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Effects of integrated nutrient management on growth, yield, quality and economics of sprouting broccoli (*Brassica oleracea var. italica*) cv. Shayali

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Abstract
A field experiment was conducted in the research farm of All India Coordinated Research Project on Vegetable, Orissa University of Agriculture and Technology, Bhubaneswar during 2014-15 to study the integrated nutrient management in Sprouting Broccoli cv. Shayali for growth, yield, quality and economics in a randomised block design with 10 treatments. The soil test based recommended fertiliser dose applied was NPK @ 200: 50: 150 kg/ha. The Treatment, T_7 i.e., 50% NPK + Vermicompost @2.5t/ha recorded maximum values for plant height (51.56cm), plant spread N-S (61.63cm) and E-W (64.91cm), number of leaves per plant (22.27), leaf area (405.45cm^2), leaf length (23.15cm), leaf width (18.18cm), days to 50% head initiation (50.67days) and days to first harvest (51.00). The treatment, T_7 also recorded highest head girth (42.76cm), head diameter (14.16cm), terminal head weight (327.57g), head volume (595.67cc), gross yield (233.56q/ha), marketable yield (163.63q/ha), vitamin C (80.24mg/g), dry matter (11.77%), gross returns (Rs.700680.00/ha), net returns (Rs. 525510.00/ha) and benefit cost ratio (4.0). This was followed by treatment T_9 (50% NPK +poultry manure @ 2.5t/ha).
Among all the treatments, the Treatment T_7 i.e., application of 50% recommended dose of NPK/ha with 2.5 tonnes of vermicompost in sprouting broccoli was found to be the best for obtaining better growth, optimum yield, better quality produce, highest net returns as well as cost benefit ratio and is recommended for Odisha condition.

Keywords: sprouting broccoli, shayali, INM, growth, yield, quality, economics

Introduction
Sprouting broccoli (*Brassica oleracea* var. *italica*) is an important Cole crop after cabbage and cauliflower. It is a very nutritious vegetable rich in vitamin A (130 times and 22 times higher than cauliflower and cabbage, respectively), thiamine, riboflavin, niacin, vitamin C and minerals like Ca, P, K and Fe.
Among the various agronomic practices influencing the production, nutrition is found to exert a great influence on growth, yield, quality and economics of Cole crops. Imbalanced use and ever-increasing cost of chemical fertilizers are two deterrents factors for enhancing productivity of these crops. Integrated nutrient management is a balanced use of inorganic fertilizers, organic manures, crop residues and biofertilizers in combination to maintain the desired crop production along with maintenance of soil health (Hazra, 2007) [8]. The integrated plant nutrient supply and management system aims at sustaining productivity with minimum deleterious effect on soil health and environment. The system enhances nutrient use efficiency, maintains soil health, enhances yield and reduces cost of cultivation (Sharma, 2008) [16]. The increasing cost of chemical fertilizers stresses the need to substitute a part of the nutrient requirement through organic sources to make cultivation of sprouting broccoli an economically viable preposition.
Being a newly introduced crop in Odisha, there is an urgent need for standardization of integrated nutrient management practices with locally available organic manures integrated with inorganic fertilizers. Keeping this in view, a field experiment was carried out with the objectives to study the effect of integrated application of inorganic fertilizers and organic manures on growth, yield attributes and yield, quality and economics of broccoli.

Materials and Methods
The experiment was conducted in the experimental field of All India Coordinated Research Project on Vegetable, Orissa University of Agriculture and Technology, Bhubaneswar during 2014-15 in a Randomised Block Design with 10 treatments and three replications. The treatments were, Control (T_0), 100% NPK (T_1), 20 tonnes FYM (T_2), 50% NPK + FYM 10

tonnes (T_3), Neem cake @5q/ha (T_4), 50% NPK fertilizer + Neem cake @2.5q/ha (T_5), Vermicompost @ 5t/ha (T_6), 50% NPK fertilizer + Vermicompost @2.5t/ha(T_7), Poultry manure@5t/ha(T_8), 50% N P K fertilizer+ Poultry manure 2.5t/ha (T_9). The soil test based recommended fertiliser dose applied was NPK @ 200: 50: 150 kg/ha.

The initial status of the soil of the research plot was 0.182 % Organic carbon, 187.5 kg of available N, 82.27 kg of available P and 106.76 kg of available K/ha. The soil texture was sandy loam with pH of 7.25.

