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**Journal of Agriculture and Ecology**

ISSN: 2456-9410

Volume: 12

*Journal of Agriculture and Ecology* (2021) 12: 88-93  
<http://doi.org/10.53911/JAE.2021.12208>



## Research Article

## Open Access

## Effect of bio-fertilizers on growth and yield of spinach (*Beta vulgaris* L.) cv. All Green

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### Article Info

#### Article history

Received: 15 November 2021  
Accepted: 28 December 2021  
Available online: 31 December 2021

#### Key Words:

Spinach, *Beta vulgaris*,  
Azotobacter, PSB,  
biofertilizer.

### Abstract

Spinach beet is one of the most common leafy vegetables of tropical and sub-tropical regions. The popular palak growing states include Uttar Pradesh, West Bengal, Maharashtra and Gujarat. However, Palak is not very popular in South India. It is primarily used as potherb. It is a rich Source of vitamin A and C and also contains appreciable amount of protein, calcium and iron. The leaves contain low oxalic acid. Variety All Green was developed at the Indian Agricultural Research Institute, New Delhi, it produces green tender leaves and gives about 6-7 cuttings at 15-20 days interval with yields about 12 tonnes/ha. Bio-fertilizers are less expressive, ecofriendly and sustainable likely to assume greater significance complement or supplement to inorganic fertilizers. A field experiment was conducted to see the effect of biofertilizers on growth and yield of spinach. Under study treatments imposed were Control – RDF (T<sub>0</sub>), *Azotobacter* @ 10kg/ha (T<sub>1</sub>), PSB @10 kg/ha (T<sub>2</sub>), *Azotobacter* + PSB each @10 kg/ha (T<sub>3</sub>), *Azotobacter* + PSB as seed treatment (T<sub>4</sub>), *Azotobacter* @ 2 lit/ha (T<sub>5</sub>), PSB @2 lit/ha (T<sub>6</sub>), *Azotobacter*+ PSB each @2 lit/ha (T<sub>7</sub>), *Azotobacter* @10 kg and PSB @2 lit/ha (T<sub>8</sub>), *Azotobacter* @ 2 lit + PSB @ 10 kg/ha (T<sub>9</sub>). Result revealed that biofertilizer supplementation beneficial over control with respect to growth and yield of crop. Among biofertilizers of *Azotobacter* and PSB each at 2 litre per hectare application through liquid formulation was better and economic to the farmers for growing spinach cv. All Green.

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**Preferred citation:** Singh DK, Yadav PK & Choudhary MK. 2021. Effect of bio-fertilizers on growth and yield of spinach (*Beta vulgaris* L.) cv. All Green. *Journal of Agriculture and Ecology*, 12: 88-93; <http://doi.org/10.53911/JAE.2021.12208>.

### Introduction

The spinach (*Beta vulgaris* L.) commonly called as palak belonging to family Chenopodiaceae is one of the most popular vegetable crop grown in India and other parts of the world as leafy vegetable. It is used fresh, canned or as frozen products. It is low in calories and with a high biological value,

extremely rich in antioxidants especially when fresh steam or quickly boiled. Spinach is a rich source of vitamin A, iron and calcium and also contains appreciable quantity of ascorbic acid, riboflavin and small quantity of thiamine. The leaves are bright green in colour, lustrous, fleshy and accepted by the varied groups of populations. The crop can be

harvested 6 to 7 times, with application of nitrogen after each harvest (Thompson & Kelly 1957). In India, during last decade the area and production under vegetable crops is increasing steadily. Presently total area under vegetable cultivation is 10.2 million hectare and produced 197.2 million tonnes annually (Anon. 2021). According to ICMR per person daily requirement of leafy vegetable is about 50-60 g and productivity of our country around 19.7 tonnes per hectare which is very low that other developed countries like Spain *i.e.* 39.3 tonnes per hectare.

