DOI: http://doi.org/10.4038/atrsj.v2i1.35

*ISSN: 2792 – 1360* *Journal of Agro-Technology and Rural Sciences* *Volume 2, Issue 1; July 2022*

# SITE-SPECIFIC MACRONUTRIENT MANAGEMENT FOR CAULIFLOWER (*Brassica oleracea* L.) IN BATAPOLA SRI LANKA

Ruhunuge I.J.A.[1]*, Mallawaarachchi M.A.R.N.[1], Rathnayake M.Y.A.S.[2] and Kirthisinghe J.P.[3]

[1] Department of Crop Management, Faculty of Agriculture, Aquinas College of Higher Studies, Colombo 8
[2] Provincial Department of Agriculture (NWP), Dambulla Road, Kurunegala
[1, 3] Postgraduate Institute of Agriculture, University of Peradeniya, Peradeniya

**Corresponding Author: isuriruhunuge999@gmail.com* (https://orcid.org/0000-0001-8761-5996 )
*Received: 03.01.2022; Accepted: 29.05.2022; Published: 18.07.2022*

## ABSTRACT

*A blanket fertilizer was recommended by the Department of Agriculture (DOA) for all species of cabbage. However, the fertilizer application is needed to be site-specific. Hence a field experiment was conducted at Ambalangoda during the Maha season in 2019 with the objective of evaluating the effect of Calcium (Ca), Magnesium (Mg) and Boron (B) on the yield and the Quality of cauliflower. Batapola Ambalangoda soil was analyzed for available nutrients and identified the most deficit macronutrients as Ca, B and Mg. This was laid out in a Randomized Complete Block Design with four replicates. One plot size was 1m × 2m and each plot had ten plants. Five treatments were taken as NPK (DOA recommendation) (T1), NPK + Ca + Mg (T2), NPK + Ca + Mg + B (T3), NPK + Ca (T4), NPK + Mg (T5). Incorporating magnesium, calcium and boron with the DOA recommendation resulted in larger cauliflower curds under field conditions, contributing to a 44.2 % increase in curd yield. The additional four days of shelf life were observed in the curds of T3.*

***Keywords: Blanket fertilizer, Cauliflower, Micronutrients, Site-specific nutrient management***

## INTRODUCTION

Cauliflower (*Brassica oleracea* L.) is a cruciferous crop grown for its white curds, which are edible. This crop grows in a cool, wet climate and is sensitive to extreme temperatures (Din et al., 2007). Cauliflower's poor yield is caused due to many factors; among them, imbalanced and low availability of specific nutrients is the major limitation (Bairwa et al., 2021). Hence the soil was collected from the experimental site in Batapola, Ambalangoda and available nutrients were analyzed.SSNM(site-specific nutrient management) is a method of providing nutrients to plants that best match their natural spatial and temporal nutritional requirements (Verma et al ., 2020). Site-specific management, in association with 4R Nutrient Stewardship, provides perfect crop management systems and utilizes the right source, rate, time, and location of nutrients to be applied (Mascarenhas., 2014). As a result of site-specific nutrient management, it will Increase fertilizer use efficiency and reduce nutrient losses. A site-specific nutrient estimate is developed based on preliminary soil analysis and sorption tests (Ningawale et al., 2016). Application of the micronutrient as calcium, magnesium and boron along with the recommended doses of macronutrients such as nitrogen, phosphorus, and potassium boast up yield component of cauliflower (Kumar et al., 2012). According to (Tiwari., 2007), the following are the key characteristics of SSNM: Based on soil testing, primary and secondary nutrients are applied to specific sites making the best use of existing nutrients such as those found in soil residues parts and manures whereas SSNM also offers directions for selecting the most cost-effective nutritional combinations. Three essential phases in site-specific nutrient management include assessing soil and crop variability, controlling the variability, and evaluating it (Choudhary et al., 2016). We can moderate variability and conduct precision farming by using the current technologies to assess variability and provide site-specific agronomic solutions. This site-specific nutrient management includes the identification of nutrient deficiency in that specific site and the formulation of fertilizers to compensate for that deficit. Balanced fertilization is required to maintain optimum soil health, including the application of all necessary plant nutrients in the right amount and form (Singh H et al., 2010). As a result, this study aimed to develop a site-specific secondary macronutrients suggestion for cauliflower in Batapola and assess the effectiveness of the fertilizer. Calcium (Ca), Boron (B) and Magnesium (Mg) were the secondary macronutrients that were deficient in the experimental site and therefore, for the recommendation only deficit quantity was added.

