Madras Agric. J., 100 (1-3): 163-166, March 2013
https://doi.org/10.29321/MAJ.10.001263

**Short Note**

# Response to Seaweed Extract on Growth and Yield of Tomato (*Solanum lycopersicum* L.) Hybrid COTH 2

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**Investigation was undertaken to study the effect of seaweed gel on growth and yield of tomato hybrid COTH 2 at College Orchard, Horticultural College and Research Institute, Coimbatore during 2008-09 with ten treatments including one absolute control. The treatment NPK @ 200:300:200 kg ha$^{-1}$ + O6 EM and MA GEL @ 12.5 kg acre$^{-1}$ + O6 EM and MA GEL 1% spray recorded highest plant height, number of leaves, number of branches and leaf area index. Early flower opening and individual fruit weight, fruit yield per plant, yield per plot and yield per hectare were found to be higher.**

**Key words**: Tomato hybrid, seaweed gel, growth, yield

Tomato (*Solanum lycopersicum* L.) is one of the most widely grown vegetables and is an important source of vitamins A and C. Tomato is popularly grown throughout India and the major tomato producing states are Maharashtra, Bihar, Karnataka, Uttar Pradesh, Orissa, Andhra Pradesh, Madhya Pradesh and Assam. In India, tomato is cultivated in an area of 6.34 L.Ha, production of 124.3L t and productivity of 19.6 t ha$^{-1}$ (Indiastat.com, 2009-10). Inorganic fertilizers are usually quick release formulas making nutrients rapidly available to plants. But increasing cost of the chemical fertilizers is also limiting its optimal use. Indiscriminate use of chemical fertilizers can build up toxic concentration of salts in the soil, thus creating chemical imbalance leading to environmental hazards through leaching.

Seaweed extracts contain natural plant growth regulators (PGR) such as auxins and cytokinins which control the growth and structural development of plants. Application of seaweed (*Ascophyllum nodosum)* extract 1% to roots resulted in earlier germination and produced transplants with increased root length and shoot length compared to control in tomato (Poincelot, 1993). Heckman (1994) reported that application of ROOT PLUS 2% solution in the soil before transplanting increased the fresh cabbage yield by 13 %. Abdel Mawgoud *et al*., 2010 observed 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.

With this background, an attempt was made to study the effect of seaweed gel on growth and yield of tomato.

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## Materials and Methods

An experiment was conducted to study the effect of seaweed gel on growth and yield of tomato (*Solanum lycopersicum* L.) hybrid COTH 2 at College Orchard, Department of Vegetable Crops, Horticultural College and Research Institute, Coimbatore during 2008-09.

Seaweed liquid formulation O6 EM and MA GEL, a proprietary product of Bio Organic Technology (SNAP Natural and Alginate Products Ltd., Ranipet, Tamilnadu) was used as soil drenching and foliar feeding. O6 is a stabilized gel type sea algae based concentrate containing a consortium of beneficial bacteria, which acts as an effective microbial inoculants in the soil. EM formulation (Effective Micro organism) consists of both aerobic and anaerobic beneficial bacteria such as photosynthetic bacteria, nitrogen fixing bacteria and phosphate solubilizing bacteria. MA formulation (Micro Algae) is an efficient N-fixing Micro Algae, such as *Chroococus turgidus*. O6 EM and MA easily dissolve in water applied as soil drench (or) sprayed on the foliage. Soil drenching was done at five stages *viz.,* 30, 45, 60, 90, 120 days after planting, foliar application at three stages *viz*., vegetative, flowering and fruiting stages.

Fertilizer schedule was followed as for normal crop 200:300:200 NPK kg ha$^{-1}$. The experimental plot was laid out in red sandy loam in Randomized Block Design with ten treatment combinations replicated thrice. The plot size was 4 m x 3 m and spacing followed was 60 cm x 45 cm. Observations on growth and yield characters were recorded in five randomly selected plants and overall mean were computed and presented in the Table 1 and 2.

## Results and Discussion

### *Growth parameters*

### *Plant height*

Plant height of tomato was significantly influenced by the seaweed gel application (Table.1). Plant height of tomato crop varied from 54.9 cm to 65.1 cm.

The treatment, $T_7$ (NPK @ 200:300:200 kg $ha^{-1}$ + O6 EM and MA GEL @ 12.5 kg $acre^{-1}$ drenching + O6 EM and MA GEL 1% spray) produced significantly taller plants (65.1 cm) followed by $T_6$ (59.9cm). The lowest plant height (54.9cm) was recorded in $T_1$ (Control).

