better yield of different crops (Zaka *et al.,* 2004). Prevailing elevated temperature, dry spell, squat precipitation and deduction of almost all the crop residues are some main reasons of low natural organic substance. Therefore, adding up of organic fertilizers becomes necessary to boost organic material content of soil and for superior crop production ultimately.

Organic farming is known as a significant factor of the Europe for the introduction of the agricultural sector and the development of organic and natural fruits is increasing within the last years (Anon. 2007). However, the limited availability of classical organic fertilizers (i.e. manure) also in not specialized farms, and scarce information about the effects of new kinds of organic fertilizers like plant extracts (Sas-Paszt *et al.,* 2007) or microbial inocula (Malusa *et al.,* 2007) are serious bottlenecks threatening the future development of the sector. Just lately, the substitution of chemical substance fertilizers with organic and natural fertilizers to beat the pervious problems (Wong *et al.,* 1999) has turned into a necessity in extensive agricultural systems across the world where chemicals are intensively used (Tuzel *et al.,* 2003). Only L-Amino Acids are part of the proteins and able to effectively build the needed protein. So, providing additional L-amino via root or leaf tissue ensures the plant has plenty of materials for proteins synthesis, formation of vegetative tissues and chlorophyll synthesis (El-Desouky *et al.,* 2011). Organic and natural fertilizers that are comes from pure natural animal collagen, derives excellent constituents such as glycine, proline, hydroxyproline and micro-molecule, bioactive peptide via advanced hydrolysis process. These ingredients envelop three major functions in crops that are; photosynthetic factor, hydro balance factor and nutritional chelating factor with total contents of 55%. Amino acids also function in the formation of other organic and natural ingredients, amines, purines and pyrimidine, alkaloids, vitamin supplements, enzymes, terpenoids among others (Pratelli and Pilot, 2007). Studies also showed that spraying amino acid (Glutamic) can improve the vegetative, physical parameters and fruit quality of watermelon (Maheswari *et al*., 2004).

Humic acidity/Humate are an organic and natural chemical that is also used by fertilizer industry as an organic and natural source, which had bio-regulatory effects in plants. It benefits plant growth by improving nutrient uptake and hormonal effects. The use of humic acid (HA) is a potential natural resource to be utilized as an alternative for increasing crop development. It really is a naturally occurring polymeric organic compound and is produced by the decay of organic materials and is found in soil, peat and lignite (Sharif *et al.,* 2002). Under certain conditions, humic acid solution when applied on the root zone had beneficial effects on plant development. Numerous studies have been reported that humic acid solution improved vegetative growth, yield, quality (El-Ghozoli, 2003), and significantly increased the dry matter production of crops (El-Ghanam and El-Ghozoli, 2003). Thus, facilitating efficient nutrient uptake by plants, and was particularly promotes the transport and availability of micronutrients (Bohme and Thi Lua, 1997).

Another organic and natural source, many organic fertilizer producers greatly use of nowadays, is the utilization of bio-stimulants, which can boost the efficiency of conventional nutrient fertilizers. Marine bioactive chemicals extracted from sea algae are being used in agricultural and horticultural vegetation. Liquid extracts extracted from seaweeds have lately gained importance as foliar sprays for many plants

including various grasses, cereals, blossoms and vegetable species by implementing many beneficial effects in the terms of enhancement of their yield and quality (Blunden, 1991; Crouch and Van Staden, 1994). Seaweed extracts contains major and minor nutrients, amino acids, vitamins, cytokinins, auxin and abcissic 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). These extracts also accounted in developing 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). Unlike, chemical substance fertilizers, extracts produced from seaweeds are biodegradable, non-toxic, non-polluting and non-hazardous to humans, pets and wild birds (Dhargalkar and Pereira, 2005). The aim of this study was to evaluate the outcome of humic acid, seaweed extract and amino acids both from plant and animal origin on the growth, yield and chemical parameters of soilless strawberry production under greenhouse condition.

