



Effect of Different Levels of PSB and Organic Starter Solution on Growth and Yield of Broccoli (*Brassica oleracea* var. *italica* L.) c v. Lucky

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present investigation entitled "Effect of different levels of PSB and organic starter solution on growth and yield of Broccoli" was conducted in the Horticulture Research Farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology and Science, Prayagraj (UP) During October 2021 to February 2022. The experiment was laid out in RBD with 9 treatments with 3 replications. The results revealed that 40ml/Plant PSB + 40ml/Plant Starter Solution TA41 (Diluted) performed the best in terms of days to Plant Height (30.56), Leaf length (46.86), Leaf width (16.71), Leaf Number (14.89), Days to initiation (49.5), Head weight (530 g), Head yield per plot (3.22 Kg), Head yield per hectare (14.6t/ha) and B: C Ratio (4.9). Therefore, 40 ml/Plant PSB + 40 ml/Plant Starter Solution TA41 (Diluted) is the best when compared to other treatments. As, the highest cost benefit ratio was observed in treatment 40 ml/Plant PSB + 40 ml/Plant Starter solution TA41 (Diluted) i.e., (4.9) which states that it is economically profitable compared to all other treatments.

Keywords: Broccoli; growth; yield; PSB; starter solution.

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1. INTRODUCTION

Broccoli (*Brassica oleraceae* var. *italica*) belongs to the genus *Brassica* and the family *Brassicaceae* which includes a wide range of crop plants derived from the Mediterranean sea and modified over the years by selection and breeding [1]. Broccoli is often boiled or steamed but may be eaten raw. The p-solubilization ability of rhizosphere microorganisms is considered to be one of the most important traits associated with plant phosphate nutrition. Phosphate solubilizing bacteria play an important role in supplementing phosphorous to plants allowing sustainable use of phosphate [2-5]. PSB (Phosphate Solubilizing Bacteria) are beneficial bacteria capable of solubilizing inorganic phosphorus from insoluble compounds. Also, PSB can minimize the pathogenic microorganism mostly due to the synthesis of antifungal compounds, antibiotics and siderophores that is beneficial for plants [6].

Starter solutions are mixtures of soluble fertilizer and water used to get young plants off to a good start [7,8]. TA41 constitutes of photosynthetic bacteria, actinomycetes, beneficial fungi and yeast. Improvement in broccoli growth and yield under starter solution was observed by [9]. The starter solution supplies readily available nutrients directly to the soil-rhizosphere system.

2. MATERIALS AND METHODS

The experiment was conducted at Experimental Research Field, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology & Sciences, and Prayagraj (UP) in 2021. Broccoli was planted in the field at a spacing of 60cm×45cm in a plot of 1m×1.5m size PSB (Phosphate Solubilizing Bacteria) and organic starter solution (TA41). Normal cultural and plant protection measures were followed during the cultivation process. Plants were selected randomly from each plot as a representative sample for recording data.

The experiment considered of nine treatments with T₀ Control, T₁ 20 ml/plant PSB (diluted), T₂ 40 ml/plant PSB (diluted), T₃ 20ml/plant starter solution TA41 (diluted), T₄ 40ml/plant starter solution TA41(diluted), T₅ 20 ml/plant PSB+ 20 ml/Plant Starter Solution TA41 (diluted), T₆ 20 ml/plant PSB+ 40ml/Plant Starter solution TA41 (diluted), T₇ 40 ml/plant PSB+ 20 ml/Plant Starter solution TA41 (diluted), T₈ 40 ml/plant PSB + 40 ml/Plant Starter solution TA41 (diluted) was laid

out in randomized block design with three replications.

3. RESULTS AND DISCUSSION

The present investigation concluded that the treatment 40 ml/Plant PSB + 40 ml/Plant Starter Solution TA41 (Diluted) found best in terms of plant growth parameters and in terms of yield parameters. In terms of economics the maximum cost benefit ratio (4.9) was also found in treatment 40ml/Plant PSB + 40ml/Plant Starter Solution TA41 (Diluted) and is highly recommended to farmers for commercial cultivation.

