

Original Research Article

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## Growth and Yield Attributing Characters of Sprouting Broccoli (*Brassica oleracea* L. var. *italica* Planck) as Influenced by Integrated Nutrient Management

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### ABSTRACT

#### Keywords

INM, Growth, Azotobacter, Vermicompost, Yield

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A field experiment was conducted during the *rabi* season of 2018-19 at the Vegetable Research Station, Kalyanpur, C. S. A. University of Agriculture and Technology, Kanpur, (U. P.) to study the effect of integrated nutrient management on vegetative growth, yield and yield attributing characters of sprouting broccoli. Twelve treatments along with control were evaluated in Randomized Block Design (RBD) with three replications. After investigation, it was found that the application of Vermicompost and Azotobacter recorded significantly higher growth and yield characters than other treatments. In overall investigations, the obtained results specified that the integrated application of Vermicompost @ 5 t ha<sup>-1</sup> + Azotobacter show promising results in the cultivation of sprouting broccoli and better for obtaining the higher growth and yields of sprouting broccoli and further the Vermicompost with Azotobacter combination shows good growth and high yield of sprouting broccoli crop.

### Introduction

Sprouting Broccoli (*Brassica oleracea* L. var. *italica* Planck 2n=2x=18) is one of the important and potential cole crops belonging to the Brassicaceae family with originated in the Mediterranean region where it has been cultivated since Roman times. It is a rich source of vitamins and minerals. In fact, it contains more vitamin A than cabbage and cauliflower and the highest amount of proteins among the cole crop. It also contains anti-cancerous compounds and antioxidants.

Broccoli is of two types: heading type and sprouting (green and purple) type. Heading broccoli forms curd like cauliflower; while sprouting broccoli contains a group of green immature buds and thick fleshy flower stalk forming a head and more popular in India.

The use of biofertilizers in combination with chemical fertilizers and organic manures offers a great opportunity to increase the production as well as the quality of broccoli (Shree *et al.*, 2014). The incorporation of organic nutrients in the form of

vermicompost, farmyard manure and biofertilizer is known to influence the physico-chemical and biological properties of the soil resulting in enhanced uptake of nutrients from the soil (Lal and Kanaujia, 2013). Integrated nutrient management having chemical fertilizers applied along with organic sources of nutrients is an effective method for economization of production cost as well as maintenance of soil fertility (Kumar *et al.*, 2011). Organic manure can serve as an alternative practice to mineral fertilizers and microbial biomass (Suresh *et al.*, 2004). Use of organic manures improves soil texture, structure, humus, aeration, water holding capacity and microbial activity (Gupta *et al.*, 2010) and (Dauda *et al.*, 2008). The crops grown with integrated nutrient management techniques are nutritionally and environmentally superior. Therefore, keeping in view the above facts in mind, an attempt has been made in the present investigation to study the Effect of INM practices on growth and yield characters of sprouting broccoli (*Brassica oleracea* L. var. *italica*).

## Materials and Methods

The experiment was carried out at the Vegetable Research Station, C. S. A. University of Agriculture and Technology Kalyanpur, Kanpur on sprouting broccoli var. Green Magic during *rabi* season of 2018-19. The soil of the experimental site was sandy loam having soil pH 7.5, organic carbon 1.20 %, available N (210.50 kg ha<sup>-1</sup>), P (45.50 kg ha<sup>-1</sup>) and K (195.40 kg ha<sup>-1</sup>). The experiment was laid out in a Randomized Block Design (RBD) with three replications. Four weeks old healthy seedlings with uniform vigour were transplanted in 30 October, 2018 with plot size that measured 2.40 x 1.35 m at the spacing of 60 x 45 cm. The treatments consisted of T<sub>0</sub>- Control, T<sub>1</sub>- 100% RDF (120: 80: 60 N P K ha<sup>-1</sup>), T<sub>2</sub>- FYM @ 25 t ha<sup>-1</sup>, T<sub>3</sub>- Vermicompost @ 5 t ha<sup>-1</sup>, T<sub>4</sub>- Azotobacter,