Materials and methods

Experimental site and planting materials

This study was placed at experiment station of horticulture department (PMAS) Arid Agriculture University Rawalpindi of geographical coordinates 33° 36' 0" North, 73° 4' 0" East and 1,660 feet elevation. The agro-climate of region comprises humid to sub-tropical climate and fall under semi-arid zone having hot and long summers followed by mild and short winters. Annual rainfall of region is about 1044 mm, most of which occur during monsoon (July-September). Transplants of strawberry var. Chandler were obtained from Mingora Research Station Swat and plantation was done during mid-November of 2014/2015 and 2015/2016. Plants were planted in plastic pots holding 2.5 liter soilless planting media, peat moss, and were placed in the walk-in tunnel. Peat moss used as growing media was composed of mixture of more strongly decomposed peat (Frozen Black Peat), slightly to medium decomposes peat (White Peat) and NPK fertilizer. The chemical properties and NPK concentration of peat moss was given in Table 1.

Organic fertilizers

Parameters

Vegetative growth parameters

Plant height, Crown diameter, Number of leaves, Number of trusses, Number of runners, Leaf area, Plant biomass.

Flowering and Fruit Setting

Day to flower, Average number of flower, Fruit set percentage, Number of fruits per plant and Fruit yield.

Physical characters

Fruit size and Fruit weight.

Fruit Quality Attributes

Total soluble solids (TSS), Titratable acidity (%), Reducing sugars (%), Total sugars (%), and Non-reducing sugars (%).

Statistical analysis

The data statistically analyzed according to Randomized Complete Block Design (RCBD)and the data analysis was carried out with the help of ANOVA (Analysis of Variance) process and means was compared with the help of least standard Division (LSD) test at 5% level of significance on Software M Stat. C as described by(Steel *et al.,* 1997).

Results

Vegetative Characters

The results analyzed (Fig.1) for the application of organic fertilizers on vegetative growth of strawberry plants. It is obvious from the data that among all applied treatment, plant based amino acid led to a marked simulative impact on growth parameters as compared with the control treatment in both seasons, including plant height, crown diameter, number of leaves, trusses, runners, leaf area and plant biomass. However in the second season, these increments were much higher as compared to plant cultivated during first year.

