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EFFECTS OF ORGANIC AND INORGANIC SOURCES OF NUTRIENT ON YIELD, QUALITY AND SHELF LIFE OF BROCCOLI

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ABSTRACT

The study was conducted at Jashore Sadar Upazila, Bangladesh during 2019-20 and 2020-21 to evaluate the effects of organic and inorganic nutrient sources on yield, quality and shelf life of broccoli through Randomized Complete Block Design with three replications and ten treatments which were: T_1 = Soil test based 100% NPK, T_2 = Vermicompost 4 t ha^{-1} + soil test based 50% NPK, T_3 = Vermicompost 2 t ha^{-1} + 100% NPK, T_4 =Tricho-compost 2 t ha^{-1} + 100% NPK, T_5=FYM 6 t ha^{-1} + 100% NPK, T_6 = Tricho-compost 4 t ha^{-1} + 50% NPK, T_7 =FYM 12 t ha^{-1} + 50% NPK, T_8= Vermicompost 1 t ha^{-1} + 125% NPK, T_9= Tricho-compost 1 t ha^{-1} + 125% NPK, T_{10}= FYM 3 t ha^{-1}+125% NPK. Completely Randomized Design was designed to determine the shelf life of broccoli with three replications considering three factors; (i) Organic and inorganic nutrient sources; (ii) storage materials at room temperature (iii) storage materials at cold storage. Findings revealed that treatment T_3 produced significantly maximum marketable curd yield 30.57 and 30.23 t ha-^{1} and the highest Benefit Cost Ratio (3.70 and 3.66) in the respective years. The treatment T_2 effectively increased post-harvest quality attributes and also recorded the highest shelf life 8.36 and 8.55 days at room temperature (14-24^0 C with RH 60-65%), 26.33 and 27.25 days at cold storage (4° C with RH 90-95%) condition using High -Density Polyethylene (HDP; 15 micron) vacuum pack during the years of 2019-20 and 2020-21 respectively.

Contribution/Originality: This study is one of very few studies which have investigated to evaluate pre-harvest foliar application effects of mineral nutrients on yield, quality and shelf life of broccoli. As a new concept, the study is original.

1. INTRODUCTION

Broccoli is one of the most important high value and nutrient rich vegetables of Cole crops belongs to the family Brassicaceae. Broccoli has a reputation as a supper food and it is known to be a healthy and delectable vegetable which is

wealthy in many supplements. Broccoli is a nutritional powerhouse full of vitamins, minerals, fibers and antioxidants that support many dimensions of human health [1-3]. Broccoli is also considered a low Glycemic Index (GI=10) wonder food for diabetics [4]. Global production of broccoli was 27 million tons in 2019. Out of this, 73% broccoli production accounted by China and India. The rest of production supplemented by USA, Mexico, Spain, Italy, Turkey, Bangladesh, Poland and France [5]. Farmers of Bangladesh are very much interested to produce and extent broccoli for its high value.

Application of balanced fertilizers is essential to produce high quality and potential yield of broccoli for getting maximum returns [6]. Most of the farmers in Bangladesh are not aware of the use of balanced fertilizers and they produce different vegetables without maintaining proper dose of fertilizers to test the soil. Generally, to get higher yield the farmers are indiscriminately using chemical fertilizers without addition of sufficient quantities of organic manures which are responsible for the improvement of soil health including vegetables high value and shelf life [7]. Only chemical fertilizers may accelerate the crops yield initially but it has adverse effects later on Gupta, et al. [8]. On the other hand, organic manure has the capability to meet up the need based essential plant nutrients for maintain the quality attributes as well as improved properties of soil health [9]. Organic manures viz., Tricho-compost, Vermicompost and FarmYard Manure (FYM) which are able to maximize the crop's yield and protect from devastating pests and environmental pollution resulting researchers interest on the use of organic manures avoiding synthetic chemicals. Therefore, use of organic fertilizers combined with inorganic fertilizers leads to higher yield, better quality, and increased shelf life and also improves soil health.

Preservation capability of broccoli is comparatively poor than other Cole crops like cauliflower. Yellowing is the main problem in post-harvest life of broccoli which leads to poor marketability due to consumer dislike [10]. Farmers are not aware about the shelf life of broccoli. They apply huge amount of chemical fertilizers and pesticides often overdoses, more frequencies and even mixing of two or more chemicals as cocktail formulation to achieve better yield during production [11]. Consequently, the storage longevity of broccoli reduces spontaneously. In this circumstance, it is essential to improve post- harvest quality and lingering the shelf life of the said crop. The investigator opined that application of appropriate organic manures viz. Vermicompost, Tricho-compost and Farm Yard Manure (FYM) in combination with chemical fertilizers is one of the best options to maintain the shelf life of broccoli. Packaging materials help not only to keep these vegetables from drying out but also to preserve nutritive value, flavour, texture and color [12]. Polyethylene bag delayed color change due to synchronized effect of increased humidity and fluctuated atmosphere composition [13]. Vacuum pack with low temperature (storage at 4^0 C with 95% RH) is the effective technique to maintain the shelf life of broccoli [14]. Hence, this study also focuses on low cost technology like, Low- Density Polyethylene (LDP; 35 micron) bag, High -Density Polyethylene (HDP; 15 micron) vacuum pack, 2% egg shell powder and 2% ascorbic acid solution to sustain the shelf life of broccoli both at room temperature and cold storage condition. Very few investigators studied partially on the above context. Considering above all, the investigator would like to take an in -depth study on "The effects of Organic and Inorganic Sources of Nutrient on Yield, Quality and Shelf life of Broccoli".

2. MATERIALS AND METHODS

The field study was conducted in the Rabi seasons at Chanchra, Jashore Sadar Upazila, Jashore, of Bangladesh during the years 2019-20 and 2020-21. Randomized Complete Block Design (RCBD) had been followed including ten treatments and three replications which were; T_1 = Soil test based 100% NPK, T_2 = Vermicompost 4 t ha^{-1} + soil test based 50% NPK, T_3 = Vermicompost 2 t ha^{-1} + 100% NPK, T_4 =Tricho-compost 2 t ha^{-1} + 100% NPK, T_5=FYM 6 t ha^{-1} + 100% NPK, T_6 = Tricho-compost 4 t ha^{-1} + 50% NPK, T_7 =FYM 12 t ha^{-1} + 50% NPK, T_8= Vermicompost 1 t ha^{-1} + 125% NPK, T_9= Tricho-compost 1 t ha^{-1} + 125% NPK, T_{10}= FYM 3 t ha^{-1}+125% NPK. The soil test based synthetic fertilizers was: N_{115} P_{30} $K_{75}S_{20}Zn_3B_1$kgha^{-1}. 'Green Crown' variety of broccoli was used for conducting the field experiment. Before sowing on the nursery bed, seeds were treated by Thiram @ 2.5 g per kg of seeds. Healthy and appropriate age of seedlings (21 days) had been transplanted to the experimental plots of

