*Eco. Env. & Cons. 26 (February Suppl. Issue) : 2020; pp. (S100-S106)*
*Copyright@ EM International*
*ISSN 0971–765X*

# Effect of boronated sulphur on the growth and yield of Cauliflower

**D. Panda and S. Mondal**

***Department of Crop Physiology, Institute of Agriculture, Visva-Bharati University, P.O. Sriniketan 731 236, West Bengal, India***

(Received 28 July, 2019; accepted 29 October, 2019)

**ABSTRACT**

A field experiment was conducted at Agriculture Farm of Institute of Agriculture, Visva-Bharati University, Sriniketan to study the effect of different levels of Boronated Sulphur on cauliflower during Rabi season of 2018-19. The growth and yield parameters of cauliflower were recorded at 40 and 60 DAT. The experimental finding revealed that fertilization with Boronated Sulphur (7.5 kg/ha, 10 kg/acre, 15kg/ha and 20kg/ha) significantly increased the growth parameters such as plant height and number of leaves per plant both at 40 and 60 DAT, whereas significantly reduced the days required to curd initiation and curd maturity. However, application of 10kg/ha of Boronated sulphur significantly increased the yield parameters of cauliflower such as curd wt./plant and curd yield/ha. The ascorbic acid content of the curds was found to be significantly higher from treatments of Boronated Sulphur $T_3$ (10 kg/acre) and $T_4$ (15kg/acre). However, $T_3$ (10 kg/acre of Boronated Sulphur) was the best treatment in terms of growth as well as yield parameters of cauliflower such as plant height (21.77cm), number of leaves per plant (18.17), stem diameter (2.34 cm), curd initiation (65.2 days), curd maturity (67.2 days), curd weight (726.83g), fresh curd yield (17.44 t/ha), vitamin C (41.47 mg/l00g) and physiological parameters such as chlorophyll a (2.102 mg/g), chlorophyll b (0.869 mg/g), total chlorophyll (2.970 mg/g) and carotenoids (0.344 mg/g) content and relative leaf water content (82.3%).

***Key words**: Boron, Boronated sulphur, Growth, Cauliflower, Sulphur, Yield*

## Introduction

Cauliflower (*Brassica oleracea* var. botrytis) is one of the important cole crops of India. This annual vegetable crop which belongs to the family Brassicaceae is propagated by seeds. The edible head, which is an immature inflorescence, is also called as curd. The head of a cauliflower is a white inflorescence meristem. Weather is a limiting factor for the production of cauliflower in the fact that this crop requires a day time temperatures 21-29 $^oC$ sunny and moist soil condition. This vegetable has a lot of demand due to its delicious taste and culinary uses. India is one of the leading producers of vegetables and ranks second next to china in terms of total production. The total area under vegetable production in India was 10259 thousand ha in the year 2017-18 and the total production was 184394 thousand MT (Anonymous, 2019). India contributes about 14 percent of world production of vegetables (Moklikar *et al.,* 2018). According to national nutrition guidelines average recommended vegetable consumption is 300 g (Krishnaswamy *et al.,* 2003). However, the actual per capita consumption of vegetables in India is 175 g (Moklikar *et al.,* 2018). Among the vegetables potato, tomato, onion, cabbage and cauliflower account for around 60% of the total vegetable production in the country (Anonymous, 2011). West Bengal was the largest producer of cauliflower in the year 2014-15 with production and productivity 74.60 thousand ha, 1889.96 thousand MT/ha respectively (Anonymous, 2015). The production technology of vegetables needs to be augmented for achieving optimum productivity of these crops. Proper variety of seed, proper time of planting, spacing, crop husbandry, nutrient management and control of pests and disease are some of the important aspects of crop production which should be looked into. Among these crop management practices, nutrient management is the most important one and can be exploited to achieve higher productivity of vegetables and to fulfil the dietary requirement of growing populace.

