Research Article

Effect of Fertility Levels and Boron on Quality and Economics of Cauliflower (*Brassica oleracea* var. *botrytis* L.)

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Abstract

A field experiment consisting five levels of fertility and four levels of boron in RBD with three replications was conducted at Horticulture Farm, S.K.N. College of Agriculture, Jobner (Jaipur) during *Rabi* season 2016-17. Results revealed that different fertility and boron levels significantly influenced quality and economics of cauliflower. Nitrogen, Phosphorus, Potassium & Boron content in curd, net returns (Rs. 380340 ha^{-1}) and B:C ratio (3.90:1) in relation to curd yield $plant^{-1}$ and curd yield ha^{-1} (190.89 q ha^{-1}) were found highest with application of 50% RDF through inorganic fertilizers and 50% RDF through vermicompost treatment. Similarly, the boron level with 2.5 kg ha^{-1} significantly increased the Nitrogen, Phosphorus, Potassium & Boron content in curd, net return (Rs. 370879 ha^{-1}) and B:C ratio (3.97:1) in relation to curd yield $plant^{-1}$ and ha^{-1} (185.53 q ha^{-1}) as compared to control and 1.5 kg boron ha^{-1} but statistically at par with 2.0 kg boron ha^{-1}. Further, the combined application of 50% RDF through inorganic fertilizer and 50% through vermicompost alongwith 2.5 kg boron ha^{-1} proved to be most superior treatment combination but remained at par with 2.0 kg boron ha^{-1} in terms of total yield $plot^{-1}$ (5.35 kg $plot^{-1}$) and ha^{-1} (220.22 q/ha) and net return (Rs. 449866 ha^{-1}).

Keywords: Cauliflower, RDF, Boron, Quality attributes and Economics

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Introduction

Cauliflower (*Brassica oleracea* var. *botrytis* L.*)* is the most popular vegetable crop among cole crops belong to the family cruciferae. It was introduced in India in 1822 at Saharanpur from Kew (UK). It is being grown round the year for its white and tender curd. It is widely cultivated all over India and abroad for its special nutritive values, high productivity and wider adaptability under different ecological conditions. Cauliflower has small thick stem, bearing whorl of leaves and branched tap root system. The main point develops into shortened shoot system whose apices make up the convex surface of curd. It is used as fried as well as dried vegetable, soup and pickles. It is a rich source of nutrient including vitamin-A (51 IU), vitamin-C (56 mg), riboflavin (0.10 mg), thiamin (0.04 mg), nicotinic acid (1.0 mg), calcium (33 mg), phosphorus (57 mg), potassium (138 mg), moisture (90.8 g), carbohydrates (4.0 g), protein (2.6 g), fat (0.4 g), fiber (1.2 g), and iron (1.5 mg) as per 100 g of edible portion of cauliflower (Fageria *et al.*, 2012). India is the largest producer of cauliflower in the world. It is grown commercially on an area of about 433.9 lakh hectares with an annual production 85.73 lakh tonnes and productivity of 19.8 MT/ha in India [1].

Nitrogen is the most deficient element in coarse textured sandy soils of Rajasthan. It is main constituent of protein, nucleic acid, chlorophyll and pigments. Optimum application of nitrogen favours the transformation of carbohydrates into protein and promotes the formation of protoplasm and is highly sense the plant become more succulent. Phosphorus is indispensable constituent of nucleic acid, phosphoric acid and several enzymes. It is also needed for the transfer of energy within the plant system and has beneficial effect on early root development, plant growth and quality of produce (Yawalkar *et al*. 1996). Likewise, Potassium also play vital role in crop productivity. It imparts increased vigour and disease resistance to plant and function as in activator of numerous enzymes. It also regulates water conduction within the plant cell and water loss from the plant by maintaining the balance between anabolism, respiration and transpiration (Rutkauskiene and Poderys, 1999). Application of NPK through inorganic fertilizer can enhances the growth and yield to a considerable extent but soil fertility and productivity can be retained for longer period. Therefore, it is important to supplement the recommended dose of fertilizer through organic and inorganic source. Vermicompost is a good source of organic fertilization. It is a mixture of worm carting, organic material, humus, and living earthworm and their cocoon and other organism. Earthworm reduces the C: N ratio, increase humic acid content, cation exchange capacity and soluble carbohydrate (Talasilkar *et al*., 1999).

