Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2020; 9(5): 3137-3140
Received: 08-06-2020
Accepted: 13-07-2020

Giriraj Char
Department of Horticulture, College of Agriculture, Rewa, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, India

TK Singh
Department of Horticulture, College of Agriculture, Rewa, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, India

Shruti Singh
Department of Horticulture, College of Agriculture, Rewa, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, India

Corresponding Author:
Giriraj Char
Department of Horticulture, College of Agriculture, Rewa, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, India

Effect of bio-fertilizers and mulching on yield attributes, yield and economics of Broccoli (*Brassica oleracea* var. *italica* Plenck) under protected condition

Giriraj Char, TK Singh and Shruti Singh

DOI: https://doi.org/10.22271/phyto.2020.v9.i5ar.12824

Abstract
The field experiment was conducted at the Horticulture Instructional farm, JNKVV, College of Agriculture, Rewa (M.P.) during Rabi, 2018-19. The experiment consists of twelve treatment combinations with bio-fertilizers and mulch in Randomized Block Design. The best result found that application of T_{12} (Black polythene + *Azotobacter* + PSB) with significantly superior over rest of the treatments. The concerning curd diameter 16.02 cm fresh plant weight 1247.7 g, primary curd weight 425.5 g, secondary curd weight 284.8 g, yield per ha 227.5 q. The maximum net return (465054 Rs/ha) and B:C ratio (4.5) were obtained in treatment twelve (T_{12}) followed by T_8 (426604 Rs/ha). Whereas the highest B: C ratio 5.03 was recorded in T_8 (Rice straw + PSB + *Azotobacter*) treatments due to less treatment cost as compared to other treatment.

Keywords: Broccoli, B: C ratio, Bio-fertilizers, Mulching

Introduction
Broccoli (*Brassica oleracea* var. *italic* Plenck), belongs to family Cruciferae, is a member of Cole group. The species originated in the Mediterranean region. The area under cauliflower and broccoli is 1.38 MH with a production of 24.18 MT globally. India occupies 0.43 MH of land with a production of 8.57 MT (Anon., 2017) [2]. In India, the major broccoli growing states are Himachal Pradesh, Jammu and Kashmir, Uttar Pradesh and Northern plains. The crop contains protein (28.2%), carbohydrate (66.4%), fat (3.7%), minerals (Ca, P and Fe) and important vitamins like A, B and C (Acharya *et al.*, 2015) [1]. The broccoli rich source of sulforaphane compound which is associated with reducing the risk of cancer. It is beneficial and more nutritious than any other vegetables of the same genus (Yoldas *et al.*, 2008) [17]. The bio-fertilizers are important beneficial microorganisms, which can mobilize the nutritionally important elements from non-unstable tostable form through biological processes and are known to increase yield in several vegetables (Kumar *et al.*, 2015) [4]. *Azotobacter* has been well recognized for vegetable crops and several reports showed the role of nitrogen fixation. They can fix 15-20 kg/ha N per year and also produce antifungal compounds to fight against many plant pathogens. bio-fertilizers increase germination of seeds and vigor in young plants leading to improved crop stands (Siddique *et al.*, 2014) [13]. Phosphate solubilizers bacteria help in the solubilization of native phosphorus from rock phosphate and other sparingly soluble forms of soil phosphorus by secreting organic acid. Also, there are problems of losses of applied fertilizers and fixation of phosphorus. Phosphate Solubilizing Bacteria (PSB) plays a significant role in solubilizing insoluble phosphate in the soil. Mulching is one of the important techniques or practices of covering the soil to make more favorable conditions for plant growth, development and efficient crop production. Different mulch (rice straw and black plastic) reduces the weed population, maintains soil temperature, increase soil moisture, reduces soil erosion and improves beneficial microorganism activity of the soil create environment around the root zone (Kumara and Dey, 2011) [5]. Hence, keeping in view the above facts in mind present investigation is framed to assess the "Effect of bio-fertilizers and mulching on yield and economics of broccoli (*Brassica oleracea* var. *Italic* Plenck) under protected condition".