Four weeks old healthy seedlings of Sprouting Broccoli cv. Shayali were transplanted in the first week of December, 2014 in the spacing of 50 cm x 40 cm. Each treatment was allotted to a plot size of 3.0 m x 2.7 m. Recommended cultural practices were followed to raise a successful crop. Observations were recorded on growth and growth attributing characters, yield and yield attributing characters, physico-chemical parameters and economics on ten numbers of selected plants in each plot excluding the border rows and were subjected to statistical analysis separately according to Panse and Sukhatme (1967). Chemical analysis were done as per AOAC 1970) [1].

Results and Discussion

The present investigation was carried out to study the effect of integrated nutrient management in broccoli. Observations on the plant characters were recorded to study the effect of chemical fertilizers along with different organic manures on growth and growth attributing parameters, yield and yield attributing characters, qualitative characters and economics.

Growth and growth attributing characters

The effects of judicious use of chemical fertilisers and organic manures on growth attributing characters of Sprouting Broccoli cv. Shayali are presented in Table 1. It is evident from the Table that plant height of different treatments ranged from 35.27 cm to 51.56cm. All the treatments showed significantly increased plant height than the control (T_0). However, the optimum plant height of 51.56cm was recorded in T_3 (50% RDF+10 t FYM) followed by T_1 (51.5cm), T_9 (49.01cm), T_7 (48.97cm) and T_5 (48.88cm) which are statistically at par with T_3. Nitrogen being a constituent of amino acids, nucleotides, nucleic acids, a number of co-enzymes, auxins, cytokinins and alkaloids, induces cell elongation, cell enlargement and cell division. The results of present investigation in terms of plant height corroborates the findings of Mohapatra *et al.* (2013) [12] in broccoli, Harish (2009) [7] and Sangeeta Shree*et et al.* (2014) [17] in brinjal. However, leaf number (22.27), leaf length (23.15 cm) and leaf width (18.18 cm) was found to be significantly optimum in T_7 and least in T_0 whereas the highest plant spread (N-S) recorded in the treatment T_9 (50% NPK + 2.5 t poultry manure) with plant spread of 63.41cm followed by T_5 (50 % NPK fertilizer + Neem cake @2.5q/ha). Treatments T_5 (60.85cm), T_3 (60.35cm), T_1 (59.69cm), T_2 (58.28cm) are statistically at par. Control ($T_{0)}$ had the lowest plant spread whereas the plant spread in E-W direction was found to be significantly optimum in Treatment T_3 (50% RDF+10 t FYM) which was statistically at par withT_9, T_5, T_2, T_1. The leaf area of Broccoli with different levels of NPK and organic manures showed significant variations among the treatments. The optimum leaf area recorded was 405.45 cm^2 in T_7 (50 % NPK + Vermicompost @ 2.5kg/ha) followed by 398.28cm^2 in T_9. However, control plot,T_0 recorded lowest leaf area of 259.99 cm^2 only. The increase in leaf length under different treatments can be attributed to the increase in plant spread. Similar findings have also been reported by Pandey *et al.* (2008) [13].

Table 1: Growth attributing characters of Sprouting Broccoli cv. Shayali.

Treatment	Plant height (cm)	Leaf number	Leaf length (cm)	Leaf width (cm)	Plant spread (N-S) (cm)	Plant spread (E-W) (cm)	Leaf area (cm^2)
T_0	31.33	15.47	17.77	14.47	51.10	47.27	259.99
T_1	49.91	20.47	21.59	17.12	61.32	57.40	325.20
T_2	46.15	19.67	20.71	17.46	55.12	56.74	337.60
T_3	54.68	18.37	22.43	17.92	64.30	62.52	388.04
T_4	46.00	18.40	18.60	16.17	57.17	52.29	319.17
T_5	50.79	19.40	22.02	16.78	61.38	59.86	340.50
T_6	48.19	18.20	19.18	17.78	59.40	53.71	317.00
T_7	56.58	22.27	23.15	18.18	61.63	64.91	405.45
T_8	48.97	18.27	19.39	16.60	57.91	55.03	317.03
T_9	51.16	19.20	19.51	16.95	61.45	60.85	398.28
CD (5%)	2.80	2.41	1.84	1.23	4.84	5.26	53.18

Yield and yield attributing characters

It is revealed from Table 2 that the number of days taken to 50% head initiation and head maturity was significantly affected due to application of different treatments. The plots getting 50% recommended dose of NPK + 2.5 tonnes of vermicompost and 50% NPK + 2.5 tonnes of FYM reached 1st to head initiation (50.67 days) and head maturity (51 days). The treatment, $T_1$with recommended dose of fertilizer 200:50:100kg N P K, significantly delayed to head initiation and head maturity. It was also observed by Chaubey *et al.* (2006) [5] in his study on cabbage that higher fertility level favoured the maturity time whereas the process of growth and development was slower at lower fertility level.