Boron is also an essential plant micro nutrient for a constituent of cell membrane and essential for cell division. Deficiency of boron causes abnormal cell division at the points which especially lead to disorder like hollow stem in cauliflower. Boron is also concerned with the precipitation of excess cation, buffer action, maintenance of conducting tissues and help in absorption of nitrogen. Its primary role is concerned with metabolism both uptake and its efficient use in plants. Boron also affect the cambial and phloem tissues of storage root or stem apical meristems and leaves, vascular cambia of fruits and other organs which are capable of meristematic activities (Singh, 1991)

Materials and Methods

The field experiment entitled "Effect of Fertility Levels and Boron on Growth, Yield and Quality of Cauliflower (*Brassica oleracea var. botrytis L.)* was conducted at Horticulture farm, S.K.N. College of Agriculture, Jobner, Jaipur during *Rabi* season during Nov, 2016 to Feb, 2017. The experiment consisting five levels of fertility (Control, 100% RDF through inorganic fertilizers, 75% RDF through inorganic fertilizer + 25% through vermicompost, 50% RDF through inorganic fertilizer + 50% through vermicompost and 25% RDF through inorganic fertilizer + 75% through vermicompost) and four levels of boron (0, 1.5, 2.0 and 2.5 kg boron/ha) tested alone and is combination. The total 20 treatment combinations were evaluated in RBD with three replications.

Treatment application

The recommended dose of fertilizer for cauliflower is 120:100:100 kg/ha nitrogen, phosphorus and potash were applied respectively through urea (46% N), single super phosphate (16% P) and muriete of potash (60% K) as per treatment combination. Full dose of single super phosphate, muriete of potash and half dose of urea in various treatments were applied as the basal dose at the time of transplanting of seedling of in main field. Remaining half dose of urea was given as top dressing in two split doses at 30 and 45 days after transplanting. Vermicompost. The required quantity of vermicompost was given as per treatment combination. The whole quantity of vermicompost was uniformly spread at the time of bed preparation and then thoroughly mixed. Boron was applied in the bed as per treatment combination through agriculture grade elemental borax contenting 11% boron was broadcasted before transplanting and incorporated in the soil. The observations related to the quality attributes given in **Table 1**.

Table 1 Periodical observation to be recorded

Quality attributes	Estimated by using
Nitrogen content in curd (%)	Nesselar's reagent in spectrophotometer method (Snell and Snell, 1949)
Phosphorus content in curd (%)	Spectrophotometer method using Triacid Ammonium Molybdate-Ammonium Vabnadete solution (Jackson, 1973).
Potassium content in curd	Flame photometer method including Triacid, Potassium standard solution (Richards, 1954)
Boron content in curd (ppm)	Calorimetric method (Hatcher and Wilcox, 1950) using curcumin

Results and Discussion

Effect of fertility levels on quality attributes

The perusal of data presented in **Table 2** and **Figure 1** revealed that application of different levels of fertility significantly influenced the NPK content in curd. The maximum nitrogen (2.97 %), phosphorus (0.32 %) and potassium content (2.80 %) was recorded under F_4 (25 per cent RDF through inorganic fertilizer and 75 per cent through vermicompost), which was statistically at par with F_1, F_2 and F_3 treatments in case of nitrogen content, statistically at par with F_3 in case of phosphorus content and at par with F_3 and F_2 in case of potassium content. Whereas, minimum nitrogen (2.45 %), phosphorus and potassium (2.28 %) content in curd was observed under control. The mean increase under F_4 treatment was found to be 17.50 per cent higher over control (F_0) in nitrogen content, 25.00, 15.62 and 6.25 per cent higher as compared to F_0, F_1 and F_2 treatments in phosphorus content and 18.57 and 11.07 per cent higher over to F_0 and F_1 treatments under potassium content in curd, respectively. The NPK are considered as one of the major nutrient required for proper growth and development of the plant. Besides this, nitrogen is a main constituent of protoplasm, cell nucleus, amino acids, proteins, chlorophyll and many other metabolic products. Phosphorus is a constituent of nucleic acid, phytin and phospholipids. The beneficial influence of phosphorus in early stages of growth may be explained by early stimulation of root system through efficient translocation to the root of certain growth stimulation compounds formed on account of protoplasmic activity of tops in phosphorus fed plants, when enhanced absorption of nitrogen and other nutrient and their utilization. So an adequate supply of phosphorus in early stage of plant life is an important in laying down the primordial for the reproductive parts of the cauliflower (Thakur *et al.* 1991).

