Environment and Ecology 42 (3B) : 1369—1374, July—September 2024
Article DOI: https://doi.org/10.60151/envec/SPMC5561
ISSN 0970-0420

Enhancement of Growth and Yield of Valentena (Purple Cauliflower) through Different Micronutrient Optimization

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Received 8 February 2024, Accepted 14 July 2024, Published on 4 September 2024

ABSTRACT

Cauliflower (*Brassica oleracea* var. *botrytis* L.) is a prominent member of the cole group of vegetables and is widely cultivated for its high yield. To ensure good yield, it requires sufficient macronutrients and micronutrients. Boron, molybdenum and zinc are crucial micronutrients for cauliflower where their deficiencies are common in cauliflower crop and can lead to specific symptoms. Hence the study was conducted to evaluate the "Enhancement of growth and yield of Valentena (purple cauliflower) through different micronutrient Optimization" during *rabi* 2022-23 at Horticulture Research Farm, Ranadevi, M. S. Swaminathan School of Agriculture, Centurion University of Technology and Management, Paralakhemundi, Odisha. The experiment used a Randomized block design, comprising eight treatments replicated thrice. These treatments involved various combinations of micronutrients: T_1 (100% RDF), T_2 (100% RDF + Borax at 20 kg ha^{-1}), T_3 (100% RDF + Ammonium molybdate at 2 kg ha^{-1}), T_4 (100% RDF + $ZnSO_4$ at 25 kg ha^{-1}), T_5 (100% RDF + Ammonium molybdate at 2 kg ha^{-1} + $ZnSO_4$ at 25 kg ha^{-1}), T_6 (100% RDF + Borax at 20 kg ha^{-1} + $ZnSO_4$ at 25 kg ha^{-1}), T_7 (100% RDF + Ammonium molybdate at 2 kg ha^{-1} + Borax at 20 kg ha^{-1}), T_8 (100% RDF + Borax at 20 kg ha^{-1} + Ammonium molybdate at 2 kg ha^{-1} + $ZnSO_4$ at 25 kg ha^{-1}). Analysis of results showed that treatment T_3 (100% RDF + Ammonium molybdate at 2 kg ha^{-1}) exhibited maximum growth parameters, including stem length (17.65 cm), stem girth (42.83 mm), and number of leaves (18.40). The tallest plant height (61.05 cm) was observed in treatment T_2 (100% RDF + Borax at 20 kg ha^{-1}). Regarding yield and yield attributing characteristics, treatment T_5 (100% RDF + Ammonium molybdate at 2 kg ha^{-1} + $ZnSO_4$ at 25 kg ha^{-1}) recorded the highest pure curd weight (1114.78 g), pure curd yield per hectare (33.32 kg), and the shortest duration for curd initiation (55.67 days). It is therefore suggested that farmers to implement a micronutrient combination approach in their agricultural practices to enhance the growth and yield of Valentena (purple cauliflower) and other crops.

Keywords Growth, Yield, Micronutrients, Purple cauliflower, Recommended NPK.

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INTRODUCTION

Vegetables are crucial for human nutrition as they provide essential bioactive nutrients like dietary fiber, vitamins, minerals, and non-nutritive phytochemicals such as flavonoids, phenolic compounds, and bioactive peptides (Ülger *et al*. 2018). Cauliflower (*Brassica oleracea* var. *botrytis*), belonging to the cruciferous family of vegetables, is classified as a cool-season crop and has a chromosome number, 2n = 18. It is a widely cultivated vegetable across India and the world. The "cole group," from which cauliflower is believed to have originated, was the wild cabbage, known as "cole warts" (*Brassica oleracea* var. *sylvestris*), and the eastern Mediterranean region is considered to be its center of origin (Bairwa *et al.* 2023). It was introduced in India in 1822 (Swarup and Chatterjee 1972) and is well adapted to all kinds of soils, having good soil fertility (Islam 2008).

India is the second largest cauliflower producing country globally with an area of 479'000 ha, production of 9437'000 MT and productivity of 19.69 t ha^{-1} (Ministry of Agriculture and Farmers Welfare 2021-22). The main cauliflower cultivating states are West Bengal, Bihar, Maharashtra, Madhya Pradesh, Odisha, Gujarat and Chhattisgarh. Odisha is the 6th largest producer of cauliflower in the country with an area 40.56'000 ha, production 642.94'000 tonnes and productivity is 15.85 tonnes per hectare (Ministry of Agriculture and Farmers Welfare 2021-22).