T<sub>5</sub>- 100% RDF + FYM @ 25 t ha<sup>-1</sup>, T<sub>6</sub>- 100% RDF + Vermicompost @ 5 t ha<sup>-1</sup>, T<sub>7</sub>- 100% RDF + Azotobacter, T<sub>8</sub>- Vermicompost @ 5 t ha<sup>-1</sup> + Azotobacter, T<sub>9</sub>- 100% RDF + FYM @ 25 t ha<sup>-1</sup> + Azotobacter, T<sub>10</sub>- 100% RDF + Vermicompost @ 5 t ha<sup>-1</sup> + Azotobacter and T<sub>11</sub>- 100% RDF + FYM @ 12.5 t ha<sup>-1</sup> + Vermicompost @ 2.5 t ha<sup>-1</sup> + Azotobacter. The full dose of P and K and half dose of N were applied at the time of transplanting and the remaining half dose of N was given in two equal doses at 30 and 60 days after transplanting. The source of nitrogen, phosphorus and potash were urea, diammonium phosphate and muriate of potash, respectively. Recommended cultural practices were followed to raise a successful crop. Observations on growth and yield attributing characters were recorded in each replication of all the treatments during the investigation. The observations recorded for growth and yield attributing characters viz. plant height (cm), number of leaves plant<sup>-1</sup>, leaf length (cm), leaf width (cm), plant spreading (cm), days of first curd initiation, days to 50% curd initiation, days to curd maturity, stalk diameter (cm), stalk length (cm), curd diameter (cm), curd length (cm), curd width (cm), weight of curd without leaves (g), curd yield (kg plot<sup>-1</sup>) and curd yield (q ha<sup>-1</sup>).

## Results and Discussion

Inorganic fertilizers with different organic manures along with biofertilizers alone or in combination were found to have a significant effect on growth characters as compared to control (Table 1). The data was taken on plant height (cm), number of leaves plant<sup>-1</sup>, leaf length (cm), leaf width (cm) and plant spreading of broccoli at 30, 60 and harvesting stage after transplanting influenced by significant differences among the treatments. The application of Vermicompost @ 5 t ha<sup>-1</sup> + Azotobacter (T<sub>8</sub>) was recorded

maximum plant height (27.79, 49.13 and 50.68 cm, respectively), number of leaves plant<sup>-1</sup> (9.23, 15.93 and 18.33, respectively), leaf length (9.44, 46.86 and 48.55 cm, respectively), leaf width (5.28, 21.36 and 23.85 cm, respectively) and plant spreading (37.12, 60.03 and 68.46 cm, respectively). The minimum values of growth characters were recorded in control. The use of bio-fertilization may be attributed to the physical, chemical and biological properties of soil which help in better nutrient absorption and utilization by plants resulting in better plant growth. This might be attributed to certain growth promoting substances secreted by the biofertilizers which in turn might have led to better root development, better transportation of water, uptake and deposition of nutrients. Meena *et al.*, (2017) reported that higher plant growth parameter in broccoli was recorded

with Vermicompost and Azotobacter along with inorganic fertilizers. Similarly, results due to the effect of organic manures and bio-fertilizer were recorded by Mohapatra *et al.*, (2013), Shree *et al.*, (2014), Kumar *et al.*, (2013), Mal *et al.*, (2015), Mohanta *et al.*, (2018) and Singh *et a.*, (2018). These results conform with the findings of the present experiment.

Integrated nutrient application of inorganic fertilizers, organic manures and biofertilizers alone or in combination significantly increased yield and yield attributing characters of broccoli as compared to control (Table 2). The application of Vermicompost @ 5 t ha<sup>-1</sup> + Azotobacter (T<sub>8</sub>) were recorded minimum days of first curd initiation (51.00), days to 50% curd initiation (54.66) and days to curd maturity (71.66).