The available sulphur was found to be low to medium in more than 70% of the soil samples collected from different states such as Uttar Pradesh, Madhya Pradesh, Maharashtra, Andhra Pradesh, Karnataka Jharkhand, Odisha and West Bengal (Biswas *et al.,* 2004). The response of sulphur application is high due to Sulphur deficiency in Indian soils. Sulphur is necessary for growth and development of plants. Cystine, cysteine and methionine are the three sulphur containing amino acids. Different physiological functions such as nutrient uptake, chlorophyll biosynthesis, stress resistance and carbohydrate formation are known to be enhanced by application of right amount of sulphur. Some micronutrients such as zinc, iron, copper and manganese are easily available to plant by application of Sulphur (El-Tantawy and El-Beik, 2009). As per Nasreen *et al.* (2007), the assimilation of primary nutrients such as nitrogen, phosphorus and potash is decreased under sulphur deficient condition. The sulphur requirement of cauliflower which belongs to the family brassicaceae is characteristically high. Sulphur is very essential for the growth of this crop and sulphur deficiency will reduce both crop yield and marketable quality of cauliflower (Westerman *et al.,* 2000). Most of soils of West Bengal are deficient in micronutrients such as Zinc and Boron. Nearly 34 per cent soils of West Bengal are Zn-deficient (Mondal *et al.*, 2015). According to Singh (2001), nearly 68 percent soil of West Bengal and about 38 percent of soils of India are deficient in Boron respectively. Hence, special emphasis is needed for proper management of micronutrient deficiency with given priority to Zinc & Boron in vegetable growing areas. Boron presence facilitates following activities in plant: such as carbohydrate transport, sugar starch balance, pectin formation, sugars amination and pollen germination. Boron is also essential for auxin transport, protein synthesis and nucleic acids synthesis. Some of the cellular activities such as division, differentiation, maturation, respiration, growth requires presence of boron in the plants. Micronutrient requirement of cauliflower for optimum growth is very high. Boron plays important role in the growth and development of cauliflower and its deficiency affects yield as well as quality of cauliflower. Browning of cauliflower is one of the common physiological disorder of this crop which occurs due to boron deficiency. The present study tries find out the response of cauliflower in Boronated Sulphur (Sulphur fortified with Boron) with respect to growth and yield.

## Materials and Methods

The field experiment was conducted during rabi season of 2018-19 at Agriculture Farm, Institute of Agriculture which is located at the heart of the sub-humid, sub-tropical belt of West Bengal. The experiment was laid out in Randomized Block Design (RBD) with seven treatment combinations, replicated thrice in 5m×4m plots. All the plots were demarcated by 10 cm high ridges on all sides. Adequate numbers of irrigation channels were also constructed to provide irrigation independently to each plot. The soil of the experimental plot was sandy loam in texture. The soil was medium in available phosphorus ($P_2O_5$) and available potassium ($K_2O$) and low in available nitrogen (N).The spacing of the crop was 60 cm × 50cm. The cauliflower variety Madhuri was used in this experiment. This variety of cauliflower has erect growth habit. The maturity duration is 80-90 days after planting. The pure white curd is dome shaped and good for staggered harvesting. The land was ploughed with tractor drawn plough followed by harrowing and levelling. The recommended dose of fertilizers of West Bengal, *i.e.* 100-75-50 kg N-$P_2O_5$-$K_2O$/ ha was applied to all the plots of the experiment. No organic manure was applied. Boronated Sulphur was used as the only source of Sulphur and Boron**.** DAP (18-46-0) and Urea were used as source Nitrogen. SSP was not used as source of phosphorous as it contains Sulphur**.** The treatments of fertilizers included Control ($T_1$), Boronated Sulphur @7.5 kg/acre ($T_2$), Boronated Sulphur @10 kg/acre ($T_3$), Boronated Sulphur @ 15 kg/acre ($T_4$), Boronated

