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Impact of different Macro and Micronutrients on economics of cauliflower (*Brassica oleracea* var. *botrytis* L.) cv. "Pusa Sharad"

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Abstract
A Field experiment was conducted to evaluate the effect of different micronutrients on the economics of cauliflower. The study was carried out for two consecutive years (i.e., *rabi* season 2017-18 and 2018-19) at Research cum instructional farm of horticulture, Department of Vegetable Science, IGKV, Raipur. The experiment was consisted of 15 treatments and laid down following the complete randomized block design with three replications. The traits such as cost of cultivation (Rs ha^{-1}), gross income (Rs ha^{-1}), net income (Rs ha^{-1}), and B: C ratio were calculated. The experimental results suggested that almost all the treatments showed a positively influenced the economics, however, the application of 100% RDF + Borax @ 20 kg ha^{-1} + Ammonium molybdate @ 2 kg ha^{-1} + ZnSO4 @ 25 kg ha^{-1} significantly increased the economic associated observed traits. Therefore, it can be concluded that the application of micronutrients is an effective approach in cauliflower to increases the economic benefits.

Keywords: Cauliflower, macronutrients, micronutrients, economics, B: C ratio

Introduction
Cauliflower (*Brassica oleracea* var. *botrytis* L.) belongs to the family Brassicaceae was introduced in India in year 1822 (Swarup and Chatterjee, 1972) [19]. Cauliflower (2n=18) is an important cool-season vegetable crop cultivated throughout India during *the rabi* season. The crop is well adapted to all kinds of soils, having good soil fertility (Islam, 2008) [6]. The economic part curd is pre-floral apical meristem, developed from center point that is short shoot system. In Chhattisgarh state, the area under cauliflower cultivation was 23.95 thousand hectares with the production of 453.19 thousand metric tons with the productivity of 18.92 mt/ha during the year 2016, (Anonymous, 2017) [3].

The macro (nitrogen, phosphorus, potassium) and micronutrients (boron, molybdenum, and zinc) are essential for proper crop growth and development in cauliflower (Rahman *et al.*, 2007) [15]. Previously, several researchers have documented the crucial role of these macro and micronutrients during the plant developmental process in cauliflower and various other crops belonging Brassicaceae family (Alam and Raza 2001; Narayanamma *et al*., 2007; (Kodithuwakku and Kirthisinghe 2009; Das, 2012, Ningawale *et al*., 2016) [2, 13, 9, 14]. Despite many factors responsible for low productivity in cauliflower, inadequate and imbalanced nutrient supply holds the highest position.

During last few decades the uses of fertilizers which supplies macronutrient have been increased to several folds; whereas, application of micronutrients have been largely neglected. Thus, micronutrient deficiencies are more prevalent in crops grown on Indian soils. In addition, over-mining of soil nutrients by plants causes most of the micronutrients to run short in supply to the crops further contributed towards lesser yields (Joshi 1997). Therefore, rational and optimum use of micronutrients coupled with recommended fertilizers would be beneficial to increase curd yield per unit area in cauliflower. Moreover, most of the available pieces of literature are confined to studies where either single or interaction of only two micronutrients was taken into considerations (Lashkari *et al*., 2008; Dhakal *et al*., 2009; Ahmed *et al*., 2011; Singh et *al*., 2011; Kant *et al*., 2013; Ningawale *et al*., 2016) [10, 5, 1, 17, 8, 14]. Keeping in view this scenario, a field study on the effect of different micronutrients in relation to the growth and yield of cauliflower during consecutive seasons has been carried out to generate scientific information.