It is also evident from the Table that optimum head weight of 327.57gwas obtained in the treatment T_7 (50% NPK + 2.5t vermicompost) which is statistically at par with T_9 (50%NPK + 2.5t poultry manure) and T_3 (50%NPK + 2.5t FYM). Control (T_0) produced the lowest head weight (187.70g)

The maximum volume of head was also obtained in T_7 (596cc) which is significantly superior to all other treatments. Treatment, T_9 and T_3 are significantly at par as per the head volume is concerned. This may be due to increased vegetative growth as induced by integrated nutrient management which might account for increased carbohydrates accumulation as a result of increased photosynthesis.

It was recorded that the diameter of head, head girth and head height were markedly influenced by different treatments. The data shown in Table 2 revealed to record highest head diameter in treatment T_7 (14.16cm) followed by T_9 (12.34) and T_3 (13.83). The lowest head diameter was observed in

control (T_0) containing no manure and no fertilizer. The similar result was also obtained in case of head girth. Treatment T_7 recorded the highest head girth (42.76cm), which is significantly at par with T_3 andT_9.

The height of head was found to be non-significant as is evident from Table 2. Different doses of organic and inorganic fertilizers exerted no effect on height of head. It was also observed by Chaubey *et al*. (2006) [5] in his study on cabbage that higher fertility level favoured the maturity time whereas the process of growth and development was slower at lower fertility level.

A perusal of detailed data Presented in Table 3 indicated that weight of head per plant showed significant variation among the treatments. The maximum head weight (301.83g) was recorded with application of 50% of recommended dose of inorganic nutrients of and 2.5 tonnes of vermicompost (T_7) which was at par with application of 50% of recommended dose of inorganic nutrients +2.5 tonnes of poultry manure (T_9) and treatment containing RDF 50% + 2.5 tonnes of FYM (T_3). The lowest head weight was observed in control (T_0) containing no manure and fertilizer.

The data in the Table 3 also clearly recorded that a wide variation in total yield per plot can be obtained by altering the levels of N, P and K among the treatments. Highest yield per plot (27.03 kg) was obtained from T_3 followed by 26.70 kg in T_2. In T_5, 24.15 kg of tuber per plot was obtained followed by 23.15 kg in T_6, 22.20 kg in T_1 and 18.93 kg in T_4. Lowest yield per plot (18.18kg) was recorded in control. Similarly there was significant variation among the treatments of the total yield of head per hectare. Highest head yield (236.56 t/ha) per hectare was recorded in T_7 followed by T_1 (216.52t/h), T_9 (196.48t/ha), T_3 (194.36 t/ha), T_5 (178.20t/ha) and T_6 (176.96 t/ha). However, lowest yield of 121.80 t/ha was recorded in control plot, T_0. Sharma (2000) [15] in an experiment at Lari (Spiti valley**,** Himachal Pradesh, India) on influence of integrated nutrient management in sprouting broccoli cultivar 'Green Head' concluded that integration of organic and inorganic fertilizers significantly increased the head yield over inorganic fertilizers alone and also over control. Kanwar *et al.* (2002) [9] reported significant increase in curd weight, curd diameter, plant height and curd yield of cauliflower with application of 50% NPK + organic manure.

Table 2: Yield attributing characters of Sprouting Broccoli cv. Shayali.

Treatment	Days to 50% head initiation	Days to 1st harvest	Head weight (g)	Head girth (cm)	Head diameter (cm)	Head height (cm)	Head volume (cm^3)
T_0	61.67	62.00	187.70	32.84	10.67	13.91	295.67
T_1	51.00	53.00	263.78	39.94	12.33	14.78	325.67
T_2	55.33	56.00	242.23	36.07	12.12	15.06	403.33
T_3	50.67	52.33	308.19	41.17	13.83	15.04	518.33
T_4	55.33	55.33	191.70	35.32	12.02	14.25	391.67
T_5	54.67	54.67	226.95	38.13	12.89	15.38	371.00
T_6	54.00	56.33	212.19	37.56	11.57	14.24	436.00
T_7	50.67	51.00	327.57	42.76	14.16	15.11	595.67
T_8	55.00	55.00	202.78	37.33	12.55	14.89	482.67
T_9	53.00	54.00	282.42	41.49	12.34	14.50	546.00
CD (5%)	4.33	3.96	37.40	2.73	1.31	1.06	30.83

Table 3: Yield of Sprouting Broccoli cv. Shayali.