Materials and Methods
The experiment was conducted at the Horticulture Instructional farm, JNKVV, College of Agriculture, Rewa (M.P.) during *Rabi*, 2018-19. The experiment consists of twelve treatment combinations with bio-fertilizers (PSB and *Azotobacter)* and mulch (Rice straw and Black

polythene sheet) in Randomized Block Design with three replications. Before sowing the seedling were treated with PSB and *Azotobacter* culture alone as well as in combination of both as per treatment plan, using standard methods. The five week old seedlings of broccoli were transplanted in the field on 15th November, 2018. The distance between row to row and plant to plant was kept 50 cm x 50 cm. The five plants were randomly selected and tagged before flowering from each line to record the data on the following attributes. The observations were taken on different yield and yield attributing characters like diameter of curd (cm),fresh plant weight (g), primary curd weight (g), secondary curd weight (g), total yield per plant (g) and yield per ha. The B: C ratio was calculated taking into considerations of the costs incurred and income generated. The statistical formula was used for compilation of data and drawing of conclusion.The treatment combinations was T_1-Control, T_2- *Azotobacter*, T_3–Phosphate Solubilizing Bacteria (PSB), T_4-*Azotobacter* + PSB, T_5-Rice straw, T_6-Rice straw + *Azotobacter*, T_7-Rice straw + PSB, T_8-Rice straw + *Azotobacter* + PSB, T_9-Black polythene, T_{10}-Black polythene + *Azotobacter*, T_{11}-Black polythene + PSB and T_{12}-Black polythene + *Azotobacter* + PSB. The recorded data were statistically analysed using analysis of variance as formulated at 5% level of significance (Panse and Sukhatme, 1985) [9].

Results and Discussion

The presented data in table 1. is concerning with the yield attributes of broccoli as affected by bio-fertilizer and mulch either alone or in combinations. The curd diameter was also influenced significantly due to applied treatments. Amongst the treatments, T_{12} recorded maximum curd diameter (16.02 cm) followed by T_8 (15.06 cm) and then T_{11} (14.03 cm). The values were non-significant to each other. The curd diameter tended to decrease significantly under the combined application bio-fertilizers and mulching that means 11.05, 12.02, 12.05, 13.01 cm from T_4, T_6, T_7 and T_{10} treatments. The curd diameter was further decreased under the separately applied bio-fertilizers and mulching i.e. 11.00, 10.04, 9.07 and 9.01 cm from T_9, T_5, T_3, and T_2 treatments. The minimum curd diameter (7.08 cm) was recorded from the control treatment. The fresh plant weight influenced significantly due to bio-fertilizers and mulching treatments. The combined application of Black polythene + *Azotobacter* + PSB (T_{12}) found maximum fresh plant weight 1247.7g followed by T8 (Rice straw + *Azotobacter* + PSB) which gave 1190.0g plant weight and T_{11}(Black polythene +PSB) also found1128.0g fresh plant weight. This parameter was continued to decrease up to significant extent in T_{10}, T_7, T_6 and T_4 treatments where bio-fertilizers and mulching were applied. Accordingly, T_{10} were recorded 1076.9g, T_7 1000.7g and T_6 996.0g and T_4 940.3g. The fresh plant weight was further decreased under the separately applied bio-fertilizers and mulching i.e. 920.8, 866.3, 806.5 and 787.5 g from T_9, T_5, T_3, and T_2 treatments. The equally lowest plant weight (697.4 g) was noted in control. The maximum primary curd weight 425.5g was recorded with T_{12} followed by T_8 (400.1g) and T_{11} (384.4g). This parameter was continued to decrease primary curd weight up to significant extent in T_{10} (380.9g), T_7 (345.0g) T_6 (299.0g) and T_4 (294.4g) where bio-fertilizers and mulching were applied. The primary curd weight was further decreased under the separately applied bio-fertilizers and mulching i.e. 248.1g (T_9), 207.5g (T_5), 206.0g (T_3) and 195.8g (T_2) and minimum (175.2g) was recorded control (T_1).Maximum secondary curd weight 284.8g was recorded with Treatment T_{12} followed by T_8 (232.4 g) and T_{11}(217.7 g). This parameter was continued to decrease up to significant extent in T_{10}, T_7, T_6 and T_4 treatments where bio-fertilizers and mulching were applied. Accordingly, T_{10} recorded 204.3g, $T_7$198.4 g, T_6 194.6g and $T_4$189.9g secondary curd weight. The secondary curd weight was further decreased under the separately applied bio-fertilizers and mulching *i.e.*183.2, 178.7, 170.6, 164.6 g from T_9, T_5, T_3, and T_2 treatments. The equally lowest secondary curd weight (150.5 g) was noted in control treatment. Maximum yield per ha 227.5 q/ha was recorded with Treatment T_{12} followed by T_8 (202.6 q/ha) and T_{11} (192.8 q/ha). This parameter was continued to decrease up to significant extent in T_{10} recorded 187.0 q/ha, T_7 (174.5 q/ha), T_6 (158.2 q/ha) and T_4 (155.2 q/ha) where bio-fertilizers and mulching were applied. The yield per ha was further decreased under the separately applied bio-fertilizers and mulching *i.e.*T_9 (138.5q/ha), T_5 (123.8q/ha), T_3 (120.8q/ha), T_2 (115.3q/ha) from and treatments. The equally lowest plant weight (104.6 q/ha) was noted in control treatment. The economics of different treatments *viz*., net return and benefit cost ratio has been worked out and presented in table 2. Maximum net return (465054 Rs/ha) and B:C ratio (4.5) were obtained in treatment twelve (T_{12}). Whereas the highest B:C ratio 5.03 was recorded in T_8 (Rice straw + PSB + *Azotobacter*) and treatments due to less treatment cost as compared to other treatment. On the other hand, the control treatment recorded the lowest net return (191504 Rs/ha).

