Studies on the soil application of micronutrients and its influence on growth, yield and quality of chow chow (*Sechium edule* (Jacq) Swartz)

ABSTRACT

Chow chow is one of the major vegetable crops being cultivated under hill region of Tamil Nadu. It gives regular income upto eight months under rainfed conditions. Prevalence of micronutrient deficiency in chowchow reduce the yield and quality fruit production during past one decade and forcing many farmers switch to other crops. In order to increase the yield of chowchow, an investigation was carried out from November 2020 to June, 2021 to study the effect of soil application of micronutrients at Horticultural Research Station, Thandiyankudisai, Perumbarai, Dindigul district, Tamil Nadu. The micronutrients were applied two months after the planting. The results of the experiment reveals that, the micronutrients application of $ZnSO_4$ 20kg + $FeSO_4$ 20kg + $MgSO_4$ 25kg + Borax 10kg +$CuSO_4$ 2.5kg +Mo 1kg recorded the highest values for number of fruits (19.59/ vine), fruit length (11.43cm), fruit diameter (12.38cm), fruit weight (362.67g), yield per vine (7.11kg) and yield per hectare (32.90 t).

Key words: Chow chow, *Sechium edule*, micronutrients, nutrients, micronutrients

Abbreviations

$ZnSO_4$ - Zinc sulphate
Fe SO_4 - Ferrous sulfate
Mg SO_4 - Magnesium sulfate
Cu SO_4 - Copper(II) sulfate
Mo – Molybdenum
IAA - Indole acetic acid

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1. INTRODUCTION

Chowchow (*Sechium edule* (Jacq) Swartz) is grown in subtropical areas of Tamil Nadu, Karnataka, West Bengal, Uttarakhand, Himachal Pradesh and entire North Eastern hill (NEH) regions. In eastern Himalayas, chowchow is cultivated in kitchen garden of every tribals as an important component of their everyday diet. It is known by different names like chayote, Irish and air potato. Chowchow is a common commercial crop in the hill regions owing to its hardiness and profuse fruiting with less care. It grows luxuriantly under high rainfall conditions. It is herbaceous perennial, monoecious climber cum vine with edible tuberous root, produces large and many fruits that are single seeded and viviparous. It is mainly propagated by seed (whole fruit with seed) (Sanwal, *et al*., 11).

Micronutrients plays a vital role in absorption and balancing nutrients. Iron, zinc, manganese, copper and boron are the important micronutrient elements with specific and essential physiological functions in plants. Its requirements are in small quantities for normal growth and development of plants. Micronutrients are present in lower level in soil than macronutrients but are equally important in crop nutrition, since plants grown in micronutrient deficient soils show similar reductions in productivity as those grown in macronutrient deficit soils. Micronutrient deficiencies are becoming a major issue in the recent years due to intensive cropping, loss of top soil by erosion, leaching, liming of soil (Bharath, *et al*., 2). The prerequisite criteria for improved growth, yield and quality of chowchow vegetable is balanced nutrient application. However, nutrients can be applied either in the soil or by foliar application but the main advantage of foliar application is immediate availability of nutrients to plants. Micronutrients plays role in absorption and balancing nutrients (Singh and Kalloo, 14). Iron, zinc, manganese, copper and boron are the important micronutrient elements with specific and essential physiological functions in plants.

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Zinc plays a major role in activity of dehydrogenase, aldolase, isomerase, proteinase, peptidase and phosphohydrolase (Mousavi, 7). It is directly involved in the synthesis on indole acetic acid (IAA) and proteins (Abdou, *et al*., 1). Zinc deficiency symptoms appear as interveinal chlorosis on young leaves. Boron play's role on absorption of water and carbohydrate metabolism (Haque, *et al*., 4), translocation of carbohydrates, DNA formation in meristems, cell division and elongation, active salt absorption and photosynthesis. Boron involves indirectly in metabolic activity of nitrogen, phosphorous, fat and hormones. Boron plays a role in flowering and fruit formation (Nalla, *et al*., 8). Deficiency of boron, causes meristematic tissue hypertrophy, degeneration and disintegration in cambium cells. The deficiency of boron leads to sterility, reduction in fruit size and yield (Davis *et al.,* 3). Boron deficiency affects synthesis of amino acids and proteins, translocation of sugar, starch, nitrogen and phosphorus. Iron plays role in enzyme and chlorophyll synthesis. It is a part of various flavoproteins and participates in oxidation reduction process such as nitrate, sulphate and nitrogen fixation. If its deficiency continues, the entire leaf including veins exhibits chlorotic symptoms and the crop may exhibit bleached appearance, dry and finally dies.

