EFFECT OF BORON AND SILICON FERTILIZATION ON THE GROWTH, YIELD AND NUTRIENT UPTAKE BY TOMATO (Lycopersicon esculentum L.) IN COASTAL SALINE SANDY SOIL

[1]S. KARTHIKA, [1]D. ELAYARAJA, [2]S. JAWAHAR AND [3]NEERU JAIN
[1]Department of Soil Science and Agricultural Chemistry, [2]Department of Agronomy,
Faculty of Agriculture, Annamalai University, Annamalai Nagar- 608 002.
[3]Head, Application Research Privi Life Sciences Pvt., Ltd., Navi Mumbai, Maharashtra, India

ABSTRACT

A field experiment was carried out at Perampattu coastal farmer's field during July-October, 2018, to study the effect of boron and silicon fertilization on the growth, yield and nutrients uptake by tomato in coastal saline sandy soil. Texturally, the experimental soil was sandy loam and taxonomically classified as *Typic Ustifluvent* with initial soil characteristics (0-15 cm layer) of the experimental site were, pH–8.41 and EC–2.85 dS m^{-1}. The soil registered low organic carbon status of 2.31 g kg^{-1}, 134.56 kg ha^{-1} of alkaline $KMnO_4$ –N; 9.43 kg ha^{-1} of Olsen–P and 159.31 kg ha^{-1} of NH_4OAc-K, respectively. The available hot water soluble B content of 0.07 mg kg^{-1} and silicon content of 84.0 mg kg^{-1} in soil. The various treatments included were, T_1- Control (RDF alone), T_2 –RDF + Composted coirpith (CCP) @ 12.5 t ha^{-1}, T_3–RDF + Borax @ 15 kg ha^{-1} + Silixol granules @ 20 kg ha^{-1} soil application (SA), T_4-RDF + Borax + Silixol granules foliar application (FA) @ 0.5% twice at pre-flowering (PFS) and flowering stage (FS), T_5-RDF + CCP + Borax @ 15 kg ha^{-1} + Silixol granules @ 20 kg ha^{-1} (SA), T_6-RDF + CCP + Borax + Silixol granules (FA) and T_7–RDF + CCP + Borax + Silixol granules (SA+FA). The above treatments were arranged in a Randomized Block Design (RBD) with three replications and tested with tomato var. Shivam hybrid as test crop. The results of the study clearly indicated that the yield benefit of the treatment (T_7), combined application of recommended dose of NPK fertilizer + borax @ 15 kg ha^{-1} + silixol granules @ 20 kg ha^{-1} (SA) through soil as well as foliar spray of borax @ 0.5% + silixol @ 0.5 per cent twice at pre flowering and flowering stage along with CCP @ 12.5 t ha^{-1} superior in increasing the growth, yield and nutrient uptake by tomato.

Key words: *Borax, Silxol Granules, Fertilization, RDF, CCP, Growth, Yield, Nutrient Uptake, Tomato.*

I. INTRODUCTION

The boron is the most common micronutrient deficient in coastal saline soils, which are facilitates with coarse textured and highly leached due to poor organic matter status. Boron is an essential micronutrient is needed very much for the growth, quality of fruits and fruit yield of tomato. Boron is known to arrest the flower drop, increased the size of fruits as well as more number of fruits production. Boron also plays a pivotal role in cell division in the process of nodule formation besides its involvement in vitamins and carbohydrate synthesis and also plays an important role in various enzymatic activities in the development of plant growth and increasing the fruit yield and quality of tomato crop. Several earlier works has emphasized the need for application of boron for increasing the growth, yield and fruit quality of tomato (Barche *et al.,* 2011 and Meena *et al.*, 2015). In coastal saline soils the deficiency of macro and micronutrients are common due to poor organic matter and cation exchange capacity. In coarse textured soils, even the applied nutrients are leached due to poor retention capacity of nutrients which lead to low use efficiency of applied fertilizers under saline condition.

