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Influence of bulky organic inputs on growth, yield and biochemical attributes of broccoli (*Brassica oleracea* L. var*. italica*)

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ABSTRACT

Broccoli (Brassica oleracea L. *var. italica) belonging to the family Brassicaceae or Cruciferae is an important cool season crop after cabbage and cauliflower that requires moderate temperatures for optimum growth and quality; performs poorly in hot weather. Organic broccoli farming offers one of the most sustainable farming methods with recurring benefits to not only long term soil health but also provides lasting stability in production by rendering better confrontation against different biotic and abiotic stresses. Two years field experiment was conducted during rabi seasons of 2017-2018 and 2019-2020 at Instructional cum Research Farm, Department of Horticulture, School of Agricultural Sciences, Nagaland University, Medziphema campus, Nagaland. The experiment comprised of ten treatments with cultivar calabrese were laid out in randomized block design replicated by three times. Among the various treatments, vermicompost @ 5 t ha^{-1} recorded maximum plant height (36.41 cm), stalk length (32.22 cm), plant spread (36.94 cm), dry recovery (34.42%), head diameter (14.66 cm), head size (204.87 cm^2), gross head weight (738.16 g), net head weight (439.16 g) and projected yield (12.17 t ha^{-1}). Broccoli plant applied in different doses of vermicompost (2.5 to 5 t ha^{-1}) performed well significantly as compared to other bulky organic inputs in most of biochemical characters also viz. TSS (4.26 to 4.29 ^{0}Brix), vit-C (104.18 to 106.53 mg 100 g^{-1} pulp) and crude protein (2.44 to 2.65%).*

Key words: Broccoli, growth, organic inputs, yield, biochemical composition

INTRODUCTION

Vegetables play a key role in neutralizing the acids produced during digestion of high protein and fatty foods and also provide valuable roughages which help in movement of food in intestine. Vegetable cultivation is gaining momentum due to their productivity, use in diversification, nutritional and medicinal values, value addition and export potential. Vegetables are recognized as health food globally and play an important role in overcoming micronutrient deficiencies and providing opportunities of higher farm income. India is a diversified country with different agro climatic zones ranging from cool temperate to hot tropical zones on which a large number of vegetable crops are grown. India's share of the world vegetable market is around 14%. It produces 189.464 million tones of vegetables from an area of 10.3 million hectares (Anon, 2020). Among the vegetable crops, broccoli stands out because it is very nutritious, rich in minerals, delicious and has antioxidant properties. Watt (1983) stated broccoli is more nutritious than any other cole crops such as cabbage, cauliflower and kohlrabi. The crop contains vitamin A (130 times and 22 times higher than cauliflower and cabbage, respectively), thiamin, riboflavin, niacin, vitamin-C and minerals like Ca, P, K and Fe (Kumar *et al.,* 2011). Cultivation of broccoli was started commercially in1923 (Decoteau, 2000). However, broccoli production is very low compared to other cole crops cultivating foothill region of Nagaland. So, adopting the principles with bulky organic inputs from different sources which are locally available. Northeast India is considered as the best organic farming hot spot of India and the possibility of enhancing the farming income of the rural people through organic means are immense. The organic farming can be one of the solutions to improve the socioeconomic condition of this hilly region as only the locally available farmyard manures (cow dung manure, pig manure, poultry manure and vermicompost) are used. Due to the increasing demand for organic products all over the world, the vegetable growers can receive higher income from their produce if grown organically. Considering the above aspects, the

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research work was carried out to assess the effect of different sources of bulky organic inputs on growth, yield and biochemical attributes of broccoli in north eastern hilly region and particularly foot hill condition of Nagaland.

