Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; 7(3): 3722-3725
Received: 13-03-2018
Accepted: 18-04-2018

Tenlajila Imsong
Department of Horticulture, Sam Higgingbottom University of Agriculture, Technology and Sciences (SHUATS), Allahabad, Uttar Pradesh, India

Vijay Bahadur
Department of Horticulture, Sam Higgingbottom University of Agriculture, Technology and Sciences (SHUATS), Allahabad, Uttar Pradesh, India

Samir E Topno
Department of Horticulture, Sam Higgingbottom University of Agriculture, Technology and Sciences (SHUATS), Allahabad, Uttar Pradesh, India

Correspondence
Tenlajila Imsong
Department of Horticulture, Sam Higgingbottom University of Agriculture, Technology and Sciences (SHUATS), Allahabad, Uttar Pradesh, India

Influence of photosynthetic bacteria and Biochar on the growth, yield and quality of broccoli (*Brassica olearacea* var. *italica)*

Tenlajila Imsong, Vijay Bahadur and Samir E Topno

Abstract
The increase in use of chemical fertilizers and non-renewable resources in agriculture is increasing the environmental concerns. In this report we reviewed the work concerning the use of biochar for soil amendment and photosynthetic bacteria (*Rhodopseudomonas palustris*) as biofertilizer targeting the growth, yield and quality parameters on the crop broccoli (*Brassica oleracea var italica*). The experiment was carried out in a Randomized block design consisting of 10 treatments each replicated thrice using only biochar, photosynthetic bacteria and vermicompost to find out the best combination of bichar and PSB. Among the treatments T_2 had the best overall growth, yield and quality and lowest was reported on T_0 (Control).

Keywords: broccoli, biochar, photosynthetic bacteria, growth parameter, quality paramenter and yield parameters

Introduction
Biochar is a fine-grained porous substance that resembles charcoal produced by natural burning. However, biochar is produced by the combustion of biomass under oxygen limited conditions at high temperatures (from 600 to 1000°C) in a gasifier. Biochar is unlikely to have a major role as a fertilizer but, because of its structure, it can be expected to increase water-holding capacity, and be a good habitat for microbes and plant nutrients. (Ty *et al.* 2012)
Photosynthetic bacteria are currently being used in various applications which include water purification, bio-fertilizers, animal feed and bioremediation of chemicals among many others. They are used in the treatment of polluted water since they can grow and utilize toxic substances such as H_2S.
Photosynthetic bacteria (PSB) is being classified into three type, namely Purple sulfur bacteria (family *Chromatiaceae*), Purple non-sulfur bacteria (family *Rhodospirillaceae*) and Green Sulfur Bacteria (family *Chlorobiaceae*) In the context of Agriculture**,** *Rhodospririllaceae*, a family of Purple non-sulfur bacteria is being mostly used as Bio-fertilizer.
Rhodopseudomonas palustris is one of the phototrophic purple non-sulfur bacteria (PNSB) that belong to the class α-*proteobacteria*. This bacterium is widely distributed in various aquatic ecosystems as well as in sediments, moist soils, natural wetlands, and paddy fields. They can improve soil fertility, enhance plant nutrition availability and uptake, and support the health of plants. (Wong *et. al*. 2014) [15].

Materials and Methods
The experiment was carried out on September 2017 to February 2018 on SHUATS experimental field consisting of 10 treatments *viz* T_0 (Control), T_1 (PSB 50L/ha + Biochar 20t/ha), T_2 (PSB 100L/ha + Biochar 30t/ha), T_3 (PSB 150L/ha + Biochar 50t/ha), T_4 (PSB 50L/ha + Biochar 30t/ha), T_5 (PSB 100L/ha + Biochar 50t/ha), T_6 (PSB 150L/ha + Biochar 20t/ha), T_7 (PSB 50L/ha +Biochar 50t/ha), T_8 (PSB 100L/ha + Biochar 20t/ha), T_9 (PSB 150L/ha + Biochar 30t/ha).
Photosynthetic bacteria were procured from Japan and biochar was made from the rice husk by the process of pyrolysis. Vermicompost at 20 tons/ha was applied.
Biochar was applied before transplanting by incorporating on the soil and PSB was diluted with 66,600 liters/ha of water and applied to the crop weekly during the irrigation.
A 35 days old seedling of broccoli was transplanted to a plot size of $3m^2$ with a spacing of 50cm×50cm accommodating 9 plants per plot.
The parameters relating to growth were recorded at 30, 60 and 90 days after transplanting and the days of first visible head of broccoli from the day of transplanting was noted for recording

days to head initiation. Yielding attribute and yield were measure to make a critical analysis of the crop as affected by different treatments.