Table 2 Effect of fertility levels and boron on NPK, boron TSS content, net return and B:C ratio of curd of cauliflower

Treatments	N content (%)	P content (%)	K content (%)	Boron content (ppm)	TSS (%)	Net returns (Rs/ha)	B:C ratio
Fertility levels							
F_0	2.45	0.24	2.28	41.71	5.99	203919	2.77
F_1	2.76	0.27	2.49	44.97	6.77	288625	3.54
F_2	2.85	0.30	2.66	47.46	7.24	331537	3.71
F_3	2.92	0.31	2.77	49.23	7.53	380340	3.90
F_4	2.97	0.32	2.80	49.93	7.61	360285	3.41
SEm$\pm$	0.07	0.01	0.07	0.47	0.19	3979	0.06
CD (P=0.05)	0.21	0.02	0.20	1.34	0.54	11391	0.17
Boron levels							
B_0	2.49	0.25	2.38	41.91	6.13	203567	2.43
B_1	2.74	0.28	2.57	45.85	7.04	316795	3.54
B_2	2.94	0.30	2.70	49.25	7.39	360524	3.94
B_3	2.99	0.31	2.75	49.95	7.54	370879	3.97
SEm+	0.06	0.01	0.06	0.42	0.17	3559	0.05
CD (P=0.05)	0.19	0.02	0.18	1.21	0.49	10277	0.15

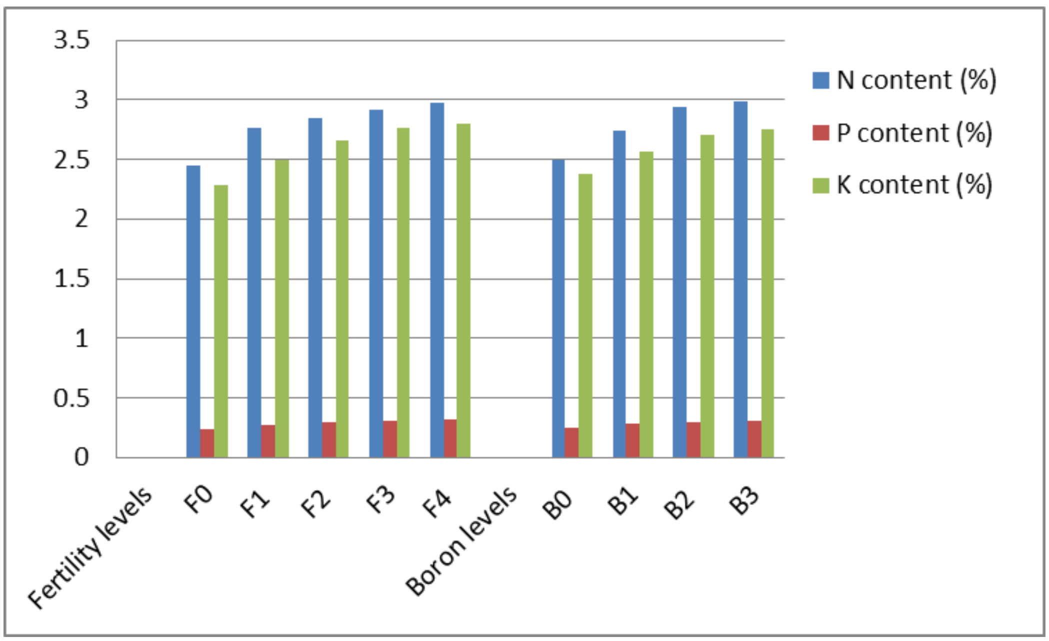

Figure 1 Effect of fertility levels and boron on NPK content of cauliflower

The data presented in Table 2 revealed that the application of fertility levels produced significant impact on boron and TSS content in curd of cauliflower. The maximum boron (49.93 ppm) and TSS content in curd (7.61 %) were recorded under 25 per cent RDF through inorganic fertilizer and 75 per cent through vermicompost (F_4) which were significantly higher over F_0, F_1 and F_2 but statistically at par with F_3. The minimum boron (41.71 ppm) and TSS content in curd (5.99 %) were recorded under the treatment F_0. The increase in boron content in curd under F_4 treatment was found to be 16.46, 9.93 and 4.14 per cent and TSS content in curd 25.71, 11.23 and 3.86 per cent more than F_0, F_1 and F_2 treatments, respectively. The increased in N, P, K and B might be due to better growth of plant and favourable nutritional environment for supply of nutrients in balanced from and in adequate amount. Improved efficiency of the plant in terms of physiological aspect and utility might have been achieved either through a higher NPK and micronutrient uptake capacity by plant. The results are close conformity with the findings of Kumhar *et al.* (2004) in cauliflower and Choudhary *et al.* (2012) [2] in sprouting broccoli.