Further, salinity causes unfavourable conditions that restrain normal crop production. The factors that contribute significantly to salinity were soil salinity causes like seawater intrusion and direct watering of crops with saline water. The wetted foliage of growing tomato absorbs the salts directly. As a result, salinity in coastal areas affects tomato growth and in severe cases which resulted in total yield loss. These soils are low in N, low to medium in P and medium to high in K status (Swarajyalakshmi *et al.*, 2003). Due to the heavy losses in tomato production, farmers did not take risk with tomato cultivation. Apart from nutrient deficiencies, micronutrient deficiency is one of the major limiting factors for crop production in coastal saline soil. Among the micronutrients, boron plays an important role in improving the yield and quality of tomato in addition to checking various diseases and physiological disorders (Salam *et al*. 2011). Plants, especially fruit crops, can take up large amounts of silicon where it contributes to their mechanical strength. Silicon interferes in the plant growth, by providing more erect leaves, increasing solar radiation interception, photosynthetic efficiency, tolerance to various biotic and abiotic stresses and increases yield. Further, Silicon foliar spray improved growth and physiological indices hence could increase the ability of plants to resistance water stress (Asgharipour and Mosapour, 2016). Tomato is one of the major vegetable crops grown in coastal soils and responds to high levels of boron and silicon fertilization. Therefore it is quite meaningful to evaluate the effect of increased levels of boron and silicon for tomato in coastal saline soil. Hence, the present study was carried out to study the effect of boron and silicon fertilization on the growth, yield and nutrient uptake by tomato in coastal saline sandy soil to alleviate the biotic and abiotic stress on tomato crops and to enhance their productivity.

II. MATERIALS AND METHODS

A field experiment was conducted in a farmer's field at Perampattu coastal village, near Chidambaram in Cuddalore district, Tamilnadu during July –October, 2018. The initial soil of the experimental site had a pH–8.41 and EC-2.85 d Sm^{-1}. The soil was low in organic carbon (2.31 g kg^{-1}), low in available N (134.56 kg ha^{-1}), available P (9.43 kg ha^{-1}) and medium in available K (159.31 kg ha^{-1}). The various treatments included were, T_1- Control (RDF alone), T_2 –RDF + Composted coirpith (CCP) @ 12.5 t ha^{-1}, T_3 –RDF + Borax @ 15 kg ha^{-1} + Silixol granules @ 20 kg ha^{-1} soil application (SA), T_4-RDF + Borax + Silixol granules foliar application (FA) @ 0.5% twice at pre-flowering (PFS) and flowering stage (FS), T_5-RDF + CCP + Borax @ 15 kg ha^{-1} + Silixol granules @ 20 kg ha^{-1} (SA), T_6-RDF + CCP + Borax + Silixol granules (FA) and T_7–RDF + CCP + Borax + Silixol granules (SA+FA). The experiment was laid out in a Randomized Block Design (RBD) with three replications, using tomato var. Shivam hybrid as test crop. An uniform fertilizer dose of 200 kg of N + 250 kg of P_2O_5 + 250 kg of K_2O per hectare for tomato was applied as urea, single super phosphate and muriate of potash, respectively. The entire dose of N, P_2O_5 and K_2O were applied as basal. Composted coirpith (CCP) @ 12.5 t ha^{-1} were applied basally and well incorporated into the soil as per the treatment schedule. Required quantities of boron and silicon as per the treatment schedule were applied through soil as well as foliar. Foliar application of B and Si @ 0.5 per cent at pre flowering and flowering stage was applied as per the treatment. The biofertilizer *Azospirillum* @ 2 kg ha^{-1} was applied to all the experimental plots. Various growth components like plant height, number of branches $plant^{-1}$and dry matter production (DMP) recorded at different critical stages like flowering, fruit formation and at harvest stage. The yield components *viz.*, number of fruits $plant^{-1}$, fruit diameter, fruit set percentage and single fruit weight was recorded at harvest stage. The fruit and stover samples were collected at different critical stages and analysed for the content of N, P, K, B and Si using the standard procedure as outlined by Jackson (1973) and uptake were calculated. At harvest fruit and stover yield were also recorded.