Sulphur @ 20 kg/acre ($T_5$), Bentonnite Sulphur (90%) @ 10 kg/acre ($T_6$) and Bentonnite Sulphur+ Boron (equivalent to Boronated Sulphur 10 kg/acre) [$T_7$]. The NPK fertilizers, Boronated Sulphur, Bentonnite Sulphur and Boron were applied as basal dose. The cauliflower seedlings of about 35 days old age were transplanted in the field as per treatment and layout. The seedlings should be transplanted carefully without damaging the root and shoot portions by fixing in the soil gently. The seedlings of uniform size and growth behaviour were selected for transplanting. A gentle irrigation was given immediately after transplanting. Irrigation was applied at regular intervals to maintain soil moisture level to almost field capacity. First irrigation was applied immediately after transplanting of the seedlings and subsequently during the crop period at a regular interval of 7-10 days. Carbendazin (12%) + Mancozeb (63%) WP @ 2g per litre was sprayed twice at 30 and 45 DAT for protection of the crop from diseases and Chlorpyrifos 20% EC @2ml per litre was sprayed twice to avoid the pest attack.The mature curds of marketable size were harvested manually. The growth parameters such as plant height, number of leaves per plant and stem diamete rwere recorded twice at 40 and 60 days after transplanting (DAT). The days taken in curd initiation was worked out by counting the days taken from transplanting to the initiation of curd. The curd maturity was worked out by counting the days from curd initiation to come in edible stage (horticulture maturity). For yield and yield attributes such as curd weight per plant (g) and curd yield per plant (g), the heads were separated from three plants and fresh weight of curds was weighed by electronic balance and the average weight per plant was worked out. The curd yield per hactare was recorded by weighing the heads after harvest in kg/plot and finally expressed as ton/ha. Chlorophyll content and relative leaf water content (RWC) was measured at 60 DAT. Chlorophyll content of leaves was measured adopting the method of Hiscox and Israelstam (1979) using Dimethyl sulfoxide (DMSO) as solvent and was determined by using the formula given by Arnon (1949). Relative leaf relative water content (RWC) estimation was determined by using the methods of Weatherley (1950). Ascorbic acid (Vitamin C) content in the cauliflower heads were estimated by titration method using 2, 4 dichlorophenol indophenols dye solution as indicator and expressed in mg/l00g (Rangana, 1979).

## Results and Discussion

### Effect on plant height

The effect of boronated sulphur on the plant height of cauliflower was studied at 40 and 60 DAT (Table 1). The plant height was found to increase by the application of boronated sulphur. There was a significant difference in plant heieght obtained from different treatments of Boronated Sulphur, Sulphur and boron at both the stages of growth.The highest plant height (14.43 cm and 21.77cm at 40 and 60 DAT respectively) was obtained from $T_3$ (Boronated Sulphur @ 10 kg/acre), which was at par with $T_4$(Boronated Sulphur @ 15 kg/acre), where as lowest (10.57cm and 16.57cm ar 40 and 60 DAT respectively) was recorded from $T_1$ (control). Plant height recorded at both stages (40 and 60 DAT) from $T_2$, $T_3$, $T_4$, $T_5$ were found to be significantly higher than the control. The plant height was also found to increase by application of Bentonnite Sulphur+ Boron (equal

**Table 1.** Effect of Boronated Sulphur on the growth parameters of cauliflower

| Treatments | Plant Height (cm) | | Number of leaves/plant | | Stem diameter (cm) | | Days to Curd | Days to curd |
|---|---|---|---|---|---|---|---|---|
| | 40 DAT | 60DAT | 40 DAT | 60 DAT | 40 DAT | 60 DAT | initiation | maturity |
| $T_1$ | 10.57 | 16.57 | 7.60 | 14.27 | 0.91 | 1.78 | 71.10 | 82.57 |
| $T_2$ | 13.00 | 19.33 | 8.43 | 16.43 | 1.10 | 1.95 | 69.13 | 80.45 |
| $T_3$ | 14.43 | 21.77 | 10.17 | 18.17 | 1.42 | 2.34 | 65.20 | 76.20 |
| $T_4$ | 13.43 | 19.43 | 10.07 | 17.80 | 1.29 | 1.97 | 66.03 | 78.03 |
| $T_5$ | 12.80 | 18.80 | 9.63 | 16.63 | 1.20 | 2.06 | 67.67 | 78.54 |
| $T_6$ | 12.63 | 18.63 | 9.67 | 16.33 | 1.17 | 1.83 | 68.07 | 79.77 |
| $T_7$ | 12.23 | 18.23 | 9.63 | 16.30 | 1.15 | 1.91 | 67.73 | 79.47 |
| SEm(±) | 0.53 | 0.70 | 0.63 | 0.59 | 0.06 | 0.10 | 1.03 | 0.83 |
| CD(0.05) | 1.57 | 2.06 | 1.84 | 1.73 | 0.18 | 0.28 | 3.02 | 2.44 |

