CARIBBEAN FOOD CROPS SOCIETY

51

Fifty-first Annual Meeting 2015

Paramaribo, Suriname
Volume LI

PROCEEDINGS

OF THE

51ST ANNUAL MEETING

Caribbean Food Crops Society
51ST Annual Meeting
July 19 – July 24, 2015

Royal Ballroom Hotel Torarica,
Paramaribo, Suriname

Edited by
Ranoe S.Mangal-Jhari, Lydia Ori, Abdullah Adil Ansari, and
Wilfredo Colón

Published by the Caribbean Food Crops Society

ISSN 95-07-0410

Copies of this publication may be obtained from:

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1193 Calle Guayacán
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CFCS Website: http://cfcs.eea.uprm.edu/

Proceedings of the Caribbean Food Crops Society. 51:102-106. 2015

EFFECT OF BIOSTIMULANTS ON THE YIELD PERFORMANCE OF ORGANICALLY-GROWN OKRA CULTIVARS IN THE U.S. VIRGIN ISLANDS

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Abstract: Okra is one of the widely grown vegetables for the commercial market in the United States Virgin Islands and the rest of the Caribbean. Plant biostimulants or agricultural biostimulants include diverse substances and microorganisms that are derived from commercial marine algae extracts, enhance plant growth of fruits and vegetables. Plants of eight cultivars of okra (Abelmoschus esculentus) were treated weekly with Stimplex® (5 mL/L) liquid seaweed extract of Ascophyllum nodosum and Biozest® (100 mL/5L) crop biostimulant as foliar spray to assess their influence on yields. Half of the plants in a row (5 plants) were sprayed weekly and half of the plants (5plants) were untreated (control). Eight cultivars of okra ca. Clemson Spineless 80, Red Burgundy, Clemson Spineless, Jambalaya, Red Velvet, Annie Oakley II, Perkins Mammoth and Chant were investigated. The experimental design was a randomized complete block with 3 replications and consisted of rows spaced 3' apart and spaced 2' between the plants within a row. They were organically managed. Results showed that Biozest® treated plants of most of the cultivars responded positively. Marketable yields were higher with Biozest® treated plants of Clemson Spineless 80 (0.5%), Annie Oakley II (27.9%), Perkins Mammoth (49%), Jambalaya (41.2), Chant (16%) and Red Burgundy (60%) than with the untreated control. Higher marketable yields were obtained with Stimplex® treated plants of Jambalaya (62%), Red Burgundy (58%) and Perkins Mammoth (30%) than with the untreated control. Cultivars produced lower or non-significant yields with Clemson Spineless 80, Clemson Spineless, Red Velvet, Annie Oakley II and Chant. The results show that biostimulants may increase yields in okra. However, further research trials are needed to fully explain the effects of biostimulants in commercial production.

Keywords: Crop biostimulant, Organic, Production, Yield.

INTRODUCTION

Okra is a well-known, versatile, warm-season vegetable crop produced in the southern region of the United States. It is grown commercially in Georgia, South Carolina, Tennessee, Alabama, Texas, California, and Florida. Most southern states cultivate enough okra to satisfy local demand. There are ≈15,000 acres of land (6,000 ha) of okra produced annually in the United States. It is valued as highly nutritional and is easy to cultivate. Tender green pods are consumed as a vegetable and used as a thickening agent in soups. Well drained soil with organic matter is suitable for production of okra. This can be achieved by applying animal manures or incorporating green manure crops (Colditz and Barber, 1975). Moreover, biostimulants provide better growth and development of plants in organic management systems. There are number of varieties of okra available in the market for commercial production in an organic crop management system.

The biostimulant federation defined biostimulants as "materials, including microorganisms, that are applied to plant, seed, soil or other growing media that may improve the plant's capability to assimilate useful nutrients, or deliver benefits to plant development" (Pamela et. al. 2014). Marine bioactive elements extracted from seaweed like Stimplex® and Biozest® are currently used in organic farming in order to avoid extreme application of fertilizers and improve the uptake of nutrients through the roots or leaves. A number of products that have properties to improve the plant growth are utilized as development promoters or biostimulants on vegetables, regardless of the fact that some of their active components remain unknown to the end user. Among them, seaweed products are embedded as permissible organic (natural) manures (Alessandra et. al. 2014). Stimplex® is a biostimulant derived from seaweed. It is best used in drip irrigation fertigation and applied after 2 weeks of emergence and then weekly until the end of blooming occurs. Effects of the biostimulants have been reported to increase the production by an upsurge in the efficiency of nutrient use and to provide resistance to various biotic and abiotic stresses (Zhang et. al. 2004). In a study conducted on pepper (Capsicum annuum L.) to explore the effect of natural biostimulants on yield and quality parameters of fruits, significant results, in terms of yield and other parameters like fruit quality were reported. There was an increase observed in the pigment content of leaves with the application of biostimulant and marketable yields of treated pepper cultivars as compared to their controls. The results indicated that natural biostimulants had a synergistic effect on the vitamin C and total phenolic content in pepper fruits. The antioxidant activities were also noticeably higher ($P < 0.05$) in treated plants excluding the phenolic content. (Nada et. al. 2011).Thus the use of biostimulants is considered a good approach to increase the overall production of the crop.

