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Effect of Organic and Inorganic Sources of Nitrogen Fertilizers on Soil Properties and Yield of Broccoli (*Brassica oleracea* var. *italica*)

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A B S T R A C T

A field experiment was conducted during *Rabi* season 2018-2019 to study the "Effect of organic and inorganic sources of nitrogen fertilizers on soil properties and yield of broccoli (*Brassica oleracea* var. *italica*)" at Students' Research Farm, P.G. Department of Agriculture, Khalsa College, Amritsar. The experiment was laid out in randomised block design (RBD) replicated three times with ten treatments. Plant nutrients applied through inorganic fertilizer or in combinations with organic manures along with bio-fertilizer did not show any significant effect on pH and EC in different treatments but organic carbon content was influence significantly due to application of 100% FYM + bio-fertilizer compared to rest of treatments. The availability of macro and micronutrients were profound increased by integrated use of nutrient sources. Maximum values of available N, P and K were observed to be 243.10 kg ha^{-1}, 21.24 kg ha^{-1} and 310.63 kg ha^{-1}, respectively in a treatment where 50% nitrogen was supplied through inorganic fertilizer + 50% N through poultry manure conjoint with bio-fertilizer. Similarly, available micronutrients (Zn, Fe, Cu and Mn) were also found highest in treatment T_{10}. During the experimentation, growth and yield attributes were also recorded. However, values regarding plant growth parameters, yield as well as nutrient uptake were noticed highest in treatment T_2 (100% NPK through inorganic fertilizers) which was at par with T_{10} in which integrated nutrient system applied. The overall results suggests that integrated application of organic inputs along with 50% reduced chemical fertilizers was found to be best for sustaining crop productivity and enhance the soil health.

Keywords

FYM, Yield, Inorganic fertilizer, Bio-fertilizer

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Introduction

Broccoli (*Brassica oleracea* var. *italica*) is one of an important cool season vegetable of Brassicacae family. It contains 3.3 per cent protein and high content of vitamin A, C and appreciable quantity of thiamine, niacin and riboflavin. It also contains high concentration of carotenoids which are believed to be chemo-preventive and associated with a decreased risk of human cancers (Anonymous, 2019). It is of having high value exotic vegetable and cultivated for its tender flowering head and secondary heads *i.e.*, spears which develops in the axil of leaves and may contribute up to 50 percent of the total yield. Generally, it can be classified into three distinct groups *viz.*, white, purple and green, out of which green type is highly nutritious. The glucosinolate content of purple-headed broccoli has been found in the range of 72-212 mg/100g. Broccoli is a rich source of vitamins, amino acids and essential minerals also contain the compounds, namely glucoraphanin, which can be processed into an anticancer compound sulphoraphane (Liu *et al.,* 2018).

After green revolution, scenario of Indian agriculture has faced many problems such as stagnation or even decrease in production and productivity of major crops, deterioration of soil fertility, decline in factor productivity, low diversity of production systems and increasing cost of production. These constraints have cropped-up partially as a result of continuous cropping without proper nutrient management and indiscriminate use of agrochemicals on soil and crops (Sharma and Subehia, 2014). Fertilizers play a vital role in enhancing the production and productivity of any crop but continuous and imbalanced use of high analysis chemical fertilizers, adversely affects the production potential and soil health. Increasing productivity and keeping pace with the rising food demand with minimum environmental disturbance has thus become a challenge to farmers and scientists alike. Integrated use of chemical and organic fertilizers would be quite promising not only for sustainable production, but also for maintaining soil fertility status as well as preventing the soil resource from degradation.

