

## Growth, Yield and Economics of Broccoli (*Brassica oleracea* var. *Italica*) as Influenced by Organic and Inorganic Nutrients

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### Abstract

An experiment entitled "Growth, yield and economics of broccoli (*Brassica oleracea*) as influenced by organic and inorganic nutrients" was carried out at the site for "Network project on Bio fertilizer" in the campus of College of Agriculture, Orissa University of Agriculture and Technology, Bhubaneswar during Rabi 2008-09 and 2009-10. Results revealed that out of ten treatments tried, the T<sub>10</sub> i.e. 75% NP+ 100% K+ bio inoculants+ VC (5t/ha) proved to be the best on account of growth factor such as plant height, leaf area and curd diameter. The plant height, leaf area and curd diameter in T<sub>10</sub> was 41.58 cm, 363.32 cm<sup>2</sup> and 46.91 cm respectively. The yield was also highest in T<sub>10</sub> i.e. 149.43 q/ha. Similarly, the highest net return was also obtained from T<sub>10</sub> i.e. ₹ 95,455 with benefit cost ratio of 3.45.

Broccoli (*Brassica oleracea* L.var *italica*) is a member of the family Brassicaceae and is a native of Mediterranean region. It is a recent introduction to India and is becoming popular among the rich people because of its low fat content, low in calories, high vitamin C and good source of vitamin A, B<sub>2</sub> and calcium (Sanwal and Yadav, 2006). Maximum amount of β- carotene is stored in the florets, but there is a plenty of nutrition like calcium, iron, thiamine, niacin and vitamin C in its stalk. Broccoli contains a compound Glucoraphanin that can be processed into an anti cancer compound Sulphoraphane. It also contains Indole-3-carbinol, a chemical which boost DNA repair in cells and appears to block the growth of cancer cells.

### Highlights

- Suitable dose of NPK fertilizer along with organic manures for higher yield of Broccoli have been worked out.
- Efficiency of different INM schedules for improving productivity and quality have been evaluated with reference to resource use efficiency and economics.

**Keywords:** Biofertilizers, vermicompost, FYM, B:C., curd

### Materials and Methods

The present experiment entitled "Growth, yield and economics of broccoli (*Brassica oleracea*) as influenced by organic and inorganic nutrients" was carried out at "Network project on Bio fertilizer" in the campus of College of Agriculture, Orissa University of Agriculture and Technology, Bhubaneswar during Rabi 2008-09 and 2009-10 in Randomized block design with 10 treatments replicated thrice. The individual plot size was 3m × 2.8m

having a spacing of 50cm × 40cm. The total area of the experimental plot was 367.92 m<sup>2</sup>. Puspaa (F<sub>1</sub> hybrid, Seminis company) variety of broccoli was taken for the trial. General recommendation of fertilizer used for the experiment was 120:30:60 of NPK (kg/ha) including bio fertilizer *Azotobacter*, *Azospirillum*, PSB in the ratio of 1:1:1. Besides bio fertilizer FYM 10 t/ha and vermicompost 5 t/ha were also used as per the treatments. However, the detail treatments are given below:



Sl. No.	Notation	Treatments
1	T <sub>1</sub>	Absolute control
2	T <sub>2</sub>	100% NPK
3	T <sub>3</sub>	100% NPK +100% FYM
4	T <sub>4</sub>	100% NPK + 100% V.C
5	T <sub>5</sub>	100% NPK +50%FYM +50% VC
6	T <sub>6</sub>	100% NPK +50%FYM+ 25% VC +25% VC
7	T <sub>7</sub>	100% NPK +50% V.C +50%VC
8	T <sub>8</sub>	100% NPK + 50%V.C +25%VC +25%VC
9	T <sub>9</sub>	75%NP+100% K+Bioinoculant+100% FYM
10	T <sub>10</sub>	75 % NP+100% K +Bioinoculant+100% VC

