



## **Response of Cauliflower to Different Forms of Boron and Relation to Boron Availability in Red and Lateritic Soils of West Midnapore District of West Bengal**

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### **Authors' contributions**

*This work was carried out in collaboration among all authors. Authors SM and FHR designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors TKC and SD managed the analyses of the study. Author KN managed the literature searches. All authors read and approved the final manuscript.*

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### **ABSTRACT**

A field experiment on Cauliflower (*Brassica oleracea* var. *botrytis* L.) was conducted to study the different form of Boron deficiency which in terms will increase yield of Cauliflower in red and lateritic soils during 2011-12 at Kapgari village of Seva Bharati Krishi Vigyan Kendra at West Midnapore district of West Bengal. The design adopted was Randomised Block Design (RBD) having ten replications with four treatments. The different forms of boron treated cauliflower plants attributed

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higher yields over control. Among different treatments evaluated, the treatment T3 i.e. FYM @ 10 t/ha + Boric acid (20% Boron) @ 0.3% as foliar spray after one month of planting showed better yield (91% fresh curd harvested) and quality in respect to curd size (24 cm) and weight (2.70 kg) followed marginally by T4 i.e. FYM @ 10 t/ha + Total B<sub>2</sub>O (liquid Boron - 20% Boron) @ 1.5 g/L of water as foliar spray after one month of planting in all aspects followed by T1 i.e. Farmyard manure @ 10 t/ha as basal dose and T2 i.e. FYM @ 10 t/ha+ Borax @ 15 kg/ha as basal dose respectively. Treatment T3 also achieved 13.41%, 51.66% and 139.47% more fresh curds as compared to T4, T2 and T1 respectively. Treatment T4 showed improved performance (82% fresh curd) after T3 which achieve economic thresh level over T2 (60% fresh curd) and T1 (38% fresh curd) respectively. Lower curd size recorded with T1 (16 cm) followed by T2 (18 cm) and T4 (20 cm). T3 recorded highest weight of the curd (2.7 kg) as compared to T1 (1.25 kg), T2 (1.5 kg) and T4 (2.0 kg). Highest available form of boron in the soil is found in T3 (37.50 ppm) followed by T4 (35.0 ppm), T2 (30.62 ppm) and T1 (27.4 ppm) respectively. It is clearly understood that Treatment T3 i.e. FYM @ 10 t/ha + Boric acid (20% B) @ 0.3% as foliar spray after one month of planting emerged out to be the best treatment in respect to yield, curd size and weight of curd.

**Keywords:** Boron; cauliflower; curd; red and lateritic soils; West Midnapore.

## 1. INTRODUCTION

Cauliflower (*Brassica oleracea* var. *botrytis* L. 2n=18) one of extensively grown winter vegetable crop of *Cruciferae* family has registered a pride place in India owing to its flavour, nutrition and delicious taste. The edible portion called curd constitutes roughly 45 per cent of the entire plant [1,2]. It was originated in Cyprus and around Mediterranean coast and developed from wild cabbage, with the genus *Brassica oleracea* var. *botrytis* having several related promising recommended high yielding, hybrid location and season specific varieties. It grows well in temperate region throughout the year except in winter, tropical region in winter and sub-tropical region in winter as well as late and early winter also. It can be grown in all types of soil with good soil fertility [3]. The cauliflower has 2.6 g protein, 1.9 g minerals, 4 g carbohydrate, 33 mg calcium, 20 mg magnesium, 56 mg Vitamin C and other minerals also, but it is low in fat content (0.4 g) [4]. It is used mainly as vegetable in India and also used in pickle, salad, soups etc. It is well known for its nutritional value, as it provides vitamins and fibre, preventing against some types of cancers and heart diseases [5,6,7]; easily produced; and has already spread its popularity on global market [8].

Cauliflower was grown in 453 thousand hectares area having a total production of 8668 thousand MT in India during 2017-18 [9]. Though primarily the crop is a cool season crop, it is grown not only during the winter months, but also during post monsoon and autumn season as an early produce for its higher return in West Bengal condition. In Eastern India, red soil is dominated as main growing media of Cauliflower. Because

of over mining of the soil nutrient by plants most of the micronutrients run short in supply to the crops and some disorder appears resulting in low yields [10]. High acidic soil having pH 5-5.5 causes serious problem of hollow stem of Dutch Cauliflower. Boron deficiency has been commonly reported in soils which are highly leached [11].

The typical symptoms are darkening of the curd and darkened stems. The cauliflower is also an indicator plant for boron determination [12]. Boron (B) is an essential micronutrient for the growth of plant new cells. It is not readily mobile in the plant. Its deficiency in plant ceases the terminal bud growth, followed by death of young leaves. Application of boron significantly increases curd diameter, weight of curd, yield and quality of cauliflower [13,14,15].