Materials and methods

The present investigation was conducted during *rabi* season of 2017-18 and 2018-19 at Horticultural Research cum Instructional Farm, Department of Vegetable Science, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.). The field experiments were laid out in Randomized Block Design with three replications having fifteen treatment combinations of were T_1 - Control (100% RDF 120:80:60 kg ha^{-1}), T_2 -100% RDF + Borax @ 20 kg ha^{-1}, T_3 - 100% RDF + Ammonium molybdate @ 2 kg ha^{-1}, T_4 -100% RDF + $ZnSO_4$ @ 25 kg ha^{-1}, T_5 -100% RDF + Borax @ 20 kg ha^{-1} + Ammonium molybdate @ 2 kg ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1}, T_6 -100% RDF + Ammonium molybdate @ 2 kg ha^{-1} + Borax @ 20 kg ha^{-1}, T_7 -100% RDF + Ammonium molybdate @ 2 kg ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1}, T_8 -100% RDF + Borax 20 kg ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1}, T_9 -75% RDF + Borax @ 20 kg ha^{-1}, T_{10} - 75% RDF + Ammonium molybdate @ 2 kg ha^{-1}, T_{11} - 75% RDF + $ZnSO_4$ @ 25 kg ha^{-1}, T_{12} - 75% RDF + Borax @ 20 kg ha^{-1} + Ammonium molybdate @ 2 kg ha^{-1} +$ZnSO_4$ @ 25 kg ha^{-1}, T_{13} -75% RDF + Ammonium molybdate @ 2 kg ha^{-1}+ Borax @ 20 kg ha^{-1}, T_{14} -75% RDF + Ammonium molybdate @ 2 kg ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1}, T_{15}- 75% RDF + Borax 20 kg ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1}. During the economics parameters encompassed in the study were cost of cultivation (Rs ha^{-1}), gross income (Rs ha^{-1}), net income (Rs ha^{-1}), B:C ratio. Seedlings of Cauliflower variety 'Pusa Sharad' were sown in nursery bed under polyhouse conditions were raised in the nursery bed. Five weeks old seedlings were transplanted in the experimental field.

Results and Discussion

The economics of cauliflower increased significantly with the different micronutrients (Table 1).

1. Cost of cultivation (Rs ha^{-1})

The cost of cultivation (Rs ha^{-1}) was ranged from 103418 to 129668 Rs ha^{-1} during year 2017-18, from 109132 to 135382 Rs ha^{-1} during year 2018-19 and from 106275 to 132525 Rs ha^{-1} during pooled mean. The significantly maximum cost of cultivation *viz*., 129668, 135382 and 132525 Rs ha^{-1} during year 2017-18, year 2018-19 and pooled mean analysis respectively was recorded in treatment T_5 {100% RDF + Borax @ 20 kg ha^{-1} + Ammonium molybdate @ 2 kg ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1}} followed by 127949 (year 2017-18), 133663 (year 2018-19) and 130806 Rs ha^{-1} (pooled mean) in treatment T_{12} {75% RDF + Borax @ 20 kg ha^{-1} + Ammonium molybdate @ 2 kg ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1}} compared to control (103418 during year 2017-18, 109132 during year 2018-19 and 106275 Rs ha^{-1} in pooled mean respectively).

2. Gross income (Rs ha^{-1})

The gross income (Rs ha^{-1}) was ranged from 172500 to 293250 Rs ha^{-1} (year 2017-18), from 182100 to 322500 Rs ha^{-1} (year 2018-19) and from 177300 to 307875 Rs ha^{-1} (during pooled mean). The significantly highest gross income *viz*., 293250, 322500 and 307875 Rs ha^{-1} during year 2017-18, year 2018-19 and pooled mean respectively was observed with treatment T_5 {100% RDF + Borax @ 20 kg ha^{-1} + Ammonium molybdate @ 2 kg ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1}} followed by 281000, 317100 and 299050 Rs ha^{-1} during year 2017-18, year 2018-19 and pooled mean respectively with treatment T_{12} {75% RDF + Borax @ 20 kg ha^{-1} + Ammonium molybdate @ 2 kg ha^{-1} + $ZnSO_4$ @ 25 kg ha-^{1}} when compared to control (100% RDF) *viz*., 172500, 182100 and 177300 Rs ha^{-1} during year 2017-18, year 2018-19 and pooled mean respectively.

