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B Ashok Kumar
Department of Vegetable Science, Faculty of Horticulture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, West Bengal, India

U Thapa
Department of Vegetable Science, Faculty of Horticulture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, West Bengal, India

Correspondence
U Thapa
Department of Vegetable Science, Faculty of Horticulture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, West Bengal, India

Bio-Efficacy Study of Physio-Activator (Opteine) on Tomato (*Solanum lycopersicum* L.)

B Ashok Kumar and U Thapa

Abstract
The present investigation conducted in the year 2016 - 2017 to check Bio-efficacy study of physio-activator (opteine) on tomato cv. PAN 1286. The test product applied as foliar spray with seven different treatments i.e. 400ml, 500ml, 600ml, 7500ml, 1250ml/ha, control and Biozyme. The statistical analysis was done using Randomized Block Design (RBD) with three replications. From the results it was concluded that application of opteine increased total and marketable yield. The application of opteine showed positive effect with respect to vegetative, reproductive yield and quality parameters compared to water and biozyme spray. Amongst different concentrations, opteine spray of 600 ml/ha produced highest fruit weight, fruit yield, fruit diameter, number of fruits per plant and minimum days to fruit set. The dose of 750 ml/ha of opteine found better for plant height, number of branches. The fruit quality parameters like lycopene, anthocynin, TSS, beta carotene and total sugar content were also influenced with application of opteine. It was concluded that sea weed extract application enhanced crop growth and ultimately increased fruit yield.

Keywords: Tomato, opteine, sea weed extract, growth, yield, quality

Introduction
Vegetables are very essential to human health as they are rich in dietary fibre and source of essential vitamins, minerals, trace elements and antioxidants. Tomato is an herbaceous annual require ample amount of nutrients within short period of time to get optimum yield. In India tomato is a major vegetable crop, contributes 11.5 % of production and 9.4 % of area share of total vegetables (Anonymous, 2016) [2]. The application of nutrients is major concern among production practices to optimize tomato productivity.

Seaweed extract is a new generation of natural organic fertilizers foster plant growth and development throughout the crop life cycle from seed germination to plant maturity in a number of ways, including improving the efficiency of the plant's metabolism to induce yield increases and enhanced crop quality (Saravanan *et al*., 2003) [14]. It increases plant tolerance from abiotic stresses, facilitating nutrient assimilation, translocation and use, rendering water use more efficient. It has newly gained importance as foliar spray for lots of crops including various varieties of grasses, flowers, cereals, vegetables and spices (Pramanick *et al*., 2014) [12]. Further, various modes of seaweed extract application such as a foliar spray, application to soil and soaking of seeds before sowing were tried and reported that extract not only enhances the germination of seeds but also increases uptake of plant nutrients and gives resistance to frost and fungal diseases (Zodape, 2001 [18]; Zodape *et al*., 2010) [19].

To achieve reasonable yields and high-quality produce, growers use a wide range of fertilizers and pesticides, which accounts for up to 38 and 43% of total crop production costs, respectively. Abundant use of these synthetic chemicals can result in detrimental effects on non-target species and in chemical contamination of soil, water supplies and harvested products. Growers continue to search for sustainable strategies that will improve crop yields without adversely impacting on the environment. The use of seaweed extract as bio-fertilizers and physio-activator offers a potential solution to these problems as reported by several workers. Seaweed extracts are classified as bio-stimulants because they contain bioactive substances at low concentrations that exhibit growth-stimulating properties

Opteine is a world leading bio-stimulant of *Ascophyllum nodosum* formed with the Physio-activator technology, which has positive effect on plant physiology. *Ascophyllum* is a prominent seaweed species belong to the brown algae type most commonly used in agriculture (Ugarte *et al*., 2006) [17]. According to FAO (2006) [5], report substantial amount of seaweeds

(15 million metric tons annually) are used as supplement for nutrients and bio-stimulants for the production of agricultural and horticultural crops. In addition, the growth enhancing potential of the seaweed extract might be attributed to the presence of macro and micronutrients.