**Table.1** Effect of integrated nutrient management on growth characters at different days after transplanting (DAT) of sprouting broccoli

Treatment	Plant height(cm)			Number of leaves per plant			Leaf length (cm)		
	30 DAT	60 DAT	At harvest	30 DAT	60 DAT	At harvest	30 DAT	60 DAT	At harvest
T <sub>0</sub>	18.86	39.01	40.62	5.95	11.46	12.45	5.23	33.46	36.58
T <sub>1</sub>	21.71	45.63	49.11	7.90	13.26	15.40	8.42	36.58	37.59
T <sub>2</sub>	23.85	47.84	48.65	7.93	14.20	14.80	8.06	34.88	38.19
T <sub>3</sub>	23.80	43.62	48.20	7.46	13.40	15.80	8.15	36.52	45.63
T <sub>4</sub>	20.63	47.08	48.54	8.33	13.86	15.86	9.36	37.71	39.43
T <sub>5</sub>	22.54	47.36	47.82	7.86	15.00	16.73	9.55	45.56	47.36
T <sub>6</sub>	27.78	46.36	47.87	8.33	15.01	16.26	8.41	38.93	40.50
T <sub>7</sub>	23.07	46.54	50.13	8.33	14.80	17.36	9.37	39.41	45.20
T <sub>8</sub>	27.79	49.13	50.68	9.23	15.93	18.33	9.44	46.86	48.55
T <sub>9</sub>	20.83	46.46	49.78	8.26	15.46	16.00	8.19	38.44	40.90
T <sub>10</sub>	22.22	48.97	49.58	8.06	14.66	15.93	8.87	40.68	46.48
T <sub>11</sub>	22.74	47.60	48.68	8.13	14.46	16.10	8.24	39.52	47.54
SE(m)±	0.83	1.33	1.38	0.216	0.409	0.574	0.183	0.666	1.000
C.D. at 5 %	2.44	3.91	4.05	0.635	1.20	1.68	0.538	1.955	2.933

**Table.Cont...**

Treatment	Leaf width (cm)			Plant spreading(cm)		
	30DAT	60DAT	At harvest	30DAT	60DAT	At harvest
T <sub>0</sub>	2.20	14.15	15.37	25.73	47.90	52.90
T <sub>1</sub>	4.22	16.01	17.84	31.66	50.42	59.24
T <sub>2</sub>	4.26	16.84	18.37	32.57	54.46	55.52
T <sub>3</sub>	4.34	17.37	19.33	28.82	48.44	58.12
T <sub>4</sub>	4.68	18.00	19.48	34.40	50.78	58.56
T <sub>5</sub>	4.40	18.48	19.34	33.26	52.72	67.29
T <sub>6</sub>	4.22	18.34	18.84	36.17	57.53	67.20
T <sub>7</sub>	4.54	16.24	22.50	36.14	55.86	64.93
T <sub>8</sub>	5.28	21.36	23.85	37.12	60.03	68.46
T <sub>9</sub>	4.16	18.14	20.36	31.37	55.53	66.19
T <sub>10</sub>	4.07	17.40	20.85	34.02	51.58	67.30
T <sub>11</sub>	4.21	18.03	19.94	32.47	53.87	65.96
SE(m)±	0.218	0.525	0.595	0.955	1.166	1.499
C.D. at 5 %	0.639	1.540	1.745	2.801	3.422	4.398

**Table.2** Effect of integrated nutrient management on yield and yield attributing characters of sprouting broccoli

Treatments	Days to first curd initiation	Days to 50 % curd initiation	Stalk diameter (cm)	Stalk length (cm)	Curd diameter (cm)	Curd length (cm)
T <sub>0</sub>	57.00	68.00	1.34	13.45	8.37	3.12
T <sub>1</sub>	52.00	57.66	2.70	15.28	9.50	4.27
T <sub>2</sub>	52.33	57.66	2.50	16.05	9.26	5.04
T <sub>3</sub>	52.33	57.66	2.72	17.18	9.93	5.62
T <sub>4</sub>	52.33	56.00	2.74	19.05	9.60	5.68
T <sub>5</sub>	52.33	57.00	2.51	17.80	10.96	5.03
T <sub>6</sub>	52.66	56.66	2.83	18.09	11.26	5.43
T <sub>7</sub>	53.00	57.00	2.85	18.95	12.11	5.59
T <sub>8</sub>	51.00	54.66	3.19	20.74	12.89	6.80
T <sub>9</sub>	52.33	57.00	2.84	20.19	10.88	6.22
T <sub>10</sub>	51.66	56.33	2.43	19.06	11.08	6.08
T <sub>11</sub>	51.66	56.33	2.78	19.26	10.71	5.52
SE (m) ±	0.415	0.743	0.119	0.333	0.395	0.187
CD @ 5%	1.220	2.181	0.352	0.977	1.158	0.547

Table.Cont...

