Research Article

Effect of Organic Manures and Bio-Fertilizers on Growth, Yield and Quality of Broccoli (*Brassica oleracea* var. italica Plenck.) cv. KTS-1

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Abstract

The present research work on evaluation Effect of organic manures and biofertilizers on growth, yield and quality of broccoli (*Brassica oleracea* var. *italica* Plenck.) cv. KTS-1 was carried out at the Horticulture Research Farm of Department of Applied Plant Science, Babasaheb Bhimrao Ambedkar University, Vidya Vihar, Rae Bareli Road, Lucknow (U.P.), India, during Rabi season of 2015-16. The research material comprised of eleven treatments along with three replications in Randomized Block Design. The highest plant height (52.67cm), number of leaves per plant (22.13), leaf length (43.07cm), leaf width (35.20cm), stem diameter (5.00), days to curd (65.13), Days to 50% curd initiation (75.23), days taken to 50% curd maturity (96.13), curd diameter (10.52), curd weight (305.33), yield (125.20 q/ha) and as well as quality parameters Maximum vitamin C contain (90.50mg/100), T.S.S contain (8.80 ^{0}Brix) and reducing sugar (3.25%), non reducing sugar (0.79%), Total sugars (3.97%) was recorded in T_8 (RDF 25% + Vermicompost 50% + *Azotobacter* 50% + *Azotobacter* 25% except acidity.

Keywords: Tomato, PSB, RDF, Vermicompost Azotobactor, growth, yield and quality.

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Introduction

Broccoli (*Brassica oleracea*.var *italica plenck;* 2n=x=18), which is originated from the Mediterranean region commonly known as Hari ghobi in hindi and a member of Cole group, belongs to the family *Brassicaceae* or *crucifereae*.The term Cole has originated from the word "*Colewart''* meaning wild cabbage while the broccoli derived its name from the Latin word Brachium meaning an arm or branch. Sprouting broccoli with a kind of terminal head consisting of green buds and thick fleshy flower Stalks morphologically resembles the cauliflower except secondary heads, which develop in the axil of leaves and may contribute up to 50 percent of the total yield. *Brassica* vegetables possess both antioxidant and anti carcinogenic properties [1]. Broccoli is known as the ''Crown of jewel nutrition'' because it is rich in vitamins and minerals. Eating large portion may also have additional benefits, since broccoli is also a rich source of many vitamins and minerals such as vitamin A and C, carotenoids, fiber, calcium and folic**.** It has about 130 times more vitamin A contents than cabbage. It contains a few important phyto-chemicals, beta-carotene, indole-3-carbinol which help to fight breast and lung cancer [2]. Phyto-chemicals prevent carcinogens (cancer causing substances) from forming. It also contains in sulfoslfuron, which block growth of tumors and reduce the risk of cancer. Broccoli sprouts are a rich source of glucosinolates, the precursor of chemo protective isothiocyanate, compound associated with reducing risk of cancer [3]. The nutritive value of sprouting broccoli per 100g of edible portion is given below: **w**ater (89.3%), protein (3.6%), fat (0.2%), carbohydrates (5.5%), fiber (1.2%), vitamin A (900 I.U.), vitamin B (33 I.U.), vitamin C(137 I.U.), vitamin E (2.3 I.U.), vitamin K (3.5 I.U.), calcium (1.29 mg), manganese (20 mg), Iron (1.3 mg), phosphorus (0.79 mg),and shlphur (1.26 mg). [4] The area of vegetable crop in India is 9396 thousand hectares with production of 162897 thousand million tons.