Though several reports are available on the use of opteine in plant culture, there has been less research on the use of this extract under tropical and sub-tropical field conditions. In fact information regarding the optimum doses of opteine for growth, yield and quality of tomato is still meager. The present study was conducted to determine the effect of opteine on tomato for growth, yield and quality attributes.

Materials and Methods

The present investigation on "Bio-efficacy study of physio-activator (opteine) on tomato" was carried out in New Alluvial Zone of West Bengal, at the open field, in the arena of Experiential Learning Programme under Department of Vegetable Science, Faculty of Horticulture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia (West Bengal) during the year 2016 - 2017. The location of the experimental site is 23.5^0N latitude and 80^0E longitude with an average altitude of 9.75m from the mean sea level (MSL). The average temperature ranges from 25-36.5^0 C during the summer months and 12-25^0 C during the winter months. The average annual rainfall is about 1500mm. The soil analysis data revealed that the soil of the experimental field [Sand (%) 74.2; Silt (%) 14.2; Clay (%) 11.5] was sandy loam in texture and slightly acidic in nature with a pH range of 6.64 to 7.2.

In present experiment the test product applied to locally available tomato variety PAN-1286. The experiment laid out in Randomized Block Design using seven treatments replicated into 3 times. The field was divided into 21 plots with plot size of 3x15=45sq.m. The test product was applied as foliar spray in three times (1st, at flowering stage; 2nd, at 14 days after first spray; and 3rd, at 14 days after second spray). The time of application along with different doses of opteine and competitor product has shown in Table (1). After the land was prepared recommended dosage of N, P and K in the form of urea, single super phosphate and murate of potash respectively along with 25 tonnes/ha of FYM was applied. Other cultural practices were followed as per the standard and recommended packages of practices of individual crops.

The observations were recorded on five randomly selected equally competitive plants from each replication for all the parameters. Plant height was recorded using meter scale from base to tip of plant and total no. of lateral per plant computed. The minimum days required for flowering of 50% plants in a plot and days to first fruit set were recorded based on regular observations during flowering. Number of fruits per plant and number of truss per plant were counted based on average from five tagged plants. Five ripe fruits from each tagged plant were used to measure diameter, pericarp thickness and weight of fruit. Total fruit yield from different plucking were recorded as fruit yield. The quality parameters TSS, lycopene content, beta carotene content, total sugars and titrable acidity were analyzed by standard procedures.

The mean values were averaged and expressed as mean of the respective characters. The observations were recorded at the scheduled dates as programmed. Data were analyzed using analysis of variance and differences were considered significant at 5% level of probability (Panse and Sukatme, 1985) [10].

Table 1: Treatment details of effect of Physio activator (opteine) on tomato

	Product	Rate/ha	Time of application / Interval
T1	Control	Water	1st flower; 14 days after 1st spray,; 14 days after 2nd spray
T2	Opteine	400 ml/ha	1st flower; 14 days after 1st spray,; 14 days after 2nd spray
T3	Opteine	500 ml/ha	1st flower; 14 days after 1st spray,; 14 days after 2nd spray
T4	Opteine	600 ml/ha	1st flower; 14 days after 1st spray,; 14 days after 2nd spray
T5	Opteine	750 ml/ha	1st flower; 14 days after 1st spray,; 14 days after 2nd spray
T6	Opteine	1250 ml/ha	1st flower; 14 days after 1st spray,; 14 days after 2nd spray
T7	Biozyme	600 ml/ha	1st flower; 14 days after 1st spray,; 14 days after 2nd spray

Results and Discussion

Effect of opteine on growth and yield attributing characters

The application of opteine showed positive response for enhanced growth of plants. The maximum plant height and number of branches were obtained with opteine compared to control and biozyme spray (Table 2). The plant height was measured among all treated and untreated plants and recorded highest plant height (113.833 cm) and number of branches per plant (8.7) with application of opteine 750 ml/ha followed by 600ml/ha. While the lowest plant height and number of branches per plant obtained in control plants sprayed with water. The similar results of increased plant height and shoot biomass with application of seaweed extract obtained by (Danesh *et al*., 2012 [3]; Pramanik *et al*., 2013) [11]. Sathya *et al*. (2010) [15] also reported maximum growth parameters with application of the seaweed liquid fertilizer in Cajanun cajan.