III. RESULTS AND DISCUSSION

Growth characters (Table 1)

The application of boron + silicon either through soil or foliage along with organics significantly and positively influenced the growth characters *viz.*, plant height, number of branches per plant and dry matter production at different growth stages of tomato. Among the various treatments, the treatment (T_7), combined application of recommended dose of NPK + composted coirpith (CCP) @ 12.5 t ha^{-1} + borax @ 15 kg ha^{-1} + silixol granules @ 20 kg ha^{-1} through soil application along with foliar application of borax @ 0.5% + silixol granules @ 0.5 per cent twice at pre flowering stage (PFS) and at flowering stage (FS) recorded the highest plant height (126.00 cm), number of branches $plant^{-1}$ (18.20) and dry matter production(16.46 t ha^{-1}) at the harvest stages of tomato, respectively. This was followed by the treatments individual application of boron and silicon nutrients (borax + silixol granules) and mode of applied (soil or foliar alone) treatments arranged in the descending order like $T_5 > T_6 > T_3$ and T_4. This was followed by the treatment T_2, application of recommended NPK along with CCP (without boron and silicon nutrition). The control produced the shortest plants and lowest number of branches $pant^{-1}$ and dry matter production of tomato over all other treatments.

In coastal saline soil, tomato responded well to the application of silicon and boron nutrition. Among the various treatments, the treatment (T_7), combined application of recommended dose of NPK fertilizer + composted coirpith (CCP) @ 12.5 t ha^{-1} + borax @ 15 kg ha^{-1} + silixol granules @ 20 kg ha^{-1} through soil application along with foliar application of borax @ 0.5% + silixol granules @ 0.5 per cent twice at pre flowering stage (PFS) and at flowering stage (FS) recorded the highest plant height, number of branches plant^{-1} and dry matter production. This might be due to the increased nutrient supply with the addition of fertilizer and organics. Further, foliar spray of micronutrients as boron and beneficial elements of silicon as "quasi-essential" might have induced the synthesis of chlorophyll content and direct effect of plant growth like enzymatic activity which in turn resulted in higher vegetative growth parameters *viz.*, plant height, number of branches per plant and DMP. These findings also are in conformity with several workers of Xie *et al.* (2015) and Jawahar *et al.* (2019).

Yield characters (Table 2)

The application of boron and silicon either through soil or foliage along with recommended dose NPK fertilizer (RDF) and organics (CCP) significantly and positively influenced the yield characters *viz.*, number of fruits plant^{-1}, single fruit weight, fruit diameter and fruits set percentage of tomato. However, the combined addition of organics, boron and silicon nutrition (B + Si) by both soil and foliage recorded the better response in respect of yield characters than sole application of RDF alone.

Among the various treatments, combined application of 100% recommended dose of NPK + composted coirpith @ 12.5 t ha^{-1} + borax @ 15 kg ha^{-1} + silixol granules @ 20 kg ha^{-1} through soil application as well as foliar spray (borax + silixol) @ 0.5 per cent twice at pre flowering stage and at flowering stage (T_7) recorded the highest number of fruits plant^{-1} (49.23), single fruit weight (102.01g), fruit diameter (5.78 cm) and fruits set percentage (88.18 %) of tomato, respectively. This was followed by the treatments which received RDF + CCP + B @ 15 kg ha^{-1} + Si @ 20 kg ha^{-1} through soil application (T_5) and RDF + CCP + B + Si through foliar application (T_6). This was followed by T_4, the application of RDF + borax + silixol granules (SA) through soil alone and treatment T_3, the application of RDF + borax + silixol @ 0.5% (FA) through foliar spray alone recorded the lowest yield characters as compared to combined application of boron and silicon (borax and silixol granules) as well as mode of application (soil and foliar spray) and without organics. The treatments recommended dose of NPK fertilizer along with composted coirpith @ 12.5 t ha^{-1} (T_2) recorded a yield characters viz., number of fruits plant^{-1} (28.88), single fruit weight (54.94 g), fruit diameter (3.87 cm) and fruits set percentage (50.14) of tomato, respectively. The minimum yield parameters such as number of fruits plant^{-1} (22.14), single fruit weight (48.91 g), fruit diameter (3.02 cm) and fruits set percentage (42.49) of tomato was recorded in the treatment T_1, (without B and Si nutrition and organics).