Boron played an important role in translocation of sugars and carbohydrates from site of synthesis to the site of storage i.e. from leaves to curds which might have resulted in the improvement in total suspended solids (TSS) content with Boron application through different supplements [16]. Boron plays crucial role in flowering and fertilization, curd quality, yield and seed yield of cauliflower as the crop is highly sensitive to boron deficiency. Moreover, boron is involved in several physiological processes viz., calcium metabolism, auxin synthesis, sugar metabolism, translocation of solutes and protein synthesis. Among many factors responsible for low productivity of cauliflower, inadequate and imbalanced nutrition occupy the top position causing nutrient deficiency, particularly of boron, responsible for deteriorated soil health and yield stagnation. However, there are different sources

of boron viz. borax, sodium penta borate, fertilizer borate, boric acid, colemanite, solubor, single super phosphate available in the market [17] and a relatively newer form i.e. liquid boron (B-20%) is also available.

In cauliflower, the symptoms appear first in small spots on the head and finally the curd is discolored and pith of the stem become brown to black. The disorders attributed to boron deficiency are hollow stem and brownish curd of cauliflower [18]. Decreasing yield trend and the deteriorated quality of cauliflower curd production in the study area have become a big problem. This is due to boron deficiency in soil and Red and Lateritic soil. But very limited research work has been carried out so far in this red and lateritic soil of Eastern India. Michigan State University Extension (1997) reported that soil application of boron @ 1.5-3 pounds highly responsive crops and 0.5-1 pound/acre highly reproductive crops would be beneficial and occasionally certain deficient soils might require boron up to @ 5 pound/acre. Foliar application of 0p.3 pound per acre in 30 gallons of water would be effective to mitigate boron deficiency of cauliflower. All India Research Network (2006) revealed that foliar spray of 0.2% borax is more effective to control boron deficiency of Cauliflower. Therefore, it has been necessary to study the performance of different forms of boron for enhancing the yield of cauliflower, through reducing the incidence of hollow stem [19]. Keeping these facts in view, the present investigation was planned to generate scientific information on influence of boron on growth yield of cauliflower and to correct boron deficiency in red and lateritic soil of West Midnapore district of West Bengal.

## 2. MATERIALS AND METHODS

The field experiment was conducted during 2011-12 in Kapgari village of Seva Bharati Krishi Vigyan Kendra, West Midnapore, West Bengal. It was laid out in 10 farmers' field during rabi season. The soil of each plot was 200 sq. meter. The soil texture is sandy loam having pH 5.5, Electrical Conductivity (EC)- 0.05 dS/m, nitrogen- 170 kg/ha, phosphorus- 39.8 kg/ha, potassium- 77 kg/ha, organic carbon- 0.48% and rich in Iron (Fe), Aluminium (Al) and deficient in Calcium (Ca), Magnesium (Mg), Boron (B) and Molybdenum (Mo).

The characteristic of soil in the red lateritic belt is having less organic matter with least water

holding capacity. The growing period of cauliflower is rabi season during October to February with temperature ranging from 12-22°C and annual rainfall ranges between 1200-1400 mm. The area was watered through flood irrigation. The seed of cauliflower var. "Bonny" Dutch variety collected from Syngenta Private Limited and 3 weeks age old seedlings were planted with spacing 45 cm x 45 cm. The other cultural practices such as application of nutrients, weed control, pests and disease management and irrigation were followed as per normal schedule. The average rainfall of the zone is 1200 mm, 80% of rain fall received during June - September and temperature varies from 16-42°C in peak winter and summer, average soil temperature is 20 - 25°C.

The experiment was laid out as per Randomized Block Design design with following four treatments and data regarding all parameters were statistically analyzed according to 'Fisher's Analysis' of various techniques given by Pansy and Sukhamte [20]. The level of significance used in Critical Difference (CD) at 0.05% where significant difference was calculated.

**Chart 1. Treatment details**

Treatments	Treatment details
T1	FYM @ 10 t/ha as basal dose
T2	FYM + Borax @ 15 kg/ha as basal dose
T3	FYM + Boric acid (20% B) @ 0.3% as foliar spray after one month of planting
T4	FYM + Total B20 (Liquid B - 20% B) @ 1.5 g/L of water as foliar spray after one month of planting

During investigation, only reproductive growth was taken into consideration. Data was recorded at regular interval. Four replications were considered under each treatment. The following parameters were measured as follows:

### 2.1 Percentage of Curd Affected

$$\text{Percentage of affected curd} = \frac{\text{Number of curd affected in each treatment}}{\text{Total number of curd in each treatment}}$$

### 2.2 Curd Size

Diameter of each curd was measured and the average was calculated by selecting 10 numbers of curds randomly under each treatment.

### 2.3 Weight of Each Curd

Weight of each curd randomly selected 10 fresh curds /10.

### 2.4 Sampling Method for Mineral Elements

For estimation of mineral content of leaves (Boron), fully matured leaves were sampled when vegetative growth was ceased and first blooming occurred. Leaf samples were dried at 70+1 degree centigrade temperature. The dried leaves were grinded in a wily mill to pass a 40 mesh screen and then stored in desiccators for analysis.