The minimum days required for 50 % flowering (38.592) and first fruit set (29.458 days) was noticed from the plant sprayed with opteine 600 ml/ha and 750 ml/ha respectively. The highest days required for 50% flowering and first fruit set was observed in control plant as well as with application of biozyme. Rayorath *et al*. (2008) [13] reported that, extract of *Ascophyllum nodosum* have been shown significant affect on root growth leading to increased mineral adsorption in Arabidopsis species.

The fruit yield attributing characters were influenced by different concentrations of opteine (Figure 1). The maximum number of truss per plant (32.167), number of fruits per truss (7.333), pericarp thickness (0.498 cm), polar diameter (5.083 cm) and equatorial diameter (4.483 cm) were recorded from the plants sprayed with opteine @ 600 ml/ha. Koyama *et al*. (2012) [8] stated that application *Ascophyllum nodosum* enhances vegetative growth early stage of crop growth followed by reproductive growth of plant. Saravanan *et al*., (2003) [14] reported increased fruit yield was correlated with improved fruit size.

Table 2: Effect of Physio-activator opteine on growth and yield attributing characters

Treatments	Plant height (cm)	No. of branches	Days to 50% flowering	Days to 1st fruit set	No. of truss per plant	No. of fruits per truss	Pericarp thickness (cm)
Control	99.300	7.600	42.017	39.708	24.717	4.758	0.430
400 ml/ha	111.000	7.910	40.183	33.667	29.000	6.333	0.467
500 ml/ha	113.000	8.335	39.492	31.500	29.958	7.167	0.468
600 ml/ha	113.333	8.562	38.592	31.417	32.167	7.333	0.498
750 ml/ha	113.833	8.700	39.633	29.458	29.950	6.833	0.483
1200ml/ha	107.833	8.217	40.117	31.500	29.300	6.192	0.472
Biozyme	103.167	7.900	41.500	34.167	26.800	5.453	0.430
C.D.	8.831	0.640	1.995	2.788	1.744	1.088	N/A