The combined application of silixol granules @ 20 kg ha^{-1} + borax @ 15 kg ha^{-1} through soil and foliar spray of borax and silixol granules @ 0.5% twice along with RDF + composted coirpith had produced the highest number of fruits plant^{-1}, single fruit weight, fruit diameter and fruit setting percentage. The beneficial influence of boron and silicon nutrition's as on the yield components of tomato might be due to activation of various enzymes and efficient utilization of applied nutrients, especially nitrogen and phosphorus, resulting in increased yield components as reported by Jarosz (2014) and Islam *et al.* (2018). Further, boron as essential micronutrient plays an important role in increasing pollen germination and pollen tube enlargement, fruit set percent and finally the yield. This statement collaborates with our research findings and resulted in better yield characters as reported by Abdul Kalam Azad (2007). Moreover, boron also responsible for stimulating cell division, biosynthesis and translocation of sugars, water and nutrient uptake and also IAA biosynthesis. The earlier report of Salim (2014) also supported the present findings.

Yield of tomato (Table 2)

The tomato responded well for the boron and silicon nutrition fertilizers application. The significant influence of B and Si fertilization (boron +silicon) along with recommended dose of NPK and organics in increasing the fruit and stover yield of tomato was well documented in the present study.

The yield realized under the present field experiment confirmed the results of previous pot experiment. The nutrient poverished coastal sandy loam soil, recorded the highest fruit yield (24.25 t ha^{-1}) and stover yield (15.01 t ha^{-1}) was recorded with combined application of recommended dose of NPK fertilizer + borax @ 15 kg ha^{-1} + silixol granules @ 20 kg ha^{-1} (SA) through soil as well as foliar spray of borax @ 0.5% + silixol @ 0.5 per cent twice at pre flowering and flowering stage along with CCP @ 12.5 t ha^{-1} (T_7). This was followed by the treatments T_5, (RDF + borax @ 15 kg ha^{-1} (SA) + silixol granules @ 20 kg ha^{-1} (SA) + CCP @ 12.5 t ha^{-1}), T_6 (RDF + Borax @ 0.5% (FA) + Silixol granules @ 0.5% (FA) + CCP @ 12.5 t ha^{-1}), T_3 (RDF +Borax @ 15 kg ha^{-1}+ Silixol granules @ 20 kg ha^{-1} (SA) through soil alone, T_4 (RDF +borax + silixol @ 0.5% (FA) through foliar spray alone and T_2 (RDF + CCP @ 12.5 t ha^{-1}). Of all the treatments, the treatment (T_7), which received recommended dose of NPK + composted coirpith along with boron and silicon nutrients through both soil (Borax @ 15 kg ha^{-1} + Silixol granules @ 20 kg ha^{-1}) and foliar (Borax @ 0.5% + Silixol granules @ 0.5%) application recorded a fruit and stover yield of 24.25 t ha^{-1} and 15.01 t ha^{-1} which was 74.63 and 48.23 per cent increase over control or 100 per cent NPK alone (without B + Si nutrition and organics). The control treatment T_1, 100 per cent NPK alone recorded a lower fruit (6.15 t ha^{-1}) and stover (7.77 t ha^{-1}) yield of tomato, respectively.

