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## Growth and yield potential of broccoli in response to organic manures and biofertilizers

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### Abstract

A field experiment was carried out at main experimental farm Department of Vegetable Science, Chandra Shekhar Azad University of Agriculture & Technology, Kalyanpur, Kanpur U.P (208002), India during Rabi season in consecutive years of 2019-2020 and 2020-2021. It comprised twelve treatment levels of treatments in a randomized block-design with three replications. The growth parameters of the broccoli crop were significantly affected by the different treatments. Maximum plant height viz. (26.12 cm), (50.35 cm), (53.60 cm), number of leaves per plant (10.40), (17.95), (19.45), leaf length (13.25 cm), (50.55 cm), (52.17 cm), leaf width (5.60 cm), (19.30 cm), (21.80 cm) and maximum plant spread (34.05 cm), (57.60 cm), (70.85 cm) respectively at 30, 60 days after transplanting and at harvesting stage were observed in treatment T<sub>2</sub> (Vermicompost 100% @ 8 t/ha) and minimum value were recorded under control (T<sub>0</sub>). Yield and yield contributing characters like days taken to first head initiation (52.97days), days taken to head maturity (76.25 days), in T<sub>2</sub> (Vermicompost 100% @ 8 t/ha) whereas maximum days to first head initiation viz. (58.00), maximum days to head maturity for harvesting viz. (80.00), was observed at harvesting stage in T<sub>0</sub> (control) respectively and Stalk length (19.60 cm), Stalk diameter (3.83 cm), head length (8.10 cm), head width (12.75 cm), head diameter (13.85 cm), yield kg/plant (0.500 kg), yield kg/plot (10.00 kg), yield q/ha (185.18q) at harvesting was observed with treatment T<sub>2</sub> (Vermicompost 100% @ 8 t/ha). Observing the results it can be stated that the using of Vermicompost plants gave better growth and yield contributing characters of broccoli in contemporary with other treatments.

**Keywords:** Broccoli, organic manure, bio-fertilizers, growth and yield

### Introduction

Broccoli (*Brassica oleracea*. var. *italica* Plenck; 2n=x=18), which is originated from the Mediterranean region commonly known as Hari gobhi in Hindi and a member of Cole group, belongs to the family Brassicaceae or cruciferae. Brassica vegetables possess both antioxidant and anti-carcinogenic properties. Broccoli is known as the Crown of jewel nutrition because it is rich in vitamins and minerals specially vitamin A, vitamin C, carotenoids, fiber, calcium and folic acid. It has about 130 times more vitamin A contents than cabbage. The nutritive value of sprouting broccoli per 100 g of edible portion is given below: water (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 sulphur (1.26 mg). (Thamburaj and Singh, 2014) [11].

Organic matter plays an important role in the chemical behaviour 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. Vermi-compost provides vital macronutrients and micronutrients. Organic manure not only balance the nutrients supply but also improve the physical and chemical properties of soil. The incorporation of organic nutrients in the form of vermi-compost and farmyard manure is known to influence favourably the physico-chemical and biological properties of the soil resulting in enhanced uptake of nutrients from soil (Lal and Kanaujia, 2013) [5]. Bio-fertilizers offer an economically attractive and ecologically sound means of reducing external inputs and improving growth and yield of vegetable produce. They contain microorganisms which are capable of mobilizing nutrient elements from unavailable form to available form through different biological processes. The aim of the investigation was to evaluate the growth and yield performance of broccoli influenced by organic manures and Bio-fertilizers. Considering the above circumstances, this work was undertaken to find out the suitable combination of organic manure and Bio-fertilizers on growth and yield of broccoli.