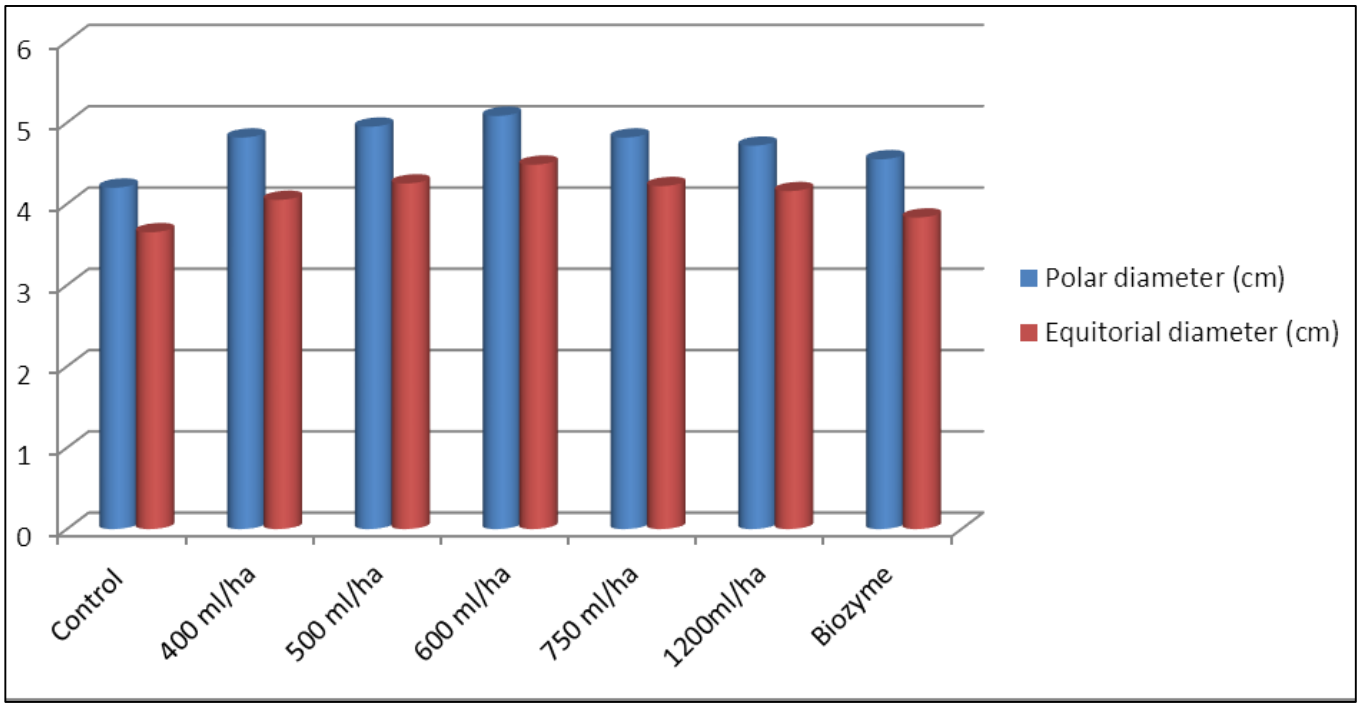

Fig 1: Effect of Physio-activator (opteine) on polar and equiorial diameter of fruit

Effect of opteine on yield and qualitative characters

The different concentrations of opteine spray produced highest individual fruit weight and fruit yield compared to control and biozyme spray (Table 3). The highest individual fruit weight of (114.667 gm), fruit yield plant^{-1} (26.113 kg) and yield hactare^{-1} (80.28 t/ha) was recorded with 600 ml/ha of opteine spray. The control and biozyme treatments recorded lowest fruit weight, fruit yield plant^{-1} and yield hactare^{-1}. The considerable effect of opteine could be due to presence of growth promoting substances. Selvaraj *et al.* (2004) [16] recorded foliar spray of sea weed extract is more effective in yield improvement in *Solanum lycopersicon.* Khan *et al.* (2009) [7]; Kumari *et al.* (2011) [9] were also reported similar increased total marketable yield with sea weed extract spray.

The fruit quality parameters like TSS, titrable acidity and total sugar content were also influenced significantly with application of different doses of opteine (Figure 2). The plants treated with opteine produced fruits with glossy and firmer flesh than fruits with control plants. The highest titrable acidity (0.763 mg/100ml) obtained from spray concentration of 750 ml/ha whereas total sugar (2.983 %) and TSS (6.292 ^{0}Brix) were recorded with opteine @ 600ml/ha. Mawgoud *et al.* (2010) [1] concluded that application of sea weed extract enhances fruit quality of vegetables.

Opteine spray of 750 ml/ha recorded highest beta carotene (2.450mg/100gm) and lycopene content (2.192mg/100gm) whereas lowest obtained from control plant and with biozyme spray. Hartz *et al.* (2005) [6] and Dobromilska *et al.* (2008) [4] reported that, increased mineral uptake with sea weed extract spray increases fruit colour.