size 3m×2m at spacing of 50 cm×40 cm as per layout on the 20th November 2019 during the first year and 16th November 2020 during the second year. According to treatment half of organic manures (Vermicompost, Tricho-compost and FYM) including TSP, Gypsum, zinc sulphate (Mono) and Boric acid had been used as basal in the respective plots. Rests of organic manures were incorporated in the pits prior to plant seedlings. Urea and Mop fertilizers were used as equal three splits at 15, 30 and 45 days after transplanting and mixed well. Improved intercultural operations were pursued well in all the research plots. The crop was irrigated and managed pests through biological methods meticulously. Broccoli curds were harvested before the buds opened on 22-29 January 2020 during the first year and 17-25 January 2021 during the second year respectively. The observation associated with yield and its contributing characteristics (curd length and diameter, marketable curd weight (g), marketable yield t ha^{-1} recorded taking five plants randomly each experimental plot in each replication.

Quality indices of broccoli viz. colour, compactness and texture were detected in fresh and stored condition. The numerical ratings for broccoli quality indices detected were quantified on a scale from 1 to 5 point hedonic scales [15] as per Table 1.

Table 1. Description of numerical ratings for broccoli quality (According to 1 to 5 point hedonic scale [15]*.

Scale	Ranges of Scores	Rating for Quality attributes of broccoli		
		Color	Compactness	Texture
1	4.50-5.00	Dark green	Very compact	Highly crispy
2	3.50-4.49	Green	Compact	Crispy
3	2.50-3.49	Light green	Medium compact	Moderately crispy
4	1.50-2.49	Light yellow	Slightly loose	Soft
5	1.00-1.49	Very yellow	Loose	Very soft

Note: *Refer to Table 1 for rating and indicating quality of broccoli.

In order to determine different nutrients content in fresh and stored broccoli curd, samples of each treatment were analyzed in the laboratory of Nutrition and Food Technology, Jashore University of Science and Technology, Jashore, Bangladesh. The standard methods were used to determine Vitamin C [16], Anti-oxidants DPPH free radical scavenging activity [17] and Phenols [18] respectively. To ascertain the shelf life for the said crop the following experimental design and methodology was followed as per the Figure 1.

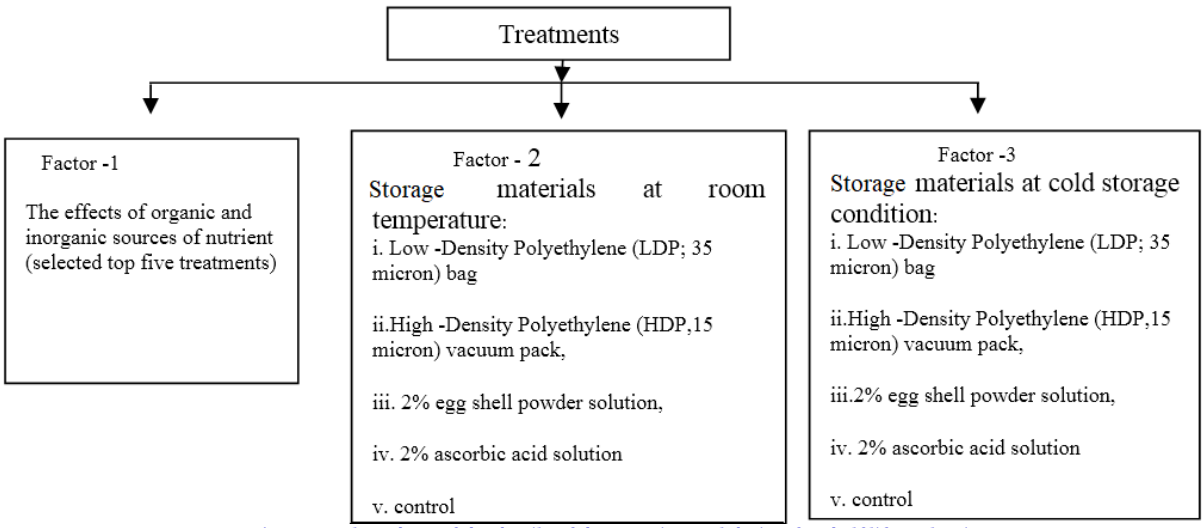

Figure 1. Flow chart of the details of the experimental design for shelf life evaluation.

The recorded data of various characters were analyzed with the help of Statistical Tool for Agricultural Research (STAR) Program and the mean values of all the treatments had been adjudged by Tukeye's test at 5% level of probability for interpretation.

3. RESULTS AND DISCUSSION

3.1. Yield Attributing Characteristics and Yield

3.1.1. Curd Length and Diameter

The perusal of data Table 2 revealed that maximum curd length 20.47 and 20.36 cm, curd diameter 21.63 and 21.56 cm were observed in the treatment T_3 (Vermicompost 2 t ha-^{1}+ soil test based 100% NPK) as compared to other treatments in the year of 2019-20 and 2020-21 respectively. Whereas, minimum curd length 11.33 and 11.39 cm and curd diameter 12.36 and 12.25 cm were recorded in treatment T_{10} (Farm Yard Manure 3 t ha-^{1}+ soil test based 125% NPK) during 2019-20 and 2020-21 years respectively. As a result of increased the rate of photosynthesis and carbohydrates accumulation in the curd which accelerated length and diameter due to the synergistic action of different nutrient sources mentioned above. These findings corroborate with the findings of Lodhi, et al. [19] and Dash, et al. [20] in broccoli and Bhowal, et al. [21] in cauliflower.

3.1.2. Marketable Curd Weight per Plant

The perusal of data (Table 1 and 2) revealed that marketable maximum curd weight per plant 611.46 and 604.45 g were recorded in the treatment T_3 (Vermicompost 2 t ha-^{1}+ soil test based 100% NPK) as compared to other treatments in the year of 2019-20 and 2020-21 respectively. Whereas, marketable minimum curd weight per plant 328.70 and 325.15 g were noted in T_{10} (Farm Yard Manure 3 t ha-^{1}+ soil test based 125% NPK) during 2019-20 and 2020-21 years respectively. This might have been the better performance on potential vegetative growth which influenced in the deposition of more carbohydrates accumulation in curd and synergistic action of different nutrient sources. These findings corroborate with the findings of broccoli [22, 23] and cauliflower [21].