Cauliflower is highly dependent on major nutrients like nitrogen, phosphorus, and potassium, as well as micronutrients like boron, molybdenum, and zinc, for their optimal growth and development (Rahman *et al.* 2007). Nitrogen is important and crucial nutrient as it involves in several physiological processes together with enzyme activity (Kodithuwakku and Kirthisinghe 2009, Neethu *et al.* 2015). Its deficiency ceases the growth and yield reduces significantly (Sharma 2016). Phosphorus is essential for a multitude of cellular functions, including photosynthesis, respiration, energy storage and transfer, as well as cell division and enlargement (Taiz and Zeiger 2006). Potassium plays a key role by maintaining the water balance in the plants. It also increases vigour and disease resistance in plants (Das 2012).

Proper supplementation of micronutrients like boron, molybdenum and zinc are critical for achieving optimal cauliflower yield and quality. Boron is essential for regulating critical metabolic processes such as carbohydrate translocation, RNA synthesis, and cell wall development in cauliflower plants (Narayanamma *et al.* 2007). It has a significant effect in maximizing curd size, production and quality of cauliflower (Kumar and Chaudhary 2002). Cauliflower exhibits 'Hollow Heart' and 'Browning of Curd' as symptoms of boron nutrient deficiency (Adhikary *et al*. 2004, Raja 2007, Sarkar *et al.* 2012, Sarker *et al.* 2019). Molybdenum is an essential for healthy growth and many plants physiological processes (Mendel and HaÈnsch 2002, Sun *et al.* 2009, Ramesh *et al*. 2023). The application of molybdenum results in enhancing productivity, quality, and profitability (Chakkal *et al.* 2022). Cauliflower with molybdenum deficiency exhibits "whiptail" symptoms where only the midrib is present, resembling a whip, and leaf blades do not fully develop (Sharma 2002, Ramesh *et al.* 2020). Zinc is a crucial micronutrient for plant growth, serving as a key component in the structure of enzymes, proteins, and various cofactors. Additionally, zinc plays a significant role in nitrogen metabolism. Its deficiency leads to poor growth, final yield and reduced quality. This study aimed to investigate the optimization of different micronutrients in the growth and yield of cauliflower.

MATERIALS AND METHODS

The present investigation entitled "Enhancement of growth and yield of Valentena (purple cauliflower) through different micronutrient Optimization" was carried out at Horticulture Research Farm, M.S. Swaminathan School of Agriculture, Centurion University of Technology and Management, Ranadevi, Paralakhemundi, Odisha. The location falls under North Eastern Ghat Agro Climatic Zone with an average annual rainfall of 1423.6 mm at an altitude of 1035 m MSL. The soil texture of the testing location was homogenous and sandy loam. Before planting the crop, soil samples were collected randomly from the experimental area. The sample was subjected to physical and chemical examination using established methods of analysis and the results were obtained from the Department of Soil Science and Agriculture

Table 1. Treatment details.

Sl. No.	Symbol	Treatment details
1	T_1	Control (100 % RDF)
2	T_2	100 % RDF + Borax @ 20 kg ha^{-1}
3	T_3	100% RDF + Ammonium molybdate @ 2 kg ha^{-1}
4	T_4	100% RDF + $ZnSO_4$ @ 25 kg ha^{-1}
5	T_5	100% RDF + Ammonium molybdate @ 2 kg ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1}
6	T_6	100% RDF + Borax 20 kg ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1}
7	T_7	100% RDF + Ammonium molybdate @ 2 kg ha^{-1} + Borax 20 kg ha^{-1}
8	T_8	100% RDF + Borax @ 20 kg ha^{-1} + Ammonium molybdate @ 2 kg ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1}

Chemistry, MSSSoA, CUTM. The experiment was conducted with 8 treatments laid out in Randomized Block Design (RBD) replicated thrice.