to Boronated Sulphur 10 kg/acre) but it was significantly lower as compared to $T_3$ (Boronated Sulphur @ 10 kg/acre).This result corroborates the finding of Khan *et al.* (2018), who reported increase in plant height of cauliflower by application of sulphur and Adhikary *et al.* (2004) who reported increase in plant height by application of borax.

**Effect on number of leaves per plant**

The effect of boronated sulphur on the number of leaves per plant was studied at 40 and 60 DAT (Table 1). The number of leaves was found to increase by the application of boronated sulphur at both the stages of growth. However highest number of leaves (10.17 and 18.17 at 40 and 60 DAT respectively) was recorded from $T_3$ (Boronated Sulphur @ 10 kg/acre) where as lowest (7.60 and 14.27 at 40 and 60 DAT respectively) was recorded from $T_1$ (control). The number of leaves recorded from $T_3$ was found to be at par with $T_4$, $T_5$, $T_6$ and $T_7$. The number of leaves recorded at both stages (40 and 60 DAT) from $T_2$, $T_3$, $T_4$ and $T_5$ were found to be significantly higher than the control.The number of leaves was also found to increase by application of Bentonnite Sulphur+ Boron (equal to Boronated Sulphur 10 kg/acre) but it was significantly lower as compared to $T_3$ (Boronated Sulphur @ 10 kg/acre). Similar results were obtained by Adhikary *et al.* (2004) and Hassan et al. (2018).

**Stem diameter**

The effect of boronated sulphur on the stem diameter at at 40 and 60 DAT (Table 1). The stem diameter was found to increase by the application of boronated sulphur. There was a significant difference in the stem diameter recorded from different treatments of Boronated Sulphur, Sulphur and boron at 40 DAT. However highest stem diameter (1.42 cm and 2.34 cm at 40 and 60 DAT respectively) was recorded from $T_3$ (Boronated Sulphur @ 10 kg/acre) where as lowest (0.91 cm and 1.78cm at 40 and 60 DAT respectively) was recorded from $T_1$ (control). The stem diameter recorded from $T_3$ was found to be at par with $T_4$ at both stages of growth. The stem diameter recorded at 40 DAT from different treatments of Boronated Sulphur, Sulphur and Boron were found to be significantly higher than the control. However the stem diameter recorded at 60 DAT from $T_3$ was significantly higher than control. The stem diameter was also found to increase by application of Bentonnite Sulphur+ Boron (equal to Boronated Sulphur 10 kg/acre) but it was significantly lower as compared to $T_3$(Boronated Sulphur @ 10 kg/acre). The result corroborates the findings of Verma and Nawange (2015), who observed the increase in stem diameter of cabbage by application of sulphur.

**Days to curd initiation**

The effect of boronated sulphur the days to curd initiation was studied and presented in Table 1. The curd initiation was found to be hastened by the application of boronated sulphur. There was a significant difference in number of days required to curd initiation recorded from different treatments of Boronated Sulphur, Sulphur and boron. However least number days to curd initiation (65.20) was recorded from $T_3$ (Boronated Sulphur @ 10 kg/acre) where as highest number of days (71.10) for curd initiation was recorded from $T_1$ (control). The number days required for curd initiation recorded from $T_3$ (Boronated Sulphur @ 10 kg/acre) was found to be at par with $T_4$, $T_5$, $T_6$ and $T_7$. The days to curd initiation recorded from $T_2$ (7.5 kg Boronated sulphur/ha), $T_3$(10 kg Boronated sulphur/ha), $T_4$(15 kg Boronated sulphur/ha) and $T_5$(20 kg Boronated sulphur/ha) were found to be significantly lower than the control. The days to curd initiation was also found to decrease by application of Bentonnite Sulphur+ Boron (equal to Boronated Sulphur 10 kg/acre) but it was significantly higher as compared to $T_3$ (Boronated Sulphur @ 10 kg/acre).Similar results were found Hassan *et al.* (2018), who found application of boron hastened the curd initiation in cauliflower.