## Materials and Methods

A field experiment was carried out at main experimental farm department of vegetable science, Chandra Shekhar Azad University of Agriculture & Technology, Kalyanpur, Kanpur U.P, India (208002) during Rabi season in consecutive years of 2019-2020 and 2020-2021 both the years at same time to determine the growth and yield potential of broccoli in response to organic manures and bio-fertilizers. The seeds of the F<sub>1</sub> hybrid Green Magic were procured from the Sakata Seed Company, (U.P.) India. The field experiment consisted of twelve treatment combination FYM 100% @ 25 t/ha (T<sub>1</sub>), Vermicompost 100% @ 8 t/ha (T<sub>2</sub>), *Azotobacter* 100% @ 5 kg/ha (T<sub>3</sub>), PSB 100% @ 5 kg/ha (T<sub>4</sub>), 50% FYM + 50% Vermicompost (T<sub>5</sub>), 50% FYM + 50% *Azotobacter* (T<sub>6</sub>), 50% FYM + 50% PSB (T<sub>7</sub>), 50% Vermicompost + 50% *Azotobacter* (T<sub>8</sub>), 50% Vermicompost + 50% PSB (T<sub>9</sub>), 50% FYM + 50% Vermicompost + 50% PSB (T<sub>10</sub>), 50% FYM + 50% Vermicompost + 50% *Azotobacter* + 50% PSB (T<sub>11</sub>), Control (T<sub>0</sub>) for broccoli production. The experiment was conducted in Randomized Block Design with three replications and 60 cm × 45 cm spacing. The seed of hybrid broccoli cv. Green Magic was sown for raising seedlings. 15 cm raised bed of 3.0×1.0 m size was prepared for the sowing of seeds. The seeds were sown on 20<sup>th</sup> October 2019-2020 and 2020-2021 in the two consecutive years of experimentation. After sowing, seeds were covered with a thin film of soil mixed with farm yard manure. The sown seedbed was finally covered with dry paddy straw to act as mulch. The seedbed was uncovered immediately after the sprouting of seeds to ensure proper germination and growth of sprouts. To ensure healthy growth, seedlings were provided with proper plant protection measures. Weeds were removed as and when necessary. The seedlings were provided with light irrigation as and when required. In the present study, The status of soil organic matter (0.78%, 0.82%), available nitrogen (210.60 kg/ha, 205.35 kg/ha), available phosphorus (45.60 kg/ha, 41.71 kg/ha), available potash (193.45 kg/ha, 186.66 kg/ha), pH range (7.66, 7.60) and E.C. (0.28 m mhos, 0.26 m mhos) determined by different methods in the two-year data 2019-2020 and 2020- 2021, respectively. Rating of the N, P, and K status was done based on the soil manual of the Department of Soil Science & Agri. Chemistry, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur.

## Result and Discussion

### Growth parameters of broccoli

Data represented in table-1, the effect of organic manure *viz.* FYM, Vermicompost and biofertilizers *viz.* *Azotobacter*, PSB on growth parameters of broccoli showed the significant variation among the treatments which were recorded at 30, 60 DAT and at harvesting stage during both the years of study. The growth parameters like- plant height (cm), number of leaves/plants, leaf length (cm), leaf width (cm) and plant spread (cm) have been showing significant variations with the application of different treatments. According to pooled data the maximum plant height (26.12 cm), (50.35 cm), (53.60 cm), number of leaves/plant (10.40), (17.95), (19.45), leaf length (13.25 cm), (50.55 cm), (52.17 cm), leaf width (5.60 cm), (19.30 cm), (21.80 cm) and plant spread (34.05 cm), (57.60 cm), (70.85 cm) at 30, 60 DAT and at harvesting stage was observed with treatment T<sub>2</sub> (Vermicompost 100% @ 8 t/ha) which were statistically at par with T<sub>11</sub> (50% FYM +

50% Vermicompost + 50% *Azotobacter* + 50% PSB), T<sub>10</sub> (50% FYM + 50% Vermicompost + 50% PSB), T<sub>8</sub> (50% Vermicompost + 50% *Azotobacter*) and T<sub>9</sub> (50% Vermicompost + 50% PSB) respectively. The minimum plant height *viz.* (17.40 cm), (18.20 cm), (17.80 cm), number of leaves/plants *viz.* (6.25), (12.20), (13.40), leaf length *viz.* (6.45 cm), (35.55 cm), (37.60 cm), leaf width *viz.* (3.10 cm), (13.35 cm), (14.55 cm) and plant spread *viz.* (21.30 cm), (45.00 cm), (50.55 cm) was observed at 30, 60 DAT and at harvesting stage in T<sub>0</sub> (control), respectively. It is also noted that the pool data of growth parameters *viz.*; plant height (46.74%), (34.62%), (29%) number of leaves/plants (66.40%), (47.13%), (45.14%), leaf length (cm) (105.42%), (42.19%), (38.75%), leaf width (cm) (80.64%), (44.56%), (49.82%), and plant spread (59.85%), (28%), (40.15%) was increased at 30, 60 DAT and at harvesting stage respectively. The results of the present investigation in terms of plant height are in concordance with the findings reported earlier by Atal, *et al.* (2019) [1] and Mal *et al.* (2015) [7] in broccoli.

