Influence of biostimulants and micronutrients as foliar spray on growth, yield and quality of chow chow (*Sechiumedule*(Jacq) Swartz)

ABSTRACT

Micronutrient deficiency is quite prevalent in the mid hills of Tamil Nadu and it greatly influences the yieldof numerous horticultural crops like chow chow. Therefore the present investigation was carried out to study the effect of foliar application of bio stimulants *viz.panchakaviya* (3%), humicacid (2%) and micronutrientson yield of chow chow.. The bio stimulants and micronutrients were sprayed on the vines at 15 day intervals on 60, 75, 90, 105, 120, 135 and 150th day after planting. The results revealed that the foliar application of *panchakaviya* (3%) recorded maximum fruit length (10.82 cm), fruit diameter (11.70 cm), number of fruits per vine (19.08), fruit weight (335 g), yield per vine (6.43 kg) and yield per hectare (26.60 t). Among the micronutrient treatments, the foliar spray of $ZnSO_4$ 0.5% + $FeSO_4$ 0.5% + Mg SO_4 0.5%+ Boric acid 0.3%+Cu SO_4 0.1%+Mo 0.02% recorded the highest values for number of fruits (20.18/ vine), fruit length (12.00 cm), fruit diameter (12.75 cm), fruit weight (363.50 g), yield per vine (7.27 kg) and yield per hectare (33.45 t). The interaction effects proved that the combined spray of *panchakaviya* (3%) and micronutrients $ZnSO_4$ 0.5% + Fe SO_4 0.5% + Mg SO_4 0.5%+ Boric acid 0.3%+Cu SO_4 0.1%+Mo 0.02% recorded the highest values for number of fruits (21.35 /vine), fruit length (12.00 cm), fruit diameter (13.00 cm), fruit weight (367.00 g), yield per vine (7.58 kg) and yield per hectare (35.45 t). The application of *panchakaviya* (3%) and micronutrients on 60, 75, 90, 105, 120, 135 and 150th day after planting increased the yield and farmers were convinced with this technology for getting higher yield.

Key words: Chow chow, chayote, *Sechiumedule*, micronutrients, biostimulants

INTRODUCTION

In India, chowchow (*Sechiumedule*(Jacq) Swartz) is grown in Tamil Nadu, Karnataka, West Bengal, Uttarakhand, Himachal Pradesh and North Eastern hill (NEH) regions. In North Eastern hill region, chowchow is cultivated in kitchen garden in every household as an important component of their everyday diet. It is known by different names like chayote, Irish 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 a herbaceous perennial, monoecious climber cum vine with edible tuberous roots, produces large and many fruits that are single seeded and viviparous. It is mainly propagated by seeds (whole fruit with seed) (Sanwal*et al*., 16). Micronutrients plays a vital role in absorption and balancing nutrients.

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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 (Mousavi, 12).The prerequisite criteria for improved growth, yield and quality of chowchow are balanced applications of nutrient. 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. Moreover, the uptake and assimilation of micronutrients is faster and the elements like zinc, iron, copper and molybdenum and boron are sparingly soluble in the soil. Zinc plays a major role in activity of dehydrogenase, aldolase, isomerase, proteinase, peptidase and phosphohydrolase (Mousavi, 12). It is directly involved in the synthesis on indole acetic acid (IAA) and proteins (Abdou *et al*., 2). Zinc deficiency symptoms appear as interveinal chlorosis on young leaves. Boron plays role on absorption of water and carbohydrate metabolism (Haque *et al.*,8), 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.*, 13). 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*., 5). 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 liquid organic manures are gaining importance during the recent years as the availability of organic manure is also declining (Subbarao, *et al*., 22). Several research works suggested that application of liquid organic manures such as humic acid and panchakaviya may enhance the fruit yield and quality (Gajjela and Chatterjee, 7). *Panchakaviya* is a fermented liquid prepared by mixing five materials obtained from cow *viz*., urine, dung, milk, curd and butter. In India it is used with deep conviction in ecological farming, traditional knowledge, sustainable farming and natural farming. The plants sprayed with *panchakaviya* registered more leaf size, leaf area and lateral branches.