The prime physiological response of see weed gel is the better availability of cytokinin, which is important in improving cell division and promotion of specific protein synthesis that ultimately lead to better growth. In addition to this, auxins, IAA in particular supplied through the same seaweed gel enhanced adventitious root formation as well as better growth. Cytokinin also promoted production of laterals by inducing the axillary bud sprouting.

**Table 1. Response of seaweed extract on growth of tomato (*Solanum lycopersicum* Mill.) hybrid COTH 2**

| Treatment | Plant height (cm) | | | | No. of branches per plant | | | | No. of leaves per plant | | | | Leaf area index | | | | Days to first flowering |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 30 DAT | 60 DAT | 90 DAT | Mean | 30 DAT | 60 DAT | 90 DAT | Mean | 30 DAT | 60 DAT | 90 DAT | Mean | 30 DAT | 60 DAT | 90 DAT | Mean | |
| $T_1$ - NPK @ 200:300:200 kg per ha (control) | 31.6 | 51.6 | 81.5 | 54.9 | 3.5 | 8.7 | 11.9 | 8.0 | 19.7 | 49.3 | 67.3 | 45.4 | 1.09 | 2.47 | 3.45 | 2.33 | 27.9 |
| $T_2$ - $T_1$ + O6 EM and MA GEL@7.5 kg $acre^{-1}$ | 35.4 | 55.4 | 81.6 | 57.4 | 3.9 | 8.9 | 11.9 | 8.2 | 20.4 | 50.3 | 69.3 | 46.6 | 1.24 | 2.68 | 3.67 | 2.53 | 27.5 |
| $T_3$ - $T_1$ + O6 EM and MA GEL@10 kg $acre^{-1}$ | 37.2 | 57.2 | 83.2 | 59.2 | 3.8 | 8.7 | 11.7 | 8.1 | 20.4 | 51.2 | 69.4 | 47.0 | 1.42 | 2.95 | 3.98 | 2.78 | 27.6 |
| $T_4$ - $T_1$ + O6 EM and MA GEL@12.5 kg $acre^{-1}$ | 36.2 | 56.6 | 86.6 | 59.8 | 4.1 | 9.1 | 12.2 | 8.4 | 21.7 | 52.3 | 70.3 | 48.1 | 1.64 | 2.76 | 3.74 | 2.71 | 26.8 |
| $T_5$ - $T_2$ + O6 EM and MA GEL 1% spray | 34.6 | 54.6 | 84.8 | 58.0 | 4.5 | 10.2 | 13.0 | 9.2 | 21.9 | 53.9 | 70.5 | 48.8 | 1.68 | 2.84 | 3.76 | 2.76 | 27.1 |
| $T_6$ - $T_3$ + O6 EM and MA GEL 1% spray | 34.4 | 54.4 | 91.1 | 59.9 | 5.3 | 10.3 | 12.8 | 9.4 | 25.3 | 57.8 | 74.8 | 52.6 | 1.78 | 2.98 | 4.43 | 3.06 | 26.1 |
| $T_7$ - $T_4$ + O6 EM and MA GEL 1% spray | 41.6 | 61.2 | 92.6 | 65.1 | 6.3 | 10.8 | 13.8 | 10.3 | 27.4 | 59.4 | 76.9 | 54.6 | 1.98 | 3.45 | 4.65 | 3.36 | 25.1 |
| $T_8$ - Vermicompost (2.5 t $ha^{-1}$) | 34.5 | 54.5 | 80.6 | 56.5 | 5.1 | 10.3 | 11.8 | 9.0 | 21.8 | 54.7 | 71.8 | 49.4 | 1.74 | 2.83 | 4.12 | 2.89 | 27.4 |
| $T_9$ - Vermicompost (2.5 t $ha^{-1}$) + O6 EM and MA GEL@12.5 kg $acre^{-1}$ | 34.2 | 54.2 | 84.2 | 57.5 | 6.1 | 9.5 | 12.0 | 9.2 | 24.8 | 57.5 | 71.2 | 51.2 | 1.75 | 2.93 | 4.10 | 2.91 | 26.9 |
| $T_{10}$ - Vermicompost (2.5 t $ha^{-1}$) + O6 EM and MA GEL@12.5 kg $acre^{-1}$ + O6 EM and MA GEL 1% spray | 35.2 | 55.2 | 85.2 | 58.5 | 4.7 | 10.6 | 12.7 | 9.3 | 25.6 | 57.4 | 72.4 | 51.8 | 1.87 | 2.89 | 4.05 | 2.93 | 26.9 |
| Grand mean | 35.0 | 54.7 | 84.3 | | 4.6 | 9.6 | 12.2 | | 22.6 | 53.7 | 70.5 | | 1.59 | 2.84 | 3.95 | | 26.5 |
| SEd | 0.68 | 1.07 | 1.65 | | 0.09 | 0.18 | 0.24 | | 0.44 | 1.06 | 1.38 | | 0.03 | 0.06 | 0.07 | | 0.52 |
| CD(P=0.05) | 1.44 | 2.26 | 2.65 | | 0.19 | 0.39 | 0.50 | | 0.94 | 2.22 | 2.91 | | 0.07 | 0.12 | 0.16 | | 1.09 |