The data (Table 1) clearly indicate the significant effect of mulching on yield and yield attributes of broccoli were found significantly superior in black polythene sheet mulch and minimum in control. The reason for this trend in the parameters related to yield attributes due to application of black polythene and mustard straw mulch might be due to the fact that use of black polythene mulch efficiently controlled weed growth by inhibiting photosynthesis conserved more soil moisture in rhizosphere created etiolated conditions in plant rhizosphere there by increased root growth and more uptake of nutrients from the soil by the plants. This situation ultimately resulted in increased yield reported by Shinde (1997) [12]. Moniruzzaman *et al.* (2007) [7] also reported increase in curd yield of cauliflower due to black polythene mulching. It is might be due to better moisture utilization during low temperature in winter season, less evaporation loss of water and lesser competition of weeds. Similar results were also reported by Parmar *et al.* (2013) [10] under polyethylene mulch (silver colour on black) produced larger fruit and have higher fruit yield per plant because of better plant growth due to favourable hydro-thermal of soil and complete weed free environment. The maximum values for all these yield attributes were found significantly superior in PSB + *Azotobacter* treatments combination followed by PSB and minimum in control. This is might be due to the fact that *Azotobacter* is known to produce antifungal, antibiotic substances that inhibit soil borne fungal pathogen reported by Mohapatra *et al.* (2013) [6]. The solubilization effect of PSB is generally due to the production of organic acids by this organism. They are also known to produce amino acids, vitamins, growth promoting substance like indole acetic acid and gibberellin acid which helps in achieving better growth of plant as well as yield and yields attributes. Biological nitrogen fixation depends appreciably on the available form of phosphorus. There for the combined inoculation with nitrogen fixer and PSB might have benefited the plant better by providing both nitrogen as well as phosphorus, than either group of organism alone. Such mutually beneficial synergistic