The humic acid is the final compound of decayed plant and animal dry matter. It is also reported to found during prehistoric deposits. The biological activities of microorganisms on plant and animal dry matter by chemical and biological humification processes gives humic matter. The humic acid as complex molecule is naturally existing in soil, peat and fresh water. The main source of humic acid is leonhardite which is formed as sedimentation layer in the earth crust. Humic acid is used to condition the soil, biocatalyst and biostimulant for plant. It is an organic source contains concentrated form of essential nutrients, vitamins and trace elements. It is effective for long term because it is not quickly used as animal manure, compost or peat. Humic acid rich in chelate nutrients especially iron in the form suitable for plant utilization. The foliar application of humic acid increases catalysis, activating respiration, photosynthesis, hormonal efficiency and nucleic acid metabolism (Serenella*et al*., 19).

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*., 15), moisture stress and climate change. The soil samples collected from

the chowchow growing fields of lower Pulney hills, Tamil Nadu revealed that micronutrient content were below the critical level and farmers are not applying any inorganic micronutrients while growing the chowchow crop (Sangeetha et al., 15). Foliar feeding is an effective method of supplying nutrients during the period of intensive plant growth and to enhance yield. It seems that there is an urgent need to standardize micronutrient application and restrict use of chemical fertilizers to avoid further deterioration of soil health. Hence, the present study was under taken to decipher the effect of biostimulantsviz.*panchakaviya* and humic acid and micronutrients on growth, yield and quality of chowchow under sub-tropical conditions of Tamil Nadu.

MATERIALS AND METHODS

The present study was undertaken during 7thMarch to 29thSeptember, 2020at Horticultural Research Station, Tamil Nadu Agricultural University located at Thadiyankudisai, Perumbarai, Dindigul district. 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 superphosphate 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 two factors. Factor one was foliar application of two biostimulantsviz., *panchakaviya* three per cent and humic acid two per cent for seven times at 15 day interval starting from 60, 75, 90, 105, 120,135 and 150th day after sowing. Second factor was foliar application of micronutrients in six combinations with one absolute control as given below:

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List 1 : List of treatments and their composition

Treatments	Composition
T1	$ZnSO_4$ 0.5% + Fe SO_4 0.5% + Mg SO_4 0.5%
T2	$ZnSO_4$ 0.5% + Fe SO_4 0.5% + Mg SO_4 0.5%+ Boric acid 0.3%
T3	$ZnSO_4$ 0.5% + Fe SO_4 0.5% + Mg SO_4 0.5%+ +Cu SO_4 0.1%

T4	$ZnSO_4$ 0.5% + Fe SO_4 0.5% + Mg SO_4 0.5%+ Mo 0.02%
T5	$ZnSO_4$ 0.5% + Fe SO_4 0.5% + Mg SO_4 0.5%+ Boric acid 0.3%+Cu SO_4 0.1%
T6	$ZnSO_4$ 0.5% + Fe SO_4 0.5% + Mg SO_4 0.5%+ Boric acid 0.3%+Cu SO_4 0.1%+Mo 0.02%
T7 (Control)	Untreated Control (Without biostimulant and micronutrient application)

Experimental plan

The experiment was laid out in factorial 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, 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 and Sukhateme (1985).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.

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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 on influence of bio-stimulants and micronutrients on flowering in chow-chow is presented in the Tables 1. The results of the experiment revealed that the days to male flowering and days to female flowering were non significant among the biostimulants and micronutrient applications. It may be due to the spray of

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biostimulants and micronutrients applied on 60 days after planting. The male flowering and female flowering occurred on 60.40 and 66.30 days after planting respectively. These results are in corroboration with the findings of (Karthick *et al.*,.10) in bitter gourd.

The highest values for fruit length and fruit diameter was recorded with the *panchakaviya* followed by humic acid application Table 2. which recorded the highest fruit length (10.82 cm and 10.54 cm) and fruit diameter (11.70 cm and 11.14 cm) compared to control. It was probably due to the favourable effect of humic acid as might have imparted major effect on plant growth and more cell division in the meristem. 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. The application of micronutrients revealed significant variation among the treatments and proved that the combined application of $ZnSO_4$ 0.5% + Fe SO_4 0.5% + Mg SO_4 0.5%+ Boric acid 0.3%+Cu SO_4 0.1%+Mo 0.02% (T6) recorded highest fruit length (12.00cm) and fruit diameter (12.75cm) (Table 2). 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 (Satpute*et al.*, 18). The interaction of biostimulant and micronutrients application also revealed that the combined application of panchakaviya (3%), humic acid (2%) and $ZnSO_4$ 0.5% + Fe SO_4 0.5% + Mg SO_4 0.5%+ Boric acid 0.3%+Cu SO_4 0.1%+Mo 0.02% (T6) had higher values for fruit length (12.00 cm and 12.00 cm) and fruit diameter (13.00 cm and 12.25 cm) compared with control (T7) (9.17 cm and 9.69 cm). This might be due to the faster absorption of nitrogen present in panchakaviya and micronutrients through cuticle of leaves which increased the plant photosynthetic assimilates. (Dongre*et al.*, 6 and Swarnam, (23).