### Yield and yield parameters of broccoli

Data represented in table-2, the effect of organic manure *viz.* FYM, Vermicompost and biofertilizers *viz.* *Azotobacter*, PSB on yield parameters of broccoli observed significant variation among the treatments. The treatments which was recorded at harvesting stage during both the year. According to couple of years study revealed that minimum days to first head initiation (52.97), minimum days to head maturity for harvesting (76.25) at harvesting was observed with treatment T<sub>2</sub> (Vermicompost 100% @ 8 t/ha) which were statistically at par with treatment T<sub>11</sub> (50% FYM + 50% Vermicompost + 50% *Azotobacter* + 50% PSB) T<sub>10</sub> (50% FYM + 50% Vermicompost + 50% PSB), T<sub>8</sub> (50% Vermicompost + 50% *Azotobacter*). The maximum days to first head initiation *viz.* (58.00), maximum days to head maturity for harvesting *viz.* (80.00) was observed at harvesting in T<sub>0</sub> (control) respectively. Maximum weight of head with guard leaves (1273.09 gm), weight of head without guard leaves (485.57 gm), percentage weight loss of head (413.60 gm), Stalk length (19.60 cm), Stalk diameter (3.83 cm), head length (8.10 cm), head width (12.75 cm), head diameter (13.85 cm), yield kg/plant (0.500 kg), yield kg/plot (10.00 kg), yield q/ha (185.18q), at harvesting was observed with treatment T<sub>2</sub> (Vermicompost 100% @ 8 t/ha) which were statistically at par with treatment T<sub>11</sub> (50% FYM + 50% Vermicompost + 50% *Azotobacter* + 50% PSB) T<sub>10</sub> (50% FYM + 50% Vermicompost + 50% PSB) respectively. The minimum, weight of head with guard leaves (740.00 gm), weight of head without guard leaves (292.50 gm), Percentage weight loss of head, (318.00 gm), Stalk length (12.47 cm), Stalk diameter (2.90 cm), head length (3.30 cm), head width (7.00 cm), head diameter (8.45 cm), yield kg/plant (0.290 kg), yield kg/plot (5.80 kg), yield q/ha (107.40q) was observed at harvesting in T<sub>0</sub> (control).

It is also noted that the pool data of yield parameters *viz.*; weight of head with guard leaves (72.03%), weight of head without guard leaves (66.00%), Stalk length (57.17%), Stalk diameter (32.06%), head length (145.45%), head width (82.14%), head diameter (63.90%), yield kg/plant (72.41%), yield kg/plot (72.41%), yield q/ha (72.42%) was increased at harvesting respectively. These results have also been reported by. Bahadur *et al.* (2003) [3], Lodhi *et al.* (2017) [6] and Dash *et al.* (2019) [3].

**Table 1:** Study on the Effect of Organic manure and Biofertilizer on Growth of Broccoli (*Brassica oleracea* L. var. *italica* Plenck), based on two years of Pooled data.

Treatment	Plant Height cm 30 DAT	60 DAT	At harvesting stage	Number of leaves/plant 30 DAT	60 DAT	At harvesting stage	leaf Length cm 30 DAT	60 DAT	At harvesting stage	Width of leaf (cm) 30 DAT	60 DAT	At harvesting stage	Plant spread (cm) 30 DAT	60 DAT	At harvesting stage
T <sub>0</sub>	17.80	37.40	41.55	6.25	12.20	13.40	6.45	35.55	37.60	3.10	13.35	14.55	21.30	45.00	50.55
T <sub>1</sub>	22.75	46.85	49.75	8.30	16.42	18.37	11.65	48.40	50.55	4.25	17.55	19.60	31.45	54.75	68.22
T <sub>2</sub>	26.12	50.35	53.60	10.40	17.95	19.45	13.25	50.55	52.17	5.60	19.30	21.80	34.05	57.60	70.85
T <sub>3</sub>	20.55	43.85	48.20	7.40	15.10	16.17	9.80	45.62	47.55	3.85	16.40	17.55	28.80	51.77	65.80
T <sub>4</sub>	21.25	45.30	48.42	7.80	15.40	16.55	10.30	46.00	48.50	3.80	15.90	18.15	29.27	53.02	66.50
T <sub>5</sub>	23.02	47.55	50.15	8.62	16.60	18.29	12.05	48.75	50.77	4.35	17.90	20.07	31.80	55.18	68.40
T <sub>6</sub>	21.85	46.65	49.30	8.15	16.09	18.00	11.30	48.32	50.20	4.03	17.25	19.25	30.85	54.40	67.50
T <sub>7</sub>	21.33	45.84	48.80	8.00	15.70	16.90	10.90	47.75	49.67	3.90	17.12	18.55	29.90	53.55	66.50
T <sub>8</sub>	23.78	48.45	51.90	9.32	17.20	18.80	12.50	49.35	51.05	4.90	18.65	20.97	32.80	56.10	69.25
T <sub>9</sub>	22.30	47.85	50.60	8.80	16.85	18.55	12.30	49.10	50.85	4.70	18.08	20.60	32.35	55.55	68.86
T <sub>10</sub>	23.95	48.75	52.27	9.85	17.50	19.12	12.75	49.70	51.55	5.15	18.90	21.27	32.92	56.60	70.15
T <sub>11</sub>	25.07	49.60	53.20	10.12	17.75	19.30	12.97	50.08	51.85	5.30	19.15	21.60	33.70	57.15	70.55
SE(m)	0.56	1.17	41.55	0.21	0.40	0.44	0.28	0.51	0.64	0.11	0.44	0.49	0.77	0.81	0.78
CD (P=0.05)	1.67	3.45	49.75	0.64	1.20	1.31	0.84	1.53	1.90	0.33	1.30	1.44	2.29	2.39	2.32