effect has also been reported by Verma and Yadav (2011) [16]. Shin *et al*. (1993) [11] reported that combined application of black polythene with *Azotobacter* + PSB found most efficacious in enhancing the plant height, number of leaves per plant, leaf area, day taken primary curd formation, diameter of central head (cm), chlorophyll content, weight of primary curd (g), weight of secondary curds (g), total yield (g/plant), yield (kg/plot) and yield (q/ha) of the sprouting broccoli. However, the combined application of black polythene with *Azotobacter* + PSB was found most efficacious in enhancing the net returns and rice straw and *Azotobacter* + PSB in B: C ratio. The significant increase in yield under the influence of combined application of bio-fertilizers with mulching might be due the clubbing of beneficial effect of both the components. The highest benefit cost ratio (3.9) was obtained broccoli crop with integrated use of inorganic fertilizer, bio inoculants and vermin-compost as an organic source. Whereas, the lowest benefit cost ratio of 1.07 was observed with no nutrient application for both the years reported by Srichandan *et al*. 2015 [15] and similar findings Chaudhary *et al*. (2015) [3] on cabbage, Singh and Kumar (2017) [14] on broccoli and Negi *et al*. (2017) [8] reported that maximum net returns (252982.41 Rs/ha) and higher benefit: cost ratio (1:4.10) on broccoli crops.

Table 1: Yield and yield attributes of broccoli as influenced by bio-fertilizers and mulching

Treatments	Treatments details	Curd Diameter (cm)	Fresh plant weight (g)	Primary curd weight (g)	Secondary curd weight (g)	Yield per ha (q)
T1	Control	7.8	697.4	175.2	150.5	104.6
T2	*Azotobacter*	9.1	787.5	195.8	164.6	115.3
T3	Phosphate Solubilizing Bacteria (PSB)	9.7	806.5	206.0	170.6	120.8
T4	*Azotobacter* + PSB	11.5	940.3	294.4	189.9	155.2
T5	Rice straw	10.4	866.3	207.5	178.7	123.8
T6	Rice straw + *Azotobacter*	12.1	996.0	299.0	194.6	158.2
T7	Rice straw +PSB	12.5	1000.7	345.0	198.4	174.5
T8	Rice straw + *Azotobacter* + PSB	15.6	1190.0	400.1	232.4	202.6
T9	Black polythene	11.0	920.8	248.1	183.2	138.5
T10	Black polythene + *Azotobacter*	13.1	1076.9	380.9	204.3	187.0
T11	Black polythene + PSB	14.3	1128.8	384.4	217.7	192.8
T12	Black polythene + *Azotobacter* + PSB	16.2	1247.7	425.5	284.8	227.5
	S.Em+	0.78	34.79	24.44	16.91	3.00
	C.D. (P =0.05)	2.26	99.20	70.19	48.55	8.63

Table 2: Economics of broccoli as influenced by bio-fertilizers and mulching

Treatments	Treatments details	Net return (Rs/ha)	B:C ratio
T1	Control	191504	2.7
T2	*Azotobacter*	218954	3.1
T3	Phosphate Solubilizing Bacteria (PSB)	230704	3.3
T4	*Azotobacter* + PSB	318504	4.3
T5	Rice straw	230604	2.9
T6	Rice straw + *Azotobacter*	315804	3.9
T7	Rice straw +PSB	356554	4.4
T8	Rice straw + *Azotobacter* + PSB	426604	5.3
T9	Black polythene	243354	2.3
T10	Black polythene + *Azotobacter*	365804	3.5
T11	Black polythene + PSB	378304	3.6
T12	Black polythene + *Azotobacter* + PSB	465054	4.5
	S.Em+	-	0.07
	C.D. (P =0.05)	-	0.22

Conclusion

On the basis of present investigation, it is concluded that the broccoli cv. Green Magic responded well in terms of growth, yield and net return to treatment T_{12} having black polythene with *Azotobacter* + PSB. This treatment resulted in maximum curd diameter 16.02 cm, fresh plant weight 1247.7 g, Primary curd weight 425.5 g, Secondary curd weight 284.8 g, Yield per ha 227.5 q and finally net return up to (465054 Rs/ha) with B:C ratio (4.5) .Whereas the highest B: C ratio 5.30 with 426604Rs/ha net return was recorded in T_8 (rice straw + *Azotobacter* + PSB) treatments due to less treatment cost as compared to other treatment. It can be recommended for commercial production of broccoli under Vindhyachal region conditions of Madhya Pradesh.