The tomato yield improvement in the treatment supplied with borax @ 15 kg ha^{-1} + silixol granules @ 20 kg ha^{-1} though soil application (SA) + borax and silixol granules @ 0.5 per cent through foliar application (FA) along with recommended NPK + CCP @ 12.5 t ha^{-1} is associated with increased growth and yield attributes of tomato. Application of boron + silicon nutrition and organics helped in the slow and steady rate of nutrient release into soil solution to match the required absorption pattern of tomato and increased the yield. Further, the favourable effect of B and Si on fruit and stover yield was also might be attributed to their effect in maintaining soil available nutrients in balanced proportions for better growth of tomato. The pronounced effect of boron and silicon foliar spray might have helped in enhancing the enzyme and photosynthetic activities, accumulation of photosynthates thereby higher fruit yield. This corroborates the earlier report of Ahmed *et al*. (2008) and Islam *et al.* (2018).

MAJOR NUTRIENTS UPTAKE BY TOMATO (Table 3)

Nitrogen Uptake

The N uptake of tomato at all the critical stages of crop growth and in fruit and stover was significantly increased with the B and Si fertilization. Application of recommended dose of NPK and CCP along with boron as borax and silicon as silixol granules either through soil or foliage and or both significantly increased the uptake of major nutrients by tomato.

Application of boron and silicon through soil and foliar spray recorded the higher nutrients uptake than either soil application or foliar spray only. Among the treatments evaluated, the combined application of boron + silicon through soil and foliage along with recommended dose of NPK and organics recorded the highest N uptake by tomato as compared to other treatments. The treatment T_7, recommended dose of NPK + CCP along with soil application of borax @ 15 kg ha^{-1} + silixol @ 20 kg ha^{-1} and foliar spray @ 0.5 per cent ranked best and recorded the highest N uptake of 50.23 and 87.98 kg ha^{-1} by fruit and stover, respectively. This was followed by treatment T_5, where soil application of borax @ 15 kg ha^{-1} + silixol @ 20 kg ha^{-1} along with composted coirpith and then treatment T_6, which received foliar application of borax + silixol @ 0.5 per cent along with RDF and CCP. The treatment T_5, recorded a N uptake of 47.54 and 83.67 kg ha^{-1} and treatment T_6, recorded a N uptake of 44.95 and 79.51 kg ha^{-1} by fruit and stover, respectively. The application of RDF + borax + silixol through soil application (T_3) and RDF + borax + silixol through foliar application (T_4) recorded a lower N uptake by tomato as compared to T_5 and T_6. Application of CCP along with RDF (T_2) having higher N uptake as compared to the treatment which received NPK alone (T_1). The lowest N uptake of 32.99 and 61.82 kg ha^{-1} by fruit and stover was noticed in control.

The N uptake was increased by combined application of recommended dose of NPK and organics (CCP) along with B @ 15 kg ha^{-1} + Si @ 20 kg ha^{-1} through soil application (SA) and B + Si through foliar application (FA) @ 0.5% twice as compared to sole application of B and Si either through soil or foliar alone. This is because of the fact that the micronutrient like boron is involved in nitrogen fixation and translocation into plant parts, which might have increased the N content of plants. The higher nitrogen absorption may also be due to stimulatory or positive effect of boron on nitrogen uptake. Further, the alkaline $KMnO_4$-N content of soil was also high for the above treatments. This might have naturally resulted in enhanced absorption of N by the crop ultimately leading to higher N uptake. In line with the present study, Barman *et al*. (2014) and Sainath Nagula (2014) also reported similar results.