MATERIALS AND METHODS

The experiment was carried out at instructional cum research farm, SAS, Nagaland University, Medziphema campus, Nagaland in rabi seasons of 2017-2018 and 2019-2020 for two years. Geographically, the research area is situated at 25°45'43" N latitude and 95°53'04" E latitude at an elevation of 305.8 m above mean sea level. Medziphema lies in a sub-tropical subhumid agroclimatic region with temperature ranging between 12˚C in winter and 32˚C in summer. The annual rainfall ranges from 200 cm to 270 cm spread over six months from April to September, while the remaining period from October to March is virtually dry. In general, the soil type of the experimental site was sandy loam in texture and well drained. The texture and fertility of the soil were ascertained by taking soil samples from a depth of 15 cm. The soil was found to be acidic (5.3) with high organic carbon content (15g kg^{-1}). The experiment with cultivar calabrese was consisted of ten treatments *viz*. T_1: FYM @ 25 t ha^{-1}, T_2: poultry manure @ 5 t ha^{-1}, T_3: vermicompost @ 5 t ha^{-1}, T_4: FYM @ 18.75 t ha^{-1}, T_5: poultry manure @ 3.75 t ha^{-1}, T_6: vermicompost @ 3.75 t ha^{-1}, T_7: FYM @ 12.5 t ha^{-1}, T_8: poultry manure @ 2.5 t ha^{-1}, T_9: vermicompost @ 2.5 t ha^{-1} and T_{10}: control using randomized block design (RBD) with three replications. Healthy and uniform 30 days old seedlings were transplanted in main field with a spacing of 60 cm x 45 cm. The growth parameters (plant height, number of leaves $plant^{-1}$, stalk length, plant spread, dry recovery percent), yield (head diameter and size, gross head weight, head compactness) and biochemical attributes (TSS, vit-C, crude protein and chlorophyll content of leaves) were observed. Total soluble solids (TSS) were determined with the help of hand refractometer calibrated in ^{0}Brix at 20 ^{0}C with necessary correction factor. Ascorbic acid (vit-C) was estimated using 2, 6-dichlorophenol indophenols dye titration method following the standard procedure of A.O.A.C (1995). Crude protein was determined by adopting standard procedure of nitrogen estimation of pulp (kjeldahl method) and worked out using the formula: % crude protein= % nitrogen content × 6.25. Head juice pH was estimated using the hand pH meter. Chorophyll content of leaves was estimated by optical density at 503 nm using spectrophotometer. Petroleum ether was used as blank. Two years pooled data were collected from five plants randomly selected from each unit plot and the mean data of each character statistically analysed by adopting analysis of variance and the treatment variance was tested against error mean square by applying Fischer Snedecore 'F' test of probability at 0.5% level of significance (Panse and Sukhatme, 1989).

RESULTS AND DISCUSSION

Growth attributes

Bulky organic inputs like FYM, vermicompost and poultry manure in different doses were found to have a significant effect on growth behaviour of broccoli as compared to control (Table 1). The plants applied with vermicompost @ 2.5 to 5t ha^{-1} reasonably increased plant height (35.12 to 36.41 cm), stalk length (30.35 to 32.22 cm) and leaf area index (38.98 to 41.65) which was statistically identical among the plants received with different doses of vermicompost in experiment. FYM @ 25 t ha^{-1} also improved the plant height (34.53 cm) and stalk length (29.33 cm) as compared to control (27.59 cm and 22.23 cm, respectively). Longmatula *et al.* (2021) recorded maximum plant height and branches using 50% NPK as inorganics + 50% vermicompost in french bean. The number of leaves $plant^{-1}$ (15.35 to 18.28) was also increased due to application of organic inputs as compared to control (12.80). Maximum leaf production in okra was attributed to beneficial effect using poultry manure (Umoetok *et al.,* 2007). The plants treated with organic inputs significantly improved the plant spread (34.78 to 44.76 cm) as compared to untreated control (32.31 cm) but the highest plant spread (44.76 cm) was noticed in poultry manure @ 5 t ha^{-1}. The maximum dry recovery percentage (34.42 %) of plant was recorded in vermicompost @ 5 t ha^{-1} followed by FYM @ 25 t ha^{-1} (32.27%) while the lowest was in control (26.90 %). The increase in plant growth with vermicompost application might be attributed to