3.1 Growth Parameters

The treatment significantly altered all the growth parameters at the successive stages of growth. The datas were taken at the interval of 25DAT, 50DAT, 75DAT. The 40 ml/plant PSB +40 ml/Plant Starter solution TA41(diluted) was observed maximum at all successive stage of growth with plant height (cm) (16.89,18.67,30.56) followed by 40ml/plant PSB+40 ml/plant Starter solution TA41 (Diluted) (16.33,18.33,29.67), leaf length (cm) (16.47,21.76,28.10) followed by 40 ml/plant PSB+40 ml/plant Starter solution TA41 (Diluted) (15.53,19.87,26.79), leaf width (cm) (9.68,12.90,16.71) followed by 40 ml/plant PSB+40 ml/plant Starter solution TA41 (Diluted) (9.76,12.90,16.71), leaf area (m²) (161.78,305.09,475.35) followed by 40ml/plant PSB+40 ml/plant Starter solution TA41 (Diluted) (158.35,265.36,447.69), leaf number per plant (10.78,12.44,14.89) followed by 40 ml/plant PSB+40 ml/plant Starter solution TA41 (Diluted) (9.33,11.56,14.22), Days taken to head initiation (49.5) followed by 40 ml/plant PSB+40 ml/plant Starter solution TA41 (Diluted) (50.46). Application of PSB generates higher yield by providing valuable nutrients to the plant and soil and also PSB could play a pivotal role making soluble phosphorus available to plants while Starter Solution gives the plants a higher survival rate and earlier renewal rate [10-12]. PSB and Starter Solution improved the broccoli growth and growth parameter. The performance of the plants was better in treated treatments in comparison to the control. These similar findings were recorded by [13,14] (Shima Sivasakthivelan et al., 2021).

3.2 Yield Parameters

The highest head weight was in the treatment 40 ml/plant PSB +40ml/Plant Starter solution

TA41(diluted) (440.00 g), highest yield per plot (3.22 kg) and the maximum yield per hectare (14.6t/ha) followed by 40ml/Plant PSB + 20 ml/Plant Starter Solution TA41 (Diluted). Similarly, Pathak and Ram [15] reported that the yield improvement through the application of

biofertilizers might be due to available nutrients, particularly N and P and micronutrients, increase microbial activity, and a production of growth-promoting substance, and plant-soil-microbes interaction in broccoli, cabbage, tomato.

Table 1. Effect of different levels of PSB and organic starter solution on growth traits of Broccoli (*Brassica oleracea* var. *italic* L.) c v. Lucky

Notations	Treatment combinations	Plant height			Leaf length		
		25 DAT	50 DAT	75 DAT	25 DAT	50 DAT	75 DAT
T ₀	Control	9.00	10.78	14.11	12.92	15.94	18.28
T ₁	20 ml/Plant PSB(Diluted)	12.67	14.67	27.00	14.27	19.87	23.78
T ₂	40 ml/plant PSB (diluted)	13.44	15.67	21.56	15.42	18.90	24.43
T ₃	20 ml/plant starter solution TA41(diluted)	11.44	13.33	24.44	14.01	16.39	23.36
T ₄	40 ml/plant starter solution TA41(diluted)	11.22	11.83	21.00	13.09	18.97	22.77
T ₅	20 ml/pant PSB+ 20ml/Plant Starter SolutionTA41 (diluted)	14.33	15.33	25.33	13.67	18.34	22.31
T ₆	20 ml/plant PSB+ 40ml/Plant Starter solutionTA41 (diluted)	15.33	16.67	28.11	16.26	19.46	25.69
T ₇	40 ml/plant PSB+ 20ml/Plant Starter solutionTA41 (diluted)	16.33	18.33	29.67	15.53	19.87	26.79
T ₈	40 ml/plant PSB +40ml/Plant Starter solution TA41(diluted)	16.89	18.67	30.56	16.47	21.76	28.10
	SE.d(±)	0.34	0.33	0.66	0.22	0.59	0.88
	CD	1.01	0.99	1.98	0.66	1.76	1.86
	CV	4.28	3.88	4.64	2.60	5.40	4.50

Table 2. Effect of different levels of PSB and organic starter solution on growth traits of Broccoli (*Brassica oleracea* var. *italic* L.) c v. Lucky

