

Effect of Stimplex[®] on Yield Performance of Tomato in Organic Management System

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Abstract. Seaweed extracts are used as biostimulant or biofertilizers in agriculture to enhance plant yield and improve growth and development in plants. In this study, the effect of Stimplex[®], liquid seaweed extract made from *Ascophyllum nodosum* as a biostimulant on the yield performance and growth of tomato (*Lycopersicon esculentum*) in open field was investigated. Tomato plants were treated weekly with 2.5 v/v % Stimplex[®] crop bio-stimulant Stimplex[®] as foliar application for 3 consecutive weeks during vegetative growth phase. Results showed that Stimplex[®] treated plants produced improved yield in Black Cherry (1.67%) and German Johnson (4.52%) cultivar but underperformed in cultivar Brandywine (2.44%) and Roma (4.58%) than the controls. However, Stimplex[®] treatment effect on yield has been small and difference was non-significant. Stimplex[®] treated plants showed tolerance to *Septoria* leaf spot and *Sclerotinia* stem rot diseases.

Keywords: Biostimulant, vegetable, production, sustainable, yield

1 Introduction

Organic agriculture has gained international recognition as a valid alternative to conventional food production both in developed and developing countries. The increasing consciousness about health hazards related to the contamination of farm produce due to excessive use of chemical fertilizers and pesticides has provided a thrust to this form of farming (Nandwani and Nwosisi, 2014). Stimplex is the seaweed (*Ascophyllum nodosum*) extract used as a bio-stimulant known to have synergistic effect on the yield, growth and development of the plants (Crouch et al., 1992). As in organic farming there are very limited resources of fertilization that are available. Bio-stimulants provide nutrition and the alternates for the inorganic-synthetic fertilizers and beneficial as they are produced from algae. Seaweed is an essential part of marine coastal ecosystems, which contains all plant nutrients, vitamins, auxin and antibiotics. Brown seaweeds are the most commonly used in agriculture and horticulture (Blunden et al, 1986) and among them *Laminaria* and *Ascophyllum* seaweeds are used for processing into dried seaweed and liquid extract. Recent studies have investigated a wide range of beneficial effects of seaweed extract applications on plants such as early seed germination and establishment, rich source of organic matter and bio-fertilizer, improved crop performance, resistance to insect pest and diseases, and enhanced shelf life of perishable products (Mattson, 2015). Stimplex[®] is a commercially used extract of seaweed (*Ascophyllum nodosum*) registered as plant bio-stimulants, which contains trace amounts of all elements, vitamins, amino acids, auxins, cytokinins (Crouch and van Staden, 1993; Spann et al., 2010). *A. nodosum* seaweed extract has been described to enhance fruit yield and quality of citrus (Fornes et al., 2002) and also reported to improve postharvest plant shelf life in tomato crop (Mattson, 2015). They have also been reported to increase drought stress tolerance of vegetables and flower seedlings (Neily et al., 2010). Foliar applications of *A. nodosum* extract are used as substitute to manage the number of thrips per leaf area unit in avocado transplants (Morales-Payan and Norrie, 2010).

Tomato (*Lycopersicon esculentum*) is one of the world's economically important, nutritious and widely grown vegetable in the world (Asgedom et al., 2011). Lycopene is a bright red carotene whose antioxidant properties are two times higher than β -carotene in destruction of free radicals (Liu et al., 2004). According to Koyama et al. (2012), *A. nodosum* extracts can increase tomato plant growth and yield and many investigations reported that environmental friendly bio-stimulants effects on crop development, growth and yield fit well with sustainable and ecological agriculture (Kayoma et al., 2012).

The objective of the present investigation was to compare the tomato fruit yield grown under organic management system and to observe the effect of Stimplex® (*Ascophyllum nodosum*) liquid seaweed extracts on fruit yield in four cultivars, i.e. Black Cherry, Brandywine, German Johnson, and Roma.