its ability to enhance nutrient availability through mineralization and humification that improved soil health and availability of soil microbial agents particularly fungi, bacteria and actinomycetes that could make it suitable for plant growth and photosynthesis (Sarkar and Ibotui, 2017, Chaudhary *et al.,* 2012). The improvement in growth characters was also reported by Mal *et al.* (2015) in broccoli using vermicompost; Singh *et al.* (2017) in carrot using FYM + vermicompost + PSB; Anil *et al.* (2017) in onion using RDF (25%) + VAM + vermicompost (50%) + azotobacter +zinc and Shapla *et al.* (2014) in broccoli using vermicompost @13t ha^{-1}

Table1: Influence of bulky organic inputs on growth attributes of broccoli

Treatments	Plant height (cm)	No. of leaves $plant^{-1}$	Stalk length (cm)	Leaf Area Index	Plant spread (cm)	Dry recovery (%)
T_1	34.53	17.42	29.33	38.88	42.72	32.27
T_2	32.47	18.28	28.28	35.10	44.76	30.07
T_3	36.41	16.77	32.22	41.65	36.94	34.42
T_4	32.37	16.79	26.36	32.92	42.46	31.11
T_5	31.32	17.06	25.32	35.90	43.42	29.47
T_6	36.27	16.72	32.15	40.82	35.83	30.97
T_7	31.30	15.71	26.29	31.86	41.21	30.81
T_8	29.77	15.35	25.18	34.82	42.21	28.07
T_9	35.12	15.85	30.35	38.98	34.78	31.87
T_{10}	27.59	12.80	22.23	29.10	32.31	26.90
SEm ±	1.03	0.56	0.98	1.47	1.08	1.02
CD (P=0.05)	2.97	1.62	2.81	4.36	3.09	3.03

T_1: FYM @ 25 t ha^{-1}, T_2: poultry manure @ 5 t ha^{-1}, T_3: vermicompost @ 5 t ha^{-1}, T_4: FYM @ 18.75 t ha^{-1}, T_5: poultry manure @ 3.75 t ha^{-1}, T_6: vermicompost @ 3.75 t ha^{-1}, T_7: FYM @ 12.5 t ha^{-1}, T_8: poultry manure @ 2.5 t ha^{-1}, T_9: vermicompost @ 2.5 t ha^{-1} and T_{10}: control

Yield attributes

Significant variation was found in yield and yield attributing characters like size, weight and head compactness in broccoli due to different organic nutrient sources (Table 2). The maximum basic head diameter (14.66 cm) and head size (204.87 cm^2) was obtained in plant treated with vermicompost @ 5 t ha^{-1} followed by vermicompost @ 3.75 t ha^{-1} (13.48 cm and 175.13 cm^2, respectively) while the lowest was noticed in control (8.81 cm and 151.49 cm^2, respectively). The maximum head compactness (11.46) was noticed by FYM @ 25 t ha^{-1} followed by poultry manure @ 5 t ha^{-1} (10.46) while the lowest was in control (5.87). Similar results were also reported by Magd *et al.* (2006) using 100% poultry manure (80 N unit/fed.) in sprouting broccoli and Sarkar *et al.* (2022) in local red ginger using poultry manure @ 3 t ha^{-1}. Maximum gross head weight (738.16 g) and net head weight (439.16 g) were obtained in vermicompost @ 5 t ha^{-1} followed by FYM @ 25 t ha^{-1} with 589.03 g and 387.99 g, respectively. Increase in head weight might be due to higher and continuous nutrient availability from organic inputs at different stages of growth. It might have resulted in better translocation of carbohydrates to storage organs which influenced the weight of lateral heads. Similar results in yield attributing characters were also observed by Meena *et al.* (2017) in broccoli using 25% RDF + 50% vermicompost + biocontrol agents; Chavan *et al.* (2016) in onion using 100% vermicompost and Walling *et al.* (2022) in broccoli with vermicompost @ 5 t ha^{-1}. The projected yield varied significantly due to different treatments and ranged in between 5.42 t and 12.17 t ha^{-1}. Application of vermicompost @ 5 t ha^{-1} recorded the highest yield (12.17 t ha^{-1}) trailed by FYM @ 25 t ha^{-1} (10.79 t ha^{-1}), while the lowest yield was observed in control (5.42 t ha^{-1}). Mal *et al.* (2015) also found maximum yield in sprouting broccoli using vermicompost @ 10 t ha^{-1}. Bulky organic inputs help in better root proliferation, which facilitate more uptake of nutrients and water, higher leaf number and more area responsible for effective photosynthesis and enhanced food accumulation. Vermicompost is considered as an excellent product since it is homogenous, rich in plant growth hormones, soil enzymes, greater microbial population and tends to hold more nutrients over a longer period without adverse impact on environment (Sarkar and Ibotui, 2017).