The fruit weight and number of fruits per vine Table 3. was found to be higher with the biostimulant application viz., panchakaviya 3% (335 g and 19.08 nos.) and humic acid (392 g and

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18.09 no's) than untreated control. The highest values were recorded in panchakaviya application. The application of micronutrients greatly influenced the fruit weight and number of fruits per vine. The maximum fruit weight (363 g) and number of fruits per vine (20.18) was recorded with the application of (T6) $ZnSO_4$ 0.5% + Fe SO_4 0.5% + Mg SO_4 0.5%+ Boric acid 0.3%+Cu SO_4 0.1%+Mo 0.02% over the untreated control (288 g and 16.29). 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 increase in fruit weight due to foliar application of micronutrients was also reported in bitter gourd by Bharathi *et al*., 3). Interaction of biostimulant and micronutrients application revealed that the combined application of panchakaviya (3%) and $ZnSO_4$ 0.5% + Fe SO_4 0.5% + Mg SO_4 0.5%+ Boric acid 0.3%+Cu SO_4 0.1%+Mo 0.02% (T6) had higher values for fruit weight (367g) and number of fruits (16.29). Increase in plant growth characters viz., 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 as reported by Chatterjee and Bandyopahyay (4).

Among the biostimulant, the panchakaviya 3 % registered highest yield per vine (6.43 kg) and yield per hectare (29.60 t) Table 4. followed by humic acid (6.11kg /vine and 27.54 t/ha). The biostimulantpanchakaviya might have caused favourable effective on chowchow. This could be due to their involvement in cell respiration, oxidative phosphorylation, photosynthesis, protein synthesis and different enzymatic response (Shafeek*et al*., 20). 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 maximum values was recorded with (T6) the

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application of $ZnSO_4$ 0.5% + Fe SO_4 0.5% + Mg SO_4 0.5%+ Boric acid 0.3%+Cu SO_4 0.1%+Mo 0.02% (7.27 kg/vine and 32.51 t/ha) followed by $ZnSO_4$ 0.5% + Fe SO_4 0.5% + Mg SO_4 0.5%+ Boric acid 0.3%+Cu SO_4 0.1% (7.06kg/vine and 32.51t/ha) when compared to control (5.20kg/vine and 22.07t/ha). The significant increase was probably due to interaction of humic substances and micronutrients as it has direct action on plants and the role of zinc in nitrogen metabolism. Furthermore, it acts as a catalyst in the oxidation and reduction process. The interaction of biostimulant and micronutrients application showed that the combined application of panchakaviya (3%) and (T6) $ZnSO_4$ 0.5% + Fe SO_4 0.5% + Mg SO_4 0.5%+ Boric acid 0.3%+Cu SO_4 0.1%+Mo 0.02% had maximum values for yield per vine (7.58kg/vine) and yield per hectare (35.44t). 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 (Swarnam*et al.*, 23). Panchakaviya contains various salts rich in N,P,K, S and micronutrients in plant available form which helps in the formation of chlorophyll in the leaves. High chlorophyll synthesis, supply of plant nutrients and growth promoting substances enhanced the fruit yield (Abdellatif*et al.*, 1). The lowest yield per vine and yield per hectare (22.07 t) was recorded in untreated control (T7). Similar results were obtained by Shnain*et al* (21).

The quality of fruits were assessed interms of total soluble solids (TSS) Table 5. and it was significantly higher over control (3.80). Among the biostimulants, application of panchakaviya spray had recorded the highest total soluble solids (4.86 brix) followed by humic acid (4.47 brix). The total soluble solids content was greatly influenced by the various micronutrients application. The maximum TSS was recorded in (T6) $ZnSO_4$ 0.5% + Fe SO_4 0.5% + Mg SO_4 0.5%+ Boric acid 0.3%+Cu SO_4 0.1%+Mo 0.02% (5.0 brix). The effect of micronutrients application on TSS was also reported by Sathya *et al.*, (17) and Lestari and Dewi (11).

In conclusion, It was found that the foliar application of panchakaviya and micronutrients (T6) $ZnSO_4$ 0.5% + Fe SO_4 0.5% + Mg SO_4 0.5%+ Boric acid 0.3%+Cu SO_4 0.1%+Mo 0.02% at 60, 75, 90, 105, 120, 135 and 150th day after sowing for seven times improved the growth, yield and quality of chowchow.