The soils of the hill region are low in pH and deficit in many micronutrients and mainly due to continuous cropping in the same soil. The yield potential of the crop have declined during last decade onwards due to various factors such as nutrient deficiencies and occurrence of viral disease (Sangeetha, *et al*., 10), moisture stress and climate change. The soil samples collected from the chowchow growing fields of lower Pulney hills revealed that micronutrient content were below the critical level and farmers are not applying any inorganic micronutrients while growing the chowchow crop. Hence, the present study was under taken to study the effect of soil application of micronutrients on growth, yield and quality of chowchow.

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Materials and Methods

The present study was carried out at Horticultural Research Station of Tamil Nadu Agricultural University located at Thadiyankudisai, Perumbarai, Dindigul district hill region during November 2020 to June, 2021. The altitude is 996 m, latitude is $10^{o}17$ North and longitude is $77^{o}42$ East. It receives an annual rainfall of 1400 mm and distributed from April to December.

The field was prepared well to a fine tilth. The pits of 1.5 cubic foot was made at a spacing of 2.4 x 1.8m and filled up with farm yard manure 10 kg, 250 g of urea, 500 g of super phosphate and 500 g of muriate of potash. The sprouted entire fruits were planted @ two per pit. The vines were allowed to trail on overhead bower. The field was irrigated initially once in seven days up to April and later grown as rainfed crop. The experiment consisted of soil application of micronutrients as given below:

T1 $ZnSO_4$ 20kg + Fe SO_4 20kg + Mg SO_4 25kg

T2 $ZnSO_4$ 20kg + Fe SO_4 20kg + Mg SO_4 25kg + Borax 1kg

T3 $ZnSO_4$ 20kg + Fe SO_4 20kg + Mg SO_4 25kg + +Cu SO_4 2.5kg

T4 $ZnSO_4$ 20kg + Fe SO_4 20kg + Mg SO_4 25kg + Mo 1kg

T5 $ZnSO_4$ 20kg + Fe SO_4 20kg + Mg SO_4 25kg + Borax 1kg+Cu SO_4 2.5kg

T6 $ZnSO_4$ 20kg + Fe SO_4 20kg + Mg SO_4 25kg + Borax 1kg+Cu SO_4 2.5kg +Mo 1kg

T7 Humic acid drenching 10% @ 500ml/plant

T8 Control

Experimental plan

The experiment was laid out in randomized block design with three replications. For each replication, five plants were randomly tagged for different treatments in the middle rows, an average value of tagged plants for particular parameter was recorded and the average value was noted as one replication. Mean values of three replications after exposing them to statistical calculations was recorded as pooled mean for the particular parameter in that particular treatment. The micronutrients were given as foliar application seven times on 60,

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75, 90, 105, 120,135 and 150th day after sowing. The observation on days to male flowering, days to female flowering, number of fruits, fruit length (cm), fruit diameter (cm), fruit weight (g), fruit yield per plant (kg) and fruit yield per hectare (tons) was recorded.

Statistical analyses

The statistical analysis of data collected was done as per the procedure given by **(**Panse, *et al*.,9)**.** Statistical analysis was carried out to know the variance for different parameters using AGRES package and significance was identified at both 1 and 5% level while non- significant results were denoted as NS.

