EFFECT OF ORGANIC NUTRIENTS AND ZINC BIOFORTIFICATION ON GROWTH AND YIELD OF SPONGE GOURD (*Luffa cylindrica* L.) CV. MAHY HARITA

ABSTRACT

A field experiment wascarriedoutatOrchard,Department of Horticulture, Annamalai University, Faculty of Agriculture, TamilNadu during 2023-2024. Theexperimentwas laid out in RBD with fifteen treatments in three replications.The organic manures used inthe experimentwere farm yard manure (25 t ha^{-1}) and enriched manure(1 t ha^{-1}) as soilapplication alongwith consortium biofertilizer (2 kg ha^{-1}) and foliar application of biostimulants*viz.,* panchagavya (3%), seaweed extract (3%) and effective microbial inoculants (2%). The zinc in the form of *Bacillus subtilis* @ 10 and20g was applied as soil application. The results of the experiment revealed that the growth parameters *viz.*,vine length, number of leaves, leaf length, leaf breadth and leaf area were recorded the highest in thetreatment that received the application of farmyard manure 25 t ha^{-1} combined with panchagavya (3%) asfoliar application and *Bacillus subtilis* @ 20g. The yield attributes*viz*., the highest number of fruits $plant^{-1}$, fruit length, fruit girth, fruit weight, fruit yield $plant^{-1}$and the zinc uptake in fruit were registered in the treatment which received the application of enriched manure@1tha[1]combinedwithpanchagavya(3%)asfoliar application and*Bacillus subtilis*@20g(T11) respectively.

Keywords:Organicmanures,biostimulants,growthparameters,yieldparameters,zinc, biofortification

1. INTRODUCTION

"Sponge gourd *(Luffa cylindrica*L.) is one of the important tropical and subtropical cucurbitaceouscrops grown extensively throughout India. It has a smooth surface and is one of the popular vegetables inIndia. It occupies an area ofabout 7.21 lakh ha with production of12.87 lakh tones.The productivity ofthis crop is 10.52 tonnes per hectare"[2]. "The tender fruits are used as vegetable which is easily digestibleand increase appetite when consumed. It is a highly nutritive vegetable and it contains moisture of 93.2 g,protein 1.2 g, fat 0.20 g, carbohydrate 2.9 g, minerals like calcium 36 mg, iron 1.1 mg and phosphorus 19mg and fibers (0.20 g) per 100 g of edible portion. The sponge of the mature fruit helps the skin inincreasingthe blood circulation andas a relief for rheumaticandarthritis sufferers. The fruits are alsousedtocurejaundiceanddiabetes.Alargequantityofinorganicfertilizersareprovidedtovegetablesin order to get higher yield and maximum income in commercial cultivation. But the application of inorganicfertilizer alone may cause human health problems and also pollute the environment. Organic fertilizerapplication may improve the growth by supplying plant nutrients including micro nutrients as well asenhances chemical, physical and biological properties of the soil, thereby providing a better environmentfor root development by improving the soil structure. Biostimulants are not a fertilizer because they haveno direct effect on increase of plant growth and productivity rather, they improve the productivity byenhancing the efficiency of nutrient uptake of already existing nutrient in soil or externally applied nutrient"[10].

"Thezincdeficiencyprobleminfoodcropscanbeaddressedthroughthezincbiofortificationapproach to provide adequate zinc content in multiple edible parts of plants. Zn scarcity affects a largeportion of arable land, and about one third of the human population suffers from zinc malnutrition due topoor Zn intake"[19]. Zinc is also critical to tissue growth, wound healing, taste acuity, connective tissuegrowth and maintenance, immune system function, bone mineralization, proper thyroid function, bloodclotting and cognitive functions. In this regard, the use of zinc-mobilizing bacteria with diverse abilities topromote plant growth is the current need to increase crop productivity, food security and to increase thezinc concentration in the edible parts of crops. The present investigation was undertaken to study theeffect of organic nutrients and zinc biofortification on seed germination, seedling vigour, growth, yield andquality ofsponge gourd cv.MahyHarita.