Effect of fertility levels on economics

A perusal of data Table 2 and **Figures 2** and **3** revealed that the application of different fertility levels significantly influenced the net returns and B:C ratio of cauliflower. The application of F_3 *i.e.* 50 per cent RDF through inorganic fertilizer and 50 per cent through vermicompost significantly recorded maximum net returns (Rs 380340/ha) and B:C ratio (3.90) as compared to control, F_1 and F_2 treatment. Though the minimum net returns (Rs 203919/ha) and B:C ratio (2.77) was recorded under F_0. The application of 50 per cent RDF through inorganic fertilizer and 50 per cent through vermicompost (F_3) remained statistically at par with 25 per cent RDF through inorganic fertilizer and 75 per cent through vermicompost (F_4) in case of net returns.

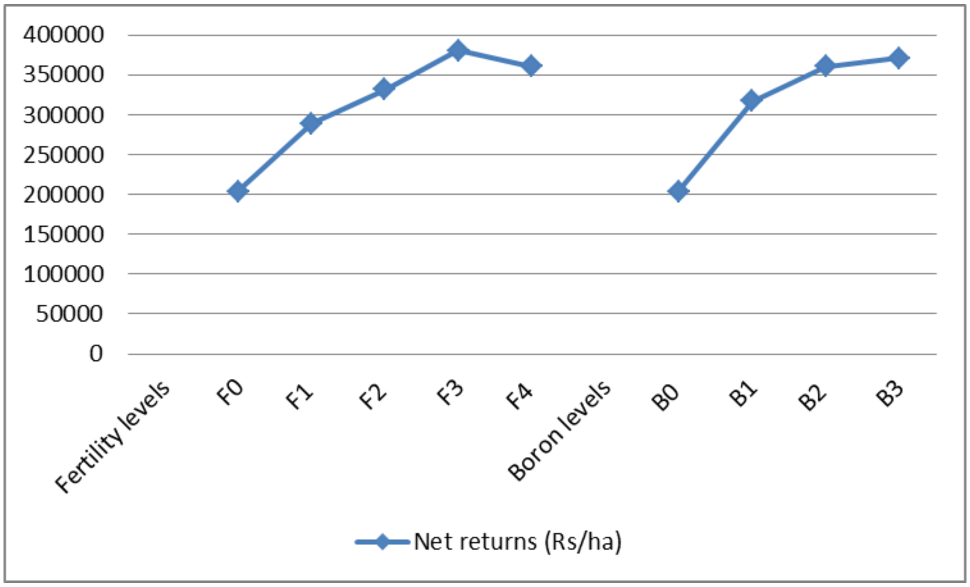

Figure 2 Effect of fertility levels and boron on net returns of cauliflower

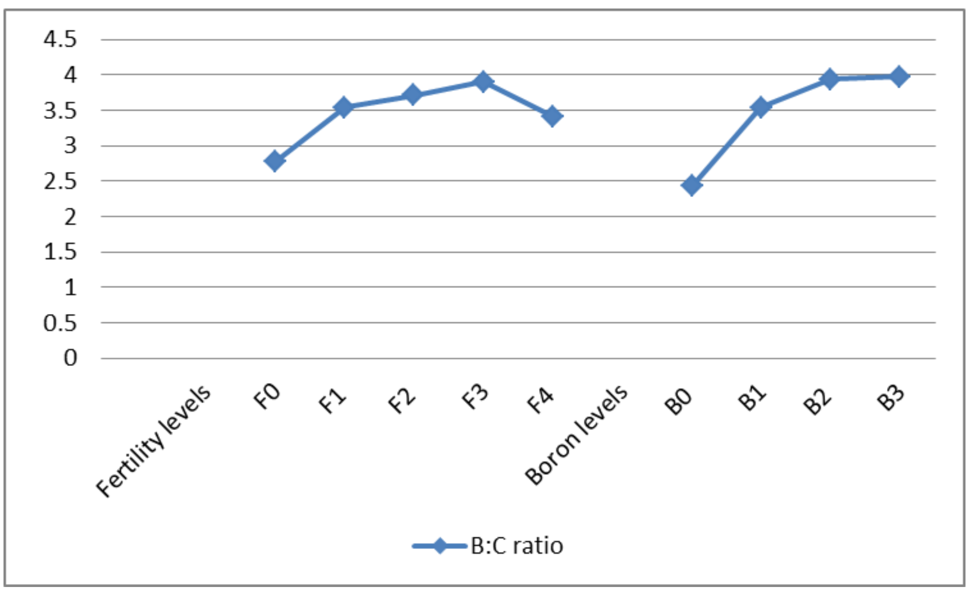

Figure 3 Effect of fertility levels and boron on B:C ratio of cauliflower

Effect of boron levels on quality attributes

The perusal of data presented in Table 2 and Figure 1 shows that the NPK content of curd was influenced by different boron levels. The maximum nitrogen (2.99 %), phosphorus (0.31 %) and potassium content (2.75 %) were recorded under under B_3 treatment (2.5 kg boron per ha), while, minimum nitrogen (2.49 %) and phosphorus content (0.25 %) were recorded in control, while minimum potassium content (2.38 %) was recorded under the treatment $B_{0,}$ B_1. The treatment B_3 was found significantly superior over control and B_1 but statistically at par with B_2 treatment (2.0 kg/ha). The increase in N content in curd under B_3 treatment was found to be 16.72 and 8.36 per cent, P content 19.35 and 9.67 per cent and K content 13.45 and 6.54 per cent higher as compared to control and B_1 treatment, respectively.

The perusal of data presented in Table 2 also found that application of boron levels significantly increased the boron and TSS content in curd. The maximum boron (49.95 ppm) and TSS content in curd (7.54 %) were recorded under 2.5 kg boron per ha (B_3), which was significantly superior to lower levels of boron application and being at par with 2.0 kg boron per ha. However, the minimum boron (41.91 ppm) and TSS content in curd (6.13 %) were recorded under the treatment B_0. The increase of boron content in curd under B_3 treatment was found to be 16.09 and 8.20 per cent more than control and B_1 treatments and increase of TSS content in curd under B_2 treatment was found to be 20.55 and 4.97 per cent more than control and B_1 treatments, respectively.