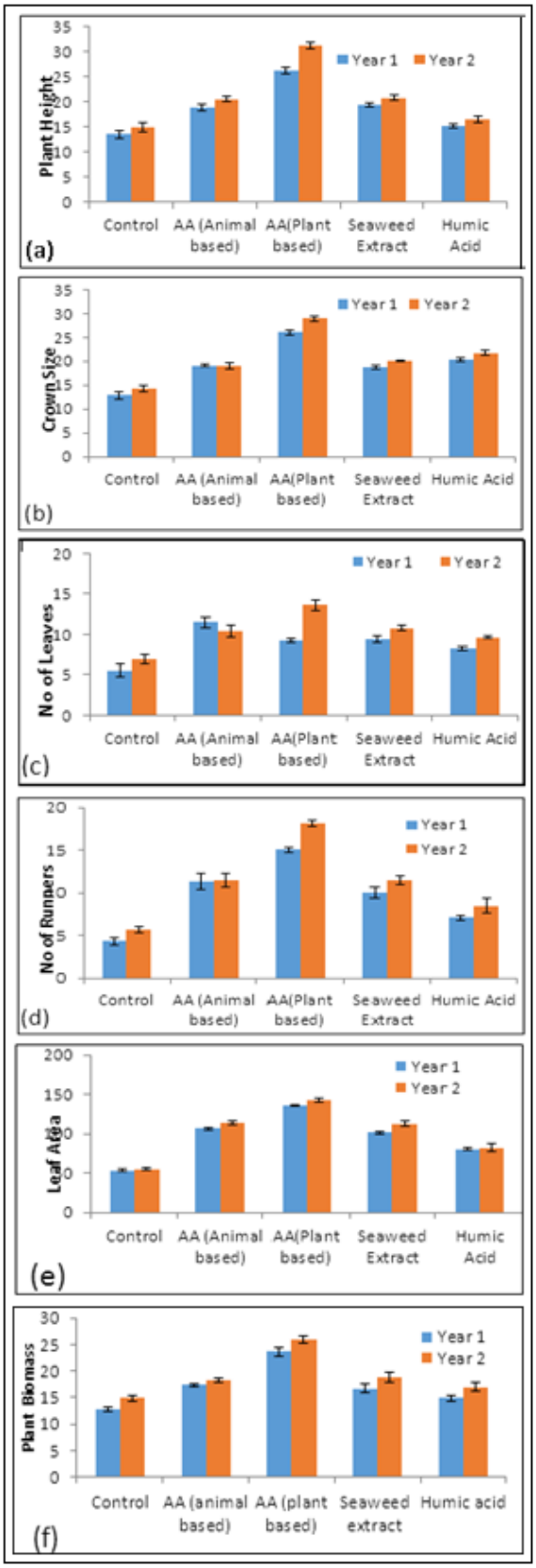

Fig.1. Effect of organic fertilizers on vegetative characters(a) Plant height (b) Crown diameter (c) No. of leaves (d) No. of runners (e) Leaf area (f) Plant biomass. Vertical bars represent standard error at ($p \leq 0.05$).

Animal based amino acid also enhanced plant growth and development during both growing seasons followed by humic acid and seaweed extract.

Flowering and Fruit Setting

The statistical analysis of variance revealed that organic fertilizers significantly impact the flower and fruit setting attributes of strawberry plants also shown in Fig. 2.Application of plant based amino acid also enhanced reproductive parameters such as number of flowers, number of fruits, fruit per plant and total yield during both growing years, with the exception of days required to flower in which animal based amino acid significantly reduced the estimated duration. Animal based amino acid was also as effective as application of plant based amino acid except fruit per plant. Similarly,

Physical characters

Data presented in Fig. 3 clearly indicate the effect of organic fertilizer treatment on physical characters of straw berry fruits such as fruit size and fruit weight. It is obvious from the data that strawberry treated plants with humic acid had higher fruit size and animal based amino acid application resulted in enhanced fruit weight. This effect was more prominent during second year production.

Fruit quality attributes

Data in Fig. 4 clearly depicted that organic fertilizer treatments increased fruit quality attributes compared with the control treatment in both seasons. Plant based amino acid application resulted in enhancing reducing sugars, non-reducing sugars and total sugars in both seasons.

As for the total soluble solids content, data in Fig. 4 also showed that animal based amino acid increased the soluble solids content compared with the control treatment in both seasons.

In case of titratable acidity, humic acid treatment slightly reduced acidity level as compared to control while animal based amino acid gave lowest titratable acidity values in strawberry fruits.