2. MATERIALSANDMETHODS

The investigation on "Effect of organic nutrients and zinc biofortification on growth and yield ofspongegourd(*Luffacylindrica*L.)cv.MahyHarita"wascarriedoutatOrchard,DepartmentofHorticulture, Annamalai University, Faculty of Agriculture, Tamil Nadu during 2022-2023. The experimentwas laid out in RBD with 15 treatment combinations in three replications. The treatments are T_1: Control,T_2: FYM (Farmyard manure), T_3: FYM + PG + *Bacillus subtilis* @ 10g, T_4: FYM + PG + *Bacillus subtilis* @20g,T_5:FYM+SWE +*Bacillussubtilis*@10g,T_6:FYM+SWE +*Bacillussubtilis*@20g,T_7:FYM +EMI+ *Bacillus subtilis* @ 10g, T_8: FYM + EMI + *Bacillus subtilis* @ 20g, T_9: EM (Enriched manure), T_{10}: EM+PG + *Bacillus subtilis* @ 10g, T_{11}: EM+ PG + *Bacillus subtilis* @ 10g, T_{12}: EM + SWE + *Bacillus subtilis*@10g, T_{13}: EM + SWE + *Bacillus subtilis* @ 20g, T_{14}: EM + EMI + *Bacillus subtilis* @10g, T_{15}: EM + EMI +*Bacillus subtilis* @20g. The sponge gourd variety Mahy Harita (MSGH 6) produced by Mahyco privateLimited, Mumbai was used for the experiment. The fruits are dark green with slender in shape andmatures in 40-45 days after sowing. The zinc uptake of fruit was estimated by using triple acid digestionmethod described by Lindsay and Norwell (1958) with a atomic absorption spectrophotometer. The fieldwas thoroughly ploughed and divided into plots of 3m x 3m. Six pits per plot were formed and the seedswere sown. The organic manures *viz*., FYM 25 t ha^{-1}, EM 1 t ha^{-1} along with consortium of biofertilizers @2 kg ha^{-1} were incorporated at the time of last ploughing as per the treatment schedule. The zinc was applied in the form of Bacillus subtilis through soil application at 10g and 20g at different levels. The required quantity of biostimulants, namely Panchagavya (3%), seaweed extract (3%), and effective microbial inoculants (2%), were prepared and sprayed according to the treatment schedule in three split doses, viz., 20, 35, and 50 days after sowing.

The crop was irrigated every fifth day, and proper drainage facilities were provided, as the crop cannot withstand waterlogging. Weeding was done 15 days after sowing. Necessary plant protection measures were carried out as per recommendations. The plants were harvested separately for each treatment at 45 DAS.The fruits of sponge gourd take 6 to 7 days from setting to reach marketable size.

Fig.1 Experimentalfieldviewofsponge gourd(*Luffa cylindrica*L.)

3. RESULTSANDDISCUSSION

3.1. Growthparameters

The results revealed that the growth parameters (Table 1) *viz*., vine length, number of leaves, leaflength and leaf breadth were significantly influenced by the supplementation of organic manures alongwith consortium of biofertilizers and biofortification of zinc at varying levels. The highest vine length(136.40 cm, 267.37 cm, 368.46 cm), number of leaves (47.88, 85.29, 187.19), leaf length (14.16 cm) andleaf breadth (15.42 cm) were recorded with 25 t FYM ha^{-1} and foliar application of panchagavya (3%)along with soil application of *Bacillus subtilis* @ 20g. The least vine length (84.24 cm, 180.07 cm, 286.44cm), number of leaves (15.24, 41.51, 136.84), leaf length (9.53 cm) and leaf breadth (9.84 cm) wererecordedin control (T_1).

The increase in vine length could be due to the organic manure applied in the form of FYM, which might have improved the physical and chemical properties of the soil, leading to an adequate supply of nutrients to the plants, sufficient water-holding capacity, and accelerated vine length. Alternatively, the reason for increased vine length may also be due to improved nutrient uptake by plants in this treatment, resulting in improved vegetative growth.

The present findings are in close agreement with Singh et al. [17], who reported that the application of organic manures improved vine length in cucumber. The increase in plant growth might be attributed to the application of Panchagavya spray.

Sam Ruban et al. [13] reported similar findings in brinjal, where plant height significantly increased with the application of panchagavya that possess almost all macro, micronutrients and growth promoting hormones (IAA, GA)required for plant growth. Further, in the present study application of *Bacillus* also enhanced the vinelength. Sreekumar and Singh [19] reported that some of the strains of *Bacillus* were found to producemixtures of lactic acid, isovalaricacid, isobutaricacid and acetic acid which mighthave directly orindirectlypromotedthe growth attributesin sponge gourd.

