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Original Research Article

Studies on Effect of Micro Nutrients on Growth and Yield of Cauli-Flower (*Brassica oleracea* var. botrotis) cv. Sungro-Anandi

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Cauliflower, total biomass production, yield per plot, length of leaf, T.S.S. and ascorbic acid

A B S T R A C T

An investigation on "Studies on effect of micronutrients on growth, yield and quality of cauliflower (*Brassica oleracea* var. *botrytis*) Cv. Sungro-Anandi" was carried out during *rabi* season of 2015 at experimental field of Department of Horticulture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. The experiment was laid out in randomized block design with three replications and eight treatments with plot size 3.60 m x 3.0 m with spacing 60 cm x 60 cm. The micronutrient in experiment was Zn (0.5 %), Bo (0.2 %) and Fe (0.5 %), Fe (0.3 %). The micronutrients were applied to plants at 45 and 60 Day after Transplanting. The significantly high growth in terms of maximum length of leaf (32.26 cm) and total biomass production ((2849.20 g) was recorded by the foliar application of $FeSo_4$ 0.5% + Borax Spray 0.2% + $ZnSo_4$ 0.5% Spray. The yield per plot was significantly influenced by the foliar application of micronutrients. The maximum yield per plot (34.80 kg) was observed by the foliar application of $FeSo_4$ 0.5% + Borax Spray 0.2% + $ZnSo_4$ 0.5% Spray. The total soluble solid and ascorbic acid was significantly influenced by the foliar application of micronutrients. The maximum T.S.S. (6.80^0 Brix) was observed by the foliar application of Borax Spray 0.2% + $ZnSo_4$ 0.5% Spray and ascorbic acid (65.96 mg/100g) was observed by the foliar application of $FeSo_4$ 0.5% + Borax Spray 0.2% + $ZnSo_4$ 0.5% Spray.

Introduction

Cauliflower (*Brassica oleraceae* var. *Botrytis* L.) is one of the most important winter vegetables among the cole crops which belongs to the genus *Brassica* of the family *Cruciferae*. Cauliflower is essentially a cold weather hardly crop and thrives best in cool and moist climate. This was originated from Cyprus and the first crop of cauliflower was introduced in India in sixth century A.D. There is a great demand to his vegetable on account of its delicious taste due to abortive floral parts which are fleshy and closely are used for culinary purposed either along or mixed with potato. Pickle can also be prepared from the firm curd.

India is the second largest producer of vegetables (next to China) with 2.1 per cent of total cropped area under vegetable crops, contributing 14 per cent of world production. Area under vegetable crops in India was 9542 thousand ha and production was 169478 thousand MT in year 2014-2015. In Maharashtra, the total area under vegetable crops was 595.0 thousand ha with 8783.01 thousand MT and 14 MT

production and productivity, respectively. Per capita consumption of vegetables has been increased from 95 g to 175 g as against 284 g, recommended dietary requirement per day.

Among different vegetables, during the last two to three decades, there is a rapid increase in the population which increases the heavy demand for vegetable production. Cauliflower is the fifth most important vegetable crop of the country primarily grown in the winter season. It is grown over an area 9542 thousand ha with production of about 169478 thousand MT and productivity is 14 MT/ha. In 2014-2015, the highest area and production of cauliflower was in West Bengal i.e. 74.60 thousand ha, 1889.96 thousand MT/ha respectively (Annon, 2014).

The present vegetable production is not sufficient to meet daily requirement of growing population and hence, there is immense scope to diversify the area under cultivation of other crops or by adopting technology generated for respect of right of variety and its seed, proper planting season, spacing, management practices, manuring and control of pests and disease. From the above, if manuring was left, it may reduce the productivity by many folds. So proper manuring at right time is most important tool. The dramatic increase in vegetable productivity and the increase in fertilizer consumption point to the crucial role environment pollution due to enormous use of chemical fertilizers.