## METHODOLOGY

This field experiment included five treatments with slightly varying magnesium, boron and calcium combinations, and it was compared to the current Department of Agriculture (DOA) standard. The field experiment was conducted from September 2019 to December 2019 at the Batapola, Ambalangoda during the Maha season. The experimental site belonged to the Red Yellow Podzolic soil group in the Low Country Wet Zone of Sri Lanka. The soil samples were tested in two replicates for available nutrients using a suggested preliminary extraction process by Portch and Hunter (2002) at a depth of one meter. The calcium and magnesium were detected by an atomic absorption spectrophotometer (Buck Scientific model 210 VGP). The fertilizer combinations for the treatments were created using the technique provided by Portch and Hunter, based on the nutrient analysis of the original soil sample and data from the fixation research (Portch and Hunter.,2002). Five treatments were tested under field conditions. The treatments (Table 1) were taken as DOA recommendation (Control) (T1), NPK with Ca and Mg (T2), NPK with Ca, Mg and B (T3), and NPK with only Ca (T4), NPK with only Mg (T5). The Experiment was designed under a Randomised Complete Block Design (RCBD) with four replicates. Urea 110 kg/ha and Triple Super Phosphate (TSP) 275 kg/ha and Muriate of Potash (MOP) 75 kg/ha were applied as basal dressing, whereas 110 kg/ha of urea was applied as top dressing 1 and as top dressing 2, urea 110 kg/ha and MOP 75 kg/ha was applied. Seedlings of cauliflower variety 'Fuji' was transplanted in the field according to the DOA recommended spacing of 50 cm x 40 cm. Light traps were fixed to control plant hopper attacks and pesticides were used to control insects and diseases and white polythene was laid around the field to protect the plants from wild boar. Department of Agriculture recommendation was identified as T1 (Table 1). Urea, triple superphosphate, muriate of potash, calcium nitrate, magnesium sulphate, and boric acid were used to supply nitrogen, phosphorus, potassium, calcium, magnesium and boron respectively.

Plant characteristics such as plant height and total leaf area, number of days to 50% flowering, and terminal yield /ha were measured and analyzed during the preharvest period for each treatment. Harvesting was done when the curd reached commercial maturity, which was when the curd was well-formed, firm, and compact with a very close texture and white or cream colour, which was the optimal harvesting stage for the best curd quality (Kirthisinghe, 2006). The curd's colour and compactness were visually appraised, and measurements were taken using a visual quality rating (VQR) scale established specifically for this study based on the Sri Lankan market value for cauliflower curd. Keeping Quality (shelf life) as a post-harvest quality evaluation was performed using the curds collected, with four curds from each fertilizer treatment randomly selected and stored separately. Two curds were maintained in the open air at room temperature 28+2 $^{o}$C among these four curds whereas the other two curds were kept in 150 gauge low-density polythene bags at room temperature 28+2 $^{o}$C with a relative humidity of 93+3 %. As a quality parameter, the storage life was calculated by counting the number of days it took to show the first signs of rotting, decaying, or colour change. The data were analyzed using the Statistical Analytical Software (SAS, 2005) package. For normally distributed data, ANOVA with the Duncan Multiple Range Test (DMRT) was used.

## RESULTS AND DISCUSSION

The preliminary soil study revealed that the CEC is 5.3 cmolkg$^{-1}$ in the experimental location of Batapola, Ambalangoda and that calcium and magnesium were deficient, with the available calcium content of 740 mg/kg and magnesium content of 193 mg/kg whereas boron was not detected. The soil had a pH of 6.3, and available nitrogen, phosphorus, and potassium at 0-15 cm depth were 26, 11, and 112 mg/kg, respectively, as determined according to AOAC 2006.03. (2009) and the official analysis method (Hall William., 2006).

### *Curd yield*

The average curd yield for the control treatment current study's DOA recommendation was 5.4 t/ha. At Ambalangoda soil, NPK with Ca, Mg and B treatment produced a better yield of 7.8 t/ha. T3 got a 44.2 percent yield increase compared to the control (Table 4). The results revealed that NPK with Ca , Mg improved production by 35.1 percent and NPK in combination with Ca raised yield by 33.3 percent whereas NPK with Mg increases yields by 25.9 percent (Table 4).

### *Mean plant height of the cauliflower*

The plots treated with NPK with Ca, Mg and B gave a significantly higher ($p<0.05$) mean plant height (10.4 cm). The minimum mean height (8.6 cm) was attained in T1, whereas the T2 recorded an average height of 9.3 cm (Table 3).