Table-1Effectoforganicmanuresandzincongrowthparametersinspongegourdcv.Mahy Harita

Tr.No	Vinelength (cm)			No.ofleaves (cm)			Leaflength(cm)	Leafbreadth(cm)	Leaf area(cm^2)
	30DAS	60DAS	90DAS	30DAS	60DAS	90DAS			
T_{1}	84.24	180.07	286.44	15.24	41.51	136.84	9.53	9.84	47.04
T_{2}	90.81	223.11	315.41	16.41	49.20	146.36	10.19	10.58	53.36
T_{3}	129.07	260.22	356.34	37.16	75.62	178.06	13.19	14.55	96.27
T_{4}	136.40	267.37	368.46	47.88	85.29	187.19	14.16	15.42	109.17
T_{5}	107.98	241.58	336.22	21.40	59.66	160.54	11.46	12.01	68.81
T_{6}	117.00	247.57	345.12	26.63	64.34	168.30	12.14	12.77	77.51
T_{7}	99.48	235.48	327.59	17.91	54.57	153.59	10.72	11.39	61.05
T_{8}	115.00	247.42	345.05	26.27	63.13	167.73	12.15	12.80	77.76
T_{9}	87.84	209.37	302.79	15.81	45.93	142.57	9.85	10.20	50.23
T_{10}	120.88	252.35	349.61	30.13	68.36	171.41	12.47	13.54	84.42
T_{11}	132.52	263.28	361.78	41.62	79.15	182.59	13.84	14.94	103.38
T_{12}	96.89	231.48	321.37	17.04	51.97	149.97	10.44	11.01	57.47
T_{13}	103.23	237.45	332.62	19.20	57.72	156.71	11.08	11.68	64.70
T_{14}	112.31	244.52	340.34	23.44	61.75	164.05	11.82	12.43	73.46
T_{15}	124.76	256.38	354.62	33.50	72.10	174.68	12.79	13.89	88.82
S.ED	**1.01**	**2.17**	**3.34**	**0.70**	**0.86**	**1.38**	**0.12**	**0.15**	**0.67**
CD(p=0.05)	**2.04**	**4.38**	**6.73**	**1.40**	**1.73**	**2.76**	**0.24**	**0.30**	**1.35**

Similar findings on the increase in the number of leaves due to the application of organic nutrients have been reported by Bhattarai and Maharajan [5] in carrot. The increase in the number of leaves could also be due to the sudden release of a higher level of nutrients and minerals from FYM, which is readily available to plants.

The nitrogen released from FYM is synthesized into amino acids which are built into complex protein andhelped in better growth. Application of consortium biofertilizer also increased the number of leaves in thepresentstudy.Theincreaseinnumberofleavesduetotheapplicationofconsortiumbiofertilizerimproves betterplantgrowthpromotionability toPGPRas theconsortium,apart fromthenutrientsupplying potential are able to synthesisephytohormones, decompose organic matter, enlarge the soilflora and improve the soil structure for root development and better absorption of water and nutrients.Foliar spray of panchagavya increase the number of leaves in the present study. It might be due to thepresence of various growth enzymes which favours rapid cell division and cell- multiplication contributingto the overall growth and development of plants resulting in better yields Kumar and Singh [8]. Accordingto the findings reported by Ali *et al*. [1] in okra, in the present study the soil application of *Bacillus*increased the number of leaves. The reason could be due to auxins, gibberellins, and cytokininsare thegrowth-promoting compounds produced by *B. subtilis*. These chemicals may helpful to increase the plantgrowthand outputbyenhancing nutrientuptake and water use efficiency.

Similar findings of enhanced leaf parameters were reported by Pathak et al. [12] in radish. The application of organic manure likely facilitated rapid cell elongation and multiplication, thanks to the adequate nitrogen supply from farmyard manure during the crop's early stages. This led to increased leaf parameters and leaf area.

The role of biofertilizers played a crucial part in crop growth by maximizing nutrient solubilization potential, efficiently transforming nutrients from unavailable to available forms. These results align with Bhuvaneshwari and Anburani [6], who observed similar effects in bottle gourd.

Panchagavya spray enhanced leaf area, likely due to its growth-regulatory substances, including IAA, GA, cytokinin, essential plant nutrients, effective microorganisms, and biofertilizers.

Previous studies have shown that panchagavya contains bacteria producing plant growth-promoting substances and exhibiting biological activities. The present findings are consistent with Esakkiamma et al. [7], who reported similar results in Dolichos lablab.

Application of Bacillus subtilis also increased leaf area, as reported by Singh [18] in cucumber.