Aljuburi and Almarsry (1995) attributed that auxin marginally increased Relative Growth Rate in Balady lime seedlings. In foliar sprays, an auxin containing seaweed product “ROOT PLUS” resulted in taller plants than mere fertilizer treatment in Broccoli (Russo *et al.,* 1994). The plants treated with *Ascophyllum nodosum* showed increase in plant growth characters (Goswami, 1992). In addition to inorganic application, foliar spray of seaweed gel enhanced the growth rate of plants since it contains humic acid, vitamins and beneficial microorganisms in the liquid formulation. The observations of the present investigation are similar with the earlier reports of Piccolo *et al*. (1993), Bohme and Papadopoulos (1999) in tomato. Application of seaweed extract as foliar spray enhanced plant growth by making the growth promoting substances readily available to the plants through absorption and translocation (Ramamoorthy *et al*., 2007).

### *Number of branches per plant*

Number of branches progressively increased at all stages of crop growth. $T_7$ had significant influence on number of branches per plant and recorded more branches per plant at all stages (6.3, 10.8 and 13.8) followed by ($T_6$) which recorded 5.3, 10.3 and 12.8 respectively at 30, 60 and 90 days after planting.

The treatment $T_1$ (Control) recorded the lowest number of leaves per plant at all the five stages of crop growth with the values of 3.5, 8.7 and 11.9 (Table 1). Increased number of plants was obtained with the application of seaweed gel by Heckman (1994), and 15-20% increased shoot growth and total fresh weight (Gendy, 1993) in tomato, probably due to the availability of auxin, cytokinin and other micro elements present in the seaweed gel.

### *Number of leaves per plant*

Number of leaves progressively increased at all stages of crop growth. Plants treated with NPK @ 200:300:200 kg $ha_1$ + O6 EM and MA GEL @ 12.5 kg $acre^{-1}$ + O6 EM and MA GEL 1% spray ($T_7$) had significant influence on leaf number per plant and recorded more leaf number per plant at all the stages (27.4, 59.4 and 76.9) followed by NPK @ 200:300:200 kg $ha^{-1}$ + O6 EM and MA GEL @ 10 kg $acre^{-1}$ + O6 EM and MA GEL 1% spray) ($T_6$) which recorded 25.3, 57.8 and 74.8 respectively with treatment, $T_1$ (Control) recording the lowest number of leaves per plant at all the five stages of crop growth. Micro and macro elements present in the seaweed extract were responsible for the enhancement of the growth of wheat plants (Beckett and Van Staden, 1990). The growth parameters were found increased

at lower concentrations of seaweed extract as also reported in *Padina* which induced maximum seedling growth in *Cajanus cajan* (Mohan *et al.,* 1994) and *Phaseolus mungo* (Lingakumar *et al.,* 2006).

***Leaf Area Index (LAI)***

The treatment, $T_7$ recorded significantly higher LAI value (3.36) followed $T_6$ (3.06) and $T_1$ (Control) had recorded the lowest (2.33) (Table 1).

Increased dry matter may be attributed and increased carbohydrate accumulation resulting from a more efficient photosynthetic activity brought about by the anatomical modifications (Poincelot *et al*., 1993).

***Days to first flowering***

The treatment comprising NPK @ 200:300:200 kg $ha^{-1}$ + O6 EM and MA GEL @ 12.5 kg $acre^{-1}$ + O6 EM and MA GEL 1% spray ($T_7$ ) induced early flowering as compared to control (Table 1.). The early flowering and fruiting in the treated plants might be due to the fact that such plants were able to build suitable carbohydrate reserves early and accumulation of cytokinins in lateral buds making effective sink in the diversion of photoassimilates. Similar results were recorded in Broccoli and Tomato (Poincelot, 1994).

***Yield parameters***

***Number of fruits per plant***

The number of fruits recorded was higher (50.3) in the treatment $T_7$ , closely followed by $T_6$ with a value of 50.1 compared to $T_1$ that recorded the least number of fruits per plant of 42.4 (Table 2).

Highest fruit yield may be due to the most pronounced effects of seaweed extract application on development of vigorous root system, which is often expressed as higher yields due to more cytokinin synthesized and translocated to axillary buds. The results are in conformity with the findings of Poincelot, 1993.