**Days to curd maturity**

The effect of boronated sulphur the days to curd maturity was studied and was presented in Table 1. The curd maturity was found to be hastened by the application of boronated sulphur. There was a significant difference in number of days required to curd maturity recorded from different treatments of Boronated Sulphur, Sulphur and boron at both the stages of growth. However least number days (76.20) to curd maturity was recorded from $T_3$ (Boronated Sulphur @ 10 kg/acre) where as highest number of days (82.57) was recorded from $T_1$ (control). The number of days required for curd maturity recorded from $T_3$ (Boronated Sulphur @ 10 kg/acre) was found to be at par with $T_4$ and $T_5$. The days to curd maturity recorded from $T_2$ (7.5 kg Boronated sulphur/ha), $T_3$(10 kg Boronated sulphur/ha), $T_4$(15 kg Boronated sulphur/ha) and $T_5$(20 kg Boronated sulphur/ha) were found to be significantly lower than the control. The days to curd maturity was also found to decrease by application of Bentonnite Sulphur+Boron (equal to Boronated Sulphur 10 kg/ acre) but it was significantly more as compared to $T_3$ (Boronated Sulphur @ 10 kg/acre). Similar results were found by Khan *et al.* (2018) who reported application of sulphur hastened days required to maturity of curd.

**Curd weight per plant**

The effect of boronated sulphur on curd weight per plant(g) of cauliflower was studied at harvest (Table 2). The curd weight per plant was found to increase by the application of boronated sulphur. However highest curd weight per plant (726.83g) was recorded from $T_3$ (Boronated Sulphur @ 10 kg/acre) where as lowest (530.50g) was recorded from $T_1$ (control).The curd weight per plant recorded from $T_3$ (Boronated Sulphur @ 10 kg/acre) was found to be at par with $T_4$. The curd weight per plant recorded from $T_2$ (7.5 kg Boronated sulphur/ha), $T_3$ (10 kg Boronated sulphur/ha) and $T_4$ (15 kg Boronated sulphur/ha) was found to be significantly higher than the control. The curd weight per plant was also found to increase by application of Bentonnite Sulphur+ Boron (equal to Boronated Sulphur 10 kg/acre) but it was significantly lower as compared to $T_3$ (Boronated Sulphur @ 10 kg/ acre). Similar results were found by Adhikary *et al.* (2004) and Hassan *et al.* (2018) who found application of boron increased the curd weight significantly.

**Curd yield**

The effect of boronated sulphur on curd yield (t/ha) of cauliflower was studied at harvest (Table 2). The curd yield was found to increase by the application of boronated sulphur. However highest curd yield (17.44 t/ha) was recorded from $T_3$ (Boronated Sulphur @ 10 kg/acre) where as lowest (12.73 t/ha) was recorded from $T_1$ (control). The curd yield (t/ ha) recorded from $T_3$ (Boronated Sulphur @ 10 kg/ acre) was found to be at par with $T_2$ and $T_4$. The curd yield was also found to increase by application of Bentonnite Sulphur+ Boron (equal to Boronated Sulphur 10 kg/acre) but it was significantly lower as compared to T3 (Boronated Sulphur @ 10 kg/ acre).This result corroborates the findings of Khan *et al.*(2018), Hassan *et al.*(2018) and Adhikary *et al.* (2004).