Table 2: Influence of bulky organic inputs on yield and yield attributing characters of broccoli

Treatments	Head diameter (cm)	Head size (cm^2)	Head compactness	Gross head weight (g)	Net head weight (g)	Projected yield (t ha^{-1})
T_1	12.64	151.49	11.46	589.03	387.99	10.79
T_2	11.46	126.34	10.46	481.84	331.25	9.19
T_3	14.66	204.87	10.04	738.16	439.16	12.17
T_4	11.68	126.90	10.29	455.60	358.36	9.93
T_5	10.50	104.85	10.19	330.72	299.36	8.27
T_6	13.48	175.13	9.86	489.04	388.22	10.75
T_7	10.50	105.11	7.03	355.45	308.75	8.56
T_8	9.78	85.61	9.47	294.44	208.48	5.78
T_9	12.46	138.26	7.39	335.43	223.88	6.21
T_{10}	8.81	70.42	5.87	257.58	195.77	5.42
SEm ±	0.17	1.77	0.22	5.56	4.35	0.39
CD (P=0.05)	0.49	5.07	0.62	15.94	12.46	1.12

Biochemical attributes

Application of different sources of bulky organic inputs significantly influenced the biochemical composition of broccoli (Table 3). The plants treated with vermicompost @ 5 t ha^{-1} showed the highest level of T.S.S (4.29 ^{0}Brix) which was statistically at par with vermicompost @ 3.75 t ha^{-1} (4.28 ^{0}Brix) and vermicompost @ 2.5 t ha^{-1} (4.26 ^{0}Brix) and the lowest TSS was noticed in control plant (3.11 ^{0}Brix). Mishra *et al.* (2014) recorded the highest TSS content in knolkhol applying 100 % NPK+ vermicompost @ 2.5 t ha^{-1}+ biofertilizer. It may be due to direct effect of vermicompost application that provides a good source of mineral and nutrients to plant body. All the organic inputs (FYM, poultry manure and vermicompost) gave a good respond in vit-C content of broccoli and it varied in between 97.84 mg and 106.53 mg $100g^{-1}$ pulp. The maximum vit-C (106.53 mg $100g^{-1}$ pulp) was noticed in plant treated with vermicompost @ 5 t ha^{-1} while the lowest was in control (97.84 mg $100g^{-1}$ pulp). Improvement of ascorbic acid in chinese cabbage by cow manure vermicompost was also reported by Wang *et al.* (2010).