Before ploughing, the pre-irrigation should be given, followed by soil pulverization through ploughing. Incorporation of farmyard manure at a rate of 20 t/ha occurred during field preparation, along with the application of the standard NPK dosage of 200:125:125 kg ha^{-1} using urea, single super phosphate, and muriate of potash. Upon layout preparation, one-third of the urea, along with the full amount of single super phosphate, muriate of potash, borax, and sodium molybdate, was applied as basal dressing per treatment. Through mixing of fertilizers with the soil was ensured. The remaining two-thirds of urea were applied in two split doses at 30 and 45 days after transplanting, preceding earthing. Micronutrients such as boron, molybdenum, and zinc were applied either individually or in combination as soil applications, depending on the treatments. For seedling cultivation, seeds of the purple cauliflower variety "Valentena" were chosen and raised in portrays. Healthy one-month-old seedlings were carefully uprooted and transplanted into the field at a spacing of 60 × 45 cm. Following transplanting, a light irrigation was administered, and the specific treatments outlined in Table 1 were implemented.

RESULTS AND DISCUSSION

Growth parameters

Observations regarding the growth parameters (Table 2, Fig. 1) revealed that there was an influence of different micronutrients on the growth parameters. The maximum plant height (61.05 cm), leaf length (48.65 cm), leaf width (23.55 cm) were noticed in the treatment T_2 (100% RDF+ Borax @ 20 kg ha^{-1}) in the meanwhile maximum number of leaves (18.40), stem length (17.65 cm) and stem grith (42.83 mm) were observed in the treatment T_3 (100% RDF + Ammonium molybdate @ 2 kg ha^{-1}). The possible reason for the observed increase in growth characteristics of a plant is linked to the specific function of boron. This function involves the precipitation of excess cations, buffer action, and maintenance of conducting tissues, which ultimately support the absorption of nitrogen. On the other hand, molybdenum triggers physiological processes by stimulating factors that enhance the plant's metabolism and growth. These findings align with previous research conducted by

Table 2. Effect of different micronutrients on growth parameters.

Symbol	Plant height (cm)	Leaf length (cm)	Leaf width (cm)	Stem length (cm)	Stem grith (cm)	Number of leaves
T_1	57.63	46.51	23.11	16.15	39.37	15.80
T_2	61.05	48.65	23.55	16.44	39.47	18.00
T_3	57.71	46.47	22.85	17.65	42.83	18.40
T_4	57.11	47.33	23.13	16.67	38.87	16.67
T_5	57.11	45.69	22.29	17.10	38.33	17.87
T_6	51.97	43.59	21.64	16.48	38.53	16.40
T_7	55.12	44.96	22.66	15.01	41.83	17.60
T_8	59.21	47.83	23.47	14.90	39.45	18.33
CD at 5%	5.24	4.49	4.49	1.62	2.97	1.57
CV	5.24	5.53	5.53	5.68	4.27	5.17
SEm (±)	1.73	1.48	1.48	0.53	0.98	0.52

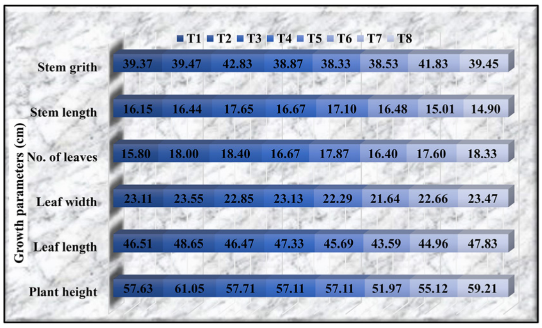

Fig. 1. Effectiveness of micronutrients on growth parameters.

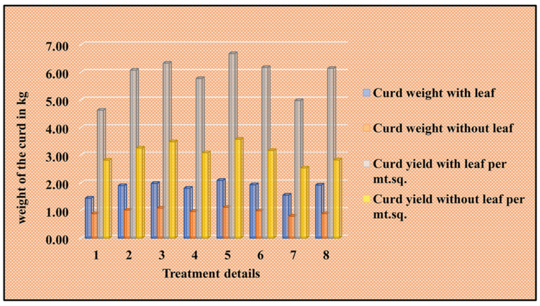

Fig. 2(a). Effectiveness of micronutrients on yield parameters.

Ghosh and Hasan (1997), Maurya *et al.* (1992) and Ramesh and Sikder (2021) on cauliflower.