### *Total leaf area of the cauliflower plant*

The total leaf area per plant (cm$^2$) was used as an indicator of plant vegetative development and as a source of synthetic material for curd growth in connection to fertilizer treatments. The leaf area at 6 WAP (weeks after planting) differed significantly ($p<0.05$) among fertilizer treatments (Table 2). T3 had the highest total leaf area (2898.9 cm$^2$) whereas the control had the lowest total leaf area (2554.1 cm$^2$) at 6 WAP.

**Table 1.** Treatment mixtures for the field experiment at Batapola, Ambalangoda.

| | Treatment | N | $P_2O_5$ | $K_2O$ | Ca | Mg | B |
|---|---|---|---|---|---|---|---|
| | | kg $ha^{-1}$ | kg $ha^{-1}$ | kg $ha^{-1}$ | kg $ha^{-1}$ | kg $ha^{-1}$ | Kgha-1 |
| T1 | NPK (Recommended) | 150 | 125 | 90 | 0 | 0 | 0 |
| T2 | NPK + Ca + Mg | 150 | 125 | 90 | 400 | 100 | 0 |
| T3 | NPK + Ca + Mg + B | 150 | 125 | 90 | 400 | 100 | 10 |
| T4 | NPK + Ca | 150 | 125 | 90 | 400 | 0 | 0 |
| T5 | NPK + Mg | 150 | 125 | 90 | 0 | 100 | 0 |

**Table 2.** The total leaf area per plant ($cm^2$) and shelf life of curd (days).

| | | | Shelf life of curd (Days) | |
|---|---|---|---|---|
| | Treatment | Total leaf area at 6WAP ($cm^2$) | Opened | Polythene wrapped |
| T1 | NPK (Recommended) | 2554.1 $^{d}$ | $10^{bc}$ | $16^{bc}$ |
| T2 | NPK + Ca + Mg | 2570.0 $^{cb}$ | $12^{b}$ | $21^{b}$ |
| T3 | NPK + Ca + Mg + B | 2898.9 $^{a}$ | $14^{a}$ | $24^{a}$ |
| T4 | NPK + Ca | 2698.2 $^{c}$ | $8^{c}$ | $14^{c}$ |
| T5 | NPK + Mg | $2740.3^{b}$ | $11^{b}$ | $18^{b}$ |

*Values within a column followed by a common letter are not significantly different at P=0.05, according to DMRT.

**Table 3.** The mean plant height (cm), number of days to 50% flowering (days) and average diameter of the curd (cm).

| | Treatment | Mean plant height (cm) | Number of days to 50% flowering (days) | Average diameter of the curd (cm) |
|---|---|---|---|---|
| T1 | NPK (Recommended) | 8.6 $^{bc}$ | 41 $^{cb}$ | 8.9 $^{bc}$ |
| T2 | NPK + Ca + Mg | 9.3 $^{d}$ | 39 $^{b}$ | 11.4 $^{d}$ |
| T3 | NPK + Ca + Mg + B | 10. 4 $^{a}$ | 35 $^{a}$ | 12.1 $^{a}$ |
| T4 | NPK + Ca | 8.2 $^{bc}$ | 43 $^{c}$ | 9..2 $^{bc}$ |
| T5 | NPK + Mg | 9.1 $^{b}$ | 38 $^{b}$ | $11.3^{b}$ |

*Values within a column followed by a common letter are not significantly different at P=0.05, according to DMRT.

**Table 4.** The average final yield with yield gain percentage at the experimental site.

| | Treatment | Final Yield (t/ha) | Yield gain % |
|---|---|---|---|
| T1 | NPK (Recommended) | 5.4 $^{c}$ | 0 |
| T2 | NPK + Ca + Mg | 7.3 $^{b}$ | + 35.1 % |
| T3 | NPK + + Ca + Mg + B | 7.8 $^{a}$ | + 44.2 % |
| T4 | NPK + Ca | 7.2 $^{b}$ | +33.3 % |
| T5 | NPK + Mg | 6.8 $^{d}$ | +25.9 % |

*Values within a column followed by a common letter are not significantly different at P=0.05, according to DMRT.

***Number of days to 50% flowering***

The variety ‘Fuji’ is an early flowering type variety. It took 36-45 days to show 50% flowering and 22–25 days from the flower initiation to get the curd matured for harvesting. Significant differences in the number of days to 50% flowering were observed among treatments ($p<0.05$) where the lowest number of days to 50% flowering was in T3 (35 days). The DOA recommended treatment showed the highest number of days (41 days) to 50% flowering (Table 3).