3.1.3. Marketable Curd Yield

The perusal of data in Table 2 revealed that significantly maximum marketable curd yield 30.57 and 30.23 t ha^{-1} were observed in the treatment T_3 (Vermicompost 2 t ha^{-1} +100% NPK) followed by T_4 (Tricho-compost 2 t ha^{-1}+100% NPK) with marketable curd yield 28.25 and 28.15 t ha^{-1}, T_5 (FYM 6 t ha^{-1}+100% NPK) with marketable curd yield 26.28 and 26.43 t ha^{-1}, T_1 (Soil test based 100% NPK) with marketable curd yield 24.52 and 23.76 t ha^{-1}, T_2 (Vermicompost 4 t ha^{-1} +soil test based 50% NPK) with marketable curd yield 22.36 and 21.67 t ha^{-1}, T_6 (Tricho-compost 4 t ha^{-1} +50% NPK) with marketable curd yield 20.76 and 20.54 t ha^{-1}, T_7 (FYM 12 t ha^{-1}+50% NPK) with marketable curd yield 19.59 and 19.43 t ha^{-1}, T_8 (Vermicompost 1 t ha^{-1}+125% NPK) with marketable curd yield 18.16 and 17.86 t ha^{-1}, T_9 (Tricho-compost 1 t ha^{-1}+125% NPK) with marketable curd yield 17.56 and 17.33 t ha^{-1} in the year of 2019-20 and 2020-21 respectively. Whereas, minimum marketable curd yield 16.43 and 16.26 t ha^{-1} were noted in treatment T_{10} (FYM 3 t ha^{-1}+125% NPK) in the year of 2019-20 and 2020-21 respectively. This might have been the better performance on potential vegetative growth which influenced in the deposition of more carbohydrates accumulation in curd and synergistic action of different nutrient sources helped to meet up need based essential nutrients to plants and enhanced the rate of photosynthesis during growth and development of the broccoli bunches and consequently produced maximum marketable curd yield. These findings corroborate with the findings of broccoli [22-24] and cauliflower [21].

3.4. Quality Attributes

3.4.1. Physioco-Chemical Analysis of Fresh Broccoli

3.4.1.1. Sensory Evaluation of colour, Compactness and Texture

The perusal of data in Table 3 revealed that maximum colour rating 4.97, 4.79, compactness rating 4.85,4.77, texture rating 4.75 and 4.67 were detected in the treatment T_2 (Vermicompost 4 t ha^{-1} +soil test based 50% NPK in the year of 2019-20 and 2020-21 respectively. Whereas, minimum colour rating 3.53, 3.44, compactness rating 3.25,

3.19, texture rating 3.39 and 3.25 were noted in treatment T_1 (Soil test based 100% NPK) in the year of 2019-20 and 2020-21 respectively. This finding corroborates with [10].

Table 2. Effects of organic and inorganic sources of nutrient on yield attributes and yield of broccoli.

Treatment	Curd length (cm)		Curd diameter (cm)		Marketable curd weight per plant (g)		Marketable curd yield (t ha^{-1})	
	2019-20	2020-21	2019-20	2020-21	2019-20	2020-21	2019-20	2020-21
T_1	16.45abc	16.39abc	17.57abcd	17.42abc	490.33abcd	475.17abc	24.52abcd	23.76abc
T_2	14.67abc	14.55abc	15.75bcd	15.66abc	447.14abcd	433.34abc	22.36abcd	21.67abc
T_3	20.47a	20.36a	21.63a	21.56a	611.46a	604.55a	30.57a	30.23a
T_4	18.23ab	18.07ab	19.56ab	19.48ab	565.05ab	563.01ab	28.25ab	28.15ab
T_5	17.25abc	17.33abc	18.45abc	15.88abc	525.65abc	528.69abc	26.28abc	26.43abc
T_6	14.33abc	14.25abc	15.39bcd	15.25abc	415.12bcd	410.73abc	20.76bcd	20.54abc
T_7	13.76bc	13.69bc	14.27bcd	14.22bc	391.79bcd	388.61bc	19.59bcd	19.43bc
T_8	12.63bc	12.36bc	13.53cd	13.46bc	363.11cd	357.24bc	18.16cd	17.86bc
T_9	12.49bc	12.33bc	13.48cd	13.37bc	351.17cd	346.57c	17.56cd	17.33c
T_{10}	11.33c	11.39c	12.36d	12.25c	328.70d	325.15c	16.43d	16.26c
SEm ±	1.72	1.76	1.51	1.92	54.22	58.90	2.71	2.95
LSD(P=0.05)	0.10	0.09	0.01	0.28	0.05	0.12	0.05	0.12

Note: Means in the column followed by different letter(s) differed significantly by DMRT at (P=0.05) level of significance. Here, T_1 = Soil test based 100% NPK, T_2 = Vermicompost 4 t ha^{-1} + soil test based 50% NPK, T_3 = Vermicompost 2 t ha^{-1} + 100% NPK, T_4 =Tricho-compost 2 t ha^{-1} + 100% NPK, T_5= FYM 6 t ha^{-1} + 100% NPK, T_6 = Tricho-compost 4 t ha^{-1} + 50% NPK, T_7 =FYM 12 t ha^{-1} + 50% NPK, T_8= Vermicompost 1 t ha^{-1} + 125%NPK, T_9= Tricho-compost 1 t ha^{-1} + 125% NPK, T_{10}= FYM 3t ha^{-1}+125% NPK.

Table 3. Quality indices of fresh broccoli as influenced by organic and inorganic sources of nutrient.

Treatment	Quality indices of fresh broccoli					
	Color rating score		Compactness rating score		Texture rating score	
	2019-20	2020-21	2019-20	2020-21	2019-20	2020-21
T_1	3.53 d	3.44 c	3.25 c	3.19c	3.39 b	3.25 d
T_2	4.97 a	4.79 a	4.85 a	4.77 a	4.75 a	4.67 a
T_3	4.49 ab	4.41ab	4.33 b	4.26 b	4.45 a	4.21 ab
T_4	4.33 bc	4.17 b	4.25 b	4.19 b	3.83 b	3.75 bc
T_5	3.95 cd	3.63 c	3.49 c	3.45 c	3.75 b	3.63 cd
LSD (P=0.05)	0.14	0.13	0.01	0.01	0.08	0.09

Note: Means in the column followed by different letter(s) differed significantly by DMRT at (P=0.05) level of significance. Here, T_1 = Soil test based 100% NPK, T_2 = Vermicompost 4 t ha^{-1} +soil test based 50% NPK, T_3 = Vermicompost 2 t ha^{-1} +100% NPK, T_4 =Tricho-compost 2 t ha^{-1}+100% NPK, T_5 =FYM 6 t ha^{-1}+100% NPK.