Biofertilizers have a great potential to bridge the gap between demand and supply of nutrient. Bio-fertilizers contain micro organism which are capable of mobilizing nutritive elements from non usable form to usable from through biological processes. In addition, there are other bio-fertilizer, phosphate solubilizing bacteria (PSB), Phosphate-solubilizing fungi and vesicular *arbusculer mycorrhizae* (VAM). Besides increasing phosphate levels, VAM is also known to increase the levels of important micronutrients like copper and zinc in the plant parts vegetables. These biofertilizers are organic in origin and thus are absolutely safe, organic manures and biofertilizers so as to minimize the cost of production and to maintain biological productivity of soil Choudhary *et al.*, 2012 [5]. Organic matter plays an important role in the chemicals behavior of several metals in soil throughout its active groups

(Flavonic and humic acids) which have the ability to retain the metals in complex and chelate forms. Vermicompost provides vital macronutrients and micronutrients. Organic manure not only balance the nutrients supply but also improve the physical and chemical properties of soil Nair and Peter, 1990 [6]. Authentic information on organic cultivation aspects of sprouting broccoli is not available as it is a minor crop. Expecting a good demand for organic vegetable, crop specific organic production technology is to be developed. Keeping in view the above facts in mind, an experiment entitled effect of organic manures and biofertilizers on growth, yield and quality of broccoli (*Brassica oleracea* var. *italica* Plenck.) cv. KTS-1

Materials and Methods

The present investigation entitled **"**Effect of organic manures and biofertilizers on growth, yield and quality of broccoli (*Brassicsa oleracea* L. var. *italica* Plenck) cv. KTS-1 was carried out at the Horticulture Research Farm- I of the Department of Applied Plant Sciences (Horticulture), Babasaheb Bhimrao Ambedkar University, (A central university), Vidya-Vihar Rae Bareli Road, Lucknow- 226 025 (U.P.) India. The field experiment was conducted at Horticulture Research Farm-I of the Babasaheb Bhimrao Ambedkar University during Rabi season of 2015-16. Geographically, Lucknow is situated at $26^0$50′ N latitude, $80^0$52′ E longitude and altitude of 111 meter above mean sea level (MSL). Lucknow has humid subtropical climate with an average annual rainfall of about 750 cm. The winter is severe and summer is dry and hot. The maximum temperature generally goes up to (43^0c) in summer and average minimum up to 2^0C in winter. Monsoon generally sets in during the third week of June and recedes by the end of September with heavy rainfall during monsoon season. The seed of broccoli collected from IARI, Regional Research Station Katrain Kullu valley (H.P). Broccoli seeds KTS-1 were sown in the nursery beds of Horticulture Research Farm-I, Babasaheb Bhimrao Ambedkar University, Lucknow, by sowing in row method on 17 October 2015. Raised bed about 5-6 meter long, one meter width and 15 cm above ground level, was prepared. The seed beds were covered with compost, mulching, and thatches with polythene paper over the bed to protect the young seedlings from adverse climatic condition, 30 days after sowing, seedlings were ready for transplanting. These healthy seedling uniform shape and size were selected and transplanting in well prepared field. Five plants were randomly selected and tagged before flowering from each line to record the data on the following attributes. The observations were recorded on plant height, number of leaves per plant, leaf length (cm), leaf width (cm), Days to curd, Days to 50% curd initiation, Days taken to 50% curd maturity, Curd diameter (cm), Curd weight (g), yield (q/ha), T.S.S acidity (%), ascorbic acid and Sugar contain **Figures 1** and **2**. Least significant difference at 5% level was used for finding the significant differences among the treatment means. s. Data on growth and yield components were collected using standard procedures and were analyzed statistically as per the procedure given by Panse and Sukhatme, 1967 [7].

Figure 1 A general view of experimental field of broccoli at vegetative growth

Result and discussion

Growth parameters

Regarding the growth parameters viz. plant height, number of leaves per plant, leaf length (cm), leaf width (cm), Days to curd, Days to 50% curd initiation, Days taken to 50% curd maturity. In the present study, plant height was significantly influenced the growth over control by organic and bio-fertilizers treatment. Data recorded in respect of

height of plant show that the effect of organic and bio-fertilizers *i.e.* reduced doses of fertilizers with bio-fertilizers and fertilizer on plant height was significantly at all stages of plant growth. **Table 1** indicated that the maximum plant 52.675 cm was observed in the treatment T_8 (RDF 25%+ VC 50%+ *Azotobacter* 25%), whereas, the least mean plant height values noted (40.07cm) in the T_0 (control). Similar results due to effect of organic and bio-fertilizer were recorded by Maurya *et al*. 2008 [8], Dalal *et al.* 2010 [9], choudary *et al*. 2004 [10], Bahaduria *et al*. 2005 [11], Ghulam *et al*. 2012 [12] and Shree *et al*. 2014 [13].