**Table 2:** Study on the Effect of Organic manure and Biofertilizer on Yield Attributing traits of Broccoli (*Brassica oleracea* L. var. *italica* Plenck), based on two years of Pooled data.

Treatment	Days to first curd initiation	Days to curd maturity for harvesting	Weight of curd with guard leaves (g)	weight of curd without guard leaves (g)	Percentage weight loss of curd (g) after 24 hours at room temp	%	Stalk length (cm)	Stalk diameter (cm)	Curd length (cm)	Curd width (cm)	curd diameter (cm)	Average yield kg/plant	Average yield kg/plot	Average yield (q/ha)
T <sub>0</sub>	58.00	80.000	740.00	292.50	318.00	9.20	12.47	2.90	3.30	7.00	8.45	0.29	5.80	107.40
T <sub>1</sub>	54.85	78.520	1,102.99	422.50	373.10	8.90	17.05	3.46	6.95	11.50	12.55	0.42	8.44	156.48
T <sub>2</sub>	52.97	76.250	1,273.09	500.57	413.60	14.80	19.60	3.83	8.10	12.75	13.85	0.50	10.00	185.18
T <sub>3</sub>	55.20	79.080	978.08	360.20	331.60	9.80	15.75	3.14	6.44	10.35	11.25	0.36	7.20	133.33
T <sub>4</sub>	56.05	78.970	1,025.45	355.20	338.05	9.90	16.15	3.21	6.62	10.65	11.80	0.35	7.10	131.48
T <sub>5</sub>	54.45	78.320	1,125.80	424.50	390.35	8.04	17.50	3.55	7.05	11.73	12.80	0.43	8.70	161.11
T <sub>6</sub>	55.45	78.750	1,068.07	395.55	368.16	6.90	16.65	3.32	6.88	11.25	12.30	0.39	7.90	146.29
T <sub>7</sub>	55.80	78.970	1,050.27	387.85	360.60	7.02	16.35	3.26	6.76	10.78	12.05	0.38	7.75	143.33
T <sub>8</sub>	53.50	77.800	1,205.32	440.72	393.93	10.61	18.25	3.70	7.62	12.17	13.37	0.44	8.80	162.96
T <sub>9</sub>	53.85	78.100	1,175.63	435.49	391.85	10.02	17.96	3.63	7.32	11.90	13.05	0.43	8.70	161.11
T <sub>10</sub>	53.27	77.350	1,235.45	472.80	400.63	15.26	18.76	3.72	7.82	12.40	13.58	0.47	9.45	174.81
T <sub>11</sub>	53.10	76.750	1,265.22	478.95	405.47	15.3	19.20	3.81	7.97	12.60	13.68	0.47	9.57	177.03
SE(m)	0.52	0.54	38.39	10.44	10.31		0.41	0.08	0.17	0.28	0.31	0.010	0.21	4.24
CD (P=0.05)	1.54	1.61	113.34	30.84	30.44		1.23	0.25	0.52	0.84	0.92	0.031	0.62	12.54

## Conclusion

Among the all treatments, T<sub>2</sub> observed the maximum weight of head with guard leaves (1273.09 gm), weight of head without guard leaves (485.57 gm), yield kg/plant (0.500 kg), yield kg/plot (10.00 kg), yield q/ha (185.18q) at harvesting was observed with treatment T<sub>2</sub> (Vermicompost 100% @ 8 t/ha). The influence of organic manure and biofertilizers on yield of broccoli sought to be increased in the treatment receiving Vermicompost to increase the yield q/ha. These results conformity with finding of Kumar *et al.* (2013) [4], Meena *et al.* (2017) [8], Lodhi *et al.* (2017) [6], Mohanta *et al.* (2018) [9]. Hence, soil application of Vermicompost 100% @ 8 t/ha was found to be the best for obtaining the highest yield (185.18q/ha) in the condition of Uttar Pradesh.

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