MATERIALS AND METHODS

Materials: Seed of eight cultivars of okra as follows: Clemson spineless, Clemson Spineless 80, Red Burgundy, Jambalaya, Red Velvet, Annie Oakley II, Perkins Mammoth and Chant. Biozest® and Stimplex® (extract of seaweed Ascophyllum nodosum) were used for treatments.

Methods: The experimental design was a complete randomized block with three replications. The trial was conducted from 7 October, 2013 through 27 November, 2013. Crops were grown using National Organic Program (NOP) standards and permitted practices. Seeds were planted in 72-cell trays containing farmer produced organic compost at the University of the Virgin Islands on St. Croix, greenhouse reared, and transplanted into the field 21 days after germination. Land preparation was done by ploughing and leveling of field with mechanical tractors. The rows were spaced 3' apart and each plant had 2' spacing as per the standard cultivation practices. There were 36 plants per plot for each variety for a total of 864 plants in the field. First five plants of the left row were treated with Biozest® and the remaining five were kept as a control (untreated). Similarly, the first five plants of the right row were treated with Stimplex®, while the remaining five were kept as a control (untreated). The plants were irrigated regularly after the initial 10 days. The tender pods of okra plant are harvested every two days and the data of total yield, marketable yield, and average number of fruits per plant has been calculated. No chemical insecticides, fungicides or herbicides were sprayed during this trial. Removal of weeds was done using mechanical and manual tools. After the complete period of crop production the data was compiled and analyzed using SAS 9.0 and the significant results were calculated.

RESULTS AND DISCUSSION

Significant results observed from the application of the biostimulants in okra vary according to the cultivar and biostimulant used. As shown in figure 1, Clemson spineless shows the decrease in average marketable yield and average yield per plant when treated with Biozest® and Stimplex® than the control. However, this variety has high marketable and less average per plant yield when treated with Stimplex®.

Chant is highest yielder among all of these cultivars (Fig. 1). It has higher marketable and per plant yields when treated with Stimplex® and lower yields when treated with Biozest®. Red burgundy is moderate yielder and there are not significant differences in the yields with the both Stimplex® and Biozest®, however, the treated plants of this variety yields better than the control plants.

Annie Oakley and Perkins mammoth, both varieties when treated with stimplex have high marketable and per plant yields as compare to biozest treated and control plants (Fig. 2). Clemson spineless and Red Velvet have higher average marketable yields with the Stimplex® treatment. On the other hand, in case of average yield per plant the Clemson spineless gave higher results than Red velvet when plants were treated with Biozest and vice-versa.

Clemson spineless, Clemson spineless 80 and red velvet were significantly different from each other in terms of yields with two treatments. However, in other varieties Biozest® treated plants, on average, performed poor than the Stimplex® treated plants in terms of average yield per plant. We did not find any significant differences in the average fruit weight of the okra varieties in Stimplex®, Biozest® and control plants (Table 1).

Table 1. Fruit weight (g) of eggplant varieties treated with biostimulants and control (untreated)

Varieties	**Stimplex**	**Biozest**	**Control**
Nubia (NA)	319.72	112.55	341.05
Fairy Tale (FT)	42.42	49.70	44.30
Dancer (DR)	217.22	214.08	216.38
Beatrice (BE)	319.32	242.80	262.40
Calliope (CE)	160.03	162.46	208.66
Orient Charm (OC)	127.58	123.27	131.91
Barbarella (BA)	211.01	229.38	281.08
Rosa Bianca (RB)	336.4	549.1	528.53
Machiaw (MW)	104.25	124.99	104.28
Shooting Stars (SS)	149.70	167.13	153.03

Figure 2: Average plant yield in okra varieties grown at the UVI Agriculture Experiment Station, St Croix.