## Results and Discussion

The data presented in Table 1, recorded the maximum plant height in T<sub>10</sub> (41.67 cm and 41.49 cm) which was statistically significant than all other treatments tried in the experiments followed by T<sub>9</sub> (35.10 cm and 35.69 cm) for the year 2008-09 and 2009-10. Similarly, as per Table 2, leaf area was recorded to be highest in T<sub>10</sub> (370.08 cm<sup>2</sup> and 356.64 cm<sup>2</sup>) during 2008-09 and 2009-10 respectively. In Table 3 curd diameter was found to be highest i.e. 46.16 cm and 47.66 cm and in Table 4, maximum yield during 2008-09 and 2009-10 was (145.35 q/ha and 153.51 q/ha). In Table 5 maximum expenditure was ₹ 39,535 in T<sub>10</sub> during 2008-09 whereas ₹ 41,130 in T<sub>8</sub> during 2009-10. The gross return was highest in T<sub>10</sub> during both the year of experimentation (₹ 1,45,000 and ₹ 1,53,000). Similarly, net return was also highest in T<sub>10</sub> during both the year (₹ 1, 05,465 and ₹ 1, 15,480) with highest B: C ratio of 3.7 and 4.1 respectively.

The crop responded positively to the direct and residual effect of graded dose of inorganic nutrients integrated with organic and biological sources either alone or mostly together. The biometrical parameters of broccoli crop like height of the plant, leaf area and curd diameter and finally the yield were influenced synergistically by the stimulatory (capacity to synthesis and secrete thiamine, riboflavin, pyridoxine, cynocobalamine, nicotinic acid, pantothenic acid, IAA and gibberellic acid) therapeutic (ability of the microbes manufacturing and secreting antibiotic and antifungal substances which protect the plant against fungal diseases), catalytic (*Azotobacter* encourages the population and activity of ammonifying and nitrifying bacteria with azospirillum and PSB ), roles in addition to nutritional properties (nitrogen fixation by *Azotobacter* 10-25 kg/ha, by azospirillum 20-30 kg/ha and phosphorous solubilisation equivalent to 30-40 kg/ha ) by release of organic acids for solubilisation of insoluble phosphate making iron, aluminium and manganese inactive by

complex formation in acid soils and release of organic anions which compete with phosphate anion for absorption and all influence of organic matter on the soil as well as crop growth

The present result revealed that the plant height in broccoli crop was influenced by the combined application of NPK and Biofertilizer along with different organic sources. Application of 100% chemical fertilizer alone could not influence significantly than the combined application in both the years tried. However, it individually differed significantly over control. The application of Biofertilizer might be attributed to longer amount of sustain supply of nutrients during the entire growth period. Significant increase in plant height might also be due to the production of different phytohormones like Indole acetic acid, Gibberellic acid and cytokinin produced by the Biofertilizer. The increase in plant height might also be due to the action of phosphobacteria in synthesis of growth promoting substances like vitamin B<sub>12</sub>, Auxin and Indole acetic acid. Further, the chemical fertilizer mainly nitrogen in presence of Vermicompost resulted quick cell formation and elongation which might have increased the height of the plant. These results corroborate the findings of Manivannan and Singh (2009), Bhardwaj *et al.* (2007), Brahma *et al.* (2012) Mohammed *et al.* (2015) in broccoli crop.

The leaf area expansion is one of the indications of the response of growth factor in many of the nutritional investigation and is also a direct indicator of photosynthetic potentiality of the plant. From the present investigation there is a significant effect on the increase in leaf area than control and other treatments by applying 75% NP with 100% K along with Biofertilizer in presence of Vermicompost. A similar result was also observed by Thakur *et al.* (2010) in cauliflower.

The diameter of the curd was found to be significantly influenced with respect to the combined effect of 75% NP + 100% K with Biofertilizer and Vermicompost as an organic source over other treatments. There was an increase in the curd diameter up to 75% of the recommended dose of NP + 100% K along with Biofertilizer and Vermicompost which might have favored the production as well as accumulation of the prepared food, thereby increasing the individual curd weight. Similar, results were also observed by Bracy *et al.* (2015), Maurya *et al.* (2008) in broccoli crop.