Table 3: Influence of bulky organic inputs on biochemical composition of broccoli

Treatments	TSS (^{0}Brix)	Vit-C (mg $100g^{-1}$ pulp)	Crude protein (%)	pH of head	Chlorophyll of leaf (mg g^{-1})
T_1	3.77	103.26	2.38	4.89	3.26
T_2	3.67	102.58	2.14	4.80	2.64
T_3	4.29	106.53	2.65	5.14	3.95
T_4	3.72	102.35	2.24	4.67	3.05
T_5	3.64	101.54	2.06	4.85	2.62
T_6	4.28	104.92	2.55	5.07	3.91
T_7	3.67	101.21	2.19	4.72	2.72
T_8	3.61	99.96	2.02	4.76	2.56
T_9	4.26	104.18	2.44	4.84	3.89
T_{10}	3.11	97.84	1.12	4.32	2.26
SEm ±	0.09	1.41	0.08	0.05	0.09
CD (P=0.05)	0.27	4.03	0.22	0.13	0.25

Application of different sources of nutrients increased the crude protein content (2.02 to 2.65%) as compared to control (1.12%) in broccoli. Maximum crude protein in head was noticed in vermicompost treated plants (2.44 to 2.65%) trailed by FYM @ 25 t ha^{-1} (2.38%). The primary metabolite nitrogen through application of vermicompost might be resulted in high nitrogen uptake by plants that could lead to high protein content (Mishra *et al.,* 2014). The findings were in accordance with Divya (2010) in knolkhol and Padamwar and Dakore (2010) in

cole crops using organic inputs along with RDF. The recorded pH of head ranged from 4.32 to 5.14 due to different teeatments. Disparity in pH of head showed due to different sources of nutrient application in broccoli. The total chlorophyll content in leaf was also significantly influenced by application of bulky organic inputs and varied in between 2.26 mg and 3.95 mg g^{-1} in green leaf. The range of chlorophyll (3.91 to 3.95 mg g^{-1}) in leaf was found to improve applying all level of vermicompost. Similar findings were reported by Tanushree *et al.* (2017) in mustard using 75% NPK + vermicompost @ 2.5 t ha^{-1}. The impact of leaf chlorophyll content plays a vital role in photosynthesis and ultimately improve the head quality.

Based on the findings, it can be concluded from the experiment that the broccoli plants treated with vermicompost (2.5 to 5 t ha^{-1}) exceptionally enhanced the vegetative growth, optimum yield and best quality head as compared to other treatments.

REFERENCES

Anil, K., Ram, R.B., Maji, S., Kishor, S., Govind, R.Y. and Meena, K.R. (2017) Effect of organic manures, biofertilizers and micronutrients on growth, yield and quality of onion (*Allium cepa* L.). *International Journal of Agricultural Sciences* **13** (2): 236-241.

Anonymous (2020) National Horticulture Database. Department of Agriculture and Cooperation, Ministry of Agriculture, Govt. of India, New Delhi, India.

A.O.A.C. (1995) *Official Method of Analysis*. Association of official analytical chemist, Washington D.C, USA, 14th Edn.

Chavan, D.L., Chavan, N.H. and Choudhary, S.M. (2016) Effect of different organic manures on growth and yield of onion (*Allium cepa* L.). *The Bioscan* **11** (4): 2529-2532.

Choudhary, S., Soni, A.K. and Jat, N.K. (2012) Effect of organic and inorganic sources of nutrients on growth, yield and quality of sprouting broccoli cv. Cbh-1. *Indian Journal of Horticulture* **69** (4): 550-554.

Decoteau, D.R. (2000) *Vegetable Crops*. Upper Rever Company, New Jersey, USA.

Divya, C.V. (2010) Studies on organic production techniques in Knolkhol (*Brassica oleracea* var. gongylodes L.). *M.Sc. thesis*, University of Agricultural Science, Dharwad, Karnataka, India.

Kumar, M., Das, B., Prasad, K.K. and Kumar, P. (2011) Effect of integrated nutrient management on quality of broccoli (*Brassica oleracea* var. *italica*) cv. fiesta under Jharkhand conditions. *The Asian Journal of Horticulture* **6**: 388-392.

Longmatula, Kanaujia, S.P. and Changkiri, M. (2021) Response of French bean (*Phaseolus vulgaris*) to integrated nutrient management on acid alfisol of Nagaland. *Annals of Plant and Soil Research* **23** (1):61-65.

