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

ABSTRACT

A field experiment was carried out to study the "Effect of organic nutrients and zinc biofortification ongrowthandyieldofspongegourd(*Luffacylindrica*L.)cv.MahyHarita"wascarriedoutatOrchard,Department of Horticulture, Annamalai University, Faculty of Agriculture, TamilNadu during 2023-2024. Theexperimentwas laid out in RCBD 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 of 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 results of the experiment revealed that the yield attributes*viz*., the highest number of fruits $plant^{-1}$, fruit length, fruit girth, fruit weight and fruit yield $plant^{-1}$, fruit $yieldplot^{-1}$, and fruit yield ha^{-1} were registered in the treatment which received the application of enriched manure@1tha^{-1}combinedwithpanchagavya(3%)asfoliar application and*Bacillus subtilis*@20g(T_{11}).

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.

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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 RCBD with 15 treatment combinations in three replications. The treatments are T_1: Control,T_2: FYM (Farmyard manure), T_3: FYM + PG (panchagavya) + *Bacillus subtilis* @ 10g, T_4: FYM + PG + *Bacillus subtilis* @20g,T_5:FYM+SWE (seaweedextract) +*Bacillussubtilis*@10g,T_6:FYM+SWE +*Bacillussubtilis*@20g,T_7:FYM +EMI (effectivemicrobialInoculants) + *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 wasapplied in the form of *Bacillus subtilis* through soil application as 10g and 20 g at different levels. Therequiredquantityofbiostimulantspanchagavya@(3%),seaweedextract@(3%)

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inoculants @ (2%) were prepared and spray according to the treatment schedule in three split doses *viz.,*20, 35, 50 days after sowing. The crop was irrigated every fifth day and proper drainage facilities wereprovided as the crop cannot with stand water logging. Weeding was done at 15 days after sowing.Necessaryplantprotectionmeasureswerecarriedoutasperrecommendation.Theplantswereharveste d separately for each treatment as 45 DAS. The fruits of sponge gourd fruit takes 6 to 7 day fromsetting to reachthemarketable 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) wererecordedwith control (T_1).

The increase in vine length could be due to the organic manure applied in the form of FYM mighthave improved the physical and chemical properties of the soil and leading to the adequate supply ofnutrients to the plants with sufficient water holding capacity and might have accelerated the vine length.Thereasonforincreasedvinelengthmayalsoduetoimprovednutrientuptakebyplantsinthistreatment, resulting improved vegetative growth. The present findings are in close agreement with Singh*et al*. [17] who reported the application of organic manures improved the vine length in cucumber. Theincrease in growth of plants might be attributed due to the application of panchagavya spray also

SamRuban*et al*.[13]inbrinjalwhoreportedthatplantheightsignificantlyincreasedwithapplicationof

Comment [I3]: Replace this reference with any vine vegetable work as brinjal is bushy plant with different plant physiology

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 orindirectly promotedthe 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 increase in number of leaves due to application of organic nutrients have beenreported by Bhattarai and Maharajan [5] in carrot. The increase in number of leaves could also be due tosuddenreleaseofhigherlevelofnutrientsandmineralsfromFYMwhichisreadilyavailabletoplants.

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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.

Comment [I5]: Add reference

Similar findings ofenhanced leafparameters were reported by Pathak*et al*. [12] in radish.Application of organic manure could have involved in rapid elongation and multiplication of cells in thepresence ofadequate quantity of nitrogen supplied by farmyard manure in the earlier stages of crop,leadstoincreasein leafparametersandleafarea.Theroleofbiofertilizerswhichhadapositiverelationship with crop growth by maximizing the solubilizing potentialassisting in efficient transformationofnutrientsfromunavailableformtoavailableform.Theseresultswereinconcurrencewith Bhuvaneshwari and Anburani [6] in bottle gourd. The spray of panchagavya enhanced the leaf area couldbe due to the presence of growth regulatory substances such as IAA, GA, cytokinin, essential plantnutrients, effective microorganisms and biofertilizers present in panchagavya. It also been reported tocontain bacteria producing plant growth promoting substances as wellas bacteria having biologicalactivities. The present findings are in close affirmative with Esakkiammal*et al.* [7] in dolichus lablab.Applicationof*Bacillus subtilis*alsoincreasedtheleafareareportedbySingh[18]incucumber.

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).

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The application of various organic manures combined with foliar application of panchagavya andsoil application of *Bacillus subtilis* enhanced the yield parameters. The increase in high yield and yieldparameters *viz*., number of fruits, fruit length, fruit girth, single fruit weight, fruit yield per plant and fruityield per plot were found in organic treatments might be due to the synergistic interaction betweenenrichedcompostandbiofertilizersconsortiumandthemineralizationofmacroandmicronutrientsfrom

organicmanuresmighthave helped to gethigheryields.Such findings werein accordance withBarik*etal*. [4] in ridge gourd. Further, in the present study combined application of panchagavya improved themaximumfruityieldandcouldbedueto microbespresentinpanchagavyathatproducedgrowthhormones which helped in increasing weight of fruit and number of fruits plant^{-1} through cell division andcell elongation by translocation of more amount of carbohydrates to the developing fruits. The effect ofpanchagavyaon yieldparameterswerealreadyreportedbySanjiv*etal*.[13]intomato.

Further in the present study, the *Bacillus subtilis* isolate increased the yield of plants in addition toinducing resistanceto biotrophic fungalplantpathogens in tomato. Thesearepresumablytransportedinto the shoot*via*the xylem.Intensified andprolongedsynthesisofthesephytohormones mayberegarded as a cause of delayed senescence and improved yields. The results of this experiment weresupported by the findings of Sreekumar and Singh [19] in sponge gourd who recorded significantly higherfruityieldby applicationof*Bacillus subtilis*andincreasedthenumber offruitsanddiameteroffruits.

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**

Comment [I7]: Need reconsideration of paragraph and rewrite according to results in table 2

Comment [I8]: Add error value in ± format also known as error bars for significance

3.3. Zinccontent

The result revealed 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 increasein the uptake of micro and macro-nutrients capability of plants could be due to the application of organicnutrients and inoculation with PGPR that results in the formation and improvement of lateral roots andimproved the root biomass. The soil application of *Bacillus subtilis* strain also increased in the uptake ofnutrients.Similarfindingswerealso reportedbyAnwar*etal*.[3]inokraplants.

Comment [I9]: T11 in the material and methods describe other story

4. CONCLUTION

Based on the findings of the experiment it is concluded that the ~~Based on the field experimentsconducted,itcanbeconcludedthat~~,combinedapplicationofenrichedmanure@1tha^{-1}+panchagavya (3%) + *Bacillussubtilis*@ 20g was reported to be the besttreatment in enhancinggrowth,yield,and qualityofsponge gourdcv.MahyHarita.

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