2 Materials and Methods

Organic seeds of four tomato cultivars, i.e. Black cherry, Brandywine, German Johnson, Roma were obtained from Johnny seed company, Maine. Seeds were sown in potting trays (72 cell) using organic potting mix, and kept in the greenhouse for 3-4 weeks. Transplants of four cultivars transferred in the field after 6 weeks of sowing. For each cultivar, 3 replications used, 12 plants/block, total 36 plants were transferred treated with Stimplex® and a control or untreated. Stimplex® was procured from Acadian Company, Canada. Six plants in each row were treated and six untreated, total twelve plants/row/cultivar. The experiment was conducted using randomized block design (RBD) with three replications. Plants were spaced 3 ft. between rows and 2 ft. plant to plant distance within row. Drip irrigation system was used to irrigate plants. Nutri-rich (Organic Materials Review Institute-OMRI) 100% Natural Organic Fertilizer (4-3-2 Ca 7%) and Nature Safe (OMRI listed 8-5-5 Pelleted Grade) fertilizers were applied in the field on weekly basis in order to provide 5.23lb nitrogen, 10.46lb phosphorus and 10.46lb potash. During 3rd week of June, tomatoes were conditioned with weekly 2.5% Stimplex® crop bio-stimulant applications (i.e. 2.5ml Stimplex® in 4L of deionized water). Seaweed extract treatment were applied at 0.6ml/L as foliar spray (Spraymaster, Hummert International, MO) once in 2 weeks and untreated plants served as control. At the end of 3rd application of Stimplex® treated plants received a total of 7.5ml of Stimplex® product. During the 6-week conditioning period all the plants were fully irrigated every 2-3 day as needed. Cultivation procedures (weeding, irrigation, fertilization, and plant protection against pest and diseases) were performed according to National Organic Program (NOP) rules and production practices for tomatoes.

At the end of the study, Fruits were harvested gradually as they turned red ripe fruit and achieved the physiological maturity. Data were collected from all 1-6 plants/replication, total 18 plants on maturity, number of fruits, total yield, marketable yield, fruit weight, fruit dimension for each cultivar. The percentage of fruits with infectious diseases, cracks and blossom end rot in total yield was separated as culls.

3 Statistical Analysis

All data were analyzed using Microsoft Excel and SAS Software (version 9.4, SAS, Cary, NC). All data attributes were carried out in triplicates for each cultivar. Results were expressed as means \pm Standard error. Two way Analysis of Variance (ANOVA) test (5% Confidence Interval) was used to determine the significant differences between each cultivar. In t-test, $P < 0.05$ was considered to be statistically significant.

4 Result and Discussion

4.1 Yield Performance

The bio-stimulant (*Ascophyllum nodosum* seaweed extract) effect on yields varied among all the investigated tomato cultivars. Stimplex® treated plants of German Johnson (4.52%) and Black Cherry (1.67%) cultivars produced higher yields (20.05tons/ha) and (22.65 tons/ha) than the controls respectively (Fig.1). However, Stimplex® treated Brandywine (2.44%) and Roma (4.58%) cultivars produced lower yields (13.50 tons/ha) and (26.0 tons/ha) than the control plants. However, there were not significant ($P < 0.05$) differences observed in production for Stimplex® treated and Control in each cultivar, which may be because of the low concentration of (2.5 v/v %) Stimplex® used in this experiment. Yield data obtained from the current study is in comparison to the research conducted by Zodape et al (2010) and it suggests that an increase in concentration might improve the yields of tomato cultivars. Zodape et al. (2010) conducted a concentration analysis experiment using seaweed extract on tomatoes (2.5, 5.0, 7.5, 10.0 v/v %) and reported that foliar application of 5.0 v/v % seaweed bio-

stimulant (*K. alvarezzi*) recorded the highest yields (38.09 tons/ha). Additional research trials need to be conducted to determine the optimum concentration of Stimplex® required for maximum yield in tomato.