Treatments	Curd width (cm)	Days to curd maturity	Weight of curd without leaves (g)	Curd yield (kg plot <sup>-1</sup> )	Curd yield (q ha <sup>-1</sup> )
T <sub>0</sub>	8.28	77.00	291.33	3.69	113.98
T <sub>1</sub>	9.97	75.33	343.80	4.12	127.15
T <sub>2</sub>	9.92	76.66	338.73	4.06	125.30
T <sub>3</sub>	8.96	76.33	330.66	3.96	122.32
T <sub>4</sub>	9.28	76.66	334.80	4.10	123.86
T <sub>5</sub>	11.01	76.00	332.53	3.98	122.93
T <sub>6</sub>	10.80	74.00	368.53	4.82	148.76
T <sub>7</sub>	11.08	72.00	357.06	5.36	165.53
T <sub>8</sub>	11.72	71.66	459.40	5.80	179.21
T <sub>9</sub>	10.75	75.33	453.73	5.49	169.44
T <sub>10</sub>	10.70	74.66	439.46	5.26	162.54
T <sub>11</sub>	10.96	75.00	431.13	5.08	140.94
SE (m) ±	0.251	0.833	15.166	0.281	5.666
CD @ 5%	0.736	2.445	44.492	0.826	16.624

These finding has also been observed by Westerveld *et al.*, (2003) in cabbage. It was also observed by Chaubeyet *et al.*, (2006) in their study on cabbage that higher fertility levels favoured the maturity time whereas the process of growth and development was slower at lower fertility level. The stalk diameter and stalk length were observed that markedly influenced by different treatments. The maximum stalk diameter (3.19 cm) and stalk length (20.74 cm) were obtained with the application of Vermicompost @ 5 t ha<sup>-1</sup> + Azotobacter (T<sub>8</sub>). This may be due to increased vegetative growth as induced by integrated nutrient management which might account for increased carbohydrate accumulation as a result of increased photosynthesis. Similarly, the maximum curd diameter (12.89 cm), curd length (6.80 cm) and curd width (11.72 cm) were found with the same treatment. The data regarding the effect of integrated nutrient management on curd weight (g), curd yield (kg plot<sup>-1</sup>) and curd yield (q ha<sup>-1</sup>) showed significant variation obtained by altering the different

fertilizer levels among the treatments. The maximum weight of curd without leaves (459.40 g), curd yield (5.80 kg plot<sup>-1</sup>) and curd yield (179.21 q ha<sup>-1</sup>) were recorded in the treatment with the combination of Vermicompost @ 5 t ha<sup>-1</sup> + Azotobacter (T<sub>8</sub>) followed by (T<sub>9</sub>) with the application of 100% RDF + FYM @ 25t ha<sup>-1</sup> + Azotobacter. However, the beneficial role of organic manures and biofertilizers in improving physical, chemical and biological properties of soil, which in turn, help in better nutrient absorption by plants, also resulted in higher values for yield contributing characters. These results conform with the finding of Atal *et al.*, (2019), Akbar *et al.*, (2009), Khan *et al.*, (2009), Kumar *et al.*, (2010) and Chatterjee *et al.*, (2014) also found that Vermicompost and Azotobacter along with inorganic fertilizers maximum yield characters in cabbage and cauliflower.

Based on results, it could be concluded that the application of Vermicompost @ 5 t ha<sup>-1</sup> + Azotobacter (T<sub>8</sub>) was found to be the best

treatment combination in terms of growth as well as yield attributes characters of sprouting broccoli.

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