Treatment	Gross head weight (g)	Net head weight (g)	Yield (marketable) (kg/plot)	Yield (gross) (Kg/plot)	Net Yield (q/ha)	Gross yield(q/ha)
T_0	210.32	162.54	5.98	8.13	89.56	121.80
T_1	271.85	199.08	12.99	17.61	160.39	216.52
T_2	251.93	184.28	9.14	12.59	112.81	154.63
T_3	295.28	211.43	11.33	15.82	139.83	194.36
T_4	240.70	184.65	7.80	10.16	96.23	125.09
T_5	259.43	183.68	10.24	14.46	126.39	178.20
T_6	238.18	173.35	10.46	14.37	129.17	176.96
T_7	301.83	210.53	13.25	18.99	163.63	233.56
T_8	259.45	187.08	8.87	12.30	109.44	151.02
T_9	279.65	202.20	11.53	15.94	142.38	196.48
CD (5%)	31.89	20.68	1.61	1.78	19.90	26.86

Quality parameters

A perusal of data depicted in Table 4 recorded significant variation among the treatments regarding dry matter percentage of head. It was found to be highest in T_1 (11.77%) followed by 11.12% in T_7. The lowest percentage of dry matter was recorded in T_0 (7.49%). Similar results were also noted by Kumar *et al*. (2013) in broccoli.

The study on vitamin C content indicated that the ascorbic acid content in head decreased significantly with application of higher dose of nutrients. The highest ascorbic acid content (80.24mg/g) in head was recorded in the treatment T_7 (50% N: P: K + vermicompost @2.5t/ha) followed by T_2 with 79.87mg/g of ascorbic acid per 100g of juice. The lowest (65.28mg/g) ascorbic acid was found in control T_0. These findings are in close agreement with those reported Guo *et al*. (2004) in cabbage, Bambal *et al.* (1998) [3] in cauliflower.

There is a general observation that organically managed crop have usually higher vitamin C than the conventional fertilized crop because when a plant is exposed with more nitrogen, it increases protein production and reduces carbohydrates synthesis. Since vitamin C is synthesized from carbohydrates, its levels are also reduced. In case of organically managed soil, plants are generally exposed with comparatively lower amount of nitrogen and several plant nutrients are released slowly over time. Therefore, organic crop would be expected to maintain higher vitamin 'C' and carbohydrates and less protein as reported by Bahadur *et al*. (2003) [2] in broccoli. Chaterjee *et al.* (2005) [4] studied the effect of organic

nutrition in sprouting broccoli var. Green Country with different treatments of biofertilizers *viz.*, *Azotobacter*, Phosphate Solubilizers, Potashmobilizers and Vesicular-Arbuscular- Mycorrhizae and recoded that the organic sources of nutrition produced significantly better quality of curd parameters than inorganic sources.

Table 4: Quality parameters of Sprouting Broccoli cv. Shayali.

Treatment	Vit c content (mg/g)	Dry matter content (%)
T_0	65.28	7.49
T_1	75.49	11.11
T_2	72.87	10.00
T_3	79.43	10.55
T_4	70.75	8.69
T_5	77.90	9.12
T_6	72.24	8.99
T_7	80.24	11.77
T_8	71.48	8.13
T_9	76.44	10.76
CD (5%)	2.88	1.06

Economics of production

The economics of different treatments on sprouting broccoli with respect to gross and net returns per hectare and benefit cost ratio have been presented in Table 5.

It was revealed that the treatment T_7 (50% NPK + 2.5t vermicompost) resulted in highest gross returns of Rs.7,00,680/ha followed by treatment T_1 i.e., 100% RDF (Rs. 6,49,560/ha) followed by T_9 *i.e.*, 50% NPK + 2.5 tonnes of poultry manure (Rs. 5,89,440/ha). The lowest gross returns of Rs. 3,65,400 were recorded in T_0 (control).

The highest net returns of Rs. 5,25,510/ha and benefit cost ratio of 4.0 were obtained in T_7 (50% NPK + 2.5 tonnes of vermicompost), followed by treatment T_1 (Rs.5,11,356 /ha and 4.7). Lowest net return was recorded in the control, T_0 (Rs. 2,35,375/ha). Treatments T_8 (5 tonnes of poultry manure), T_6 (5 tonnes of vermicompost) and T_2 (20 tonnes of FYM) resulted in low benefit cost ratio of 2.3, 2.7 and 2.7, respectively. Parmar and Sharma (2001) [14] studied the effect of organic manures with four levels of nitrogen in cauliflower under mid-hills of western Himalayas at Bajaura (Kullu). It was concluded that application of 100% recommended NPK along with 30t/ha farmyard manure was most suitable treatment combination for cauliflower which could generate net income of Rs.62, 800 per hectare.