The technique of representative sample was adopted for recording the observations on various morphological characters in broccoli. At every observation, five plants from each plot were randomly selected and tagged. The observations were recorded from these samples.

Results and Discussion

Results regarding the influence of biochar and PSB on growth, yield and quality of broccoli have been recorded, interpreted in the light of impact of different treatments during the experimentation, as well as relevant discussion have been presented under following heads:

Growth Parameters

The treatment T_2 (PSB 100L/ha + Biochar 30t/ha) observed maximum at all successive stage of growth (30, 60 and 90 DAT) with plant height (21.2cm, 41.63cm and 65.83cm), number of leaves (7.8, 23.53 and 32.47), leaf width (7.43cm, 15.53 cm and 20.42cm), leaf area (154.64 cm^2, 391.29 cm^2 and 588.09cm^2), leaf area index (6.17, 15.28 and 23.49) and days to head initiation at 71.07 days fallowed by T_9 (PSB 150L/ha + Biochar 30t/ha). This findings are similar to Upadhyay *et al.* (2014) [8] and Trupiano *et al.* (2017) [6].

Biochar improved the broccoli growth parameters due to improvement of soil, better water holding capacity, increase in organic matter and retaining nutrients. PSB improved the soil fertility as it significantly increased the Nitrogen, Potassium and Phosphorus level in the soil. It was found that the treated treatments gave better growth over the control.

Yield Parameters

The treatment T_2 (PSB 100L/ha + Biochar 30t/ha) observed maximum weight of the head (499.37g) and maximum head diameter (16.55 cm) closely followed by T_9 (PSB 150L/ha + Biochar 30t/ha). It is evident from the table 2. that maximum head yield per plot (4.49 kg) and maximum head yield per hectare (14.98 t/ha) was recorded in T_9 (PSB 150L/ha + Biochar 30t/ha) fallowed by T_9 (PSB 150L/ha + Biochar 30t/ha). These similar findings were recorded by Upadhyay *et al.* (2014) [8] and Trupiano *et al.* (2017) [6]. It was found out that biochar and PSB increased the yield as compared to the control.

Quality Parameters

The significantly higher total soluble solids (8.59°Brix) was recorded T_2 (PSB 100L/ha + Biochar 30t/ha) fallowed by T_9 (PSB 150L/ha + Biochar 30t/ha) (8.24°Brix). The maximum vitamin C (91.55 mg/100 gm of fresh broccoli head) was recorded in T_2 (PSB 100L/ha + Biochar 30t/ha) fallowed by T_9 (PSB 150L/ha + Biochar 30t/ha) (83.62 mg). Whereas minimum findings are associated with T_0 (Control) as presented by the table.

Table 1: Influence of Photosynthetic bacteria and Biochar on the growth parameters on broccoli.

Treatment	Treatment combination	Plant height (cm)			Number of leaves		
		30DAT	60 DAT	90DAT	30DAT	60DAT	90DAT
T_0	Control	9.87	5.1	10.13	18.47	21.03	36.77
T_1	PSB 50L + Biochar 20t/ha	13.6	5.87	10.47	19.93	24.87	39.89
T_2	PSB 100L + Biochar 30t	21.2	7.8	23.73	32.47	41.73	65.83
T_3	PSB 150L + Biochar 50t	16.27	6.8	22.07	29.87	40.8	62.3
T_4	PSB 50L + Biochar 30t	15.53	6.17	18.97	29.87	36.37	56.62
T_5	PSB 100L + Biochar 50t	14.4	6.13	17.87	29.8	35.83	55.81
T_6	PSB 150L + Biochar 20t	14.17	6.07	15.9	28.87	35.57	51.69
T_7	PSB 50L +Biochar 50t	13.95	6	15.4	25.33	35.2	49.65
T_8	PSB 100L + Biochar 20t	17.63	7	22.53	31.13	40.87	63.75
T_9	PSB 150L + Biochar 30t	19.1	7.2	23.53	31.4	41.63	65.25
	F-test	S	S	S	S	S	S
	$S.E_{d(\pm)}$	1.72	0.47	1.10	2.28	2.38	1.75
	C.D at 5%	3.62	0.99	2.31	4.80	4.99	3.68

Table 1.1: Influence of Photosynthetic bacteria and Biochar on the growth parameters on broccoli.