The role of micronutrients in regulation plant growth and yield is established. Zinc is an activator of enzyme involves in protein synthesis and has direct effect on the enzymatic regulation in plants. Boron regulates metabolism involved in translocation of carbohydrates, cell wall development and RNA synthesis. (Narayanamma *et al.*, 2007)

The Marathwada region is totally new area for is cultivation; However, it is need to produce better quality curd. Micronutrients like boron, molybdenum, zinc and $FeSO_4$ play an important role to improve growth, yield and quality of cauliflower. Te effect of foliar application of micronutrients under Marathwada condition is yet not tested. The response may differ in growth, yield and quality parameter of the cauliflower. Hence, the present investigation is entailed "effect of micronutrients on growth, yield and quality of cauliflower (*Brassica oleracea* var. *botrytis*)" under open field condition was proposed with to study the effect of micronutrients on growth, yield and quality of cauliflower.

Materials and Methods

A field experiment entitled "Studies on effect of micronutrients on growth, yield and quality of cauliflower (*Brassica oleracea* var. *botrytis*)" was conducted at Department of Horticulture, VNMKV, Parbhani during winter (*rabi*) season of 2015. The details of the materials used and methods adopted during the course of investigation are described in this chapter.

Seeds of Sungro-Anandi were obtained from the Department of Horticulture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. Raised beds of 3.0 x 1.0 x 0.15 m^3 (L x B x H) size and seedling were prepared. The upper layer of 5 cm of each bed was mixed with equal quantity of well rotten FYM and sieved soil. Seeds of Sungro-Anandi were sown in rows of 10 cm apart on 10th October, 2015 considering seed rate 200-350 g ha^{-1}. Watering was done regularly by rose can. Raised beds were kept clean by weeding regularly. The seedlings were kept

healthy by taking two sprays of pesticides as and when required.

In the present investigation, micronutrients *viz*. Boron, $FeSO_4$, and $ZnSO_4$ were tried involving 8 treatment combinations. Hence, the experiment was laid out in Randomized Block Design with three replications. The collected data was analysed by statistical method suggested by Panse and Sukhatme (1985).

Results and Discussion

The present investigation was carried out to study the "Studies on effect of micronutrients on growth, yield and quality of cauliflower (*Brassica oleracea* var. *botrytis*)". The experimental field was undertaken at Department of Horticulture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani during *rabi* season of 2015-2016. The observations recorded in the respect of vegetative growth, reproductive growth, yield and quality. The results obtained are presented in this chapter.

Growth parameter

The results obtained in respect of growth parameters viz. height, number of leaves per plant, length of leaf, diameter of stem (at 25, 50, and 75 days after transplanting) have been presented as given below.

Length of leaf

It is evident from the data shown in Table 5 that, the results were statistically significant in respect of length of leaf per plant.

The observations recorded at 25 days after transplanting indicated that maximum leaf length (20.07 cm) per plant were recorded in treatment T_5 ($FeSo_4$ 0.5% + $ZnSo_4$ 0.5%). Treatments T_8 ($FeSo_4$ 0.5% + Borax 0.2% + $ZnSo_4$ 0.5%) and T_2 ($Feso_4$ Spray 0.5%) were statistically at par to each other. Similarly, T_7 ($Znso_4$ 0.5% + Borax spray 0.2%) T_1, T_3, T_5 and T_6 were statistically at par to each other. The lowest leaf length (17.71cm) per plant was recorded in T_4 (Borax Spray 0.2%).

At 50 days after transplanting, maximum leaf length (32.26 cm) per plant were recorded in treatment T_8 ($FeSo_4$ 0.5% + Borax 0.2% + $ZnSo_4$ 0.5%) and which was statistically significant over all other treatments. T_5, T_6 and T_3 were statistically at par to each other. Minimum leaf length (27.77 cm) per plant was recorded in treatment T_1 (control).