3.4.1.2. Chemical Analysis of Fresh Broccoli Curds

The perusal of data in Table 4 and 5 revealed that maximum dry matter 16.37%,16.25%, carbohydrates 5.33 g, 5.45 g, vitamin C, 89.54 mg /100 g ,89.73 mg/ 100 g, anti oxidants, 74.29 mg/ 100 g, 75.33 mg/100 g, phenols, 43.69 mg/ 100 g, 45.33 mg/100 g were recorded in the treatment T_2 (Vermicompost @ 4 t ha^{-1} +Soil test based 50% NPK) in the year of 2019-20 and 2020-21 respectively except protein which was maximum noted in treatment T_1. (Soil test based 100% NPK). It might be due to synergistic effects of vermcompost with inorganic nutrient sources helped to meet up need based essential nutrients to plants and enhanced the rate of photosynthesis during growth and development of the broccoli bunches and consequently produced maximum dry matter, carbohydrates, vitamin C, antioxidants and phenols in broccoli curd. This finding corroborates with Mohanta, et al. [22]; Singh, et al. [24]; Zaki, et al. [25].

3.5. Physioco-Chemical Analysis of Stored Broccoli

3.5.1. Sensory Evaluation of Colour, Compactness and Texture

The perusal of data in Table 6 revealed that maximum colour rating 4.19, 4.29, compactness rating 3.95, 4.29, texture rating 4.21 and 4.17 were detected in the treatment T_2 (Vermicompost 4 t ha^{-1} +Soil test based 50% NPK) using High -Density Polyethylene (HDP; 15 micron) vacuum pack after 20 days at cold storage (4^0 C with RH 90-95%) condition in the year of 2019-20 and 2020-21 respectively. Whereas, minimum colour rating 1.77,1.71,

compactness rating 2.33,2.47, texture rating 1.81 and 1.99 were noted in the treatment T_1 (Soil test based 100% NPK) after 12 days at open place condition within cold storage in the year of 2019-20 and 2020-21 respectively. Similarly, when broccoli curds stored at room temperature (14-24^0 C with RH 70-75%), maximum colour rating 4.23, 4.33, compactness rating 4.17,4.37, texture rating 3.97 and 4.25 were detected in the same treatment T_2 using High -Density Polyethylene (HDP; 15 micron) vacuum pack after 5 days in the year of 2019-20 and 2020-21 respectively. Minimum colour rating 1.63, 1.69, compactness rating 2.25,2.33, texture rating 1.75 and 1.83 were noted in treatment T_1 (Soil test based 100% NPK) after 3 days at room temperature (14-24^0 C with RH 60-65%) condition. This finding corroborates with Chingtham and Banik [10].

Table 4. Effects of organic and inorganic sources of nutrient-on-nutrient content in fresh broccoli curd (2019-20).

Treatment	Dry Matter (%)	Protein (g)	Carbohy-drates(g)	Vitamin c (mg/100g)	Antioxidants (mg/100g)	Phenol (mg/100g)
T_1	10.49 c	2.69 a	2.85 c	70.33 c	57.13 c	28.55 c
T_2	16.37 a	2.17 c	5.33 a	89.54 a	74.29 a	43.69 a
T_3	13.45 b	2.55 ab	4.05 b	81.79 b	67.33 b	38.47 ab
T_4	12.33 bc	2.43 abc	3.49 bc	79.46 b	65.46 b	36.65 b
T_5	12.17 bc	2.35 bc	3.27 bc	77.13 bc	64.24 b	36.49 b
SEm ±	1.09	0.1237	0.4001	3.13	3.01	2.84
LSD(P=0.05)	0.66	2.46	0.21	0.34	0.59	0.87

Table 5. Effects of organic and inorganic sources of nutrient on nutrient content in fresh broccoli curd (2020-21).

Treatment	Dry Matter (%)	Protein (g)	Carbohydrates(g)	Vitamin C (mg/100g)	Antioxidants (mg/100g)	Phenol (mg/100g)
T_1	10.45 c	2.68 a	2.83 c	70.26 c	56.75 c	28.48 c
T_2	16.25 a	2.23 c	5.45 a	89.73 a	75.33 a	45.33 a
T_3	13.36 b	2.49 ab	4.08 b	82.17 b	69.27 ab	38.66 b
T_4	12.45 bc	2.38 bc	3.53 bc	79.25 b	65.56 b	36.47 b
T_5	12.09 bc	2.27 c	3.25 bc	77.33 bc	64.45 b	36.13 b
SEm ±	0.9095	0.0852	0.4001	3.12	3.10	2.84
LSD(P=0.05)	0.24	0.43	0.15	0.30	0.37	0.46

Note: Means in the column followed by different letter(s) differed significantly by DMRT at (P=0.05) level of significance. Here, T_1 = Soil test based 100% NPK, T_2 = Vermicompost 4 t ha^{-1} +soil test based 50% NPK, T_3 = Vermicompost 2 t ha^{-1} +100% NPK, T_4 =Tricho-compost 2 t ha^{-1}+100% NPK, T_5 =FYM 6 t ha^{-1}+100% NPK.

3.5.2. Chemical Analysis of Post-Storage Broccoli Curds at Maximum Shelf-Life Stage

A cursory glance of Table 7 and 8 revealed that maximum appreciable amount of nutrients viz. carbohydrates 5.25 g, 5.23 g, vitamin C 86.33 mg/100 g, 83.13 mg/100 g, antioxidants 70.27 mg/100 g, 67.88 mg/100 g, phenols 41.66 mg/100 g and 41.16 mg/100 g were found to be retained in the treatment T_2 (Vermicompost 4 t ha^{-1} +Soil test based 50% NPK) along with High -Density Polyethylene (HDP; 15 micron) vacuum pack at cold storage condition (4^0 C with RH 90-95%) up to maximum 26.33 and 27.25 days in the year of 2019-20 and 2020-21 respectively which is less than the nutrients 1.50%, 3.58%, 5.41% and 4.65% respectively in fresh broccoli curds as mentioned in table 4 in the year of 2019-2020 and 4.04%,7.36%, 9.89% and 9.20% respectively less than the nutrients in fresh broccoli curds as mentioned in table 5 in the year of 2020-2021.

Table 6. Effects of pre-harvest application of organic and inorganic nutrient sources and storage condition along with each level of storage materials on nutrients content in broccoli curd at maximum shelf life stage (2019-2020).

A) Using Low -Density Polyethylene (LDP; 35 micron) bag.