Applications of different levels of NPK in combinations with Biofertilizer and Vermicompost increased the yield of fresh curd and ultimately yield/ha were also increased. Maximum yield (149.43 q/ha) was obtained with use of 75% recommended dose of chemical fertilizer

**Table 1.** Plant height (cm) of broccoli as influenced by integrated use of organic manures, bioinoculation and chemical fertilizers

Sl. No.	Treatments	Plant height (cm)		
		2008-09	2009-10	Pooled
1	Absolute control	11.89	13.89	12.89
2	100% NPK	16.44	16.45	16.45
3	100% NPK +100% FYM	16.87	17.24	17.06
4	100% NPK + 100% V.C	20.53	21.90	21.22
5	100% NPK +50% FYM +50% VC	22.68	23.20	22.94
6	100% NPK +50% FYM + 25% VC +25% VC	26.77	27.01	26.89
7	100% NPK +50% V.C +50% VC	26.90	28.43	27.67
8	100% NPK + 50% V.C +25% VC +25% VC	30.20	30.15	30.18
9	75% NP +100% K+ Bioinoculant+100% FYM	35.10	35.69	35.40
10	75 % NP + 100% K +Bioinoculant + 100% VC	41.67	41.49	41.58
	SEM±	1.33	1.31	0.69
	CD(0.05)	3.95	3.90	1.94

**Table 2.** Leaf area (cm<sup>2</sup>) of broccoli as influenced by integrated use of organic manures, bioinoculation and chemical fertilizers

Sl. No.	Treatments	Leaf area (cm <sup>2</sup> )		
		2008-09	2009-10	Pooled
1	Absolute control	150.25	167.29	158.77
2	100% NPK	220.0	214.2	217.12
3	100% NPK +100% FYM	225.01	242.77	233.89
4	100% NPK + 100% V.C	232.37	251.87	241.94
5	100% NPK +50% FYM +50% VC	244.14	245.59	244.80
6	100% NPK +50% FYM + 25% VC +25% VC	260.36	264.69	262.35
7	100% NPK +50% V.C +50% VC	272.14	291.28	281.64
8	100% NPK + 50% V.C +25% VC +25% VC	288.91	291.71	289.86
9	75% NP +100% K+ Bioinoculant+100% FYM	315.53	322.42	318.71
10	75 % NP + 100% K +Bioinoculant + 100% VC	370.08	356.64	363.32
	SEM±	16.54	13.15	7.99
	CD(0.05)	49.14	39.06	22.25

**Table 3.** Diameter of the curd (cm) of broccoli as influenced by integrated use of organic manures, bioinoculation and chemical fertilizers

Sl. No.	Treatments	Curd diameter (cm)		
		2008-09	2009-10	Pooled
1	Absolute control	19.40	19.50	19.45
2	100% NPK	38.70	39.12	38.91
3	100% NPK +100% FYM	42.57	44.75	43.66
4	100% NPK + 100% V.C	42.23	43.16	42.70
5	100% NPK +50% FYM +50% VC	43.67	43.06	43.37
6	100% NPK +50% FYM + 25% VC +25% VC	41.14	42.61	41.88
7	100% NPK +50% V.C +50% VC	42.97	44.07	43.52
8	100% NPK + 50% V.C +25% VC +25% VC	42.45	42.37	42.41
9	75% NP +100% K+ Bioinoculant+100% FYM	40.85	43.29	42.07
10	75 % NP + 100% K +Bioinoculant + 100% VC	46.16	47.66	46.91
	SEM±	1.86	2.15	1.05
	CD(0.05)	5.53	6.37	2.93

**Table 4.** Yield (q/ha) of broccoli as influenced by integrated use of organic manures, bioinoculation and chemical fertilizers

Sl. No.	Treatments	Yield (q/ha)		
		2008-09	2009-10	Pooled
1	Absolute control	37.49	35.66	36.57
2	100% NPK	66.66	73.27	69.97
3	100% NPK +100% FYM	102.25	84.38	93.32
4	100% NPK + 100% V.C	90.31	107.24	98.77
5	100% NPK +50%FYM +50% VC	93.67	84.33	89.00
6	100% NPK +50%FYM + 25% VC +25% VC	105.55	107.79	106.67
7	100% NPK +50% V.C +50%VC	95.46	107.45	101.45
8	100% NPK + 50%V.C +25%VC + 25% VC	120.05	140.14	130.10
9	75% NP +100% K+ Bioinoculant + 100% FYM	126.32	142.52	134.42
10	75 % NP + 100% K + Bioinoculant + 100% VC	145.35	153.51	149.43
	SEM±	6.83	7.69	4.37
	CD(0.05)	20.30	22.87	12.17