Figure 2 A general view of experiment at harvesting of curd of broccoli

Number of leaves per plant

Regarding the number of leaves, it was observed that the effect of different treatment of organic manure and bio-fertilizer. Table 1 indicated that the maximum numbers of leaves 22.13 were observed in the treatment T_8 (RDF 25%+ VC 50%+ *Azotobacter* 25%. Increase in number of leaves might be due to the application of organic fertilizer along with vermicompost and *Azotobacter*. This ultimately helped in increasing the uptake of nitrogen and other nutrients and produced more number of leaves. Similar finding due to organic and bio-fertilizer were reported by Velmurugan *et al.* 2008 [14], Sharma 2002 [15] and Bahaduria *et al*. 2005 [11].

Leaf length (cm)

Regarding the leaf length (cm), It was observed that the effect of different treatment of organic manure and bio-fertilizer. Table 1 indicated that the maximum leaf length 43.07cm was observed in the treatment T_8 (RDF 25%+ VC 50%+ *Azotabacter* 25%).Increase in length of leaves might be due to the application of organic manure and bio-fertilizers along with vermicompost and *Azotobacter*. These results are in agreement with the findings of Maurya *et al.* 2008 [8], Velmurugan *et al*. 2008 [14], Bahaduria *et al*. 2005 [11].

Leaf width (cm)

Leaf width was influenced by the application of organic manure and biofertilizer under different treatments, Table 1 indicates that the pattern of increasing leaf width 35.20 cm observed in the treatment T_8 (RDF 25%+ VC 50%+ *Azotobacter* 25%) under the treatment receiving nitrogen through organic manure couple with nitrogen fixation through Azotobacter supported by additional use of vermicompost leads to more leaf width. Similar results due to effect of organic and bio-fertilizer were recorded by Maurya *et al*. 2008 [8], Dalal *et al*. 2010 [9], choudary et al. 2004 [10] and Bahaduria *et al*. 2005 [11].

Table 1 Impact of bio-fertilizers on vegetative growth parameters

Symbols	Treatments	Plant height (cm)	Number of leaves	Leaf length (cm)	Leaf width (cm)	Stem diameter (cm)	Days to curd initiation	Days to 50 % curd initiation	Days taken to 50 % curd maturity	Curd diameter (cm)	Curd weight (g)	Yield (q/ha)
T_0	Control	40.07	18.17	32.15	29.63	3.09	65.13	75.23	96.13	7.30	160.00	69.20
T_1	Press mud (100%)	42.67	19.46	32.99	29.70	3.31	62.93	71.77	91.97	8.91	214.00	70.97
T_2	Vermi compost (100%)	43.37	18.97	38.63	30.53	3.37	64.00	72.50	92.72	9.11	255.33	81.89
T_3	*Azotobacter* (100%)	43.40	19.73	40.93	31.23	3.28	61.93	75.10	91.83	8.71	184.67	87.58
T_4	PSB (100%)	46.00	18.20	39.94	30.13	4.02	62.51	74.70	94.37	8.52	194.33	89.57
T_5	RDF (25%) + PM (25%)	41.67	20.67	41.82	30.50	4.16	62.37	71.90	92.47	8.82	183.67	94.02
T_6	RDF (50%) + VC (50%)	46.33	18.93	39.61	32.13	3.40	62.45	74.57	92.90	9.26	252.00	93.10
T_7	RDF (25%) + PM (50%) + *Azotobacter (25%)*	46.67	19.73	39.79	32.23	3.22	60.67	74.36	93.73	9.43	239.00	97.71
T_8	RDF (25%) + VC (50%) + *Azotobacter* (25%)	52.67	22.13	43.07	35.20	5.00	58.98	70.13	89.83	10.52	305.33	125.20
T_9	RDF (25%) + VC (50%) + PSB (25%)	50.73	21.03	40.21	33.33	3.88	60.56	72.00	92.70	10.05	200.67	114.98
T_{10}	RDF (25%) + PM (50%) + PSB (25%)	49.73	20.33	41.16	33.10	3.59	61.93	72.93	93.30	9.88	194.33	107.28
T_{11}	RDF (25%) + VC (25%) + *Azotobacter* (25%) + PSB (25%)	51.73	21.37	42.12	34.23	4.81	60.27	71.27	91.69	10.14	293.00	117.34
	SE (m) ±	1.603	1.501	1.588	0.393	0.346	2.149	2.994	1.369	90.683	32.305	1.447
	CD at 5 %	4.733	N/S	4.688	1.160	1.023	N/S	N/S	N/S	N/S	0.794	4.271