Table 5: Economics of production of Sprouting Broccoli cv. Shayali.

Treatment	Cost of cultivation (Rs./ha)	Net income (Rs./ha)	Gross income (Rs./ha)	B:C ratio
T_0	1,30,025	2,35,375	3,65,400	2.8
T_1	1,38,204	5,11,356	6,49,560	4.7
T_2	1,71,811	2,92,079	4,63,890	2.7
T_3	1,57,589	4,25,491	5,83,080	3.7
T_4	1,34,025	2,41,245	3,75,270	2.8
T_5	1,44,486	3,90,114	5,34,600	3.7
T_6	1,96,622	3,34,258	5,30,880	2.7
T_7	1,75,170	5,25,510	7,00,680	4.0
T_8	1,96,983	2,56,077	4,53,060	2.3
T_9	1,68,411	4,21,029	5,89,440	3.5

N. B.: Sale rate of sprouting broccoli @ Rs. 30/kg.

References

1. AOAC. Official method of Analysis of the Association of Official Analytical Chemists, Association of Official Analytical Chemists. Washington, DC. 1970, 101p
2. Bahadur A, Singh J, Upadhaya AK. Effect of manures and bio fertilizers on growth, yield and quality attributes of broccoli (*Brassica oleracea* L. var. *italic* Plenck.), Vegetable Science. 2003; 30(2):192-194.
3. Bambal AS, Verma RM, Panchbhai DM, Maharkar VK, Khankhane RN. Effect of bio fertilizers and nitrogen levels on growth and yield of cauliflower (*Brassica oleracea* var. botrytis. L), Orissa Journal of Horticulture. 1998; 26:14-17.
4. Chaterjee B, Ghanti P, Thapa U, Tripathy P. Effect of organic nutrition in sprouting broccoli (*Brassica oleracea* L. var. italica Plenck.), Vegetable Science. 2005; 32(1):51-54.
5. Chaubey T, Srivastava BK, Singh M, Chaubey PK, Rai M. Influence of fertility levels and seasons on maturity and morphological traits of cabbage, Vegetable Science. 2006; 33(1):29-33.
6. Guo X, Hongbin Z, Wenjun W, Shuya Y, Ji W, Lishu X. Effect of different rates of nitrogen and potassium on the yield and quality of cabbage, Plant Nutrition and Fertilizer Science. 2004; 10(2):161-166.
7. Harish DK. Studies on organic brinjal (Solanum melongena L.) production. Thesis submitted to University of Agricultural Sciences, Dharwad for award of M. Sc. (Ag.) degree, 2009.
8. Hazra CR. Organic manures for sustainable agriculture. Journal of Agricultural Issue. 2007; 12(1):1-10.
9. Kanwar K, Paliyal SS, Nandal TR. Integrated nutrient management in cauliflower (Pusa Snowball K-1), Research on Crops. 2002; 3(3):579-589.
10. Kumar M, Kumari P, Ojha RK, Kumar A, Prasad KK. Effect of Temperature on Growth and Yield of Broccoli under INM, Annals of Horticulture. 2013; 6(1):70.
11. Kumar M, Das B, Prasad KK, Kumar P. Effect of Integrated Nutrient Management on Growth and Yield of *Broccoli* (*Brassica oleracea* var. italica) under Jharkhand Conditions, Vegetable Science. 2013; 40(1):117-120.
12. Mohapatra SK, Munsi PS, Mahapatra PN. Effect of Integrated Nutrient Management on Growth, Yield and Economics of *Broccoli* (*Brassica oleracea* L. Var. italic Plenck.), Vegetable Science. 2013; 40(1):69-72.
13. Pandey A, Kumar S. Potential of *Azotobacter* and *Azospirillium* as biofertilizer for upland agriculture A review. Journal of Science and Industrial Research. 1989; 48:134-144.
14. Parmar DK, Sharma V. Integrated nutrient management in cauliflower under mid-hills of western Himalayas. Annual Agricultural Research New Series. 2001; 22(3):432-433.
15. Sharma KC. Influence of Integrated Nutrient management on yield and economics of broccoli (*Brassicae oleracea* L.var. italica Plenck.) under cold temperate conditions, Vegetable Science. 2000; 27(1):62-63.
16. Sharma PD. Nutrient management: challenges and options, Journal of the Indian Society of Soil Science. 2008; 55:395-403.
17. Sangeeta Shree, Singh VK, Kumar R. Effect of integrated nutrient management on yield and quality of cauliflower (brassica oleracea var. botrytis l.), the bioscan. 2014; 9(3):1053-1058.