3.2. Yieldparameters

The results revealed (Table-2) that the higher number of fruits plant^{-1} (23.76), fruit length (37.30cm), fruit girth (14.64 cm), single fruit weight (234.18 g) and highest fruit yield plant^{-1} (5.24 kg plant^{-1}). Theleast number of fruits plant^{-1} (9.22), fruit length (16.69 cm), fruit girth (11.59 cm), single fruit weight (90.40g),andfruityield plant^{-1}(1.02 kgplant^{-1})were recorded inthe treatmentT_1(control).

The application of various organic manures, combined with foliar application of panchagavya and soil application of Bacillus subtilis, enhanced the yield parameters. The increase in high yield and yield parameters, viz., number of fruits, fruit length, fruit girth, single fruit weight, and fruit yield per plant found in organic treatments, might be due to the synergistic interaction between enriched compost and biofertilizers consortium and the mineralization of macro and micronutrients from organic manures, which might have helped achieve higher yields.

Such findings were in accordance with Barik et al. [4] in ridge gourd. Further, in the present study, combined application of panchagavya improved maximum fruit yield and could be due to microbes present in panchagavya that produced growth hormones, which helped increase the weight of fruit and number of fruits per plant through cell division and cell elongation by translocating more carbohydrates to developing fruits.

The effect of panchagavya on yield parameters was already reported by Sanjiv et al. [13] in tomato. Furthermore, in the present study, Bacillus subtilis isolates increased plant yield and induced resistance to biotrophic fungal plant pathogens in tomato. These are presumably transported into the shoot via the xylem. Intensified and prolonged synthesis of these phytohormones may be regarded as a cause of delayed senescence and improved yields.

The results of this experiment were supported by the findings of Sreekumar and Singh [19] in sponge gourd, who recorded significantly higher fruit yield by applying Bacillus subtilis and increased the number and diameter of fruits.

Table-2 Effect of organic manures and zinc on yield parameters in sponge gourd

cv.MahyHarita

Tr.No.	No. offruitsper plant^{-1}	Fruitlength (cm)	Fruit girth (cm)	Mean singlefruitweight (g)	Fruit yieldplant^{-1} (kg)	Zinc uptakein fruit (mg100g^{-1})
T_1	9.22	16.69	11.59	90.40	1.02	0.10
T_2	10.01	21.56	12.05	121.15	1.36	0.60
T_3	17.61	28.77	13.92	204.21	3.41	2.03
T_4	19.12	34.23	14.48	228.41	4.23	2.20
T_5	11.81	26.05	12.58	161.64	1.85	1.61
T_6	13.28	26.57	12.97	171.34	2.20	1.73
T_7	14.01	27.18	13.43	183.91	2.53	1.82
T_8	16.46	28.00	13.76	194.15	3.10	1.95
T_9	10.65	22.40	12.36	138.32	1.42	0.90
T_{10}	18.76	32.20	14.29	223.81	4.13	2.12
T_{11}	23.76	37.30	14.64	234.18	5.24	2.31
T_{12}	11.87	26.22	13.18	163.18	1.92	1.62
T_{13}	15.21	27.01	13.53	188.73	2.83	1.89
T_{14}	13.96	26.01	13.07	182.36	2.50	1.80
T_{15}	18.22	31.20	14.12	217.34	3.90	2.08
S.ED	**0.33**	**0.35**	**0.18**	**3.71**	**0.07**	**1.70**
CD(p=0.05)	**0.66**	**0.70**	**0.36**	**7.48**	**0.15**	**3.41**

3.3. Zinccontent

The result revealed (Table-2) that the zinc content in fruit were recorded highest in treatment T_{11} (2.31 mg100 g^{-1}) which received the application of enriched manure 1 t ha^{-1} + panchagavya @ 3% + *Bacillussubtilis* @ 20g. The least zinc content in fruit (0.10 mg 100 g^{-1}) were recorded in T_1 (control). The soil application of zinc in the form of *Bacillus subtilis* increased in the zinc uptake in fruits. SimilarfindingswerereportedbyAnwar*etal*.[3]inokraplants.

4. CONCLUTION

Based on the field experiments conducted, it can be concluded that the combined application of:

- Enriched manure at 1 t/ha
- Panchagavya (3% concentration)
- Bacillus subtilis at 20g

was the most effective treatment in enhancing growth, yield, and quality of sponge gourd cv. MahyHarita.

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