However there is need for integrated application as alternate nutrient source for sustaining the desired crop productivity. The integrated use of organic and inorganic fertilizer has received considerable attention in the past with the hope of meeting the farmer economic need as well as maintaining favourable ecological condition on long term basis (Kumar *et al.*, 2007). Organic manures act as a reservoir of plant nutrients and prevent nutrient leaching by maintaining a high cation exchange capacity, as well as buffering growing plants against sudden changes in their chemical environment (Elnasikh and Satti., 2017). In large sense, biofertilizers offer an economically attractive and ecologically sound means of reducing external inputs and improving quantity and quality of vegetable produce (Ekta *et al.*, 2017). These potential biological fertilizers play a key role in productivity and sustainability of soil and also protect the environment as ecofriendly and cost effective inputs for the farmers. They contain microorganisms which are capable of mobilizing nutrient elements from unavailable form to available form through different biological processes such as nitrogen fixation and solubilisation of rock phosphate. Therefore, keeping in view the above facts in mind, the present investigation was undertaken to study the effect of organic and inorganic sources of nitrogen fertilizers on soil properties and yield of broccoli (*Brassica oleracea* var. *italica*).

Materials and Methods

The present investigation was carried out at Student's Research Farm, Khalsa College, Amritsar during Rabi season 2018-2019. Amritsar is located at 31°-38° N latitude and 74°-52° E longitudes with an elevation of 236 m MSL and represents the sub-tropical climate and humid zone of Punjab region. These treatments were evaluated in randomized block design (RBD) at a spacing of 45 cm × 45 cm with three replications. The experiment was consisting of ten treatments viz., T_1 – Control, T_2 - 100% RDF, T_3 - 50% RDNF + 50% N (PM), T_4 - 50% RDNF + 50% N (FYM), T_5 - 50% RDNF + 50% N (FYM) +

Bio-fertilizer, T_6 - 100% N (PM) + Bio-fertilizer, T_7 - 100% N (FYM) + Bio-fertilizer, T_8 - 50% N (PM) + 50% N (FYM), T_{10} - 50% RDNF + 50% (PM) + Bio-fertilizer. The soil of the experimental field as tested was sandy loam in texture (pH 8.23), low in organic carbon (0.42 %) and medium in available N (195.72 kg ha^{-1}), available P (15.11 kg ha^{-1}) and available K (254.56 kg ha^{-1}). The recommended dose of nitrogenous fertilizers (RDNF) and organic manures *viz*., farmyard manure (FYM), poultry manure (PM) containing various macro and micronutrients (Table 1) were applied according to treatments. These organic manures were incorporated into soil before 15 days from transplanting. The seedlings of broccoli cultivar Palam Samridhi were procured from Centre of Excellence for Vegetables, Kartarpur. The seeds of cultivar sown in the plastic plug trays by using cocopeat, perlite and vermiculite in ratio 3:1:1, respectively inside the automatic ventilated polyhouse to get healthy and disease free seedlings of broccoli. Seedlings were transplanted in plots size 2.7 × 2.7 m and fertilizers used were urea (46% N), single superphosphate (16% P) and muriate of potash (60% K). The half dose of N and full dose of P and K was applied as basal dressing and remainder of N was top-dressed after 4 weeks of transplanting as recommended in the package of practices for cultivation of vegetables published by Punjab Agricultural University, Ludhiana.

The soil samples from 0-15 cm depth were collected before sowing and at the time of curd harvesting. Collected soil samples were air dried in shade and ground with the help of pestle and mortar. These ground samples were then passed through 2 mm sieve and stored in polyethylene bags for further analysis of soil. Soil samples were analysed for pH and EC in 1:2 soil: water suspension, organic carbon (Walkley and Black, 1934), available N (Subbiah and Asija, 1965), available P (Olsen, 1954), available K (Merwin and Peech, 1951) and DTPA-extractable Zn, Cu, Fe and Mn by the method of (Lindsay and Norvell, 1978). Total N (Chapman and Pratt, 1961) uptake in plant samples was analyzed after the harvest. Agronomic nitrogen use efficiency (Dilz, 1988) and apparent nitrogen recovery were calculated as described by (Novoa and Loomis, 1981).