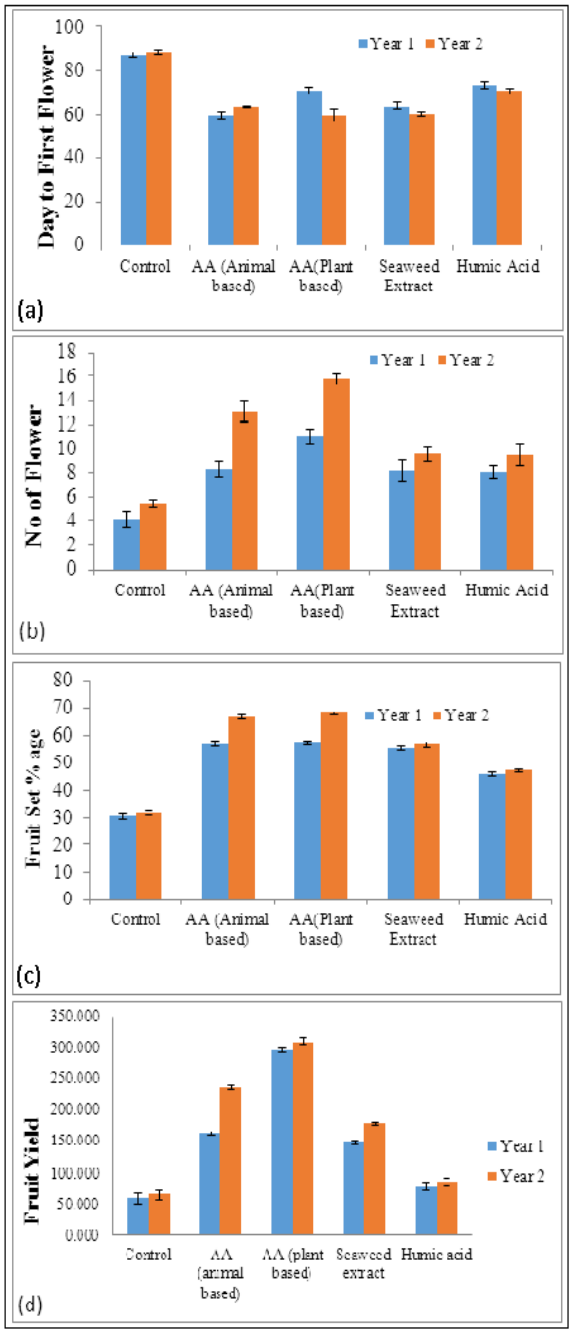

Fig. 2. Effect of organic fertilizers on flower and fruit setting(a) Days required to flower (b) No. of flower (c) Fruit set percentage (d) Fruit yield. Vertical bars represent standard error at ($p \leq 0.05$).

Discussion

Organic fertilizers such as plant growth regulators are composed of peptides, amino acids, poly-saccrides, phyto hormones (Parrado *et al.,* 2008) and generally made up of humic acids, algae extract, mycorrhizal fungi, vitamins and supplementary compounds which can greatly differ according to the manufacturer (Ferrini and Nicese, 2002).

Results revealed that the Application of both plant and animal based amino acid considerably enhanced vegetative growth, flowering and fruit setting parameters as well as fruit quality parameters.

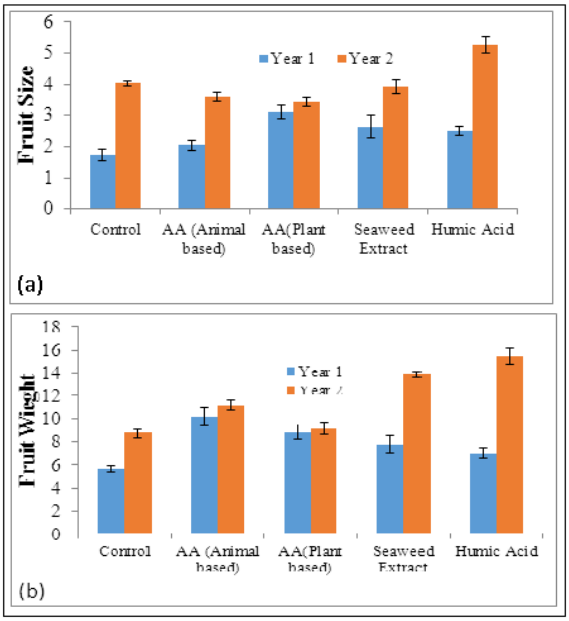

Fig. 3. Effect of organic fertilizers on fruit physical attributes (a) Fruit size (b) Fruit weight. Vertical bars represent standard error at ($p \leq 0.05$).

This increment is resulted due to Amino acids as they are essential components for proteins synthesis, development of vegetative structure and chlorophyll synthesis (Abo Sedra *et al.*, 2010). Amino acids in small quantities generally resulted to the enhancement of plant metabolism, including carbon and nitrogen metabolism and improving plant resistance against biotic and abiotic stresses (Maini, 2006).

Amino acids also played most important part in metabolism and protein assimilation which essential for cellular formation and subsequently enhanced fresh and dry matter (Fawzy *et al.,* 2012). Moreover application of amino acid increased plant protein content which ultimately increased the dry matter (Das *et al.*, 2002).

Several studies revealed that the application of amino acids enhanced the vegetative growth characters (El-Aal, 2012; Fawzy *et al.*, 2012; Shaheen *et al.*, 2013; Colla *et al.*, 2014).