**Table 2. Response of seaweed extract on yield of Tomato (*solanum lycopersicum* mill.) Hybrid COTH 2**

| Treatment | Number of fruits per plant | Single Fruit Weight (g) | Yield per plant (kg) | Fruit Yield (t/ ha) |
|---|---|---|---|---|
| $T_1$ - NPK @ 200:300:200 kg per ha (control) | 42.4 | 49.87 | 2.09 | 65.3 |
| $T_2$ - $T_1$ + O6 EM and MA GEL@7.5 kg $acre^{-1}$ | 45.6 | 50.63 | 2.11 | 71.0 |
| $T_3$ - $T_1$ + O6 EM and MA GEL@10 kg $acre^{-1}$ | 47.3 | 50.43 | 2.30 | 74.4 |
| $T_4$ - $T_1$ + O6 EM and MA GEL@12.5 kg $acre^{-1}$ | 47.1 | 52.34 | 2.31 | 76.0 |
| $T_5$ - $T_2$ + O6 EM and MA GEL 1% spray | 48.3 | 53.24 | 2.35 | 76.3 |
| $T_6$ - $T_3$ + O6 EM and MA GEL 1% spray | 50.1 | 54.34 | 2.49 | 79.8 |
| $T_7$ - $T_4$ + O6 EM and MA GEL 1% spray | 50.3 | 55.31 | 2.74 | 86.2 |
| $T_8$ - Vermicompost (2.5 t $ha^{-1}$) | 42.5 | 52.39 | 2.34 | 78.1 |
| $T_9$ - Vermicompost (2.5 t $ha^{-1}$) + O6 EM and MA GEL@12.5 kg $acre^{-1}$ | 48.1 | 53.43 | 2.38 | 78.5 |
| $T_{10}$ - Vermicompost (2.5 t $ha^{-1}$) + O6 EM and MA GEL@12.5 kg $acre^{-1}$ + O6 EM and MA GEL 1% spray | 49.8 | 53.54 | 2.48 | 81.6 |
| Grand mean | 46.6 | 51.86 | 2.44 | 76.4 |
| SEd 0.91 | 1.02 | 0.05 | 1.50 | |
| CD(P=0.05) | 1.93 | 2.14 | 0.10 | 3.16 |

***Single fruit weight (g)***

$T_7$ closely followed by $T_6$ recorded 55.31g and 54.34 g of fruits per plant (Table 2) caused by increased weight and fruit yield in the treated plants due to the fact that they remained physiologically active to build up sufficient food materials and reserve for developing flowers and fruits. Similar results were found by (Nilsun *et al*., 2006) in tomato.

***Yield per plant (kg)***

The mean fruit yield varied from 2.09 kg in ($T_1$) to 2.74 kg $plant^{-1}$ ($T_7$) (Table 2). The difference in concentration of chemical in influencing yield could possibly be due to interaction of chemicals with the existing variation weather parameters like light intensity, temperature *etc.,* Increased fruit yield may also be due to the presence of plant growth regulators(IAA, GA, Kinetin and Zeatin) (Zodape *et al*., 2008 ; Abdel Mawgoud *et al.,* 2010).

***Fruit Yield (t / ha)***

Highest fruit yield was recorded in $T_7$ (86.2 Tonnes) which was significantly higher compared to other treatments closely followed by $T_6$ (79.8 Tonnes) and $T_1$ (control) recording 65.3 tonnes only(Table 2) . Increased yield may be due to increased fruit set and better fruit weight through better canopy establishment, better interception of light through significant reduction in interplant competition for solar energy and soil nutrition. This would have increased efficiency of plants photosynthesis and translocation of assimilates to the points of fruit set. Seaweed extract would also have increased yield through enhanced availability of cytokinins, the accumulation of which in lateral

buds would have made them as effective sinks in the diversion of photoassimilates as well as other flower inducing hormones which ought to have ultimately resulted in better flowering and in turn yield (Pramod Kumar *et al*., 2000).

## Conclusion

Application of NPK @ 200:300:200 kg $ha^{-1}$ + O6 EM and MA GEL @ 12.5 kg $acre^{-1}$ as soil drenching + O6 EM and MA GEL 1% spray ($T_7$) at vegetative, flowering and fruiting stages recorded the highest net return in COTH 2 tomato hybrid. The combined application of inorganic fertilizers and seaweed gel significantly influenced the growth and yield through better light interception, canopy management and enhanced availability of cytokinin, auxin provided by seaweed formulation.

## Acknowledgement

The financial assistance provided by M/s. Bio Organic Technology (SNAP Natural and Alginate Products Ltd., Ranipet, Tamilnadu) for conducting the present study is gratefully acknowledged.

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Received: October 16, 2012; Accepted: November 24, 2012