The nitrogen, phosphorus, potash, boron and TSS content of curd of cauliflower significantly increased with the application of 2.5 kg boron per ha in soil. However, this treatment was statistically at par with 2.0 kg boron per ha (Table 2). This might be due to increased concentration of nutrient in plant under boron fertilization. Due to adequate supply of nutrients with higher dose of boron might have utilization of more nutrients as compared to lower doses resulting in increasing N, P, K, B and TSS in curd of cauliflower. It is established fact that nutrient uptake by the crop depends primarily on boron accumulation and secondary nutrient concentration at cellular levels. The increase photosynthetic efficiency there by more dry matter prediction and nutrient concentration in plants seems to be major factor responsible for higher NPK and B content of curd under the influence of boron application. The results obtained in the present investigation are in close conformity with the findings of Singh (2011) in cauliflower and Saha *et al.* (2010) in broccoli.

Effect of Boron levels on economics

The data pertaining to economics of cauliflower are presented in Table 2 and Figures 2 and 3 also revealed that the application of different boron levels significantly increased the net returns and B:C ratio of cauliflower. The application of 2.5 kg boron per ha (B_3) fetched significantly maximum net returns (Rs 370879/ha) and B:C ratio to control and B_1. While minimum net returns (Rs 203567/ha) and B:C ratio (2.43) were recorded in control. B_3 treatment remained at par with B_2 treatment in case of net returns.

Conclusion

On the basis of results of present investigation it can be concluded that the combined application of 50 per cent RDF through inorganic fertilizers and 50 per cent through vermicompost along with 2.5 kg boron per ha as soil application was found best in terms of quality parameters for better cauliflower crop with net returns (Rs 449866/ha).B: C ratio of separate fertility level (50 per cent RDF through inorganic fertilizers and 50 per cent through vermicompost) and boron (2.0 kg boron per ha) were recorded highest 3.90:1 and 3.94:1 respectively.Thus application of 50 per cent RDF through inorganic fertilizers and 50 per cent through Vermicompost along with 2.0 kg boron per ha as soil application is recommended for better production of cauliflower crop to the farmers.

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