At 75 days after transplanting, maximum leaf length (39.26 cm) per plant was recorded with T_8 ($FeSo_4$ 0.5% + Borax 0.2% + $ZnSo_4$ 0.5%) which was significantly superior over all other treatments. Under study the next best treatment T_7 and T_6. Significantly lowest leaf length (35.72 cm) was observed in control (T_1).

The data pertaining to leaf length per plant (Table 5) was significantly influenced by different treatment combination during investigation. From the observation recorded, it was revealed leaf length per plant was given significant result at 25 days after transplanting.

Kumar S. *et al.*, (2012) the observations were recorded on leaf length in cauliflower influenced by the application of different treatment combination of boron and zinc and data have been presented maximum leaf length (45.22 cm).

Curd initiation

It is evident from Table 6 that effect of micronutrients on number of days required

for curd initiation of cauliflower cv. Sangro-Anandi. The results were statistically indicated significant differences in different treatments.

The minimum days to curd initiation (67.89 days) were recorded in treatment T_8 ($FeSo_4$ 0.5% + Borax 0.2% + $ZnSo_4$ 0.5%) which was statistically at par with treatment T_7 ($Znso_4$ 0.5% + Borax 0.2%) and T_6 ($FeSo_4$ 0.5% + Borax 0.2%). The maximum number of days (76.08 days) was recorded in treatment T_1 (control) except T_2 ($Feso_4$ Spray 0.5%) and T_3 ($Znso_4$ Spray 0.5%) which were at par with each other.

Interaction of micronutrients with various levels was found beneficial in reducing the days required for curd initiation as well as curd maturity. The probable reason for early curd initiation and curd maturity might be due to foliar application of boron, zinc and ferrous sulphate.

Lashkari *et al.,* (2007) the minimum days taken for curd initiation and curd maturity were recorded with individual foliar sprays of zinc and iron at 0.5% concentration, respectively.

Earliness in curd initiation and maturity might be due to physiological role of zinc and rapid translocation of photosynthesis towards the curd which might have developed advance cud (Arora *et al.,* 1990).

Curd maturity

The observations presented in Table 7 regarding the days required for curd maturity indicated significant differences in different treatments. The treatment T_8 ($FeSo_4$ 0.5% + Borax 0.2% + $ZnSo_4$ 0.5%) recorded significantly earlier curd maturity (81.19 days) as compared to all other treatments but at par with treatment T_7 ($Znso_4$ 0.5% + Borax 0.2%). The maximum number of days for curd maturity (95.36 days) were required in the treatment T_1 (control) and was at par with treatment T_2 ($Feso_4$ Spray 0.5%), T_3 and T_4.

Total biomass production per plant

Significant differences with respect to total biomass production were observed at different levels of application from the data presented in Table 9. Maximum total biomass production (2849.20 g) per plant was observed in treatment T_8 ($FeSo_4$ 0.5% + Borax 0.2% + $ZnSo_4$ 0.5%) which were significantly superior over all other treatments except T_6 ($FeSo_4$ 0.5% + Borax 0.2%) and T_7 (2674.13 g) which was statistically at par. was next T_5 best treatments. The minimum total biomass production (1821.07 g) per plant was observed in control (T_1).

Kumar *et al.,* (2012) observation were recorded on total biomass production in cauliflower influenced by the application of different treatment of combination of boron. The maximum total biomass production (1.870 kg) recorded.

Yield parameters

Curd size

Evidence of significance of difference of crop yield in response to the various treatments and their combinations can obtain from the data presented in Table 11. Maximum curd size (235.68 cm^2) per plant was observed in Treatment T_8 ($FeSo_4$ 0.5% + Borax 0.2% + $ZnSo_4$ 0.5%) which were significantly superior over all other treatments except T_7 (231.15 cm^2) ($ZnSo_4$ 0.5% + Borax 0.2%) and T_6 (230.47 cm^2) which was statistically at par. T_5 was next best treatments.