Treatment	Treatment combination(/ha)	Leaf width (cm)			Leaf area (cm^2)		
		30 DAT	60 DAT	90DAT	30DAT	60DAT	90DAT
T_0	Control	4.43	115.4	242.59	316.08	6.59	13.82
T_1	PSB 50L + Biochar 20t	5.53	124.05	281.11	384.56	8	14.73
T_2	PSB 100L + Biochar 30t	7.43	154.64	391.29	588.09	15.53	20.42
T_3	PSB 150L+ Biochar 50t	6.38	147.85	374.66	575.12	11.25	17.68
T_4	PSB 50L + Biochar 30t	6.37	138.57	344.55	487.29	10.87	17.55
T_5	PSB 100L + Biochar 50t	6.07	135.92	339.64	469.25	10.55	15.37
T_6	PSB 150L + Biochar 20t	5.77	131.49	313.69	461.88	9.83	15.21
T_7	PSB 50L +Biochar 50t	5.63	129.25	291.25	440.22	9.1	14.37
T_8	PSB 100L + Biochar 20t	6.4	149.79	380.66	585.9	11.61	19.04
T_9	PSB 150L + Biochar 30t	6.83	150.79	382.64	586.65	12.13	19.73
	F-test	S	S	S	S	S	S
	$S.E_{d(\pm)}$	0.41	4.52	37.16	27.11	1.40	0.48
	C.D at 5%	0.85	9.50	78.07	56.96	2.95	1.01

Table 1.2: Influence of Photosynthetic bacteria and Biochar on the growth parameters on broccoli.

Treatment	Treatment combination	Leaf area index			Days to head initiation (days)
		30 DAT	60 DAT	90 DAT	
T_0	Control	4.61	89.53	9.68	12.63
T_1	PSB 50L/ha + Biochar 20t/ha	4.96	86.2	11.24	15.36
T_2	PSB 100L/ha + Biochar 30t/ha	6.17	71.07	15.64	23.49
T_3	PSB 150L/ha + Biochar 50t/ha	5.91	73.3	14.96	22.96
T_4	PSB 50L/ha + Biochar 30t/ha	5.53	79.2	13.76	19.48
T_5	PSB 100L/ha + biochar 50t/ha	5.41	78	13.56	18.76
T_6	PSB 150L/ha + biochar 20t/ha	5.24	77.67	12.56	18.45
JT_7	PSB 50L/ha + biochar 50t/ha	5.15	77.27	11.64	17.59
T_8	PSB 100L/ha + biochar 20t/ha	5.97	72.27	15.2	23.43
T_9	PSB 150L/ha + biochar 30t/ha	6.01	71.53	15.28	23.45
	F-test	S	S	S	S
	$S.E_{d(\pm)}$	0.19	0.84	1.48	1.08
	C.D at 5%	0.39	1.76	3.12	2.28

Table 2: Influence of Photosynthetic bacteria and Biochar on the yield parameters on broccoli

Treatment symbol	Treatment combination	Head weight (g)	Head yield per plot (kg)	Head yield(t/ha)	Head diameter (cm)
T_0	Control	195.74	1.76	5.87	12.82
T_1	PSB 50L/ha + Biochar 20t/ha	235.71	2.12	7.07	12.95
T_2	PSB 100L/ha + Biochar 30t/ha	499.37	4.49	14.98	16.55
T_3	PSB 150L/ha + Biochar 50t/ha	343.63	3.09	10.3	16.01
T_4	PSB 50L/ha + Biochar 30t/ha	299.65	2.97	9.9	15.8
T_5	PSB 100L/ha + biochar 50t/ha	293.18	2.81	9.39	15.4
T_6	PSB 150L/ha + biochar 20t/ha	330.07	2.69	8.98	15.2
T_7	PSB 50L/ha + biochar 50t/ha	313.18	2.63	8.79	14.96
T_8	PSB 100L/ha + biochar 20t/ha	358.03	3.22	10.73	16.09
T_9	PSB 150L/ha + biochar 30t/ha	468.82	4.22	14.06	16.13
	F-test	S	S	S	S
	$S.E_{d(\pm)}$	9.75	0.09	0.29	0.18
	C.D at 5%	20.48	0.18	0.61	0.38

Table 3: Influence of Photosynthetic bacteria and Biochar on the quality parameters on broccoli