Table 1: Impact of different Macro and Micronutrients on economics of Cauliflower

Treatments	Cost of cultivation (Rs ha^{-1})			Gross income (Rs ha^{-1})			Net income (Rs. ha^{-1})			B:C ratio		
	2017-18	2018-19	Pooled Mean	2017-18	2018-19	Pooled Mean	2017-18	2018-19	Pooled Mean	2017-18	2018-19	Pooled Mean
T_1	103418	109132	106275	172500	182100	177300	69082	72968	71025	1.67	1.66	1.67
T_2	111418	117132	114275	228500	255600	242050	117082	138468	127775	2.05	2.18	2.12
T_3	119418	125132	122275	238000	262800	250400	118582	137668	128125	1.99	2.10	2.05
T_4	105668	111382	108525	221000	241800	231400	115332	130418	122875	2.09	2.17	2.13
T_5	129668	135382	132525	293250	322500	307875	163582	187118	175350	2.26	2.38	2.32
T_6	127418	133132	130275	269250	308700	288975	141832	175568	158700	2.11	2.32	2.22
T_7	121668	127382	124525	247250	271500	259375	125582	144118	134850	2.03	2.13	2.08
T_8	113668	119382	116525	256000	280800	268400	142332	161418	151875	2.24	2.35	2.29
T_9	109699	115413	112556	201250	221400	211325	91551	105987	98769	1.83	1.92	1.88
T_{10}	117699	123413	120556	210250	227100	218675	92551	103687	98119	1.79	1.84	1.81
T_{11}	103949	109663	106806	195000	202800	198900	91051	93137	92094	1.88	1.85	1.86
T_{12}	127949	133663	130806	281000	317100	299050	153051	183437	168244	2.25	2.37	2.30
T_{13}	125699	131413	128556	262000	291300	276650	136301	159887	148094	2.08	2.22	2.15
T_{14}	119949	125663	122806	246500	264600	255550	126551	138937	132744	2.06	2.11	2.08
T_{15}	111949	117663	114806	251250	273600	262425	139301	155937	147619	2.24	2.33	2.28

3. Net income (Rs ha^{-1})

The net income (Rs ha^{-1}) was ranged from 69082 to 163582 Rs ha^{-1} (year 2017-18), from 72968 to 187118 Rs ha^{-1} (year 2018-19) and from 71025 to 175350 during pooled mean. The significantly maximum net income *viz*., 163582, 187118 and 175350 Rs ha^{-1} during year 2017-18, year 2018-19 and pooled mean respectively was observed in treatment T_5 {100% RDF + Borax @ 20 kg ha^{-1} + Ammonium molybdate @ 2 kg ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1}} followed by 153051, 183437 and 168244 Rs ha^{-1} during year 2017-18, year 2018-19 and pooled mean respectively under treatment T_{12} {75% RDF + Borax @ 20 kg ha^{-1} + Ammonium molybdate @ 2 kg ha^{-1} + $ZnSO_4$ @ 25 kg ha-^{1}} when compared to control (69082 during year 2017-18, 72968 during year 2018-19 and 71025 Rs ha^{-1} during pooled mean was recorded.

4. B:C rati

The B: C ratio was ranged from 1.67 to 2.26 (during year 2017-18), from 1.66 to 2.38 (during year 2018-19) and from 1.67 to 2.32 (during pooled mean). The significantly maximum B:C ratio *viz*., 2.26 during year 2017-18, 2.38 during year 2018-19 and 2.32 pooled mean respectively was exhibited in treatment T_5 {100% RDF + Borax @ 20 kg ha^{-1} + Ammonium molybdate @ 2 kg ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1}}

followed by 2.25, 2.37 and 2.30 during year 2017-18, year 2018-19 and pooled mean respectively in treatment T_{12} {75% RDF + Borax @ 20 kg ha^{-1} + Ammonium molybdate @ 2 kg ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1}} when compared control T_1 (Control (100% RDF) during both the years and pooled mean basis.

The economics of the treatments revealed the actual return and it was calculated on the basis of yield performance and market selling price of curd. Our findings are found well in accordance with reports of Lashkari *et al.* (2008) [10]; Mohapatra *et al.* (2013) [12] Srichandan *et al.* (2015) [18]; Sharma (2016) [16] and Meena *et al.* (2018) [11].

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