Phosphorus Uptake

Mode of application had a significant difference in improving P uptake by tomato. Soil application of B + Si shared better response than foliar spray. Application of B + Si through both soil and foliage recorded the highest response in phosphorus uptake by tomato. Among the treatments, the combined application of B + Si fertilization *viz.*, borax and silixol granules through soil and foliar along with organics and NPK (T_7) accounted for a highest P uptake at different stages in plants and in fruit and stover. The highest phosphorus uptake of 9.72 kg ha^{-1} at flowering, 15.54 kg ha^{-1} at fruit formation and 20.64 kg ha^{-1} by fruit and 25.49 kg ha^{-1} by stover, respectively were recorded with recommended NPK + borax @ 15 kg ha^{-1}

+ silixol granules @ 20 kg ha^{-1} (SA) through soil and foliar spray of borax + silixol granules @ 0.5 per cent along with CCP @ 12.5 t ha^{-1} (T_7). This was followed by the treatment $T_{5,}$ (RDF + B @ 15 kg ha^{-1} + Si @ 20 kg ha^{-1} through soil along with CCP @ 12.5 t ha^{-1}) and treatment $T_{6,}$ (RDF + B + Si @ 0.5% foliar along with CCP @ 12.5 t ha^{-1}). These two treatments registered the P uptake of 19.08 and 17.46 kg ha^{-1} in fruit and 23.60 and 21.70 kg ha^{-1} in stover, respectively. This was followed by the treatments $T_{3,}$ B + Si (SA) and T_4, B + Si (FA) along with recommended NPK recorded a P uptake of 15.88 and 14.21 kg ha^{-1} in fruit and 20.02 and 18.10 kg ha^{-1} in stover, respectively. The control recorded the lowest P uptake (10.77 and 13.92 kg ha^{-1}) in fruit and stover, respectively as compared to treatment T_2, (12.52 kg ha^{-1} in fruit and 16.04 kg ha^{-1} in stover).

The highest P uptake was registered with the application of recommended NPK + B and Si fertilization along with composted coirpith, which ensured greater P uptake perhaps due to the complexation and chelation process and solubilization of P through organic acids release encountered by CCP. Further, higher P uptake recorded in tomato, receiving composted coirpith application might be due to more solubilizatin of native P from soil due to the action of various organic acids liberated by organic manure. Similar findings were also reported by Hossain *et al*. (2012).

Potassium Uptake

The uptake of potassium by tomato at all the growth stages as well as by fruit and stover was also significantly increased with boron and silicon fertilization and recommended NPK along with organics. Among the various treatments, the combined application of recommended NPK + CCP @ 12.5 t ha^{-1} + borax @ 15 kg ha^{-1} SA + silixol granules @ 20 kg ha^{-1} SA along with borax and silixol FA @ 0.5 per cent twice (T_7) registered the highest uptake of K at all the growth stages. This was followed by the treatments T_5 (RDF + CCP + borax + silixol granules as SA alone) and T_6 (RDF + CCP + borax + silixol granules as FA alone). The treatment T_5 and T_6 recorded a significant K uptake of 67.54 and 62.88 kg ha^{-1} by fruit and 111.01 and 101.65 kg ha^{-1} by stover, respectively. This was followed by the treatments $T_3 > T_4$ and T_2. The treatment T_1, application of 100% NPK alone (without organics and B + Si) recorded the lowest K uptake of 42.97 and 68.85 kg ha^{-1} by fruit and stover, respectively.

Increased K uptake might be due to better plant growth leading to higher uptake of nutrients and further on the stimulatory effect of B + Si in absorption of potassium. These results are in accordance with the findings of Islam *et al.* (2011). The ready availability of K and other nutrients from inorganic sources produced adequate biomass which resulted in better nutrient uptake of the crop. These findings are in agreement with Singh *et al.* (2006). Further added organics improved the organic carbon content of soil through decomposition which helped in the release of organically bound macro and micronutrients in soil. Earlier findings of Ray *et al.* (2005) and Noor *et al.* (2011) also reported such increased availability of nutrients with organics.