References

1. Acharya U, Thapa S, Sharma N. Study on the growth, yield and soil nutrient status of broccoli under organic nutrient management. International Journal of Current Research 2015;7(2):13029-13032.
2. Anonymous. Horticultural Statistics at a Glance. Ministry of Agriculture & Farmers Welfare GoI, New Delhi, 2017.
3. Chaudhary MM, Bhanvadia AS, Parmar PN. Effect of Integrated Nutrient Management on Growth, Yield Attributes and Yield of Cabbage (*Brassica oleracea var. capitata* L.) under middle Gujarat conditions. Trends in Biosciences 2015;8(8):2164-2168.
4. Kumar J, Phookan DB, Lal N, Kumar H, Sinha K, Hazarika M. Effect of organic manures and bio-fertilizers on nutritional quality of cabbage (*Brassica oleracea* var.

capitata). Journal of Eco- friendly Agriculture 2015;10(2):114.
5. Kumara S, Dey P. Effect of different mulches and irrigation methods on root growth, nutrient uptake, water-use efficiency and yield of strawberry. Scientia Horticulture 2011;127:318-324.
6. Mohapatra SK, Munsi PS, Mohapatra PN. Effect of Integrated Nutrient Management on growth, yield and economics of broccoli (*Brassica oleracea* var. *Italic* Plenck). Vegetable Science. 2013;40(1):69-72.
7. Moniruzzaman MS, Faisal SM, Sarkar MAR, Hossain M, Ismail Ali M, Afsar Talukder MAH. Effect of Irrigation and different mulches on yield and profitability of cauliflower. Asian Journal of Plant Sciences 2007;6(2):338-343.
8. Negi E, Punetha S, Pant SC, Kumar S, Bahuguna P, Mekap B et al. Effect of Organic Manures and Bio-fertilizers on Growth, Yield, Quality and Economics of Broccoli (*Brassica Oleracea* L.*var. italica* Plenck) cv. Green Head Under High-Hill Conditions of Uttarakhand. International Journal of Advanced Biological Research 2017;7(1):96-100.
9. Panse VG, Sukhatme PV. Statistical Methods for Agriculture Workers. II ed. ICAR New Delhi, 1985.
10. Parmar HN, Polara ND, Viradiya RR. Effect of Mulching Material on Growth Yield and Quality of Watermelon (*Citrullus lanatus* Thunb.) cv. Kiran. Universal Journal of Agricultural Research 2013;1(2):30-37.
11. Shin DY, Lee YM, Kin HJ. Effect of P.E. film mulching and planting density on growth and tuber yield in Yacon (*Polymnia souchifolia* Poepp). Korean Journal of crop Sciences 1993;38(30):240- 244.
12. Shinde D. Modeling Coupled Water-Heat Flow and Impacts upon chemical transport in Mulched Soil Beds. 1997;5(2):543-549.
13. Siddique AK, Shivle R, Mangodia N. Possible role of bio-fertilizer in organic agriculture. International Journal of Innovative Research and Studies.2014; 3(9):719-725.
14. Singh R, Kumar J. Impact of Different Shades of Plastic Mulch and Plant Geometry on Yield and Economics on Tender Stem Broccoli in Punjab, India. International Journal of Current Microbiology and Applied Sciences 2017;6(11):4228-4234.
15. Srichandan S, Mangaraj AK, Behera KK, Panda D, Das AK, Rout M. Growth, Yield and Economics of Broccoli (*Brassica oleracea var. Italica*) as Influenced by Organic and Inorganic Nutrients. International Journal of Agriculture, Environment and Biotechnology 2015;8(4):965-970.
16. Verma MK, Yadav YC. Studies on effect of bio-fertilizers with chemical fertilizers on growth and yield of cauliflower (*Brassica oleracea var. botrytis*) cv. Pusa Snowball K-1. Annals of Horticulture. 2011;4(2):202-205.
17. Yoldas F, Ceylan S, Yagmur B, Mordogan N. Effects of nitrogen fertilizer on yield, quality and nutrient content in broccoli. Journal of Plant Nutrition. 2008;31:1333-1343.