Results and Discussion

The data pertaining to different soil parameters revealed significant variations among the different treatments. It was observed that pH values had varies a narrow range of 8.01 to 8.23 under different treatments shown in Table 2. In surface soil depth 0-15 cm, the lowest pH was recorded 8.01 in treatment T_7 which were significantly lower than control and the plots where organic manures were used in combination with chemical fertilizers. The highest pH was recorded in recommended fertilizer treatment plot where full dose of NPK applied through inorganic fertilizers. The EC of surface soil slightly varied from 0.30 to 0.34 ds m^{-1} in different treatment combinations. The highest EC was recorded in plot where full dose of nitrogen applied through FYM along with bio-fertilizer and RDF treated plot had significantly lower EC than integrated nutrient management plots.

However, there was no significant difference in soil pH and soil EC was observed (Table 2). Soil organic carbon was recorded maximum in T_7 *i.e.* where 100% N through farmyard manure incorporated which was statistically at par with T_8 (0.53%) and T_6 (0.55%) where full dose of N was substituted through organic sources. Soil organic carbon in organic manure treatments was found maximum than control, RDF and integrated nutrient management treatments. The SOC content in integrated nutrient management treatments was statistically similar. Increase in soil organic carbon content with the application of FYM and poultry manure may be attributed to the direct incorporation of these organic materials in the soil and the subsequent decomposition of these materials resulting in enhanced organic carbon content of the soil. A similar finding was reported by Ghayal *et al.,* (2017).

Available nitrogen increased significantly with the conjoint application of chemical fertilizers and organic manures as compared to control. There was a significant build up of available nitrogen in soil was observed 243.10 kg ha^{-1} in integrated nutrient management treatment T_{10} which was at par with T_3 value 241.07 kg ha^{-1} but these treatments statistically significant over all other treatments consist of integrated nutrient application, recommended fertilizer, organic sources and control. This integrated use of inorganic, organic along with bio-inoculants resulted in better utilization of nutrients which enhanced yield and soil health. The results are in close conformity with Kumar and Veeragavathathan (2003).

Reduction in available P content of the soil observed under control treatment (11.28 kg ha^{-1}) occurred due to removal of P by crop in the absence of external source of P. Incorporation of 50% N through poultry manure along with 50% N through inorganic sources and bio-fertilizer recorded significantly higher available P (21.24 kg ha^{-1}) which was at par with treatment T_3 value (20.12 kg ha^{-1}) receiving half dose of N by poultry manure and remaining N by inorganic fertilizer. Incorporation of manures along with inorganic fertilizers recorded significantly higher available phosphorus as compared to other treatments.

Similar findings have also been reported by Kumar *et al.,* (2012). It was noticed that highest available potassium was obtained in treatment T_{10} receiving 50% N through inorganic sources and 50% N through poultry manure along with bio-fertilizer which was at par with T_3 in which available potassium was recorded 306.43 kg ha^{-1}. The increase in available potassium under integrated treatments might be due to addition of organic matter that reduced potassium fixation and released potassium due to interaction of organic matter with clay, besides the direct potassium addition to the pool of soil by Subehia and Sepehya (2012) (Table 3).

Available Zn, Cu, Fe and Mn mean values were lower in control plots and it increased significantly with the application of organic manures combined with the chemical fertilizers. Maximum available Zn, Cu, Fe and Mn was observed in treatment T_{10} which was at par with treatment T_3 and T_5. Such build up of cationic micronutrients in soil might be partly owing to release of native soil micronutrients resulting from the dissolution action of organic manures and also partly due to release from applied organic manures by Sur *et al.,* (2010).

The effect of judicious use of inorganic fertilizers and organic manures on growth attributing characters of sprouting Broccoli is presented in Table 4.

Maximum plant height (at 30DAT - 33.85 cm, at 60 DAT – 52.20 cm and at harvest – 66.99 cm) was observed under the entire dose of recommended NPK through inorganic fertilizers, It can be concluded that significantly higher plant height in RDF treated plot over other treatments might be due to quick release of nutrients and more availability of nitrogen. Moreover, better growth with respect to plant height in poultry manure treated plots might be due to the availability of more nitrogenous compounds to the plant. The similar results are finding by Sharma *et al.,* (2018) (Table 5).