***Curd shelf life***

Significant differences ($p<0.05$) were found between fertilizer treatments in the shelf life of cauliflower curd during storage under two various storage settings. Curds of T3 had the longest storage life (24 days) when kept at a high relative humidity in polythene bags. In both environmental conditions, the fertilizer treatment T4 had the shortest storage life. T3 in the open air at room temperature shelf life was (8 days) whereas the curds were kept in polythene bags at room temperature shelf life was (14 days) (Table 2). When the storage life of curds kept in polythene bags with a relative humidity of 93+3 percent was compared to the storage life of curds stored in other treatments, the curds stored in polythene bags with a relative humidity of 93+3 percent had the longest storage life. When compared to alternative storage settings, curds stored in polythene bags had the longest storage life, resulting in low oxygen levels and high carbon dioxide levels. T3 treated curds stored in polythene bags showed an additional 8 days of storage when compared to the curds from the T1 (DOA recommendation) stored under respective conditions.

## CONCLUSIONS

Results indicated that the yield, plant height and leaf area were higher in the NPK fertilizer mixture with Ca, Mg and B (T3) which were deficient in the experimental location. Post-harvest keeping quality is also high in the T3 compared to the control (T2). The incorporation of magnesium, calcium and boron with the DOA recommendation formed larger cauliflower curds under field conditions, contributing to a 44.2 % increase in curd yield. Adjustment of micronutrients with the DOA recommendation according to the specific site is a significant effect on the yield of cauliflower. The additional four days of shelf life observed in the curds obtained from plots treated with T3 would provide a considerable advantage, over the other treatments. This site-specific nutrient management includes the identification of nutrient deficiency in the specific site and the formulation of fertilizers to compensate for that deficit. It is the best method to attain a sustainable high yield without adversely damaging the environment, especially the soil.

## ACKNOWLEDGEMENT

The authors gratefully acknowledged the agricultural officers of the Provincial Department of Agriculture Kurunegala, field workers and farmers who helped and shared their field data with us.

## REFERENCES

Bairwa, P. L., Dixit, A. and Sahu, M. K. (2021). ‘Effect of different micronutrients on growth and yield of cauliflower (Brassica oleracea var. botrytis L.) Pusa Sharad’, *International Journal of Chemical Studies*, 9(1). pp 2647–2652.

Choudhary M, Ghasal PC, Kumar S, Yadav RP, Singh S, Meena VS, Bisht JK (2016). Conservation of agriculture and climate change: overview. Conservation Agriculture. Springer, Singapore. pp 2558- 2568.

Din F, Qasim M, Elahi N, Faridullah (2007). Responses of different sowing dates on the growth and yield of cauliflower. Sarhad Journal Agriculture;23 (2):pp 289-291.

Hall, William. (2006). Determining arsenic, cadmium, cobalt, chromium, lead, molybdenum, nickel, and selenium in fertilizers by microwave digestion and inductively coupled plasma-optical emission spectrometry detection: Collaborative study. Journal of AOC International. 89:pp 1447.

Kirthisinghe, J.P (2006). A complete and balanced fertilizer recommendation based on a systemic approach for Cauliflower (*Brassica oleracea* L.) PhD Thesis, PGIA, University of Peradeniya, Sri Lanka.

Kumar S, Kumar V, Yadav YS.(2015).‘Studies on the effect of Boron and Molybdenum on growth yield and yield attributing characters of cauliflower (*Brassica oleracea* L. var. *botrytis*)’. Annals of Horticulture;5(1):pp 53-57.

Mascarenhas, H.A.A.; Esteves, J.A.D.F.; Wutke, E.B.; Gallo, P.B.(2014).‘Micronutrients in soybeans in the state of São Paulo’. Nucleus,11:pp 131–149.

Ningawale DK, Singh R, Bose US, Gurjar SP, Sharma A, Gautam US (2016).‘Effect of boron and molybdenum on growth, yield and quality of cauliflower (*Brassica oleracea* var *botrytis*)’. Snowball 16. Indian Journal of AgriculturalSciences;86(6):pp 825-829.

Portch, S. and Hunter, A. 2002. A systematic approach to soil fertility evaluation and improvement. Canpotex Limited, Hong Kong : pp 1-61.

Singh H, Bansal SK (2010).‘A review of crop productivity and soil fertility as related to nutrient management in the Indo-Gangetic Plains of India’. Better Crops 1: pp 27–29.

SAS, (1998). Statistical Analysis System users Guide, Release 6.03. Statistical Analysis Systems Institute. Cary, NC, USA.

Tiwari KN (2007).‘Breaking yield barriers and stagnation through site-specific nutrient management. Journal of Indian Society of Soil Science’. 2007; 55:pp 444-454.

Verma, Praveen & Chauhan, Akriti & Ladon, Tanzin. (2020). Site specific nutrient management: A review. Research Journal of Pharmacognosy and Phytochemistry.