Treatment symbol	Treatment combination	Head TSS (ºbrix)	VIT. C (mg/100g broccoli fresh head)
T_0	Control	5.64	79.95
T_1	PSB 50L/ha + Biochar 20t/ha	6.13	80.56
T_2	PSB 100L/ha + Biochar 30t/ha	8.59	91.55
T_3	PSB 150L/ha + Biochar 50t/ha	8.3	85.42
T_4	PSB 50L/ha + Biochar 30t/ha	7.21	81.57
T_5	PSB 100L/ha + biochar 50t/ha	7.2	81.19
T_6	PSB 150L/ha + biochar 20t/ha	7.17	80.94
T_7	PSB 50L/ha + biochar 50t/ha	7.1	80.57
T_8	PSB 100L/ha + biochar 20t/ha	8.27	83.56
T_9	PSB 150L/ha + biochar 30t/ha	8.24	83.62
F-test		S	S
$S.E_{d(\pm)}$		0.11	1.92
C.D at 5%		0.24	4.02

References

1. Dunsin O, Aboyeji M, Adekiya C, Omolola AK, Agbaje M, Oluwaseun GA. Effect of Biochar and Npk Fertilizer on Growth, Biomass Yield and Nutritional Quality of Kale (*Brassica Oleracea*) in a Derived Agro-Ecological Zone of Nigeria. Department of Crop & Soil Sciences, Landmark University, Omu-Aran, Kwara-State. 2016; 12(2):135-141.
2. Gu Jun, Yang Xu. Application of Photosynthetic Bacteria Fertilizer on Tomato and Cucumber. Institute of Applied Microbiology, Heilongjiang Academy of Sciences, 2002.
3. Kang-Hyeong Lee, Rae-Hyun Koh Hong-Gyu Song. Enhancement of growth and yield of tomato by Rhodopseudomonas sp. Under greenhouse conditions Division of life sciences, Kangwon National University, Chuncheon Republic of Korea, 2008, 200-701.
4. Nair A, Lawson V, Jennifer T. Effect of Biochar Application on Cabbage Production. Iowa State University, Horticulture Research Station ISRF, 2012, 12-36
5. Olle M, Williams IH. Effective microorganisms and their influence on vegetable production Journal of Horticultural Science & Biotechnology. 2013; 88(4):380-386
6. Trupiano D, Cocozza C, Baronti S, Amendola C, Vaccari FP, Lustrato G, *et al*. The Effects of Biochar and Its Combination with Compost on Lettuce (*Lactuca sativa* L.) Growth, Soil Properties, and Soil Microbial Activity and Abundance Hindawi International Journal of Agronomy, 2017, Article ID 3158207, 12.
7. Ty C, Sina V, Borin K, Preston TR. Effect of different levels of Biochar on the yield and nutritive value of Celery cabbage, Chinese cabbage, Mustard green and

Water spinach. Livestock Research for Rural Development, 2012-2013, 25(1).
8. Upadhyay KP, George D, Swift RS, Galea V. The Influence of Biochar on Growth of Lettuce and Potato. Journal of Integrative Agriculture 2014; 13(3):541-546.
9. Wididana GN, Higa T. Effect of EM on the Production of Vegetable Crops inndonesia, 1995
10. William K, Qureshi RA. Evaluation of Biochar as Fertilizer for the Growth of Some Seasonal Vegetables Journal of Bioresource Management, 2015, 2(1).
11. Woofl D, Amonette JE, Street-Perrott FA, Lehmann J, Joseph S. Sustainable biochar to mitigate global climate change. Nature Comm. 2010; 1:56-64.
12. Vinh NC, Hien NV, Anh MTL, Lehmann J, Joseph S. Biochar Treatment and its Effects on Rice and Vegetable Yields in Mountainous Areas of Northern Vietnam International Journal of Agricultural and Soil Science. 2014; 2(1):5-13.
13. Vista SP, Khadka A. Determining appropriate dose of biochar for vegetables. Journal of Pharmacognosy and Phytochemistry SP1:673-677 Yadav, SP. Performance of Effective Microorganisms (EM) on Growth and Yields of Selected Vegetables Nat. fam. environ. 2000; 3:35-38.
14. Yang D, Yunguo L, Shaobo L, Xixian1 H, Zhongwu1 L, Xiaofei T, *et al*. Potential benefits of biochar in agriculture soil. Soil Science Society of China. 2017; 27(4):645-661.
15. Wong WT, Tseng CH, Hsu SH, Lur HS, Mo CW, Huang CN, *et al*. Promoting Effects of a Single *Rhodopseudomonas palustris* Inoculant on Plant Growth by *Brassica rapa chinensis* under Low Fertilizer Input Microbes Environ. 2014; 29(3);303-313.