Table.1 Nutrient composition of poultry manure and farmyard manure

Source	Macronutrients			Micronutrients			
	Per cent			mg kg^{-1}			
	N	P	K	Zn	Fe	Cu	Mn
PM	1.8	1.3	0.8	21.41	79.82	5.46	205.18
FYM	0.7	0.4	0.6	13.27	62.25	2.67	101.39

Table.2 Effect of integrated nitrogen management on soil pH, EC and organic carbon in soil

Symbol	Treatments	pH	EC (dS m^{-1})	Organic carbon (%)
T_1	Control	8.23	0.30	0.44
T_2	100% RDF	8.22	0.34	0.46
T_3	50% RDNF + 50% N (PM)	8.15	0.32	0.49
T_4	50% RDNF + 50% N (FYM)	8.11	0.31	0.51
T_5	50% RDNF + 50% N (FYM) + Bio-fertilizer	8.10	0.32	0.51
T_6	100% N (PM) + Bio-fertilizer	8.07	0.33	0.52
T_7	100% N (FYM) + Bio-fertilizer	8.01	0.33	0.55
T_8	50% N (PM) + 50% N (FYM)	8.04	0.33	0.53
T_9	50% N (PM) + 50% N (FYM) + Bio-fertilizer	8.03	0.32	0.53
T_{10}	50% RDNF + 50% (PM) + Bio-fertilizer	8.14	0.32	0.50
	CD (p=0.05)	N.S	N.S	0.03

Table.3 Effect of integrated nitrogen management on available N, P and K (kg ha^{-1}) in soil

Symbol	Treatments	Available N	Available P	Available K
T_1	Control	176.20	11.28	248.36
T_2	100% RDF	227.12	16.12	293.32
T_3	50% RDNF + 50% N (PM)	241.07	20.12	306.43
T_4	50% RDNF + 50% N (FYM)	234.12	18.44	298.63
T_5	50% RDNF + 50% N (FYM) + Bio-fertilizer	239.07	19.61	301.06
T_6	100% N (PM) + Bio-fertilizer	229.77	15.56	289.23
T_7	100% N (FYM) + Bio-fertilizer	210.54	14.07	278.63
T_8	50% N (PM) + 50% N (FYM)	214.12	14.36	281.08
T_9	50% N (PM) + 50% N (FYM) + Bio-fertilizer	215.44	15.04	285.07
T_{10}	50% RDNF + 50% (PM) + Bio-fertilizer	243.10	21.24	310.63
	CD (p=0.05)	7.70	1.97	6.01

Table.4 Effect of integrated nitrogen management on available micronutrients in soil

Symbol	Treatments	Available micronutrients (mg kg^{-1})			
		Zn	Cu	Fe	Mn
T_1	Control	0.76	0.52	2.48	8.50
T_2	100% RDF	0.78	0.55	2.51	8.55
T_3	50% RDNF + 50% N (PM)	1.10	0.86	3.72	10.83
T_4	50% RDNF + 50% N (FYM)	0.98	0.77	3.45	9.63
T_5	50% RDNF + 50% N (FYM) + Bio-fertilizer	1.06	0.81	3.64	10.57
T_6	100% N (PM) + Bio-fertilizer	0.95	0.72	3.37	9.54
T_7	100% N (FYM) + Bio-fertilizer	0.81	0.64	2.77	8.66
T_8	50% N (PM) + 50% N (FYM)	0.84	0.66	2.92	8.93
T_9	50% N (PM) + 50% N (FYM) + Bio-fertilizer	0.90	0.67	3.21	9.05
T_{10}	50% RDNF + 50% (PM) + Bio-fertilizer	1.12	0.88	3.76	11.22
	CD (p=0.05)	0.09	0.07	0.03	0.05

Table.5 Effect of integrated nitrogen management on periodic plant height (cm) of broccoli