### 2.5 Estimation of Minerals

Estimation of Boron in the soil in the control as well as Treated plots was being conducted through Atomic Absorption Spectrophotometer.

## 3. RESULTS AND DISCUSSION

Effect of different forms of Boron differed significantly among themselves in respect of all vegetative and reproductive characters. It treated cauliflower plants attributed higher yields over control. The treatment T3 *i.e.* FYM @ 10 t /ha + Boric acid (20% Boron) @ 0.3% as foliar spray after one month of planting showed better yield (91% fresh curd harvested) and quality in respect to curd size (24 cm) and weight (2.70 kg) followed marginally by T4 *i.e.* FYM @ 10 t/ha + Total B 20 (liquid Boron - 20% Boron) @ 1.5 g/L of water as foliar spray after one month of planting in all aspects followed by T1 *i.e.* FYM @ 10 t/ha as basal dose and T2 *i.e.* FYM @ 10 t /ha + Borax @ 15 kg/ha as basal dose respectively. Similar trend has also been reported by Chaudhary [21] with higher level of borax

application. Treatment T3 achieved 13.41%, 51.66% and 139.47% more fresh curds as compared to T4, T2 and T1 respectively.

It is evident from Table 1 that T4 showed improved performance (82% fresh curd) after T3 which achieve economic threshold level over T2 (60% fresh curd) and T1 (38% fresh curd) respectively. There is significant difference in treatments except T3 and T4. Highest curd size (24 cm) also recorded with T3 over T1 (16 cm), T2 (18 cm) and T4 (20 cm) respectively (Table 1). There is marked increase of 20-50% of curd size in T3 over other treatments. Our findings are in agreement with the earlier results of Singh et al. [22], Chaudhari et al. [23]. The weight of the curd normally indicates one of the major quality parameters of cauliflower. T3 recorded highest weight of the curd (2.7 kg) as compared to T1 (1.25 kg), T2 (1.5 kg) and T4 (2.0 kg). Significant difference observed between T1 and T3, T2 and T3. Regarding quality, similar observation was recorded by Chaudhary [21]; Prasad and Yadav [24]. The efficacy of boron to enhance the curd weight as well as yield has earlier been reported by Adhikary et al. [25] and Kumar et al. [26].

The increase in the curd size as well as weight by Boron application may be because of its role in stimulating the translocation of carbohydrates from the site of its synthesis to the storage tissue in the curd as Boron is a key factor in the translocation of carbohydrates which helps in better seed or fruit set [27]. These findings are in conformity with the findings of Kumar and Choudhary [13], Singh [28] and Pizeetta et al. [29] in Cauliflower. The above result also correlates with the available form of boron in the soil. It is reflected from Table 2 that highest boron content in the soil is found in T3 followed by T4, T2 and T1 respectively.

**Table 1. Effect of boron on yield of cauliflower in red laterite soils of West Midnapore district of West Bengal**

Treatments	Treatment details	Fresh curd* (%)	Curd size* (cm)	Weight of curd (kg)*
T1	FYM @ 10 t/ha as basal dose	38	16	1.25
T2	FYM + Borax @ 15 kg/ha as basal dose	60	18	1.50
T3	FYM + Boric acid (20% B) @ 0.3% as foliar spray after one month of planting	91	24	2.70
T4	FYM + Total B20+ (20% B) @ 1.5 g /L of water as foliar spray after one month of planting	82	20	2.00
CD at 5%		17.09	12	0.33

\*Mean value has been taken into consideration for fresh curd, curd size, weight of curd

**Table 2. Available boron in the soil after the harvest of cauliflower**

Treatments	Treatment details	Boron content in leaf (ppm) after harvest
T1	FYM @ 10 t /ha as basal dose	27.40
T2	FYM + Borax @ 15 kg/ha as basal dose	30.62
T3	FYM + Boric acid (20% B) @ 0.3% as foliar spray after one month of planting	37.50
T4	FYM + Total B20+ (20% B) @ 1.5 g /L of water as foliar spray after one month of planting	35.0

*ppm (parts per million)*

#### 4. CONCLUSION

It can be concluded from the investigation entitled "Response of Cauliflower to Different forms of Boron and Relation to Boron Availability in Red and Lateritic Soils of West Midnapore District of West Bengal" that at West Midnapore farmer's field the significant responses of boron, it is an essential micronutrient for the better quality and quantity of cauliflower curd production. Cauliflower is one of the most boron-requiring crops. The results of this experiment would be of immense value for cauliflower cultivation in these areas. So, from the above discussion it is clearly understood that Treatment T3 *i.e.* FYM @ 10 t/ha + Boric acid (20% B) @ 0.3% as foliar spray after one month of planting emerged out to be the best treatment in respect to yield, curd size and weight of curd followed by T4 *i.e.* FYM 10 t/ha + total B20 (liquid B - 20% B) @ 1.5 g /L of water as foliar spray after one month of planting in red and lateritic belt of West Midnapore district of West Bengal.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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