BORON AND SILICON UPTAKE BY TOMATO (Table 4)

Boron Uptake

The effect due to the different methods of boron + silicon nutrition application along with NPK and composted coirpith had significant influence on boron uptake by tomato at all the critical stages. Among the various treatments, the highest B uptake by fruit (5.17 g ha^{-1}) and stover (3.37 g ha^{-1}) was recorded with the application of recommended dose of NPK + CCP @ 12.5 t ha^{-1} along with soil application of borax @ 15 kg ha^{-1} + silixol granules @ 20 kg ha^{-1} and foliar spray (borax + silixol granules) @ 0.5 per cent twice (T_7). This was followed by the treatments which received both the nutrition (B and Si) with single mode of fertilization either soil or foliar applied treatments. The treatment T_5, (RDF + CCP + borax + silixol SA alone) and T_6, (RDF + CCP + borax + silixol FA alone) recorded a lowest B uptake of tomato as compared to above said treatment (boron + silicon nutrition both soil and foliar.) This was followed by the treatments significantly arranged in the descending order as $T_3 > T_4 >$ and T_2. These treatments were also statistically significant. Application of 100 per cent NPK alone (T_1) recorded a comparatively lower B uptake of 2.82 g ha^{-1} by fruit and 1.76 g ha^{-1} by stover as compared to application of RDF along with CCP (T_2) which recorded a B uptake of 3.49 and 2.06 g ha^{-1} by fruit and stover, respectively.

The addition of recommended dose of NPK fertilizers along with silicon and boron through soil and foliar spray enhanced the uptake of boron by tomato. This might be due to increased availability of these nutrients released from applied fertilizers. Further, micronutrient fertilizer borax applied through foliage would have been easily absorbed and translocated to the plants directly without spending energy for their transport and without any loss in transit, resulted in increased boron uptake. Similar results were earlier reported by Elayaraja (2008) and Sivaranjani (2017).

Silicon Uptake

A significant increase in silicon nutrition due to the application of NPK + organics and boron + silicon fertilization was well evidenced in the present investigation. As like boron uptake, the highest Si uptake by tomato at all the stages was recorded with the application of recommended dose of NPK fertilizer + composted coirpith @ 12.5 t ha^{-1} + borax @ 15 kg ha^{-1} (SA) + silixol granules @ 20 kg ha^{-1} (SA) through soil and foliar spray of borax + silixol @ 0.5 per cent (T_7). It recorded a Si uptake of 36.29 and 15.82 g ha^{-1} by fruit and stover, respectively. This was followed by the treatments arranged in the descending order like $T_5 > T_6 > T_3 > T_4$ and T_2. These treatments were also statistically significant. The control (NPK alone) treatment recorded the lowest Si uptake at all the critical stages of tomato (without B + Si nutrition and CCP).

Application of silicon played a stimulatory effect on the availability of the micronutrients *viz.,* B. The effect of the treatment *i.e.,* combined application of borax + silixol along with composted coirpith was more pronounced in increasing the B and Si availability. The increase of nutrients in soil might be attributed to the improved availability of nutrients. In the case of boron with the direct addition by fertilizer coupled with the involvement of decomposition products which has increased the availability of these nutrients through solubilization and complexation reaction resulting in grater absorption and uptake (Gunes *et al.,* 2008).

Further a synergistic effect of silicon and boron on the concentration of the nutrients *viz.*, B and Si was reported by earlier works (Ma and Takahashi, 2002 and Singh *et al*. (2006).

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Table 1. Effect of composted coirpith, boron and silicon fertilization on the growth characters of tomato

Treatments	Plant height (cm)			No. of branches plant^{-1}			Dry matter production (t ha^{-1})		
	FS	FFS	HS	FS	FFS	HS	FS	FFS	HS
T_1	29.75	60.33	70.20	6.01	9.32	9.10	2.06	4.18	5.84
T_2	32.83	67.75	96.50	6.47	10.14	11.40	4.42	6.03	7.41
T_3	40.87	82.24	110.00	7.43	12.05	14.50	6.56	9.92	11.18
T_4	37.04	74.70	103.40	6.99	11.12	13.30	5.83	8.21	9.39
T_5	51.12	96.18	123.80	8.31	13.73	17.00	8.15	12.20	14.81
T_6	45.86	88.20	117.20	7.85	12.91	15.80	7.41	10.85	12.80
T_7	55.18	102.95	126.00	8.72	14.65	18.20	8.83	12.92	16.46
SE_D	1.34	2.49	2.75	0.18	0.35	0.35	0.19	0.30	0.33
CD (p=0.05)	2.82	5.23	5.98	0.39	0.75	0.78	0.41	0.65	0.74