Treatment	Nutrients content At room temp.(14-24°C with RH 60-65%)						Nutrients content At cold storage (4°C with RH 90-95%)					
	Dry Matter (%)	Protein(g)	CHO (g)	Vitamin c (mg/100g)	Antioxidants (mg/100g)	Phenol (mg/100g)	Dry Matter (%)	Protein (g)	CHO (g)	Vitamin c (mg/100g)	Antioxidant (mg/100g)	Phenol (mg/100g)
T_1	9.05c	2.56a	2.69c	61.43c	46.13c	21.57c	9.25c	2.59a	2.75c	63.27c	49.34c	22.78c
T_2	15.03a	2.03c	5.03a	81.45a	66.47a	38.25a	16.05a	2.11c	5.19a	83.58a	67.42a	39.35a
T_3	12.15b	2.41ab	3.85b	72.26b	58.36b	33.27ab	12.93b	2.44ab	3.87b	74.86b	60.33b	33.78ab
T_4	10.95bc	2.26bc	3.19bc	70.34b	55.63b	31.53b	11.75bc	2.30bc	3.31bc	72.51b	58.21b	31.81b
T_5	10.33bc	2.15bc	2.91c	68.29bc	55.77b	29.55b	11.03bc	2.23bc	3.05bc	70.19bc	58.79b	30.83b
LSD (P=0.05)	0.52	1.79	0.24	0.27	0.20	0.43	0.26	3.31	0.21	0.24	0.44	0.49

B) Using High -Density Polyethylene (HDP; 15 micron) vacuum pack.

Treatment	Nutrients content At room temp.(14-24 °C with RH 60-65%)						Nutrients content At cold storage (4°C with RH 90-95%)					
	Dry Matter (%)	Protein (g)	CHO (g)	Vitamin c (mg/100g)	Antioxidants (mg/100g)	Phenol (mg/100g)	Dry Matter (%)	Protein (g)	CHO (g)	Vitamin c (mg/100g)	Antioxidant (mg/100g)	Phenol (mg/100g)
T_1	9.25c	2.61a	2.73c	63.31c	49.25c	23.36c	10.41c	2.63a	2.79c	66.25	52.36c	25.53c
T_2	15.13a	2.09c	5.14a	83.26a	68.23a	39.47a	16.31a	2.14c	5.25a	86.33	70.27a	41.66a
T_3	12.26b	2.46ab	3.93b	74.37b	60.56b	34.35ab	13.38b	2.49ab	4.01b	77.65	63.23b	36.41ab
T_4	11.07bc	2.32bc	3.31bc	72.14b	58.37b	32.36b	12.28bc	2.36abc	3.39bc	75.36	61.16b	34.52b
T_5	10.64bc	2.23bc	3.05bc	70.33bc	58.63b	30.63b	12.09bc	2.29bc	3.21bc	73.12	61.77b	33.56b
LSD (P=0.05)	0.60	2.20	0.22	0.27	0.33	0.54	0.65	3.20	0.22	0.26	0.47	0.57

C) Treated with 2% egg shell powder solution.

Treatment	Nutrients content at room temp.(14-24°C with RH 60-65%)						Nutrients content at cold storage (4°C with RH 90-95%)					
	Dry Matter (%)	Protein (g)	CHO (g)	Vitamin c (mg/100g)	Antioxidants (mg/100g)	Phenol (mg/100g)	Dry Matter (%)	Protein (g)	CHO (g)	Vitamin c (mg/100g)	Antioxidant (mg/100g)	Phenol (mg/100g)
T_1	8.75c	2.51a	2.61c	59.32c	43.56c	19.46c	9.09c	2.57a	2.69c	61.35c	47.16c	20.45c
T_2	13.63a	1.95c	4.93a	79.36a	64.13a	36.37ab	15.75a	2.08c	5.05a	81.36a	65.75a	37.52a
T_3	10.25b	2.36ab	3.75b	70.15b	56.21b	31.16b	12.27b	2.41ab	3.75b	72.73b	58.47b	31.73ab
T_4	10.47b	2.18bc	3.03bc	68.27b	52.47b	29.37b	11.15bc	2.24bc	3.17bc	70.25b	56.33b	29.64b
T_5	9.65bc	2.07c	2.81c	66.35bc	52.33b	26.45b	10.83bc	2.17bc	2.95bc	68.36bc	56.76b	28.58b
LSD (P=0.05)	0.02	1.22	0.24	0.27	0.18	0.37	0.30	2.54	0.24	0.26	0.37	0.40

D) Treated with 2% ascorbic acid solution.

Treatment	Nutrients content At room temp.(14-24°C with RH 60-65%)						Nutrients content At cold storage (4°C with RH 90-95%)					
	Dry Matter (%)	Protein (g)	CHO (g)	Vitamin c (mg/100g)	Antioxidants (mg/100g)	Phenol (mg/100g)	Dry Matter (%)	Protein (g)	CHO (g)	Vitamin c (mg/100g)	Antioxidant (mg/100g)	Phenol (mg/100g)
T_1	8.71c	2.49a	2.55c	56.44c	40.25c	18.33c	9.01c	2.55a	2.63c	58.81c	44.91c	18.11c
T_2	13.47a	1.91c	4.75a	76.29a	62.17a	35.25a	15.63a	2.05c	4.95a	79.21a	63.92a	35.72a
T_3	10.04b	2.33ab	3.61b	67.13b	54.13b	30.13ab	12.17b	2.36ab	3.67b	70.48b	56.33b	29.63ab
T_4	10.33b	2.13bc	2.94bc	65.22b	49.56b	28.31b	11.03bc	2.18bc	3.05bc	67.92b	54.14b	27.44b
T_5	9.53bc	2.03c	2.67c	63.46bc	49.75b	25.37b	10.75bc	2.11bc	2.88bc	65.91bc	54.55b	26.33b
LSD (P=0.05)	0.03	0.97	0.31	0.29	0.11	0.37	0.31	2.05	0.26	0.23	0.32	0.33

E) Control (at open place).

Treatment	Nutrients content At room temp.(14-24°C with RH 60-65%)						Nutrients content At cold storage (4°C with RH 90-95%)					
	Dry Matter (%)	Protein (g)	CHO (g)	Vitamin c (mg/100g)	Antioxidants (mg/100g)	Phenol (mg/100g)	Dry Matter (%)	Protein (g)	CHO (g)	Vitamin c (mg/100g)	Antioxidant (mg/100g)	Phenol (mg/100g)
T_1	6.75c	2.43a	2.35c	53.52c	38.17c	16.46c	7.71c	2.51a	2.56b	56.48c	42.35c	15.72c
T_2	11.23a	1.75bc	4.47a	74.13a	60.21a	33.33a	14.51a	1.81c	4.75a	77.34a	61.72a	33.67a
T_3	8.16b	2.18ab	3.49b	65.27b	51.33b	28.35ab	11.25b	2.25ab	3.47b	68.31b	54.01b	27.46ab
T_4	8.56b	1.35c	2.76bc	63.20b	46.47b	26.61b	10.46b	2.10b	2.93b	65.67b	51.69b	25.19b
T_5	8.14b	1.95ab	2.53c	60.73bc	46.63b	23.44b	9.48bc	2.03bc	2.74b	63.62bc	52.04b	23.97b
LSD (P=0.05)	0.06	1.46	86.02	0.40	0.22	0.10	0.37	0.27	0.49	0.36	0.20	0.28

Note: Means in the column followed by different letter(s) differed significantly by DMRT at (P=0.05) level of significance. Here, T_1 = Soil test based 100% NPK, T_2 = Vermicompost 4 t ha^{-1} +Soil test based 50% NPK, T_3 = Vermicompost 2 t ha^{-1} +100% NPK, T_4 =Tricho-compost 2 t ha^{-1}+100% NPK, T_5 =FYM 6 t ha^{-1}+100% NPK.