3. RESULTS AND DISCUSSION

Micronutrients are vital to the growth of plants acting as catalyst in promoting various stages of growth and development of plants. Vegetable crops, being seasonal, responds positively to the application of micronutrients. The observations recorded are presented in the Tables 1. The results of the experiment revealed that 61.30 days taken for male flower anthesis with the application of $ZnSO_4$ 20kg + Fe SO_4 20kg + Mg SO_4 25kg + Borax 1kg+Cu SO_4 2.5kg +Mo 1kg followed by $ZnSO_4$ 20kg + Fe SO_4 20kg + Mg SO_4 25kg + Borax 1kg+Cu SO_4 2.5kg (60.21). The higher days taken for female flower anthesis (64.79) recorded with the application of $ZnSO_4$ 20kg + Fe SO_4 20kg + Mg SO_4 25kg + Borax 1kg+Cu SO_4 2.5kg +Mo 1kg followed by $ZnSO_4$ 20kg + Fe SO_4 20kg + Mg SO_4 25kg + Borax 1kg+Cu SO_4 2.5kg (64.29. These results are in corroboration with the findings in bitter gourd (Karthick *et al.,* 5).

The application of micronutrients revealed significant variation in fruit length among the treatments and proved that the combined application of $ZnSO_4$ 20kg + Fe SO_4 20kg + Mg SO_4 25kg + Borax 1kg+Cu SO_4 2.5kg +Mo 1kg (T6) recorded highest fruit length (11.43cm) followed by $ZnSO_4$ 20kg + Fe SO_4 20kg + Mg SO_4 25kg + Borax 1kg+Cu SO_4 2.5kg

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(10.81cm). Iron plays an important role in promoting growth characters, being a component of ferredoxin, an electron transport protein and is associated with chloroplast. Its association in photosynthesis might have helped in better vegetative growth. This may be due to the fact that both boron and molybdenum helps in growth of meristmatic tissues growth which ultimately increases the vegetative growth and positively influence the economic parts. Similar results were obtained by Sathya, *et al.*,12). The fruit diameter varied significantly among the treatments from 7.50cm to 12.38cm. The higher fruit diameter of 12.38cm was found with the application of $ZnSO_4$ 20kg + Fe SO_4 20kg + Mg SO_4 25kg + Borax 1kg+Cu SO_4 2.5kg +Mo 1kg followed by 11.65cm with the application of $ZnSO_4$ 20kg + Fe SO_4 20kg + Mg SO_4 25kg + Borax 1kg+Cu SO_4 2.5kg. Similar results were obtained in Satpute, *et al.,13*).

The application of micronutrients greatly influenced the fruit weight and it ranged from 210g to 362.67g. The maximum fruit weight of 362.67g was observed with the application of $ZnSO_4$ 20kg + Fe SO_4 20kg + Mg SO_4 25kg + Borax 1kg+Cu SO_4 2.5kg +Mo 1kg (T6) followed by 351.33g with the application of $ZnSO_4$ 20kg + Fe SO_4 20kg + Mg SO_4 25kg + Borax 1kg+Cu SO_4 2.5kg. The increase in fruit weight due to foliar application of micronutrients was also reported in bitter gourd (Bharathi, *et al.,* 2). The increase in fruit weight and diameter by micronutrients and biostimulants may be due to its beneficial effect in enhancing the translocation of carbohydrates from the site of synthesis to the storage tissue.

The application of micronutrients greatly influenced the number of fruits per vine and it ranged from 16.43 to 19.59 nos. The maximum number of fruits per vine 19.59 was observed with the application of $ZnSO_4$ 20kg + Fe SO_4 20kg + Mg SO_4 25kg + Borax 1kg+Cu SO_4 2.5kg +Mo 1kg (T6) followed by 19.23nos. with the application of $ZnSO_4$ 20kg + Fe SO_4 20kg + Mg SO_4 25kg + Borax 1kg+Cu SO_4 2.5kg. Increase in plant growth characters viz.,

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number of fruits per vine and fruit weight by the application of micronutrients might be due to their involvement in chlorophyll formation which might have helped in favour of cell division, meristematic activity in apical tissue, expansion of cell. The increased number of fruits might be due to increase in female flower production and fruit set might be effected by boron and molybdenum in acid soils of hill region .