+ 100% K with Biofertilizer and Vermicompost which was significantly higher than other treatments including control. The increase in the yield might have been due to the performance of vegetative growth which might have influenced in the production of more amount of carbohydrates ultimately accumulated in the form of curd and thereby increase in yield. The increase in yield also may be the solubilization effect of the nutrients as well as the chelating effect of Biofertilizer on metals, thereby, the availability of essential nutrients get increased. The result is in accordance with Sanderson and Ivany (2009), Brahma *et al.* (2012), Feller and Fink (2007) and Maurya *et al.* (2008) in broccoli.

Integrated nutrient management practices with different organic manures and bioinoculant combinations exhibited noticeable influence in the economics of broccoli cultivation i.e. cost of cultivation, gross income, net income and benefit cost ratio during both the years of study (2008-09 and 2009-10). Maximum involvement of cost was marked when 100% recommended dose of inorganic fertilizer along with 100% Vermicompost was applied in broccoli crop (₹ 40,190) and the lowest was calculated with control (₹ 33,940).

Combined use of 75% NP and 100% K of the recommended dose of inorganic fertilizer with Vermicompost as an organic source along with bioinoculant recorded the highest gross return (₹ 1,49,000) per hectare, whereas, the lowest gross return was recorded where no nutrients were applied i.e. ₹ 36,575/ha.

The highest net return of ₹ 1, 10,473 (mean of two years) was calculated by applying 75% NP and 100% K of recommended dose of inorganic fertilizer with organic

manure as Vermicompost and bioinoculant as compared to other treatments tried in this experiments during 2008-09 and 2009-10. However, the lowest net returns for both the years (2008-09 and 2009-10) were calculated to be ₹ 2,635 (mean of two years). Highest benefit cost ratio of 3.9 (mean of two years) was calculated with integrated use of inorganic fertilizer (75% NP and 100% K of recommended dose of inorganic fertilizer) with bioinoculants and vermicompost as an organic source. Whereas, the lowest benefit cost ratio of 1.07 (mean of two years) was observed with no nutrient application (control) for both the years of trial i.e. 2008-09 and 2009-10. The increase in benefit cost ratio and other parameters might be due to the increase in yield which fetches more prices in the market having less expenditure.

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**Table 5.** Economics of broccoli as influenced by integrated use of organic manures, bioinoculation and chemical fertilizers

Sl. No.	Treatments	Total expenditure (₹)			Gross Return (₹)			Net return (₹)			B:C Ratio		
		2008-09	2009-10	Mean	2008-09	2009-10	Mean	2008-09	2009-10	Mean	2008-09	2009-10	Mean
1	Absolute control	33750	34130	33940	37490	35660	36575	3740	1530	2635	1.1	1.04	1.07
2	100% NPK	34633	36120	35377	66000	73270	69635	33367	37150	24359	1.9	2.03	2.0
3	100% NPK + 100% FYM	38150	35125	36638	102000	84380	93190	63850	49255	55553	2.7	2.4	2.6
4	100% NPK + 100% V.C	39250	38190	38720	90310	107240	98775	5060	69050	60055	2.3	2.8	2.6
5	100% NPK + 50% FYM + 50% VC	32650	31710	32180	93667	84330	88999	6017	52620	55819	2.9	2.7	2.8
6	100% NPK + 50% FYM - 25% VC - 25% VC	33210	34120	33665	105000	107790	106395	7790	73670	72730	3.2	3.16	3.18
7	100% NPK + 50% VC - 50% VC	38750	39235	38993	95000	107000	101000	56250	67765	62008	2.5	2.7	2.6
8	100% NPK + 50% VC + 25% VC + 25% VC	39250	41130	40190	120000	140140	130070	80750	99010	89880	3.1	3.4	3.25
9	75% NP + 100% K + Bioinoculant + 100% FYM	38435	39175	38805	126000	142520	134260	87565	103345	95455	3.3	3.6	3.45
10	75 % NP + 100% K + Bioinoculant + 100% VC	39535	37520	38528	145000	153000	149000	105465	115480	110473	3.7	4.1	3.9



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