Magd, M.M.A.E, Bassiony, A.M.E and Fawzy, Z.F. (2006) Effect of organic manure with or without chemical fertilizers on growth, yield and quality of some varieties of broccoli plants. *Journal of Applied Sciences Research* **2** (10): 791-798.

Mal, D., Chatterjee, R. and Nimbalkar, K.H. (**2015)** Effect of vermicompost and inorganic fertilizers on growth, yield and quality of sprouting broccoli (Brassica oleracea L. var. italica plenck). *International Journal of Bio-resource and Stress Management* **5** (4): 507-512.

Meena, K., Ram, R.B., Meena, M.L., Meena, J.K. and Meena, D.C. (2017) Effect of organic manures and bio-fertilizers on growth, yield and quality of broccoli (*Brassica oleracea* var. *italica* Plenck.) cv. KTS-1. *Chemical Science Review and Letters* **6** (24): 2153-2158.

Mishra, P.P., Das, A.K. and Mishra, N. (2014) Effect of integrated nutrient management on yield, quality and economics of knolkhol (*Brassica oleracea* L. cv. *Gongylodes*). *The Asian Journal of Horticulture* **9** (2):382-385.

Padamwar, S.B. and Dakore, H.G. (2010) Role of vermicompost in enhancing nutritional value of some cole crops. *International Journal Plant Sciences* **5** (1): 397-398.

Panse, V.G. and Sukhatme, P.V. (1989) Statistical Methods for Agricultural Workers. ICAR, New Delhi.

Sarkar, A. and Ibotui (2017) Efficacy of vermicompost and azotobacter on growth, yield and quality of strawberry cv. Festival. *Journal of Soils and Crops* **27** (2): 1-5.

Sarkar, A., Ozukum, M., Kanaujia, S.P. and Mathukmi, K. (2022) Influence of organic inputs on yield and quality of ginger cv. Nagaland Local Red. *Journal of Bio Innovation* **11** (3): 706-716.

Shapla, S.A., Hussain, M.A., Mandal, M.S.H., Mehraj, H. and Jamal Uddin, A.F.M. (2014) Growth and yield of broccoli (*Brassica oleracea* var. *italica* L.) to organic manures. *International Journal of Sustainable Crop Production* **9** (2): 29-32.

Singh, D.P., Kumar, S., Maji, S. and Pandey, V.K. (2017) Studies on integrated nutrient management on growth, yield and quality of carrot (*Daucus Carota* L.). *International Journal of Agriculture Sciences* **8** (51): 2187-2188.

Tanushree, M., Datta, J.K. and Mondal, N.K. (2017) Chemical fertilizer in conjunction with biofertilizer and vermicompost induced changes in morpho-physiological and bio-chemical traits of mustard crop. *Journal of the Saudi Society of Agricultural Sciences* **16** (2): 135-144.

Umoetok S.B.A, Uko A.E., Archibong, B.E., Ukeh, D.A. and Udo, I.A. (2007) Effects of application of inorganic fertilizer and poultry manure on insect pests and yield of soybeans (*Glycine max* L) in the rainforest of Nigeria. *Journal of Food, Agriculture and Environment* **5** (2):149-152.

Walling, I., Kanaujia, S.P. and Changkiri, M. (2022) Response of broccoli (*Brassica oleracea* var. *italica*) to integrated nutrient management. *Annals of Plant and Soil Research* **24** (1): 106-109.

Wang, D., Wang Q.S.X., Wei, M., Hu, J., Liu, J. and Yang. F. (2010) Influence of cow manure vermicompost on the growth, metabolite contents, and antioxidant activities of Chinese cabbage (*Brassica campestris ssp. chinensis*). *Biology and Fertility of Soils* **46**: 689-696.

Watt, B.K. (1983) *Nutritive Value of Fruits and Vegetables*. USAID, Hand Book, An Avi Book Published by Van Nostrand Reinhold, New York.