Stem diameter (cm)

Regarding the stem diameter was also recorded under different treatment, Table 1 indicates that the increasing stem diameter maximum 5.00 cm observed in the treatment T_8 (RDF 25% + VC 50% +*Azotobacter*). Similar results due to effect of organic manure and bio-fertilizer were recorded by Maurya *et al*. 2008 [8], Dalal *et al.* 2010 [9], choudary *et al*. 2004 [10], Bahaduria *et al*. 2005 [11] and Ghulam *et al.*, 2012 [12].

Curd initiation and maturity

Regarding the curd initiation days, it was observed that the effect of different treatments of organic and bio-fertilizers. Table 1 indicated that the maximum days to curd initiation (65.13days), 50% days to curd initiation (75.23) and days to 50% curd maturity (96.13) observed in the treatment T_0 (control) and minimum 58.98, 70.13 and 89.83 days was recorded in T_8 (RDF25% + VC 50% + *Azotobacter* 25%). Similar results were also recorded by Maurya *et al*. 2008 [8], Dalal *et al.* 2010 [9], choudary *et al*. 2004 [10], Bahaduria *et al*. 2005 [11], Ghulam *et al.*, 2012 [12] and Shree *et al*. 2014 [13].

Yield and yield attributing traits

Curd diameter (cm)

Regarding the curd diameter (cm), it was been observed that the effect of different treatment organic manure and bio-

fertilizer was found to influence significantly. The data are presented in Table 1 the curd diameter was recorded maximum (10.52cm) RDF + Vermicompost + *Azotobacter* under treatment T_8 followed by T_{11}(10.14cm) RDF + Vermicompost + *Azotobacter*. Minimum observation (7.30cm) *control* was recorded in the treatment T_0. It was observed that an increasing application nitrogen through organic manure, bio-fertilizer increased the curd diameter. This might have been due to increased organic manure *Azotobacter* and vermicompost which received reduced doses of RDF in treatment. Similar result were also obtained by Manivannan *et al.* 2004 [19], Singh and panday 2010 [17] Bahaduria *et al*. 2005 [11].

Curd weight (g)