**Ascorbic acid (Vitamin C) content**

The effect of boronated sulphur on ascorbic acid content (mg/100g) of cauliflower was studied during at harvest (Table 2). The ascorbic acid content was found to increase by the application of boronated sulphur. However highest ascorbic acid content (41.47 mg/100g) was recorded from $T_3$ (Boronated Sulphur @ 10 kg/acre) where as lowest (35.27 mg/100g) was recorded from $T_1$ (control). The ascorbic acid content (mg/100g) recorded from $T_3$ (Boronated Sulphur @ 10 kg/acre) was found to be at par with $T_4$ and $T_5$.The ascorbic acid content recorded from $T_3$ and $T_4$ was found to be significantly higher than the control. The ascorbic acid content was also found to increase by application of Bentonnite Sulphur+ Boron (equal to Boronated Sulphur 10 kg/acre) but it was significantly lower as compared to $T_3$ (Boronated Sulphur @ 10 kg/ acre).This result corroborates the findings of Khan et al.(2018) who reported increase in ascorbic acid content of curd by application of sulphure.

**Chlorophyll and carotenoids content**

The effect of boronated sulphur on chlorophyll a, chlorophyll b, total chlorophyll and carotenoids content (mg/g) of cauliflower leaves was studied at 60 DAT (Table 3). The chlorophyll a content (mg/g) was found to increase by the application of boronated sulphur. However highest chlorophyll a content (2.102 mg/g)was recorded from $T_3$ (Boronated Sulphur @ 10 kg/acre) where as lowest (1.836 mg/g) was recorded from $T_1$ (control). The chlorophyll a content (mg/100g) recorded from $T_3$

**Table 2.** Effect of Boronated Sulphur on the yield and quality parameters of cauliflower

| Treatments | Curd wt/ plant | Curd yield/ha | Ascorbic acid content (mg/100g) |
|---|---|---|---|
| $T_1$ | 530.50 | 12.73 | 35.27 |
| $T_2$ | 622.17 | 14.93 | 37.20 |
| $T_3$ | 726.83 | 17.44 | 41.47 |
| $T_4$ | 629.67 | 15.11 | 39.10 |
| $T_5$ | 593.83 | 14.25 | 38.38 |
| $T_6$ | 564.00 | 13.54 | 36.53 |
| $T_7$ | 552.40 | 13.26 | 36.17 |
| SEm(±) | 37.39 | 0.90 | 1.19 |
| CD(0.05) | 110.30 | 2.65 | 3.52 |

(Boronated Sulphur @ 10 kg/acre) was found to be at par with $T_4$ and $T_5$. The chlorophyll a content recorded from $T_3$, $T_4$and $T_5$ was found to be significantly higher than the control. The chlorophyll a content was also found to increase by application of Bentonnite Sulphur+ Boron (equal to Boronated Sulphur 10 kg/acre) but it was significantly lower as compared to $T_3$ (Boronated Sulphur @ 10 kg/acre).

The chlorophyll b content (mg/g) was also found to increase by the application of boronated sulphur. However highest chlorophyll b content (0.869 mg/g) was recorded from $T_3$ (Boronated Sulphur @ 10 kg/acre) where as lowest (0.625 mg/g) was recorded from $T_1$ (control). The chlorophyll b content recorded from different treatments of Boronated Sulphur, Sulphur and boron ($T_2$, $T_3$, $T_4$, $T_5$, $T_6$ and $T_7$) was found to be significantly higher than the control. The chlorophyll b content was also found to increase by application of Bentonnite Sulphur+ Boron (equal to Boronated Sulphur 10 kg/acre) but it was significantly lower as compared to $T_3$ (Boronated Sulphur @ 10 kg/acre).

The total chlorophyll content (mg/g) was also found to increase by the application of boronated sulphur. However highest content of total chlorophyll (2.970 mg/g) was recorded from $T_3$ (Boronated Sulphur @ 10 kg/acre) where as lowest (2.460 mg/g) was recorded from $T_1$ (control). The total chlorophyll content recorded from different treatments of Boronated Sulphur, Sulphur and Boron ($T_2$, $T_3$, $T_4$, $T_5$, $T_6$ and $T_7$) was found to be significantly higher than the control. The total chlorophyll content was also found to increase by application of Bentonnite Sulphur+ Boron (equal to Boronated Sulphur 10 kg/acre) but it was significantly lower as compared to $T_3$ (Boronated Sulphur @ 10 kg/acre).