The treatments exerted positive and significant effect on the yield. The yield of the crop increased linearly with an increase in fruit weight and number of fruits per vine. The application of micronutrients significantly influenced the yield per vine and yield per hectare. The application of micronutrients greatly influenced the yield per vine from 2.50kg to 7.11kg. The maximum yield per vine 7.11kg was observed with the application of $ZnSO_4$ 20kg + Fe SO_4 20kg + Mg SO_4 25kg + Borax 1kg+Cu SO_4 2.5kg +Mo 1kg (T6) followed by 6.70nos. with the application of $ZnSO_4$ 20kg + Fe SO_4 20kg + Mg SO_4 25kg + Borax 1kg+Cu SO_4 2.5kg. This could be due to their involvement in cell respiration, oxidative phosphorylation, photosynthesis, protein synthesis and different enzymatic response (Subbarao, *et.al* 15).

The application of micronutrients greatly influenced the yield per hectare. It ranged from 10.67t to 32.90t (Table 2). The maximum yield per hectare 32.93kg was observed with the application of $ZnSO_4$ 20kg + Fe SO_4 20kg + Mg SO_4 25kg + Borax 1kg+Cu SO_4 2.5kg +Mo 1kg (T6) followed by 31.39t with the application of $ZnSO_4$ 20kg + Fe SO_4 20kg + Mg SO_4 25kg + Borax 1kg+Cu SO_4 2.5kg. The increased yield per vine and yield per hectare was attributed by more number of female flower production, number of fruits and higher fruit weight due to efficient translocation of photosynthetic assimilates to fruits (Singh, *et al.*,14]

The quality of fruits were assessed in terms of total soluble solids (TSS) and it was significantly higher over control (3.80). The total soluble solids content was greatly influenced by the various micronutrients application (Fig 1). The maximum TSS of 4.39 brix was recorded in $ZnSO_4$ 20kg + Fe SO_4 20kg + Mg SO_4 25kg + Borax 1kg+Cu SO_4 2.5kg

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+Mo 1kg. The next higher TSS content (4.29brix) was found with application of $ZnSO_4$ 20kg + Fe SO_4 20kg + Mg SO_4 25kg + Borax 1kg+Cu SO_4 2.5kg The effect of micronutrients application on TSS was also reported in tomato (Sathya *et al.*, 12) and amaranthus (Lastari and Devi, 2020).

The application of micronutrients greatly influenced the mosaic disease incidence (Table 2). The per cent disease index ranged from 70.00 to 75.50t. The low per cent disease index of 70.00 was observed with the application of $ZnSO_4$ 20kg + Fe SO_4 20kg + Mg SO_4 25kg + Borax 1kg+Cu SO_4 2.5kg +Mo 1kg followed by 70.33 PDI with the application of $ZnSO_4$ 20kg + Fe SO_4 20kg + Mg SO_4 25kg + Borax 1kg+Cu SO_4 2.5kg.

In conclusion, It was found that the soil application micronutrients $ZnSO_4$ 20kg + Fe SO_4 20kg + Mg SO_4 25kg + Borax 1kg+Cu SO_4 2.5kg +Mo 1kg in mosaic disease occurred field improved the growth, yield and quality of chowchow (Yildrim, 16).

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Table 1. Effect of soil application of Micronutrients and Humic acid on growth and yield attributes of chow-chow.

Treatments	Days to male flowering (days)	Days to female flowering (days)	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g)	No. of fruits per vine
T_1-$ZnSo_4$ @ 20kg+ $FeSo_4$@20kg+ $MgSo_4$ @25kg/ha	57.57	61.93	9.21	9.80	298.00	16.43
T_2-$ZnSo_4$ @ 20kg+ $FeSo_4$@20kg+ $MgSo_4$ @25kg+Bo@10kg/ha	58.57	62.44	9.42	10.19	313.33	16.94
T_3-$ZnSo_4$ @ 20kg+ $FeSo_4$@20kg+ $MgSo_4$ @25kg+Mo @1kg/ha	59.18	63.12	10.22	10.49	325.67	17.21
T_4-$ZnSo_4$ @ 20kg+ $FeSo_4$@20kg+ $MgSo_4$ @25kg+$CuSo_4$@2.5kg/ha	59.68	63.95	10.40	11.18	338.67	18.22
T_5-$ZnSo_4$ @ 20kg+ $FeSo_4$@20kg+ $MgSo_4$ @25kg+Bo@10kg+ Mo @1kg /ha	60.21	64.29	10.81	11.65	351.33	19.23
T_6-$ZnSo_4$ @ 20kg+ $FeSo_4$@20kg+ $MgSo_4$ @25kg+Bo@10kg+ Mo @1kg + $CuSo_4$@2.5kg /ha	61.30	64.79	11.43	12.38	362.67	19.59
T_7-Humic acid drenching 10% @500ml/plant	59.35	63.37	10.33	10.73	331.33	17.36
T8: Control	55.10	60.00	7.00	7.50	210.00	11.00
S.Ed.	0.092	0.095	0.072	0.093	2.117	0.084
CD	0.184	0.190	0.144	0.186	4.234	0.168