The scalding cost of chemical fertilizers has compelled the farmer to shift towards alternatives to chemicals farming. In present condition, it is not possible to completely eliminate the use of chemicals especially fertilizers planned to minimize the use of chemicals fertilizers by the application of various low cost nutrient sources. Bio-fertilizers are less expressive, ecofriendly and sustainable likely to assume greater significance complement or supplement to inorganic fertilizers. The recent trend in vegetables production is to produce chemical free, organic produce with high nutritive value, among different inputs in organic production of vegetables is bio-fertilizers. Bio-fertilizers are an importance group of biological software containing some insoluble sources by the production of organic acid. Studies on biofertilizers on different horticultural crops like brinjal (Doifode & Nandkar 2014), cluster bean (Sonali et al. 2013) and coriander (Aishwath et al. 2014; Tripathi et al.; Sahu et al. 2014) and potato (Jatav et al. 2011) exhibited significant role in

better crop growth and yield of the crop as well as eco-friendly.

### Materials and Methods

The present investigation entitled "Effect of bio-fertilizers on growth and yield of spinach (*Beta vulgaris* L)" was undertaken at instructional cum experimental farm, Department Of Horticulture, Kulbhaskar Ashram Post Graduate College Prayagraj (Allahabad) UP during Rabi season of 2019-20. The experiment was laid out in Randomized Block Deign (RBD) with ten treatments of bio-fertilizers replicated thrice using the variety All Green. The treatment comprised of Control – RDF (T<sub>0</sub>), *Azotobacter* @ 10kg/ha (T<sub>1</sub>), PSB @10 kg/ha (T<sub>2</sub>), *Azotobacter* + PSB each @10 kg/ha (T<sub>3</sub>), *Azotobacter* + PSB as seed treatment (T<sub>4</sub>), *Azotobacter* @ 2 lit/ha (T<sub>5</sub>), PSB @2 lit/ha (T<sub>6</sub>), *Azotobacter*+ PSB each @2 lit/ha (T<sub>7</sub>), *Azotobacter* @10 kg and PSB @2 lit/ha (T<sub>8</sub>), *Azotobacter* @ 2 lit + PSB @ 10 kg/ha (T<sub>9</sub>).The experiment farmed was to study the effect of bio-fertilizers on growth and yield of spinach. The experiment was conducted on medium black cotton soil having uniform texture with good drainage experimental land was ploughed and two cries- cross harrowing were given to bring the soil to fine tilth. Field was divided into different plots as per required dimensions by using the measuring tape, rope and pegs. The plots were prepared by keeping 1m distance between two replications and 50cm distance between two treatments with manual labour. The recommended dose of fertilizers (80:4040 kg NPK/ha) was applied through urea, single super phosphate and muriate of potash was applied in which half nitrogen and full dose of phosphorus and

potash was given at the time of sowing and half dose of nitrogen was applied fifteen days after sowing of crop as top dressing Bio-fertilizers such as *Azotobacter* and PSB required for the experimentation were obtained from department of agriculture chemistry and soil science. At the time of FYM application the solid forms of *Azotobacter* and PSB were mixed with FYM and applied as per treatments. The seed treatment of *Azotobacter* and PSB, to spinach seeds was done as per recommendation before sowing seeds for required treatment. N The liquid bio-fertilizers (*Azotobacter* and PSB) were mixed with water applied to the plots as per the treatments immediately after sowing of seeds. The spinach seeds of variety All Green were sown by opening the small furrows of 3 cm depth at a distance of 15 cm X 10 cm with the help of khurpi and seeds were sown by hand drilling and covered with fine soil. The experimental plots were irrigated as per the need during dry spell. In all plots, thinning was done after complete germination of seeds. Two weeding were done to keep the plot free from weeds. The plant protection measures were taken as per and disease and pest incidence. Three plants were randomly selected from each plot under each treatment and those plants were labeled for recording various parameters viz. plant height, days required for cutting, green leaf weight, yield ( $\text{plant}^{-1} \& \text{plot}^{-1}$ ) and economics. The observations were recorded and data was

subjected to statistical analysis (Panse & Shukatme 1985).