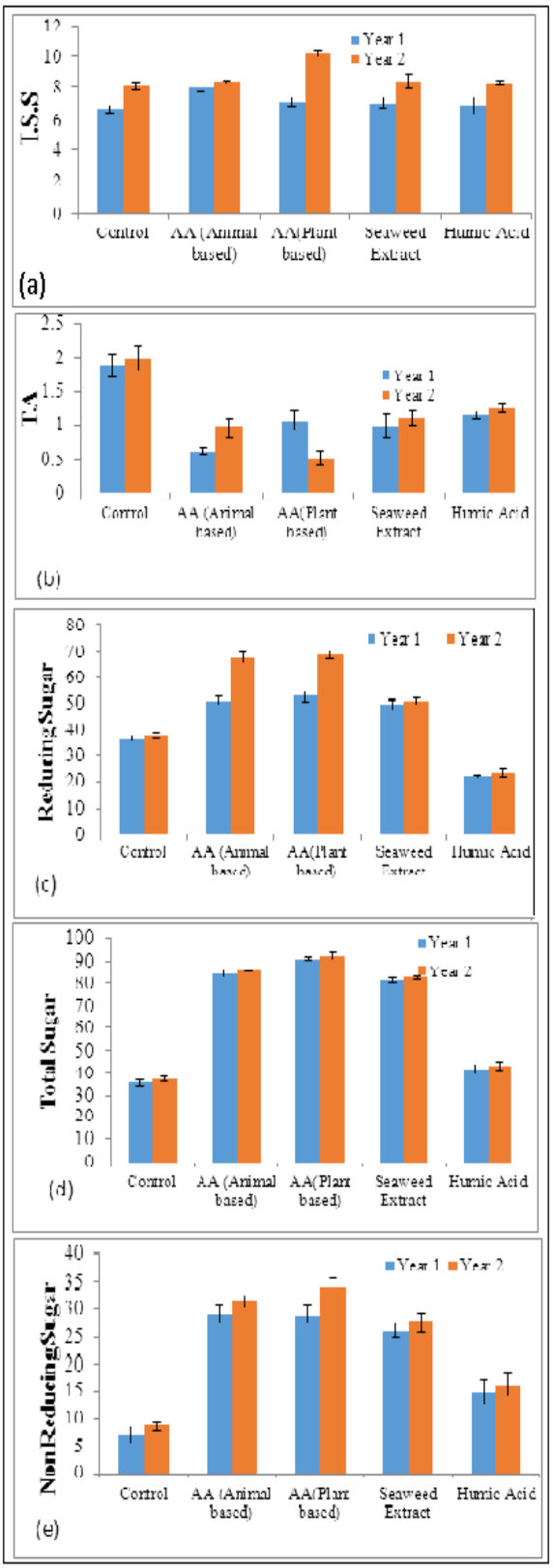

Fig.4. Effect of organic fertilizers on fruit quality attributes (a) Total soluble solids (b) Titratable acidity (c) Reducing sugars (d) Total sugars (e) Non-reducing sugars. Vertical bars represent standard error at ($p \leq 0.05$).

The most probable reason for the improvement in crown diameter by the application of amino acids is due to the presence of Hydroxy-proline in the cell wall as Hyp-rich glycoproteins, which is an extracellular structural protein of plant cells walls and extra-cellular matrix during normal development and in response to stress, auto toxicity in this case (Kieliszewski, 2001). Large crowned plants gave high early season yield as compared to plants having small crown (Durner *et al.*, 2002). Leaf area increments are of great interest since it impacts the photosynthesis activity and translocation of carbohydrates to the fruits especially newly developed ones. Similarly, it might be observed that number of leaves and branches were increased after improvement in leaf area (Abo Sedra *et al.,* 2010). Like our study similar results are depicted by El-Aal (2012) and Zewail (2014) that the application of amino acid significantly enhanced leaf area.In case of number of runners similar results are reported by Aslantas and Güleryüz (2004), Zurawicz *et al.* (2004) and Sas-Paszt *et al.* (2008) that the plant bio regulators (PBRs) had a beneficial effect on number and size of strawberry runners. Plants with vigorous growth has supplemented with high photosynthetic activity so, these plants gave high yield with good quality. Treatment of plants with organic fertilizers and bio regulators resulted in enhancing sugars concentration that could be exported sufficiently at early stages which is fundamentally required for fruit setting activities (El-Aal, 2012). The increase in fruit size in case of humic acid application is due to less number of fruits per plants which leads to less competition among them for the food reserves and also resulted in improving quality of fruits. The higher fruit yield denoted by vigorous growth and average fruit weight in amino acid treated plants. This positive influence on growth and yield could be caused by assimilation and metabolism of nitrogen in strawberry plants (Mondal *et al.,* 2013). More growth and leaf area could give high produce with high quality and total sugars content by boosting photosynthesis translocation from source to sink and also upgrade the various expansion chemicals (Thomas *et al.*, 2009).