Table 2. Effect of composted coirpith, boron and silicon fertilization on the yield characters and yield of tomato

Treatments	Yield characters				Yield	
	Number of fruits plant^{-1}	Single fruit weight (g)	Fruit diameter (cm)	Fruit set percentage	Fruit yield (t ha^{-1})	Stover yield (t ha^{-1})
T_1	22.14	48.91	3.02	42.49	6.15	7.77
T_2	28.88	54.94	3.87	50.14	8.52	8.82
T_3	39.08	72.18	4.71	67.39	11.52	11.10
T_4	34.24	63.24	4.44	62.14	10.29	10.24
T_5	45.58	96.02	5.37	81.05	20.69	13.26
T_6	42.86	85.41	5.03	75.33	17.08	12.14
T_7	49.23	102.01	5.78	88.18	24.25	15.01
SE_D	1.14	2.48	0.11	2.00	0.46	0.31
CD (p=0.05)	2.48	5.21	0.24	4.36	1.02	0.68

Table 3. Effect of composted coirpith, boron and silicon fertilization on the major nutrients (NPK) uptake (kg ha^{-1}) by tomato

Treatments	Nitrogen				Phosphorus				Potassium			
	FS	FFS	HS		FS	FFS	HS		FS	FFS	HS	
			Fruit	Stover			Fruit	Stover			Fruit	Stover
T_1	11.24	15.78	32.99	61.82	7.21	11.16	10.77	13.92	18.16	55.35	42.97	68.85
T_2	13.08	17.59	36.67	66.70	7.69	12.01	12.52	16.04	19.57	59.21	48.66	78.41
T_3	15.35	19.88	42.06	75.26	8.47	13.47	15.88	20.02	22.28	65.31	58.35	94.76
T_4	14.23	18.73	39.44	70.90	8.10	12.76	14.21	18.10	20.95	62.19	53.78	86.07
T_5	17.37	22.13	47.54	83.67	9.33	14.82	19.08	23.60	24.88	71.61	67.54	111.01
T_6	16.34	20.99	44.95	79.51	8.95	14.14	17.46	21.70	23.57	68.63	62.88	101.65
T_7	18.35	23.22	50.23	87.98	9.72	15.54	20.64	25.49	26.16	74.85	72.14	118.36
SE_D	0.85	1.08	2.45	1.89	0.23	0.28	0.72	0.88	0.60	1.35	1.76	2.40
CD (p=0.05)	0.43	0.51	1.16	4.12	0.36	0.61	1.43	1.86	1.26	2.93	3.84	5.21

Table 4. Effect of composted coirpith, boron and silicon fertilization on the boron and silicon uptake by tomato

Treatments	Boron (g ha^{-1})				Silicon (g ha^{-1})			
	FS	FFS	HS		FS	FFS	HS	
			Fruit	Stover			Fruit	Stover
T_1	1.54	1.49	2.82	1.76	7.32	15.35	14.25	8.47
T_2	1.64	1.73	3.49	2.06	10.57	18.84	18.59	7.76
T_3	1.98	2.18	4.10	2.66	15.65	26.51	25.56	12.13
T_4	1.83	1..95	3.82	2.38	13.62	23.49	21.91	10.12
T_5	2.32	2.58	4.82	3.12	17.90	32.28	33.93	14.80
T_6	2.16	2.39	4.42	2.85	16.88	30.16	30.24	13.57
T_7	2.44	2.73	5.17	3.37	19.89	34.31	36.29	15.82
SE_D	0.04	0.03	0.12	0.06	0.37	0.77	0.92	0.37
CD (p=0.05)	0.10	0.08	0.28	0.15	0.82	1.68	2.01	0.82