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Table 2. Effect of soil application of Micronutrients and Humic acid on yield and per cent disease index of mosaic disease incidence of chow-chow.

Treatments	Yield per vine (kg)	Yield per hectare (tonnes)	Incidence of CMV (%)
T_1-$ZnSo_4$ @ 20kg+ $FeSo_4$@20kg+ $MgSo_4$ @25kg/ha	4.897	22.67	73.67
T_2-$ZnSo_4$ @ 20kg+ $FeSo_4$@20kg+ $MgSo_4$ @25kg+Bo@10kg/ha	5.308	24.57	72.33
T_3-$ZnSo_4$ @ 20kg+ $FeSo_4$@20kg+ $MgSo_4$ @25kg+Mo @1kg/ha	5.606	25.95	72.67
T_4-$ZnSo_4$ @ 20kg+ $FeSo_4$@20kg+ $MgSo_4$ @25kg+$CuSo_4$@2.5kg/ha	6.174	28.58	71.33
T_5-$ZnSo_4$ @ 20kg+ $FeSo_4$@20kg+ $MgSo_4$ @25kg+Bo@10kg+ Mo @1kg /ha	6.760	31.39	70.33
T_6-$ZnSo_4$ @ 20kg+ $FeSo_4$@20kg+ $MgSo_4$ @25kg+Bo@10kg+ Mo @1kg + $CuSo_4$@2.5kg /ha	7.108	32.90	70.00
T_7-Humic acid drenching 10% @500ml/plant	5.754	26.64	72.33
T8: Control	2.50	10.67	75.50
S.Ed.	0.098	1.20	0.078
CD	0.196	2.40	0.156

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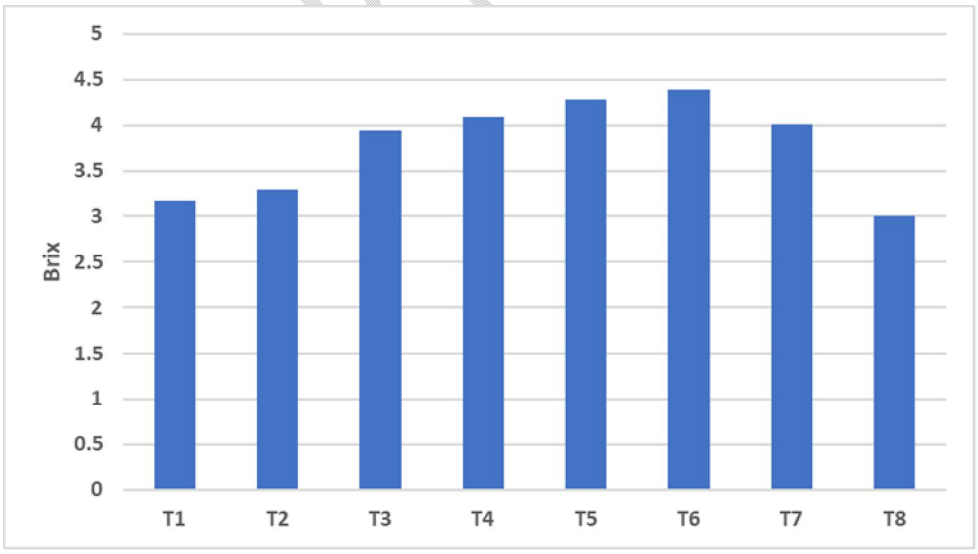

Figure 1. The effect of soil application of Micronutrients and Humic acid on growth, TSS (ºBrix)of chow-chow.