The data shows that, curd weight of sprouting broccoli was influenced significantly through the growth period of plant. In respective of curd weight per plot among the various bio-fertilizer treatments were found to be significant. The data are depicted in Table 1 the data are presented in the table 4.8 to curd weight with leaf was recorded maximum (428.3g) under treatment T_8 followed by T_{11} (419.6g) the curd weight without leaf was recorded maximum (305.3 g) under treatment T_8 followed by T_{11} (293.0g). The minimum observation (160.0 g) was recorded under treatment T_0. Treatments T_8 observed the maximum curd weight (4.62 kg) and was significantly superior over all treatments and as well as in the control, minimum weight of the curd (1.97 kg) was observed under the control treatment T_0. Treatment T_8 observed the maximum curd yield (125.2 q/ha) and was significantly superior over all treatment and as well as on the control, minimum net weight of the curd (69.20 q/ha) was observed under the control treatment T_O. The influenced of organic manure and bio-fertilizer on curd weight of sprouting broccoli sought to be increased in the treatment receiving Nitrogen S fixation through *Azotobacter* supported by additional use of vermicompost leads to increase the curd weight of sprouting broccoli Per plot or per treatment hectare yield was differed significantly due to different Organic manures and bio-fertilizer the highest yield (125.20 q./ ha) was obtained from T_8 (RDF + Vermicompost 5t/ha+ *Azotobacter* 2 kg/). Followed by T_{11} (117.34q/ha) RDF 25% +VC 5t/ha + *Azotobacter* 2kg + PSB 2kg/ha. The lowest yield (69.20s q. / ha) was obtained in T_0 (control). These results conformity with finding of Sharma et al. 2012 [16], Dalal *et al.* 2010 [9], Singh and panday 2010 [17], Bahaduria *et al*. 2005 [11], Ghulam *et al.,* 2012 [12], Shree *et al*. 2014 [13], Sharma 2002 [15] and Sharma et al. 2008 [18].

Table 2 Impact of bio-fertilizers on qualitative parameters

Symbols	Treatments	TSS (0Brix)	Vitamin C (mg/100g)	Acidity (%)	Total sugars	Reducing sugar	Non Reducing sugar
T_0	Control	6.19	80.60	0.53	1.95	1.17	0.35
T_1	Press mud (100%)	8.40	85.90	0.38	3.00	2.28	0.43
T_2	*Vermi compost* (100%)	8.51	80.66	0.37	2.70	2.27	0.42
T_3	*Azotobacter* (100%)	8.57	84.34	0.40	3.07	2.37	0.70
T_4	PSB (100%)	8.22	85.57	0.37	3.27	2.67	0.60
T_5	RDF (25%) + PM (25%)	8.00	85.97	0.38	3.30	2.74	0.56
T_6	RDF (50%) + VC (50%)	8.45	82.74	0.37	2.42	2.01	0.42
T_7	RDF (25%) + PM (50%) + *Azotobacter* (25%)	8.28	84.98	0.37	3.47	3.05	0.41
T_8	RDF (25%) + VC (50%) + *Azotobacter* (25%)	8.80	90.50	0.35	3.97	3.25	0.79
T_9	RDF (25%) + VC (50%) + PSB (25%)	8.77	85.79	0.40	3.55	3.20	0.72
T_{10}	RDF (25%) + PM (50%) + PSB (25%)	8.48	88.71	0.39	2.99	2.60	0.40
T_{11}	RDF (25%) + VC (25%) + *Azotobacter* (25%) + PSB (25%)	8.78	88.84	0.36	3.68	3.18	0.77
	SE (m) ±	0.264	4.102	0.048	0.476	0.285	0.285
	CD at 5 %	0.780	N/S	N/S	N/S	0.843	0.843

Quality traits

The results obtained during the investigation in respect to biochemical parameters viz., T.S.S acidity (%), ascorbic acid and Sugar contain. present in **Table 2**. Significant variation was observed the effect of different treatment organic manure and bio-fertilizer was found to influence significantly. The maximum T.S.S. (8.80^0B) is found in treatment T_8 and which is followed by treatments T_{11} (8.79^0B). The vitamin-C content in curd significantly influenced

by different treatment. The maximum vitamin-C content (90.50 mg/100g) was recorded under T_8 treatment followed by T_{11} (88.84s mg/100g). The maximum acidity (0.36%) Content was recorded under T_0 treatment followed by T_{11} (0.53 %). However minimum acidity % (0.35%) was recorded under the treatment T_8. The maximum total sugars Content (3.97 g) was recorded under T_8 treatment followed by T_{11} (3.68 g). The maximum reducing sugar content (3.25g) was recorded under T_8 followed by T_{11} (3.18g) and the maximum non- reducing sugar (0.79g) content was recorded under T_8 treatment followed by T_{11} (0.77 g). However minimum non-reducing sugar (0.35g) recorded maximum under T_8 90.50 RDF +Vermicompost 5 t/ha + *Azotobacte*r 2 kg/ha).The results are in conformity with the findingss of Upadhyay *et al.* 2012 [21], Raghav and kamal 2007 [20].