The carotenoids content (mg/g) was also found to increase by the application of boronated sulphur. However highest content of carotenoids (0.344 mg/g) was recorded from $T_3$ (Boronated Sulphur @ 10 kg/acre) where as lowest (0.300 mg/g) was recorded from $T_1$ (control). The carotenoids content recorded from$T_3$ (Boronated Sulphur @ 10 kg/acre) was found to be statistically at par with $T_4$. The carotenoids content recorded from different treatments of Boronated Sulphur, Sulphur and Boron ($T_2$, $T_3$, $T_4$, $T_5$, $T_6$ and $T_7$) was found to be significantly higher than the control. The carotenoids content was also found to increase by application of Bentonnite Sulphur+ Boron (equal to Boronated Sulphur 10 kg/acre) but it was significantly lower as compared to $T_3$ (Boronated Sulphur @ 10 kg/acre).

**Relative leaf water content**

The effect of boronated sulphur on relative leaf water content (RWC) of cauliflower leaves was studied at 60 DAT (Table 3). The relative leaf water content (RWC) was also found to increase by the application of boronated sulphur. However highest RWC (82.3%) was recorded from $T_3$ (Boronated Sulphur @ 10 kg/acre) where as lowest (71.8%) was recorded from $T_1$ (control). The RWC recorded from different treatments of Boronated Sulphur ($T_2$, $T_3$, $T_4$ and $T_5$) was found to be significantly higher than the control. The RWC was also found to increase by application of Bentonnite Sulphur+ Boron (equal to Boronated Sulphur 10 kg/acre) but it was significantly lower as compared to $T_3$ (Boronated Sulphur @ 10 kg/acre).

## Conclusion

The results of this experiment indicated that application of boronated sulphur ($T_3$ and $T_4$) significantly

**Table 3.** Effect of Boronated Sulphur on the physiological parameters

| Treatments | Chlorophyll a (mg/g) | Chlorophyll b (mg/g) | Total Chlorophyll (mg/g) | Carotenoids (mg/g) | RWC (%) |
|---|---|---|---|---|---|
| $T_1$ | 1.836 | 0.625 | 2.460 | 0.300 | 71.8 |
| $T_2$ | 1.934 | 0.720 | 2.653 | 0.319 | 76.3 |
| $T_3$ | 2.102 | 0.869 | 2.970 | 0.344 | 82.3 |
| $T_4$ | 1.984 | 0.765 | 2.748 | 0.338 | 78.7 |
| $T_5$ | 1.942 | 0.745 | 2.687 | 0.331 | 77.0 |
| $T_6$ | 1.897 | 0.759 | 2.655 | 0.324 | 74.5 |
| $T_7$ | 1.876 | 0.707 | 2.582 | 0.315 | 73.2 |
| SEm(±) | 0.033 | 0.023 | 0.034 | 0.003 | 1.0 |
| CD(0.05) | 0.103 | 0.070 | 0.104 | 0.010 | 3.1 |

improved most of the growth as well as yield parameters of cauliflower. However, $T_3$ (Boronated Sulphur @ 10 kg/acre) was found to be the best treatment in terms of growth and yield parameters of cauliflower such as plant height, number of leaves per plant, stem diameter, days to curd initiation, days to curd maturity, curd weight, fresh curd yield, vitamin C content and physiological parameters such as chlorophyll content of leaves and relative leaf water content. Hence 10 kg/acre of Boronated Sulphur can be recommended for achieving significantly higher yield of cauliflower.

## Acknowledgement

This research was funded by Coromandel International Limited, Secunderabad, Telangana, India

## References

Adhikary, B. H., Ghale, M. S., Adhikary, C., Dahal, S. P. and Ranabhat, D. B. 2004. Effects of Different Levels of Boron on Cauliflower (*Brassica oleracea* var. botrytis) Curd Production on Acid Soil of Malepatan, Pokhara. *Nepal Agric. Res. J.* 5: 65-67.