This is the reason that the amino acid treated plants have fruits containing high level of total soluble solids (TSS), reducing sugars, non-reducing sugars and total sugars. Titratable acidity is directly related to concentration of organic acid present in fruits which is important for better fruit quality (Kazemi *et al*, 2011). Our results indicated that the application of organic fertilizers reduced titratable acidity as reported by several studies (Eris *et al.*, 1995; El-Aidy *et al.*, 2002; Mouco *et al.,* 2009).

Conclusion

Results revealed that application of plant based amino acid enhanced all vegetative and reproductive parameters including plant height, crown size, number of leaves, number of runner, leaf area number of flower, fruit setting percentage. While animal based amino acids decreased days required for flowering and enhanced fruit weight and total soluble solids. Humic acid and seaweed extract also affect all parameters but their mean values showed no significant difference among them. Among commercially available sources of organic fertilizers amino acid either animal based or plant based provides better strawberry performance in soilless production system

References

Abd El-Aal MMM. 2012. Response of ananas melon to foliar spray with some natural extracts. Research Journal of Agriculture & Biological Sciences **8(2),** 201-212.

Abo Sedera FA, Abd El-Latif AA, Bader LAA, Rezk SM. 2010. Effect of NPK mineral fertilizer levels and foliar spray with humic and amino acids on yield and quality of strawberry. Egyptian Journal of Applied Science **25(4),** 154-169.

Bengt L, Martensson A. 2003. Organically produced plant food evidence of health benefits. Soil and Plant Science **53**, 3-15.
https://doi.org/10.1080/09064710310006490

Boehme M, Schevtschenko J, Pinker I. 2005. Effect of biostimulators on growth of vegetables in hydroponical systems. Acta Horticulturae **697**, 337-344.
http://dx.doi.org/10.17660/ActaHortic.2005.697.42

Bohme M, ThiLua H. 1997. Influence of mineral and organic treatments in the rhizosphere on the growth of tomato plants. Acta Horticulturae, **450**, 161-168.
http://dx.doi.org/10.17660/ActaHortic.1997.450.18

Campbell DJ, Beckett PHT. 1988. The soil solution in a soil treated with digested sludge. Journal of Soil Science **39**, 283-298.
http://dx.doi.org/10.1111/j.1365-2389.1988.tb01215.x

Chhaya ND.1997. Minding our marine wealth, an appraisal of Gujarat coastal resources. 30-31.

Crouch IJ, Van Staden J. 1994. Commercial seaweed products as biostimulants in horticulture. Journal of Home and Consumer Horticulture **1**, 19-76.
http://dx.doi.org/10.1300/J280v01n01_03

Dhargalkar VK, Pereira N. 2005. Seaweeds: promising plants of the millennium. Science and Culture **71**, 60-66.

Durner, EF, Poling EB, Maas JL. 2002. Recent advances in strawberry plug transplant technology. Hort Technology **12**, 545-550.

El-Desouky SA, Ismaeil FH, Wanas AL, Fathy ESL, Abd El-All MM. 2011. Effect of yeast extract, amino acids and citric acid on physioanatomical aspects and productivity of tomato plants grown in late summer season. Minufiya Journal of Agricultural Research **36(4),** 859-884.

El-Ghanam MM, EL-Ghozoli AA. 2003. Remediation role of humic acid on faba bean plants grown on sandy lead polluted soil. Ann. Agric. Sci. Moshtohor., **41(4),** 1811-1826.

EL-Ghozoli AA.2003. Influence of humic acid on faba bean plants grown in cadmium polluted soil. Ann. Agric. Sci. Moshtohor., **41(4),** 1787-1800.

El-Miniawy SM, Ragab ME, Youssef SM, Metwally AA. 2014. Influence of foliar spraying of seaweed extract on growth, yield and quality of strawberry plants. Journal of applied Science **10(2),** 88-94.