Table 3: Effect of Physio-activator opteine on yield and quality of tomato fruits

Treatments	Fruit weight (gm)	Fruit yield (kg/plant)	Fruit yield (t/ha)	TSS (^{0}BRIX)	Total Sugars (%)	Titrable Acidity (mg/100ml)
Control	85.167	14.617	70.245	5.417	1.688	0.377
400 ml/ha	107.500	20.347	74.497	5.900	2.115	0.504
500 ml/ha	112.333	23.503	78.842	6.092	2.322	0.633
600 ml/ha	114.667	26.113	80.283	6.292	2.983	0.645
750 ml/ha	111.833	22.160	79.950	6.050	2.778	0.763
1200ml/ha	109.250	21.343	77.717	5.940	2.297	0.513
Biozyme	102.000	17.332	73.817	5.717	2.028	0.446
C.D.	16.961	6.726	1.796	0.255	0.060	0.013

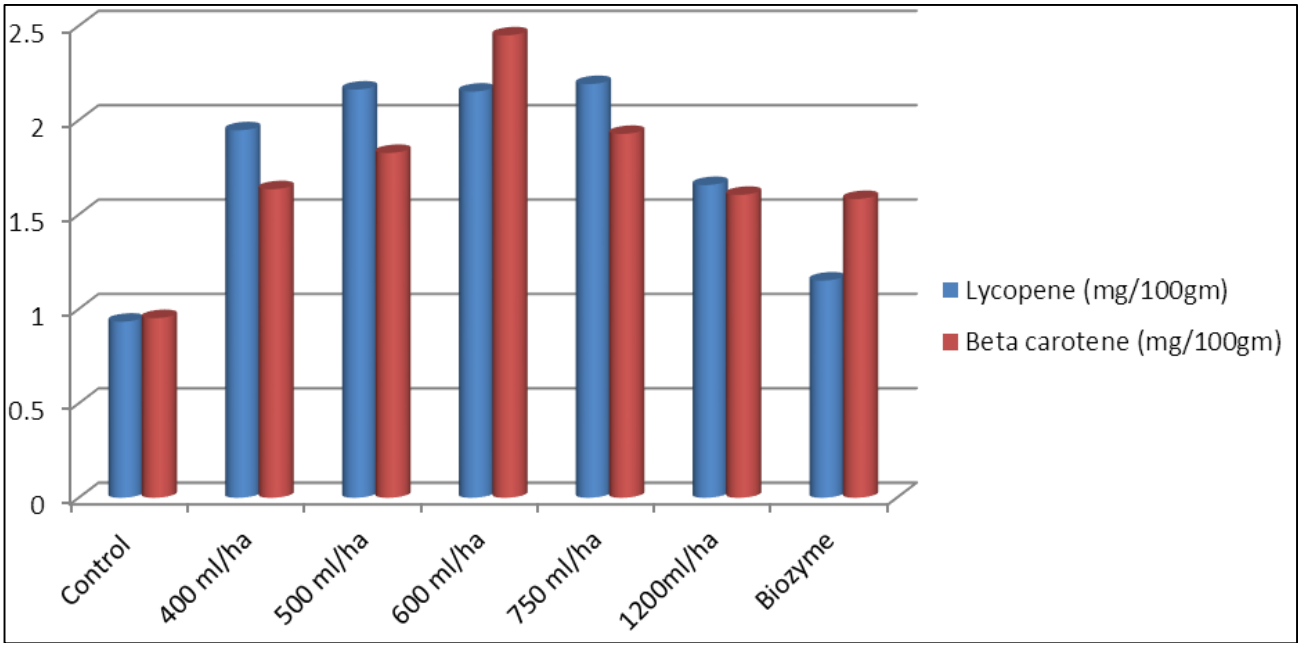

Fig 2: Effect of physio-activator (opteine) on colour variation in tomato fruits

Conclusion

It may be concluded that opteine spray of 600 ml/ha produced highest fruit weight, fruit yield, fruit diameter, number of fruits per plant and minimum days to fruit set followed by 750ml/ha of opteine found better for plant height, number of branches. The foliar spray of opteine influenced significantly from initial plant growth to total marketable yield and quality of fruits.

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