Conclusion

The overall results obtained from the present investigation clearly revealed that among various combinations of organic manures and bio-fertilizers, the treatments combination T_8 (RDF 25% + Vermicompost 50% + *Azotobacter* 25%) responded well as substitute to sole fertilizer for vegetative growth of plant except acidity i.e. highest of plant, number of leaves per plant, stem diameter, leaf length, leaf width, curd diameter maximum with the application of RDF + Vermicompost + *Azotobacter*. Production as well as nutrient to human health from broccoli under organic condition can be studied. Complete organic production technology for broccoli is may be developed for better production and human health.

References

[1] Cartea, M. E., Pablo Velasco, S.O. and Guillermo Padilla, A. H. Photochemistry, 2008, 69: 403-410.
[2] Anonymous, Cabbage, kale, broccoli, and sprouts in: you want to live forever. Times of India. New Delhi. December 2006, 3:9.
[3] Aires, A., Rose, E. and Carvalho, R. J. Sci. Food Agric, 2006, 86: 1512-16.
[4] Browen, H.D. and Hutchison, C.S. J.B. Lippinot Co., New York. 1949, Pp 21-30.
[5] Choudary, S., Choudhary, A. K. and Jat, N. K. Indian J. Hort. 2012, 69(4), 550-554.
[6] Nair, M. and Peter, K.V. Veg. Sci.1990, 17: 7-10
[7] Panse V.G. and Sukhatme P.V. (1967) Statistical methods for agricultural workers. Indian Council of Agricultural Research, New Delhi, 1967, 381.
[8] Maurya, A. K., Singh, M. P., Srivastava, B.K., Singh. Singh S. and Singh P.K. Indian Journal of Horticulture, 2008, 65:1, 116-118.6.
[9] Dalal, V. V., Bharaduya, P.S., Aghav, V.D. Asian Journal of Horticulture, 2010, 5:2, 291-293.
[10] Choudary, M. R., Saikia, A., Talukdar, N. C. (2004). Bioved, 15: ½, 83-87.8.
[11] Bhadauria, S. K. S., Dwivedi Y.C. and Kushwah, S.S. Vegetable Science. 2005, 32(1): 94-95.
[12] Ghulam, S., Khan, M.J., Usman, K and Shakeebullah (2012). Sarhad J. Agric. 2012, 28 (2): 249-252.
[13] Shree, S., Singh, K.V. and Kumar, R. The Bioscan. 2014, 9 (3):1053-1058.
[14] Velmurugan M., Balakrishnamoorthy, Rajamani, K., Shanmugasunderam, P. and Gnanam, R. Crop Research. 2008, 35: ½, 42- 45.
[15] Sharma, S. K. Indian Journal of Agricultural Sciences 2002, 72(1):5
[16] Sharma, J. P.; Rattan, P. and Kumar, S. Sabb Journal of Food and Agriculture Science. Vol. 2012, 2(1). 15-19.
[17] Singh, P. K. and Pandey, M. Indian Journal of Hill Farming. 2010, 23(2):39-41.
[18] Sharma, A.; Parmar, D. K.; Kumar, P.; Singh, Y. and Sharma R. P. International Journal of Vegetable Science. 2008, 14(3): 273-285.
[19] Manivannan, M. I., Singh, J.P. Indian Journal of Horticulture, 2004, 66:4, 496-501.13.
[20] Raghav, M., and Shashi Kamal. Environment and Ecology, 2007, 25: 4, 919-921/.6.
[21] Upadhyay, A.K., Bahadur, A. and Singh. J. Indian Journal of Agriculture Science. 2012, 82 (1): 31-34.

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