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Table 1.Impact of foliar application of biostimulants and micronutrients in chowchow on flowering.

Treatments	Days to male flower production			Days to female flower production		
	Humic acid	Panchakaviya	Mean	Humic acid	Panchakaviya	Mean
T1	60.60	60.20	60.40	65.20	65.20	65.20
T2	60.80	60.20	60.50	65.60	65.60	65.60
T3	60.00	60.60	60.30	67.60	68.40	68.00
T4	60.20	60.40	60.30	68.20	68.60	68.40
T5	60.40	60.40	60.40	65.40	69.20	67.30
T6	60.60	60.40	60.50	64.80	69.60	67.20
T7 (Control)	60.60	60.20	60.40	66.40	66.20	66.30
Mean	60.46	60.34		66.17	67.54	
	S. Ed.	C.D.		S. Ed.	C.D.	
Biostimulant (B)	0.04	0.09		0.04	0.09	
Treatment (T)	0.08	0.17		0.08	0.17	
BXT	0.12	0.24		0.12	0.24	

Table2. Impact of foliar application of biostimulants and micronutrients in chowchow on fruit development.

Treatments	Fruit length (cm)			Fruit diameter (cm)		
	Humic acid	Panchakaviya	Mean	Humic acid	Panchakaviya	Mean
T1	9.50	10.00	9.75	10.00	11.00	10.50
T2	10.15	10.50	10.23	10.50	11.00	10.75
T3	10.50	11.00	10.75	11.25	11.75	11.50
T4	10.50	11.00	10.75	12.00	12.50	12.25
T5	12.00	12.00	12.00	12.25	12.75	12.50
T6	12.00	12.00	12.00	12.25	13.00	12.75

T7 (Control)	9.12	9.20	9.17	9.50	9.88	9.69
Mean	10.54	10.82		11.14	11.70	
	S. Ed.	C.D.		S. Ed.	C.D.	
Biostimulant (B)	0.04	0.08		0.05	0.10	
Treatment (T)	0.07	0.15		0.09	0.20	
BXT	0.10	0.21		0.14	0.28	

Table 3. Impact of foliar application of biostimulants and micronutrients in chowchow on fruit yield.

Treatments	Fruit weight (g)			No. of fruits per vine		
	Humic acid	Panchakaviya	Mean	Humic acid	Panchakaviya	Mean
T1	310	320	315	17.50	18.00	17.75
T2	322	327	325	17.75	18.50	18.13
T3	331	340	335	18.50	19.00	18.75
T4	341	347	344	18.50	19.75	19.13
T5	352	357	354	19.00	20.75	19.88
T6	360	367	363	19.00	21.35	20.18
T7 (Control)	288	288	288	16.38	16.21	16.29
Mean	329	335		18.09	19.08	
	S. Ed.	C.D.		S. Ed.	C.D.	
Biostimulant (B)	1.13	2.32		0.04	0.8	
Treatment (T)	2.11	4.35		0.07	0.16	
BXT	2.99	6.15		0.11	0.22	

Table4: Impact of foliar application of biostimulants and micronutrients on yield and quality of chow chow.

Treatments	Yield per vine (kg)			Yield per hectare (t)			Total soluble solids (brix)		
	Humic acid	Panchakaviya	Mean	Humic acid	Panchakaviya	Mean	Humic acid	Panchakaviya	Mean
T1	5.48	5.71	5.59	24.96	26.49	25.72	4.00	4.00	4.00
T2	5.78	5.98	5.88	26.29	27.01	27.01	4.00	5.00	4.50
T3	6.17	6.42	6.29	28.18	28.95	28.95	4.50	5.00	4.75
T4	6.41	6.77	6.59	29.03	30.28	30.28	5.00	5.00	5.00
T5	6.81	7.33	7.06	30.77	32.51	32.51	5.00	5.00	5.00
T6	6.96	7.58	7.27	31.46	33.45	33.45	5.00	5.00	5.00
T7 (Control)	5.18	5.22	5.20	22.07	22.07	22.07	3.80	5.00	3.80
Mean	6.11	6.43		27.54	29.60		4.47	4.69	
	S. Ed.	C.D.		S. Ed.	C.D.		S. Ed.	C.D.	
Biostimulant (B)	0.04	0.09		0.12	0.02		0.04	0.09	
Treatment	0.09	0.18		0.02	0.04		0.08	0.18	

(T) BXT	0.12	0.26		0.03	0.06	0.12	0.25