Table 7. Effects of pre-harvest application of organic and inorganic nutrient sources and storage condition along with each level of storage materials on nutrients content in broccoli curd at maximum shelf life stage (2020-2021).

A) Using Low -Density Polyethylene (LDP; 35 micron) bag.

Treatment	Nutrients content At room temp.(14-24°C with RH 60-65%)						Nutrients content At cold storage (4°C with RH 90-95%)					
	Dry Matter (%)	Protein (g)	CHO (g)	Vitamin c (mg/100g)	Antioxidants (mg/100g)	Phenol (mg/100g)	Dry Matter (%)	Protein (g)	CHO (g)	Vitamin c (mg/100g)	Antioxidant (mg/100g)	Phenol (mg/100g)
T_1	8.95c	2.49a	2.66c	60.13c	46.85c	22.07c	9.25c	2.53a	2.71c	61.68c	47.31c	22.42c
T_2	14.83a	2.01b	5.19a	82.26a	67.23a	39.25a	16.07a	2.09b	5.23a	83.13a	67.88a	41.16a
T_3	11.91b	2.33a	3.81b	73.37b	60.15b	33.13ab	12.90b	2.36ab	3.85b	74.75b	60.64b	34.31b
T_4	10.63bc	2.21ab	2.37c	70.25b	57.26b	30.67b	11.59bc	2.25ab	3.21bc	71.39b	56.71b	31.95b
T_5	9.69bc	1.51c	3.05bc	68.39b	54.30b	28.25bc	10.95bc	2.17b	3.11bc	69.21b	55.46b	31.13b
LSD (P=0.05)	0.46	0.04	0.07	0.14	0.17	0.34	0.24	4.95	0.18	0.16	0.16	0.23

B) Using High -Density Polyethylene (HDP; 15 micron) vacuum pack.

Treatment	Nutrients content At room temp.(14-24°C with RH 60-65%)						Nutrients content At cold storage (4°C with RH 90-95%)					
	Dry Matter (%)	Protein (g)	CHO (g)	Vitamin c (mg/100g)	Antioxidants (mg/100g	Phenol (mg/100g	Dry Matter (%)	Protein (g)	CHO (g)	Vitamin c (mg/100g)	Antioxidant (mg/100g)	Phenol (mg/100g)
T_1	9.13c	2.53a	2.71c	62.56c	49.73c	23.15c	10.33c	2.57a	2.77c	65.93c	52.01c	25.43c
T_2	15.05a	2.07c	5.26a	84.13a	69.46a	40.73a	16.14a	2.13b	5.31a	86.43a	71.58a	43.26a
T_3	12.07b	2.37ab	3.93b	75.47b	62.25b	34.26ab	13.21b	2.41ab	4.03b	78.25b	64.94ab	36.51b
T_4	10.80bc	2.27abc	2.45c	72.35b	59.13b	32.35b	12.21bc	2.33ab	3.35bc	75.14b	61.11b	34.25b
T_5	10.64bc	2.14bc	3.13bc	70.56b	56.76b	30.47b	11.96bc	2.19b	3.25bc	73.13bc	59.96b	33.63b
LSD (P=0.05)	0.59	3.60	0.07	0.16	0.21	0.33	0.72	4.43	0.18	0.22	0.23	0.32

C) Treated with 2% egg shell powder solution.

Treatment	Nutrients content At room temp.(14-24°C with RH 60-65%)						Nutrients content At cold storage (4°C with RH 90-95%)					
	Dry Matter (%)	Protein (g)	CHO (g)	Vitamin c (mg/100g)	Antioxidants (mg/100g	Phenol (mg/100g)	Dry Matter (%)	Protein (g)	CHO (g)	Vitamin c (mg/100g)	Antioxidant (mg/100g)	Phenol (mg/100g)
T_1	8.69b	2.43a	2.59c	58.56c	43.75c	20.23c	9.15c	2.49a	2.67c	57.35c	42.81	19.37c
T_2	13.45a	1.91c	5.03a	80.13a	65.36a	37.46a	15.83a	2.03c	5.15a	79.81a	64.13	38.98a
T_3	10.07b	2.25ab	3.75b	71.25b	58.21b	31.25ab	12.26b	2.33ab	3.79b	71.22b	56.29	32.06b
T_4	9.57b	2.13bc	2.30c	68.17b	55.33b	28.36b	11.13bc	2.21abc	3.13bc	67.54b	52.26	29.63b
T_5	9.06b	1.44d	2.93bc	66.43b	51.66b	26.17bc	10.77bc	2.14bc	3.03bc	65.23b	50.99	28.53b
LSD (P=0.05)	1.45	0.04	0.08	0.16	0.11	0.33	0.28	4.26	0.18	0.11	0.13	0.17

D) Treated with 2% ascorbic acid solution.

Treatment	Nutrients content At room temp.(14-24°C with RH 60-65%)						Nutrients content At cold storage (4°C with RH 90-95%)					
	Dry Matter (%)	Protein (g)	CHO (g)	Vitamin c (mg/100g)	Antioxidants (mg/100g)	Phenol (mg/100g)	Dry Matter (%)	Protein (g)	CHO (g)	Vitamin c (mg/100g)	Antioxidant (mg/100g)	Phenol (mg/100g)
T_1	8.65b	2.39a	2.56c	55.63c	41.47d	18.55c	8.93c	2.43a	2.59c	55.25c	40.33c	18.65c
T_2	13.37a	1.85c	4.96a	77.46a	63.13a	35.47a	15.45a	1.95b	4.92a	79.33a	62.38a	37.65a
T_3	10.04b	2.21ab	3.67b	68.23b	55.25b	29.53ab	12.09b	2.23ab	3.67b	69.52b	54.06b	30.56b
T_4	9.51b	2.08bc	2.17c	66.16b	50.13bc	27.25b	10.91bc	2.09b	3.03bc	65.69b	49.91b	28.05b
T_5	9.02b	1.37d	2.83bc	63.13b	46.37cd	24.36bc	10.47bc	2.03b	2.83bc	63.33b	48.59b	26.85b
LSD (P=0.05)	1.52	0.03	0.08	0.15	0.08	0.37	0.32	3.09	0.25	0.07	0.10	0.20

E) Control.