Yield parameters

The application of different treatment combinations has influenced the yield characteristics (Figs. 2a–

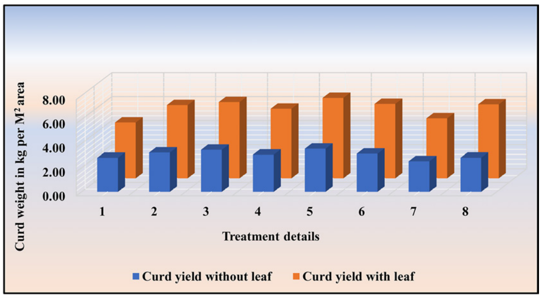

Fig. 2(b). Effectiveness of micronutrients on yield parameters.

2b) in the cauliflower (Table 3). The maximum curd weight with leaf (2087.00 g), curd weight without leaf (1114.78g), curd yield with leaf per m^2 (6.68 kg) curd yield without leaf per m^2 (3.57 kg) were noticed with treatment T_5 (100% RDF + Ammonium molybdate @ 2 kg ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1}) this might be due to application of Mo which has been found to significantly increase curd yield, and this effect can be attributed to Mo's role in phosphorus utilization. This can lead to early maturity of the plant, which in turn prevents curd deformation and results in better marketable curds compared to the control. Similar positive outcomes have been observed in experiments with cauliflower, lentil, mungbean, and blackgram, as reported by various studies (Islam 2018, Khan *et al*. 2019, Quddus *et al.* 2020, Hossain *et al.* 2020, Mahesh *et al.* 2021) and it is also evident that the increased supply of zinc through soil application has led to its availability in plants, along with other essential plant nutrients and has been found to play a

Table 3. Effect of different micronutrients on yield parameters.

Symbol	Days to curd initiation	Curd weight with leaf (g)	Curd weight without leaf (g)	Curd yield with leaf per m^2 (kg)	Curd yield without leaf per m^2 (kg)
T_1	63.67	1444.65	881.04	4.62	2.82
T_2	62.33	1898.70	1015.59	6.08	3.25
T_3	59.33	1978.41	1086.88	6.33	3.48
T_4	55.00	1804.01	962.13	5.77	3.08
T_5	55.67	2087.00	1114.78	6.68	3.57
T_6	59.00	1930.25	987.22	6.18	3.16
T_7	61.00	1553.75	792.45	4.97	2.54
T_8	57.33	1918.73	883.17	6.14	2.83
CD at 5%	4.13	297.25	158.82	0.96	0.40
CV	3.98	9.29	9.39	9.35	7.37
SEm (±)	1.36	97.99	52.36	0.32	0.13

crucial role in regulating the concentration of auxin in plants. Moreover, zinc plays a role in augmenting the uptake of vital elements by boosting the cation exchange capacity (CEC) of roots. Therefore, applying molybdenum in combination with zinc can improve the overall growth and development of the plant, leading to higher yields.

CONCLUSION

The study aims to improve the growth and yield of purple cauliflower by exploring various micronutrient optimization strategies. These treatments encompass different combinations of micronutrients, namely boron, molybdenum, and zinc, in conjunction with the prescribed dosage of nitrogen, phosphorus, and potassium (NPK). Results showed that the maximum growth parameters like stem length, stem grith and leaf count were observed in the treatment with 100% RDF+ Ammonium molybdate @ 2 kg ha^{-1}. The highest plant height was observed in the treatment with 100% RDF+ Borax @ 20 kg ha^{-1}. The treatment with 100% RDF + Ammonium molybdate @ 2 kg ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1} recorded the highest yield characteristics. It is therefore suggested that farmers to implement a micronutrient combination approach in their agricultural practices to enhance the growth and yield of Valentena (purple cauliflower) and other crops.

ACKNOWLEDGMENT

I am immensely grateful to my thesis advisor, Dr. Eggadi Ramesh, and committee members for their guidance and support. My sincere appreciation also goes to Dr. Thriveni Vangapandu, Dr. Bishnuprasad Dash, and Dr M. Chandra Surya Rao for their invaluable assistance.

Furthermore, I express my gratitude to my friend Naveen for his constant support and insightful discussions. I am deeply thankful to the faculty members and staff of M. S. Swaminathan School of Agriculture for their assistance.

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