Fawzy ZF, Abou El-magd M, Hoda AM. 2012. Influence of "Effective Microorganisms", amino acids and yeast on growth yield and quality of two cultivars of onion plants under newly reclaimed soil. Journal of Agricultural Science, 27-39.
http://dx.doi.org/10.5539/jas.v4n11p26

Jeswani, KD. 1999. We want to provide farmers updated technology in the field of agriculture, Chemical Engineering World **34**, 23-25.

Maheswari TU, Haripriya K, Poonkodi P, Kamalakannan S. 2004. Effect of foliar application of organic nutrients on some quality indices and economics of chilli (*Capsicum annuum* L.). Advances in Plant Sciences **17**, 259-262.

Malusa E, SasPaszt L,Popiæska W, Ýurawicz E. 2007. The effect of a substrate containing arbuscular mycorrhizal fungi and rhizosphere microorganisms (*Trichoderma, Bacillus*, *Pseudomonas* and *Streptomonas*) and foliar fertilization on growth response and rhizosphere pH of three strawberry cultivars. International Journal of Fruit Science **6**, 25-41.
http://dx.doi.org/10.1300/J492v06n04_04

Mondal FM, Asaduzzaman M, Kobayashi Y, Ban T, Asao T. 2013.Recovery from autotoxicity in strawberry by supplementation of amino acids. Scientia Horticulturae **164**, 137-144.
http://dx.doi.org/10.1016/j.scienta.2013.09.019

Mooney PA, Van Staden J. 1986. Algae and cytokinins. J. of Plant Physiology **123,** 1-2.
https://doi.org/10.1016/S0176-1617(86)80061-X

Pratelli R,Pilot G. 2007. Altred amino acid metabolism in glutamine dumper plants. Plant signaling and Behavior **2(3),**182-184.
http://dx.doi.org/10.4161/psb.2.3.3972

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

Shaheen AM, Rizk FA, Sawan OM, Bakry MO. 2013. Sustaining the quality and quantity of onion productivity throughout complementarity treatments between compost tea and amino acids. Middle East Journal of Agricultural Research **2(4),** 108-115.

Sharif M, KhattakRA, Sarir MS. 2002. Effect of different levels of lignitic coal derived humic acid on growth of maize plants. Communication in Soil Science and Plant Analysis**33**, 3567-3580.
http://dx.doi.org/10.1081/CSS-120015906

Turan M, Köse C. 2004. Seaweed extracts improve copper uptake of grapevine. Acta Agriculturae Scandinavica. Section B, Soil and Plant Science **54,** 213-220.
http://dx.doi.org/10.1080/09064710410030311

Turemis N. 2002. The effects of different organic deposits on yield and quality of strawberry cultivar Dorit (216). Acta Horticulturae **567**, 507-510.
http://dx.doi.org/10.17660/ActaHortic.2002.567.108

Tuzel Y,Anac D, Tuzel IH. 2003. Effects of different organic fertilizers and irrigation levels on yield and quality of organically grown greenhouse tomatoes. Ege. Univ. of Agric., Depts. of Hort., Soil Sci. and Plant Protect. 35100 Bornova, Izmir/Turkey.

Verkleij FN. 1992. Seaweed extracts in agriculture and horticulture: A review. Biological Agriculture and Horticulture**8,** 309-324.
http://dx.doi.org/10.1080/01448765.1992.9754608

Wong JWC, Ma KK, Fang KM, Cheung C. 1999. Utilization of manure compost for organic farming in Hong Kong. Bioresource Technology **67**, 43.
https://doi.org/10.1016/S0960-8524(99)00066-8

Zewail RMY. 2014. Effect of seaweed extract and amino acids on growth, productivity and some bioconstituents of common bean (*Phaseolus vulgaris*) plants. Journal of Plant Production, Mansoura University **5**, 1441-1453.

Zhang X, Schmidt RE. 2000. Hormone-containing products' impact on antioxidant status of tall fescue and creeping bentgrass subjected to drought. Crop Sciences **40**, 1344-1349.
http://dx.doi.org/10.2135/cropsci2000.4051344x

Zhang X, Ervin EH, Schmidt ER. 2003. Plant growth regulators can enhance the recovery of Kentucky bluegrass sod from heat injury. Crop Sciences **43**, 952-956.
http://dx.doi.org/10.2135/cropsci2003.9520