### Result and Discussion

It revealed that at 15 and 30 days after sowing the maximum plant height (20.55 cm, 26.66 cm) respectively was obtained in treatment of *Azotobacter* + PSB each @2 lit/ha (T<sub>7</sub>) and it was minimum in control. The significant increase in plant height due to application of *Azotobacter* + PSB @ 2 lit/ha could be due to the fact that as the microorganisms available in bio-fertilizers in liquid form might have increased the nutrient availability for better growth of the plants which in turn leads to increase the height of the plant at different growth stages. Similar results have been reported by Vivek et al. (2001) in potato. The results are also in accordance with the finding of Govindan & Thirumurugan (2003) who reported that the inoculation of *Azotobacter* and PSB significantly increased the plant height in spinach and fenugreek. In the results of present investigation minimum days required for maturity of spinach (28.12) was recorded in treatment *Azotobacter* + PSB each @2 lit/ha (T<sub>7</sub>) and it was at par with most of the treatments except, T<sub>5</sub>, T<sub>3</sub> and T<sub>6</sub> and maximum days for maturity (31.00) were required in the treatment of *Azotobacter* @ 2lit/ha (T<sub>6</sub>) treatment. It might be due to better growth achieved the plant by same treatment helping in early crop produce ready to cut.

**Table1.** Effect of bio-fertilizers on growth and yield of spinach cv. All Green

Treatment	Plant height (cm)		Days require for cutting	Fresh weight $\text{plant}^{-1}$ (g)	Yield		Per cent increase yield over control
	15 DAS	30DAS			Plot <sup>-1</sup> (kg)	Ha <sup>-1</sup> (q)	

T <sub>0</sub> -Control	6.33	8.66	29.67	70.00	2.17	36.22	-
T <sub>1</sub> - Azo. @ 10 kg ha <sup>-1</sup>	7.22	10.89	29.67	88.22	2.90	48.34	33.46
T <sub>2</sub> - PSB@10 kg ha <sup>-1</sup>	8.22	10.77	28.60	97.11	3.11	51.78	42.96
T <sub>3</sub> - Azo. +PSB 10 kg ha <sup>-1</sup>	6.78	16.55	30.67	89.77	3.50	58.33	61.07
T <sub>4</sub> - Azo. + PSB as seed treatment	7.89	10.22	29.33	75.33	2.95	49.17	35.95
T <sub>5</sub> - Azo. @ 2 lit ha <sup>-1</sup>	7.44	10.00	31.00	83.22	2.95	49.17	35.75
T <sub>6</sub> - PSB@ 2lit ha <sup>-1</sup>	6.44	8.89	30.33	91.44	2.93	48.78	34.68
T <sub>7</sub> - Azo. + PSB each @ 2 lit ha <sup>-1</sup>	9.88	19.33	28.12	98.11	3.80	63.34	74.87
T <sub>8</sub> - Azo. @ 10 kg + PSB@ 2 lit ha <sup>-1</sup>	8.22	10.44	28.32	95.44	3.50	58.33	61.07
T <sub>9</sub> - Azo @ 2lit + PSB @ 10 kg ha <sup>-1</sup>	6.66	10.22	29.67	93.89	3.12	52.00	43.87
SEm±	0.37	0.51	0.65	0.97	0.17	3.29	3.68
CD at 5%	1.09	1.52	1.93	2.88	0.51	9.77	9.89