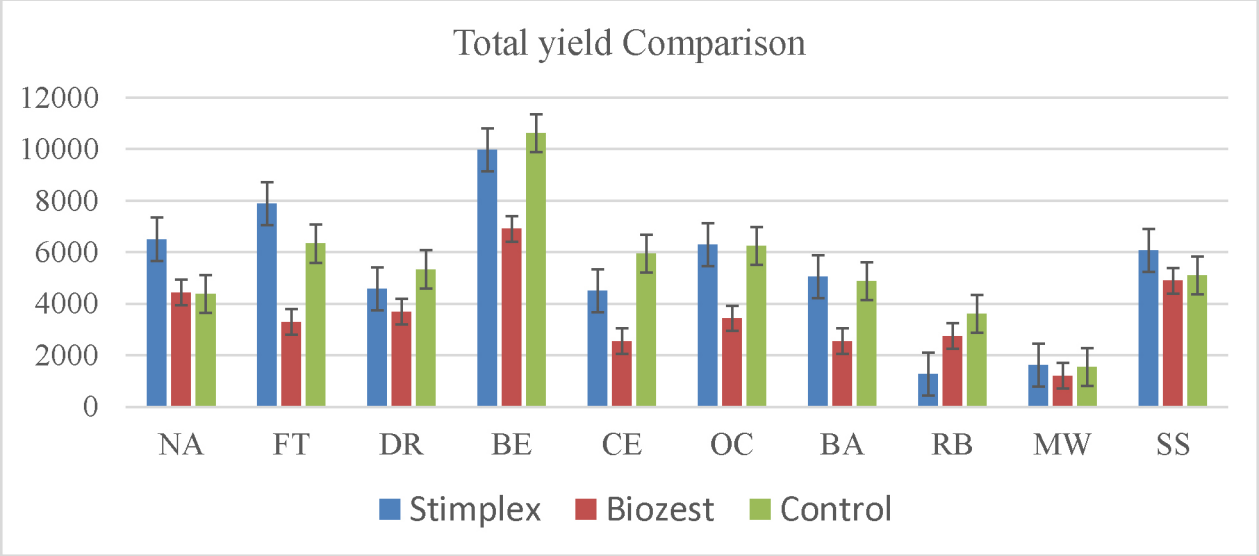
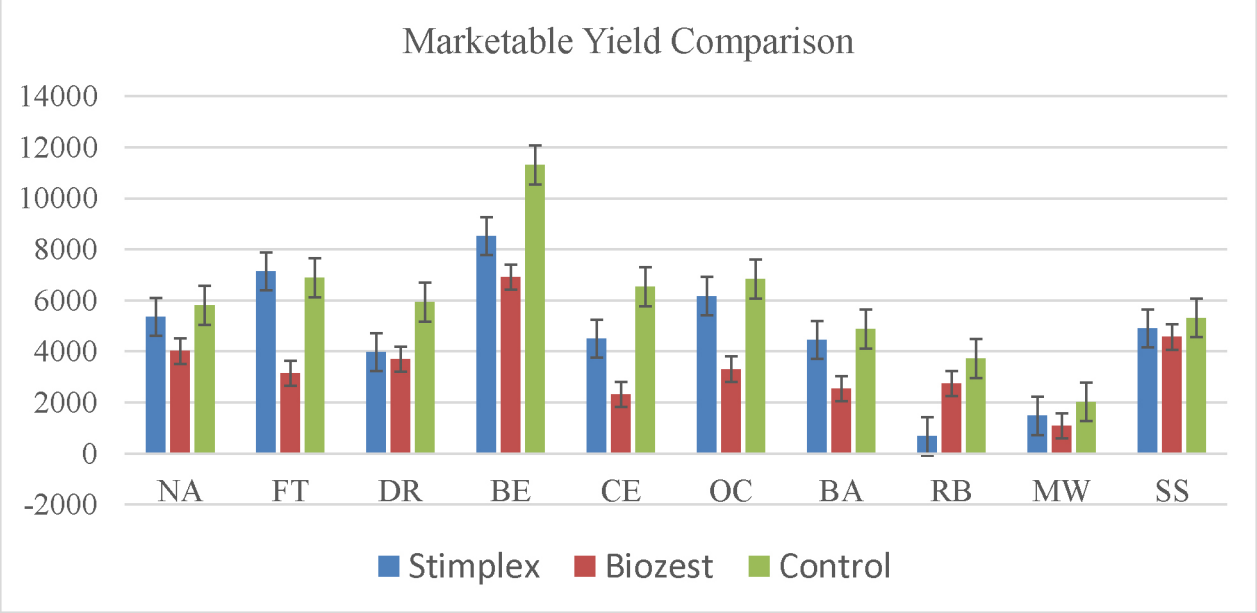


Figure 3: Okra experimental plot at UVI-AES horticultural field (plants marked with treated and untreated control).



CONCLUSION

Most of the varieties of okra performed well under the treatment of biostimulants and positive effects of Stimplex® or Biozest® for crop enhancement in organic vegetable production system were observed. Since these are the results from the one year trial, further research is needed to explain the complete benefits or effects of these biostimulants and their use in commercial production of okra.

ACKNOWLEDGEMENT

This research was conducted under Hatch grant received from USDA-NIFA. Authors wish to thank them and WRRI for funding this research. Sincere appreciations to Shamali Dennery, Paulino (Papo) Perez and Victor Almond for their field assistance.

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