Notations	Treatment combinations	Leaf width			Leaf area		
		25 DAT	50 DAT	75 DAT	25 DAT	50 DAT	75 DAT
T ₀	Control	7.26	10.19	11.36	101.00	154.70	207.60
T ₁	20 ml/Plant PSB (Diluted)	8.74	12.23	13.17	128.19	223.60	313.14
T ₂	40 ml/plant PSB (diluted)	9.68	13.48	14.06	139.32	221.72	336.52
T ₃	20 ml/plant starter solution TA41(diluted)	9.09	10.71	12.29	101.37	186.12	272.85
T ₄	40 ml/plant starter solution TA41(diluted)	8.52	10.30	14.01	121.51	197.55	319.743
T ₅	20 ml/pant PSB+ 20 ml/Plant Starter SolutionTA41 (diluted)	8.69	10.89	15.53	127.49	213.49	344.79
T ₆	20 ml/plant PSB+ 40 ml/Plant Starter solutionTA41 (diluted)	9.21	12.52	14.32	148.28	234.38	403.39
T ₇	40 ml/plant PSB+ 20 ml/Plant Starter	9.76	12.27	16.58	158.35	265.36	447.69

Notations	Treatment combinations	Leaf width			Leaf area		
		25 DAT	50 DAT	75 DAT	25 DAT	50 DAT	75 DAT
T ₈	solutionTA41 (diluted) 40 ml/plant PSB +40ml/Plant Starter solution TA41(diluted)	9.68	12.90	16.71	161.78	305.09	475.35
	SE.d(±)	0.25	0.47	0.41	7.29	12.70	15.10
	CD	0.75	1.41	1.23	15.45	26.92	32.00
	CV	4.85	6.94	5.01	6.76	6.99	5.33

Table 3. Effect of different levels of PSB and organic starter solution on growth traits of Broccoli (*Brassica oleracea* var. *italic* L.) c v. Lucky

Notations	Treatment combinations	No. of leaves per plant			Days taken for head initiation
		25 DAT	50 DAT	75 DAT	
T ₀	Control	8.78	10.11	11.78	55.72
T ₁	20 ml/Plant PSB(Diluted)	8.89	10.44	11.89	54.8
T ₂	40 ml/plant PSB (diluted)	10.22	11.22	12.56	54.23
T ₃	20 ml/plant starter solution TA41(diluted)	9.00	10.22	11.78	53.72
T ₄	40 ml/plant starter solution TA41(diluted)	9.78	11.00	12.44	53.34
T ₅	20 ml/pant PSB+ 20ml/Plant Starter SolutionTA41 (diluted)	8.89	10.44	12.67	52.69
T ₆	20 ml/plant PSB+ 40ml/Plant Starter solutionTA41 (diluted)	9.67	11.22	12.78	51.3
T ₇	40 ml/plant PSB+ 20ml/Plant Starter solutionTA41 (diluted)	9.33	11.56	14.22	50.46
T ₈	40 ml/plant PSB +40ml/Plant Starter solution TA41(diluted)	10.78	12.44	14.89	49.5
	SE.d(±)	0.26	0.25	0.41	0.68
	CD	0.77	0.74	1.24	1.44
	CV	4.69	3.91	5.58	1.58

Table 4. Effect of different levels of PSB and organic starter solution on yield traits of Broccoli (*Brassica oleracea* var. *italica* L.) c v. Lucky

Notations	Treatment combination	Head weight(g)	Head weight per plot (kg)	Head yield per tones (t/ha)
T ₀	Control	171.56	1.05	5.7
T ₁	20 ml/Plant PSB (Diluted)	227.11	1.52	7.5
T ₂	40 ml/plant PSB (diluted)	268.00	1.72	8.9
T ₃	20 ml/plant starter solution TA41(diluted)	296.42	1.63	9.8
T ₄	40 ml/plant starter solution TA41(diluted)	267.16	1.63	8.8
T ₅	20 ml/pant PSB+ 20 ml/Plant Starter SolutionTA41 (diluted)	317.53	2.10	10.5
T ₆	20 ml/plant PSB+ 40 ml/Plant Starter solutionTA41 (diluted)	346.04	2.37	11.5
T ₇	40 ml/plant PSB+ 20 ml/Plant Starter solutionTA41 (diluted)	394.11	2.69	13.1
T ₈	40 ml/plant PSB +40 ml/Plant Starter solution TA41 (diluted)	440.00	3.22	14.6
	SE.d(±)	23.71	0.15	0.45
	CD	50.27	0.33	0.96
	CV	9.58	9.47	5.52

4. CONCLUSION

On the basis of present investigation, it is concluded that the 40ml/Plant PSB+40ml/Plant TA41 Starter Solution was found best in respect to plant height, leaf length, leaf width, leaf number per plant, leaf area, days to head initiation, head weight, head yield per plot, head yield per hectare. This treatment also showed maximum gross return, net return and benefit cost ratio (4.96).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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