Treatment	Nutrients content at room temp.(14-24°C with RH 60-65%)						Nutrients content at cold storage (4°C with RH 90-95%)					
	Dry Matter (%)	Protein (g)	CHO (g)	Vitamin c (mg/100g)	Antioxidants (mg/100g)	Phenol (mg/100g)	Dry Matter (%)	Protein (g)	CHO (g)	Vitamin c (mg/100g)	Antioxidant (mg/100g)	Phenol (mg/100g)
T_1	6.77b	2.35a	2.49c	52.73c	39.43d	17.23c	7.69c	2.38a	2.44c	54.33c	39.15c	16.05c
T_2	11.16a	1.73c	4.63a	74.27a	61.25a	33.46a	14.43a	1.83c	4.76a	78.58a	61.33a	35.60a
T_3	8.10b	2.15ab	3.59b	65.75b	52.16b	27.57ab	11.35b	2.19ab	3.45b	68.72b	52.96b	28.33b
T_4	7.61b	2.04b	2.03c	64.14b	47.27bc	25.35b	10.35b	2.07bc	2.87bc	64.82b	48.76b	25.63b
T_5	7.56b	1.31d	2.71bc	60.36b	43.15cd	22.79bc	9.53bc	2.01bc	2.77 bc	62.43b	47.46b	24.35b
LSD (P=0.05)	2.72	0.02	0.13	0.16	0.07	0.49	0.28	1.99	0.29	0.07	0.10	0.17

Note: Means in the column followed by different letter(s) differed significantly by DMRT at (P=0.05) level of significance. Here, T_1 = Soil test based 100% NPK, T_2 = Vermicompost 4 t ha^{-1} +Soil test based 50% NPK, T_3 = Vermicompost 2 t ha^{-1} +100% NPK, T_4 =Tricho-compost 2 t ha^{-1}+100% NPK, T_5 =FYM 6 t ha^{-1}+100% NPK.

Similarly, when broccoli curds stored at room temperature (14-24^0 C with RH 60-65%), the various nutrients viz. carbohydrates 5.14 g, 5.19 g ,vitamin C 83.26 mg/100 g, 82.26 mg/100 g, antioxidants 68.23 mg/100 g, 67.23 mg/100 g, phenols 39.47 mg/100 g and 39.25 mg/100 g remain intact even after the broccoli curds were kept within High -Density Polyethylene (HDP; 15 micron) vacuum pack for a maximum 8.36 and 8.55 days in the same treatment which is less than the nutrients 3.56%, 7.01%, 8.16%, and 9.66% respectively in fresh broccoli curds as mentioned in table 4 in the year of 2019-2020 and 4.77%, 8.32%, 10.75% and 13.41% respectively less than the nutrients in fresh broccoli curds as mentioned in table 5 in the year of 2020-2021. This finding corroborates with Chingtham and Banik [10]; Manisha and Rajkumari [26].

3.6. Shelf Life

The perusal of data in Table 8 and 9 revealed that effects of organic and inorganic sources of nutrient and storage condition along with each level of storage materials significantly influenced on shelf life of broccoli. Maximum shelf life 8.36 and 8.55 days were observed in the treatment T_2 (Vermicompost 4 t ha^{-1} +Soil test based 50% NPK) followed by T_3 (Vermicompost 2 t ha^{-1} +100% NPK) with 5.49 and 5.33 days, T_4 (Tricho-compost 2 t ha^{-1}+100% NPK) with 5.33 and 5.25 days, T_5 (FYM 6 t ha^{-1}+100% NPK) with 5.17 and 5.27 days, and it were kept in High -Density Polyethylene (HDP; 15 micron) vacuum pack at room temperature (14-24^0 C with RH 60-65%) condition during the 2019-20 and 2021-21 respectively. Whereas, minimum shelf life 1.85 and 2.33 days were recorded in treatment T_1 (Soil test based 100% NPK,) at the same condition during the 2019-20 and 2021-21 respectively. In the same way, at cold storage (4^0 C with 90-95% RH) condition, maximum shelf life 26.33 and 27.25 days were observed in the treatment T_2 (Vermicompost 4 t ha^{-1} +Soil test based 50% NPK) followed by T_3 (Vermicompost 2 t ha^{-1} +100% NPK) with 23.43 and 22.33 days, T_4 (Tricho-compost 2 t ha^{-1}+100% NPK) with 23.43 and 21.56 days, T_5 (FYM 6 t ha^{-1}+100% NPK) with 22.68 and 21.75 days, and it were kept in High -Density Polyethylene (HDP; 15 micron) vacuum pack during the 2019-20 and 2021-21 respectively. Whereas, minimum shelf life 12.29 and 12.33 days were recorded in treatment T_1 (Soil test based 100% NPK,) at cold storage (4^0 C with 90-95% RH) condition during the 2019-20 and 2021-21 respectively. This might be due to synergistic effects of organic and inorganic sources of nutrient influenced broccoli longevity through increased nutrients uptake by the plants and enhanced greater development of water conducting tissue which enhanced the shelf life of broccoli. These findings corroborates with the findings of Dhakal, et al. [27].

Maximum shelf life in both the storage conditions within High -Density Polyethylene (HDP; 15 micron) vacuum pack might be due to its sophisticated techniques which delayed and protected the physiological deterioration of broccoli curd. Within High -Density Polyethylene (HDP; 15 micron) vacuum pack having more control over the gas exchange with the surrounding air, the levels of CO_2 and O_2 around the produce might have further slowed down conversion of starch to sugars.

Curds stored in the cold conditions had maintained a greener color and at the same time no chilling injury symptoms, no decay incidence and no rot were observed there. In addition, storage at low temperature reduced the rate of respiration, and delayed senescence during storage of curds. Pre-harvest application of organic and inorganic sources of nutrients in broccoli production and better storage conditions including appropriate use of scientific storage materials like High -Density Polyethylene (HDP; 15 micron) vacuum pack might have protected the chlorophyll degradation and ethylene production. The synchronized effects of the said treatment also might have protected available moisture and minimize the rate of respiration along with strengthening the cell wall in the vegetative parts of broccoli which restricted the yellowing color and reduced weight loss. This might have maintained the shelf life and quality of broccoli. The findings of present investigation in respect of shelf life corroborate with the findings of broccoli [14].

Table 8. Shelf life (days) comparison of storage materials at each level of treatment under different storage condition (2019-20).