Table.1 Effect of micronutrients on length of leaf, Mean number of days required for curd initiation and Mean number of days required for curd maturity

Treatments	Length of leaf			Mean number of days required for curd initiation	Mean number of days required for curd maturity
	25DAT	50DAT	75DAT		
T_1 - (Control)	18.30	27.77	35.72	76.08	95.36
T_2 - ($Feso_4$ Spray 0.5%)	19.13	29.51	36.24	74.18	91.22
T_3 - ($Znso_4$ Spray 0.5%)	18.25	30.03	35.90	73.39	89.23
T_4 - (Borax Spray 0.2%)	17.71	29.46	37.34	72.36	87.20
T_5 - ($FeSo_4$ + $ZnSo_4$ Spray) (0.5%+0.5%)	20.07	30.41	36.55	72.55	86.16
T_6 - ($FeSo_4$ + Borax Spray) (0.5% + 0.2%)	18.72	31.03	37.69	71.22	84.82
T_7 - ($Znso_4$ + Borax spray) (0.5%+0.2%)	18.72	29.17	38.92	70.33	83.12
T_8 - ($FeSo_4$ + Borax Spray+ $ZnSo_4$ Spray) (0.5% + 0.2%+0.5%)	19.41	32.26	39.26	67.89	81.19
SE ±	0.62	0.76	0.77	1.30	2.64
CD at 5 %	1.88	2.31	2.34	3.93	7.97

Table.2 Effect of micronutrients on Mean total biomass production per plant (g), Mean curd size (cm^2), Curd yield/plot (kg), Mean total soluble solid content of curd (^{0}Brix) and Mean ascorbic acid content of curd (mg/100g)

Treatments	Mean total biomass production per plant (g)	Mean curd size (cm^2)	Curd yield/plot (kg)	Mean total soluble solid content of curd (^{0}Brix)	Mean ascorbic acid content of curd (mg/100g)
T_1 - (Control)	1821.07	160.29	28.52	5.37	46.93
T_2 - ($Feso_4$ Spray 0.5%)	2228.28	187.18	30.93	6.49	54.17
T_3 - ($Znso_4$ Spray 0.5%)	2317.23	206.52	31.26	5.91	56.73
T_4 - (Borax Spray 0.2%)	2352.22	216.99	31.32	6.46	59.22
T_5 - ($FeSo_4$ + $ZnSo_4$ Spray) (0.5%+0.5%)	2534.84	224.01	31.79	6.38	62.03
T_6 - ($FeSo_4$ + Borax Spray) (0.5% + 0.2%)	2708.26	230.47	32.28	6.46	61.38
T_7 - ($Znso_4$ + Borax spray) (0.5%+0.2%)	2674.13	231.15	33.17	6.80	64.89
T_8 - ($FeSo_4$ + Borax Spray+ $ZnSo_4$ Spray) (0.5% + 0.2%+0.5%)	2849.20	235.68	34.80	6.79	65.96
SE ±	126.74	6.74	1.03	0.207	1.97
CD at 5 %	382.67	20.37	3.12	0.627	5.96

Table.3 Effect of micronutrients on B: C ratio

Treatments	Yield (mt/ha)	Total Gross income (Rs)	Total cost of production (Rs)	Net income (Rs)	B: C Ratio
T_1	264.10	114355.3	52256	62099.3	2.18
T_2	286.39	124006.8	52596	71410.8	2.35
T_3	289.41	125314.5	52590	72724.5	2.38
T_4	290.00	125570.0	52401	73169.0	2.39
T_5	294.38	127466.5	52618	74848.5	2.42
T_6	298.89	129419.3	52601	76818.3	2.46
T_7	307.16	133000.0	52606	80394.0	2.52
T_8	322.25	139534.2	52629	86905.2	2.65

Treatments Details

Symbols	Treatment Details
T_1	Control
T_2	$Feso_4$ Spray 0.5%
T_3	$Znso_4$ Spray 0.5%
T_4	Borax Spray 0.2%
T_5	$FeSo_4$ + $ZnSo_4$ Spray (0.5%+0.5%)
T_6	$FeSo_4$ + Borax Spray (0.5% + 0.2%)
T_7	$Znso_4$ + Borax spray (0.5%+0.2%)
T_8	$FeSo_4$ + Borax Spray+ $ZnSo_4$ Spray (0.5% + 0.2%+0.5%)

The minimum curd size (160.29 cm^2) per plant was observed in control (T_1).