DAS= Days after sowing

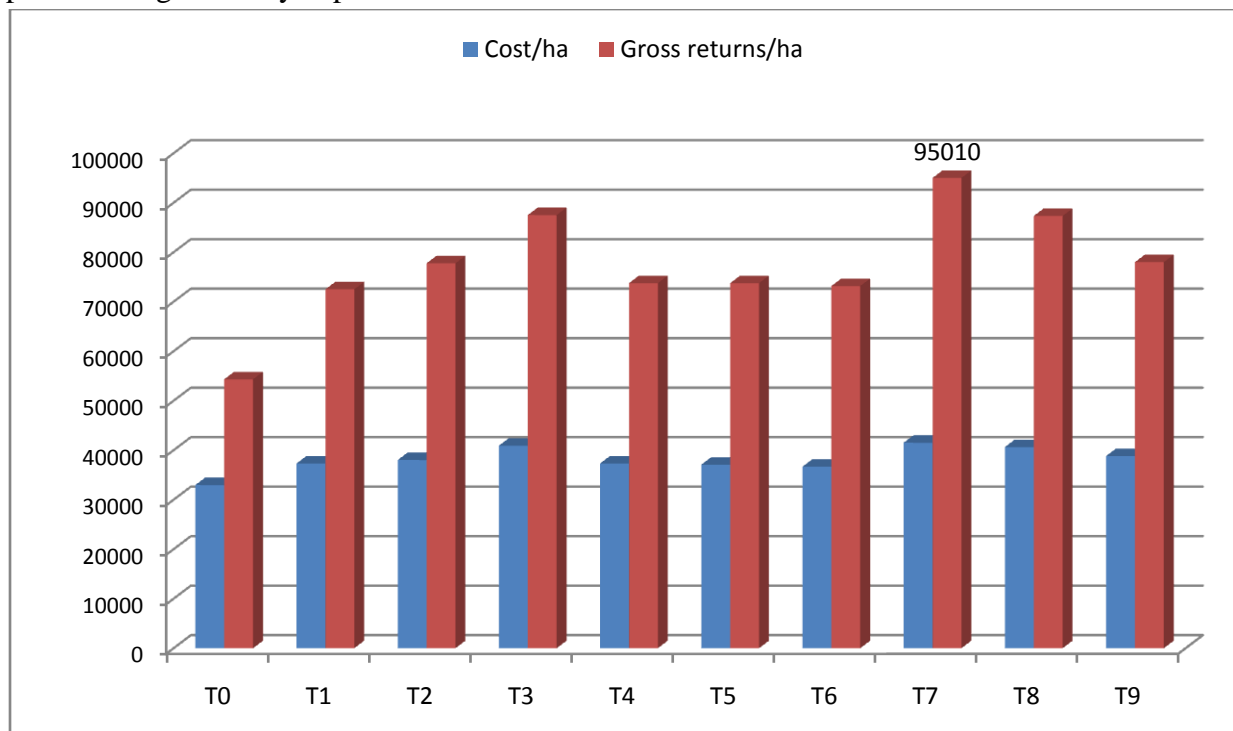
It is evident from the data that significantly maximum yield (3.8) kg/plot and yield (63.34 q/ha) was recorded in the treatment (T<sub>7</sub>) i.e. application of *Azotobacter* + PSB each @2 lit/ha and was statistically at par with treatments T<sub>3</sub> and T<sub>8</sub>. However, the minimum yield (2.17) kg/plot and 40 (36.22 q/ha) was recorded in treatment (T<sub>0</sub>) control where only RDF was applied. The highest increase in yield (74.87%) was observed with the application the treatment (T<sub>7</sub>) i.e. *Azotobacter* + PSB each @2lit/ha. It was (61.07%) followed by the treatment application (T<sub>4</sub>) i.e. application of *Azotobacter* + PSB each @ 10kg/ha in solid form It could be due to the fact that as the microorganisms available in bio-fertilizers in liquid as well as solid form might have increased the nutrient availability for better growth and yield of the spinach. This is also oblivious because of production higher plant growth number of leaves and branches in the plants produced by this treatment. The lowest increase in yield

(33.46%) was observed with the application of *Azotobacter* @ 10 kg/ha. Similar results have been reported by Dhage and Kachave (2008). They reported that application of 100 per cent RDF + Rhizobium+ PSB significantly increased yield of fenugreek. These results are also in conformity with the findings reported by Deshmukh et al. (2014) obtained significantly increased yield of cluster bean with the seed treatment of Rhizobium + AZB + PSB + VAM. The treatment of application of *Azotobacter* + PSB each @ 2 it/ha (T<sub>7</sub>) has produced maximum gross (Rs.95, 010) monetary returns (Fig. 1). The lowest values of cost of cultivation (Rs 32,691) and gross returns (Rs 54,330) were observed in control (T<sub>0</sub>). The present findings are in conformity with the reports of Jat et al. (2003) reported that the application of 80 kg P<sub>2</sub>O<sub>5</sub>/ha and seed treatment with Rhizobium + PSB resulted in getting the highest net returns in fenugreek. Similar trend of results was also reported by Tripathi et al. (2013) in coriander and Sharma



et al. (2015) in carrot. They reported that, the application of *Azotobacter* and PSB resulted in getting more net monetary returns. Thus, the application of bio-fertilizers in liquid form produced significantly superior results. As the

treatment of application of *Azotobacter* + PSB each @ 2 lit/ha (T<sub>7</sub>) produced significantly maximum growth and yield of spinach cv. All Green in Uttar Pradesh condition.



**Figure 1.** Effect of biofertilizer treatments on economics of spinach

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