Treatments	Shelf life(days) at room temperature (14-24° C with RH 60-65%)					Shelf life(days) at Cold Storage (4° C with RH 90-95%)				
	Storage materials					Storage materials				
	LDP bag	HDP Vacuum pack	2% Egg shell power solution	2% Ascorbic acid solution	Control	LDP bag	HDP Vacuum pack	2% Egg shell power solution	2% Ascorbic acid solution	Control
T_1	3.75ef	3.93e	2.42fg	2.33fg	1.85g	15.81b	19.20a	14.45bc	13.83c	12.29d
T_2	5.67f	8.36e	4.59fg	4.33fg	3.53g	21.70b	26.33a	19.59c	19.57c	14.87d
T_3	4.60ef	5.49e	3.67fg	3.61fg	2.33g	20.20b	23.43a	17.17c	16.69c	13.87d
T_4	4.37ef	5.33e	3.63fg	3.57fg	2.30g	20.16b	23.39a	17.13c	16.63c	13.79d
T_5	4.23ef	5.17e	3.57fg	3.45fg	2.25g	19.42b	22.68a	16.41g	15.90c	12.73d
LSD(P=0.05)	0.0000									

Note: Means in the column followed by different letter(s) differed significantly by DMRT at (P=0.05) level of significance. Here, T_1 = Soil test based 100% NPK, T_2 = Vermicompost 4 t ha^{-1} +Soil test based 50% NPK, T_3 = Vermicompost 2 t ha^{-1} +100% NPK, T_4 =Tricho-compost 2 t ha^{-1}+100% NPK, T_5 =FYM 6 t ha^{-1}+100% NPK.

Table 9. Shelf life (days) comparison of storage materials at each level of treatment under different storage condition (2020-21).

Treatment	Shelf life(days) at room temperature (14-24° C with RH 60-65%)					Shelf life(days) at Cold Storage (4° C with RH 90-95%)				
	Storage materials					Storage materials				
	LDP bag	HDP Vacuum pack	2% Egg shell power solution	2% Ascorbic acid solution	Control	LDP bag	HDP Vacuum pack	2% Egg shell power solution	2% Ascorbic acid solution	Control
T_1	3.69g	4.33f	2.75h	2.37h	2.33h	15.33b	18.75a	14.33c	13.25d	12.33e
T_2	6.33g	8.55f	4.33h	4.25h	3.75i	20.55b	27.25a	19.45c	18.33d	15.31e
T_3	4.25g	5.33f	3.75h	3.25i	2.55j	18.47b	22.33a	16.55c	15.75d	13.63e
T_4	4.13g	5.25f	3.55h	3.17h	2.51i	17.63b	21.56a	16.25c	15.47d	12.83e
T_5	4.05g	5.27f	3.63gh	3.33h	2.35i	17.53b	21.75a	16.31c	15.35d	13.33e
LSD(P=0.05)	0.0000									

Note: Means with the same letter are not significantly different, T_1 = Soil test based 100% NPK, T_2 = Vermicompost 4 t ha^{-1} +Soil test based 50% NPK, T_3 = Vermicompost 2 t ha^{-1} +100% NPK, T_4 =Tricho-compost 2 t ha^{-1}+100% NPK, T_5= FYM 6 t ha^{-1}+100% NPK.

3.7. Economic Consideration

Data enumerated in Table 10 and 11 revealed that maximum gross returns of BDT 458550 and 453450 ha^{-1}, net returns 334722 and 329622 ha^{-1} with BCR 3.70 and 3.66 were observed in the treatment T_3(Vermicompost 2 t ha^{-1} +100% NPK) in the year of 2019-20 and 2020-21 respectively. Whereas, minimum gross returns of BDT 246450 and 243900 ha^{-1}, net returns 132620 and 130070 ha^{-1} with BCR 2.17 and 2.14 were noted in treatment T_{10} (FYM 3 t ha^{-1}+125% NPK) in the year of 2019-20 and 2020-21 respectively. The present findings indicate that treatment T_3 is the maximum profitable treatment for broccoli production which could generate maximum net income with maximum Benefit Cost Ratio (BCR) This finding corroborates with Shamsunnahar [11]; Sharma, et al. [28].

Table 10. Economic consideration of broccoli production as influenced by pre-harvest application of organic and inorganic nutrient sources (2019-20).

Treatment	Marketable Yield (t ha^{-1})	Cost of production (BDT ha^{-1})	Gross returns (BDT ha^{-1})	Net returns (BDT ha^{-1})	Benefit Cost ratio (BCR)
T_1	24.52	107370	367800	260430	3.43
T_2	22.36	136145	335400	199255	2.46
T_3	30.57	123828	458550	334722	3.70
T_4	28.25	128217	423750	295533	3.30
T_5	26.28	116148	394200	278052	3.39
T_6	20.76	144922	311400	166478	2.15
T_7	19.59	120783	293850	173067	2.43
T_8	18.16	117674	272400	154726	2.31
T_9	17.56	119866	263400	143534	2.20
T_{10}	16.43	113830	246450	132620	2.17

Table 11. Economic consideration of broccoli production as influenced by pre-harvest application of organic and inorganic nutrient sources (2020-21).

Treatment	Marketable Yield (t ha^{-1})	Cost of production (BDT ha^{-1})	Gross returns (BDT ha^{-1})	Net returns (BDT ha^{-1})	Benefit Cost ratio (BCR)
T_1	23.76	107370	356400	249030	3.32
T_2	21.67	136145	325050	188905	2.39
T_3	30.23	123828	453450	329622	3.66
T_4	28.15	128217	422250	294033	3.29
T_5	26.43	116148	396450	280302	3.41
T_6	20.54	144922	308100	163178	2.13
T_7	19.43	120783	291450	170667	2.41
T_8	17.86	117674	267900	150226	2.28
T_9	17.33	119866	259950	140084	2.17
T_{10}	16.26	113830	243900	130070	2.14

Note: Sale rate of broccoli BDT 15/kg. Here, T_1 = Soil test based 100% NPK, T_2 = Vermicompost 4 t ha^{-1} + Soil test based 50% NPK, T_3 = Vermicompost 2 t ha^{-1} + 100% NPK, T_4 =Tricho-compost 2 t ha^{-1} + 100% NPK, T_5= FYM 6 t ha^{-1} + 100% NPK, T_6 = Tricho-compost 4 t ha^{-1} + 50% NPK, T_7 =FYM 12 t ha^{-1} + 50% NPK, T_8= Vermicompost 1 t ha^{-1} + 125% NPK, T_9= Tricho-compost 1 t ha^{-1} + 125% NPK, T_{10}= FYM 3 t ha^{-1}+125% NPK.

4. CONCLUSION

The inference of the present investigation that Vermicompost 2 t ha^{-1} + soil test based 100% NPK performed the best regarding higher yield, gross and net returns with maximum Benefit Cost Ratio (BCR) at grower's level. Simultaneously, broccoli produced through the application of Vermicompost 4 t ha-^{1} +Soil test based 50% NPK is the best for consumption and getting anticipated quality attributes of broccoli. In addition, combined use of Vermicompost 4 t ha-^{1}+ Soil test based 50% NPK along with High -Density Polyethylene (HDP; 15 micron) vacuum pack is the significantly effective for maintaining the shelf life of broccoli both at room temperature (14-24^{0} C with RH 60-65%) and at cold storage (4^{0} C with RH 90-95%) condition.

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