The present finding is in close conformity with the finding of Sharma (2002) and Singh (2003).

Cauliflower curd yield has been set aside by deficiency of micronutrients, which leads to certain physiological disorders (Mehrotra 1974). But the research done on use of zinc with combination of iron is scantly.

Therefore, the present investigation was carried out to know the beneficial effect of foliar spray of zinc and iron on yields of cauliflower cv. Snowball-16 (Lashkari, 2008).

Quality parameters

Total soluble solid

The data regarding the T.S.S. in Table 13 showed that the treatment differences were significant. The maximum T.S.S. (6.80^0 Brix) was recorded in treatment T_7 ($Znso_4$ 0.5% + Borax 0.2%) followed by T_8 (6.79^0 Brix), T_4 (6.46^0 Brix), T_6 (6.46^0 Brix) and T_5 (6.38^0 Brix). These treatments were statistically at par with each other. Treatment (T_7) was significantly superior over control (T_1). Minimum T.S.S. (5.37^0 Brix) was recorded in control (T_1).

The increased T.S.S. content evidently showed that the stored food materials

undergo either partial or complete hydrolysis and provide substrate for respiration. Being an essential component which might be involved in the respiratory process in the cell system and plant system, this could have naturally resulted in the conversion of reserved food material to soluble simple sugar.

Lashkari *et al.,* (2008) recorded that increase T.S.S. (7.20^0 Brix) was obtained with combine foliar sprays of zinc and iron at 0.5% concentration each.

Ascorbic acid

Results recorded in respect of ascorbic acid in Table 14 showed that the treatments were statistically significant. The significantly highest ascorbic acid (65.96 mg/100gm) was recorded in treatment T_8 ($FeSo_4$ 0.5% + Borax 0.2% + $ZnSo_4$ 0.5%) which was significantly superior than all other treatments. The next best treatment was observed in T_6 and statistically at par to each other. The minimum ascorbic acid (46.93 mg/100gm) was recorded in treatments T_1 (control).

Kumar *et al.,* (2010) recorded that foliar application of o.3 per cent of borax has significantly positive effect on the ascorbic acid content of cauliflower curd.

Benefit: Cost ratio (B: C)

Treatment wise per hectare cost of cultivation was worked out and used for computing the benefit: cost ratio (B: C), cost of cultivation, gross income and benefit: cost ratio are presented in Table 15.

In T_8 ($FeSo_4$ 0.5% + Borax 0.2% + $ZnSo_4$ 0.5%) treatment produced highest B: C Ratio (2.65) followed by treatment T_7 ($Znso_4$ 0.5% + Borax 0.2%) (2.52). The lowest B: C Ratio was recorded by T_1 (control) treatment (2.18).

These results are in agreement with Lashkari *et al., (*2008) in cualiflower and Jamre and Verma (2010) the highest net return and benefit: cost ration recorded under treatment Zinc sulphate 0.5 per cent.

It can be concluded from the investigation entitled "studies on effect of micronutrients on growth, yield and quality of cauliflower (*Brassica oleracea var. botrytis*) cv. Sungro-Anandi" that an foliar application of $FeSo_4$ 0.5% + Borax 0.2% + $ZnSo_4$ 0.5% treatment enhanced the vegetative and reproductive growth as well as yield and quality of Cauliflower with high net monetary returns and wider B: C ratio. Hence the treatment can be considered as the most beneficial for Cauliflower.

For confirmation of the present results, some more trials are needed as these results are based on one season study only.

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