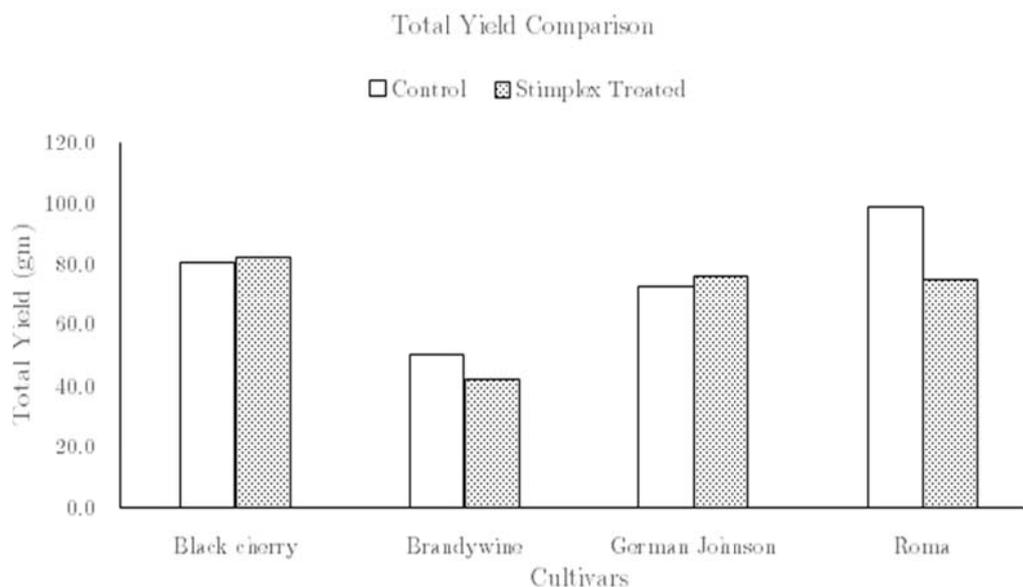


Figure 1. Total yield performance of Stimplex treated and control (un-treated) tomato cultivars ($P < 0.05$)

4.2 Disease and Insect Infestation

Foliar application of seaweed extract enhances the defense mechanism of the plant in control of diseases. Crouch and Van Staden, (1993) reported that seaweed extract treated plants provide improved resistance to *Meloidogyne incognita* disease. There were some visual observations made for tomato plant in current study. During the month of August, *Septoria* leaf spot and *Sclerotinia* stem root (soil borne) diseases were noticed in controlled tomato plants, which certainly effected stem and leaf surface. Eventually, diseases were controlled using OMRI listed fungicide Regalia 0.5%-1 v/v % in 100 gallon of water/acre. However, Stimplex® treatment led to disease free, stronger stem, better growth and development of tomato plant, which has agreed with previous studies (Crouch and Van Staden, 1993).

4.3 Growth and Development

Stimplex® contains micronutrients, amino acids and natural chelating agents to increase nutrient availability and usage. Amino acids biosynthesize gibberellins in plant tissue and directly influence the physiological activities of plant development (Zewail, 2014). Additionally, El-Ghamry et al., 2009 reported that Amino acids increased plant height, number of leaves and branches of beans significantly. In the current study, seaweed extract application showed significant increase in plant height (Table.1) for each cultivar. Stimplex® treated cultivar Brandywine recorded the highest average plant height (100.1 inches) among all cultivars. Hence, the current study agreed that the incorporation of amino acids through seaweed application increased plant growth and development.

Table 1. Average plant height of tomato cultivars grown in organic management at organic agriculture research farm, Nashville

Treatment	Cultivar	Plant Height (inch)
Control	Black Cherry	44.7±0.66
	Brandywine	95.1±1.26
	German Johnson	86±0.32
	Roma	48.5±0.98
Stimplex® Treated	Black Cherry	46.5±0.92
	Brandywine	100.1±0.081
	German Johnson	94.7±0.43
	Roma	52.6±0.37

t-test, significant at $P < 0.05$

5 Conclusion

Collectively, seaweeds have received a greater acceptance in horticulture as plant biostimulants. Foliar application of Stimplex® (*Ascophyllum nodosum*) seaweed extract increased plant yield for two cultivars i.e. Black Cherry and German Johnson cultivars at 2.5 v/v % concentration. However, fruit yield is likely to increase as concentration of SWE increases. Moreover, plants receiving Stimplex® increased overall growth and acquired enhanced defense mechanisms to control the diseases *septoria* leaf spot and *Sclerotinia* stem rot. Stimplex® is a plant growth regulator which stimulates plant maturity, promotes fruit set and improves resistance to environmental stress. Further research trials are needed to discern optimum concentrations and applications of these biostimulants.

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