Anonymous. 2011. Annual Report. Ministry of Agriculture. Government of India, New Delhi.

Anonymous. 2015. National data base, National Horticulture Board, Government of India.

Anonymous. 2019. Area and Production of Horticulture Crops: All India, http://agricoop.nic.in/sites/default/files/2018-19%20%281st% 20Adv.Est_.%29_updt.pdf

Arnon, D.L. 1949. A copper enzyme is isolated chloroplast polyphenol oxidase in *Beta vulgaris*. *Plant Physiol*. 24: 1-15. doi: 10.1104/pp.24.1.1

Biswas, B.C., Sarkar, M.C.,Tanwar, S.P.S., Das S.and Kalwe, S.P. 2004. Sulphur deficiency in soils and crop response to fertiliser sulphur in India. *Fertilizer News*. 49(10): 13-18, 21-28 and 31-33

El-Tantawy, E. M. and El-Beik, A. K. 2009. Relationship between growth, yield and storability of onion (*Allium cepa* L.) with fertilization of nitrogen, sulphur and copper under calcareous soil conditions. *Res. J. Agric. Biol. Sci*. 5 (4) : 361-71.

Hassan, M. R., Julie, S. N., Akber, A., Kundu P. K. and Zaman, M. S. 2018. Influence of micronutrient (boron) for the growth and yield of cauliflower. *J. Biosci. Agric. Res*. 18(01): 1464-1469.

Hiscox, J.D. and Isrealstam, G. F. 1979.A method for the extraction of chlorophyll from leaf tissue without maceration.*Can J. Botany*. 57 : 1332-1334. doi: 10.1139/b79-163

Khan, O. A., Raina, S., Dhura, R., Dar, M.A., Malik, M.A. and Wani, J.A. 2018. Effect of different sources of sulphur on yield and quality of cauliflower (*Brassica oleracea*) under temperate conditions of Kashmir. *Indian J. Agr Sci.* 88.284-288.

Krishnaswamy, K. 2003. Dietary Guidelines for Indians – A Manual, Indian Council of Medical Research, National Institute of Nutrition (ICMR), Hyderabad.

Moklikar, M. S., Waskar, D. P., Maind, M. M. and Bahiram, V.K. 2018. Studies on Effect of Micro Nutrients on Growth and Yield of Cauliflower (*Brassica oleracea* var. botrytis) cv. Sungro-Anandi. *Int. J. Curr. Microbiol. App. Sci*. Special Issue-6: 2351-2358

Mondal, S.S., Patra, B.C. and Banerjee, H. 2015. Micronutrient management. In: *Advances in Potato Cultivation Technology.* Kalyani Publishers, New Delhi. pp. 115-121.

Nasreen, S., Haque, M., Hossain, M. and Farid, A. 2007. Nutrient uptake and yield of onion as influenced by nitrogen and sulphur fertilization. *Bangladesh J Agric Res*. 32 : 413-420.

Rangana, S. 1979. Manual of Analysis of Fruits and Vegetables Product. Tata McGraw Hill Co. Ltd., New Delhi. 2-95, 634.

Singh, M.V. 2001. Evaluation of micronutrient stocks in different agro ecological zones of India. *Indian J. Fertilizer*. 46 : 25-42.

Verma, H. and Nawange, D.D. 2015. Effect of different levels of nitrogen and Sulphur on the growth, Yield and quality of cabbage [*Brassica Oleracea* Var. Capitata L.]. *Agric. Sci. Digest.* 35 (2) : 152-154.

Weatherley, P. E. 1950. Studies in water relations of cotton plants I: The field measurement of water deficit in leaves. *New Phytol*. 49 : 81-87.

Westerman, S., Weidner, W., De Kok, L.J. and Stulen, I. 2000. Effect of H2S exposure on 35S-sulfate uptake, transport and utilization in curly kale. *Phyton (B Aires).* 40 : 293-302.