Symbol	Treatments	30 DAT	60 DAT	At Harvest
T_1	Control	21.95	37.90	54.56
T_2	100% RDF	33.85	52.20	66.99
T_3	50% RDNF + 50% N (PM)	30.11	47.21	62.85
T_4	50% RDNF + 50% N (FYM)	27.18	45.19	60.08
T_5	50% RDNF + 50% N (FYM) + Bio-fertilizer	29.41	46.11	61.48
T_6	100% N (PM) + Bio-fertilizer	26.11	43.18	59.18
T_7	100% N (FYM) + Bio-fertilizer	22.48	39.22	55.65
T_8	50% N (PM) + 50% N (FYM)	23.85	41.18	56.18
T_9	50% N (PM) + 50% N (FYM) + Bio-fertilizer	25.05	42.51	57.48
T_{10}	50% RDNF + 50% (PM) + Bio-fertilizer	31.48	49.31	64.11
	CD (p=0.05)	2.58	3.18	3.62

Table.6 Effect of integrated nitrogen management on periodic number of leaves plant^{-1} of broccoli

Symbol	Treatments	30 DAT	60 DAT	At Harvest
T_1	Control	6.03	13.65	19.05
T_2	100% RDF	8.98	18.41	24.95
T_3	50% RDNF + 50% N (PM)	8.11	17.69	23.65
T_4	50% RDNF + 50% N (FYM)	7.45	16.85	22.81
T_5	50% RDNF + 50% N (FYM) + Bio-fertilizer	7.95	17.11	23.05
T_6	100% N (PM) + Bio-fertilizer	7.31	16.19	22.48
T_7	100% N (FYM) + Bio-fertilizer	6.51	14.95	20.82
T_8	50% N (PM) + 50% N (FYM)	6.85	15.41	21.41
T_9	50% N (PM) + 50% N (FYM) + Bio-fertilizer	7.01	15.88	21.95
T_{10}	50% RDNF + 50% (PM) + Bio-fertilizer	8.59	18.05	24.05
	CD (p=0.05)	0.42	1.01	1.20

Table.7 Effect of integrated nitrogen management on stem girth (cm), leaf area (cm), average head weight (gm) and head yield (q ha^{-1}) of broccoli

Symbol	Treatments	Stem Girth	Leaf Area	Average head weight	Head Yield
T_1	Control	3.98	260.40	210.13	103.72
T_2	100% RDF	10.11	413.24	345.19	170.49
T_3	50% RDNF + 50% N (PM)	9.15	397.21	312.88	154.53
T_4	50% RDNF + 50% N (FYM)	8.16	345.17	281.32	138.97
T_5	50% RDNF + 50% N (FYM) + Bio-fertilizer	8.75	386.07	302.61	149.42
T_6	100% N (PM) + Bio-fertilizer	7.48	340.16	270.95	133.86
T_7	100% N (FYM) + Bio-fertilizer	5.35	317.18	229.18	113.25
T_8	50% N (PM) + 50% N (FYM)	6.01	321.32	245.04	121.04
T_9	50% N (PM) + 50% N (FYM) + Bio-fertilizer	6.95	327.75	259.48	128.11
T_{10}	50% RDNF + 50% N (PM) + Bio-fertilizer	9.82	405.23	328.37	162.18
	CD (p=0.05)	1.04	28.15	19.48	8.95

Table.8 Effect of integrated nitrogen management on dry matter (q ha^{-1}), nitrogen uptake (kg ha^{-1}), agronomic nitrogen use efficiency and apparent nitrogen recovery (%) of broccoli

Symbol	Treatments	Dry matter	N Uptake	Agronomic nitrogen use efficiency (kg yield kg^{-1} N applied)	Apparent nitrogen recovery (%)
T_1	Control	19.14	22.56	---	---
T_2	100% RDF	35.07	70.14	53.41	38.06
T_3	50% RDNF + 50% N (PM)	32.65	59.24	40.64	29.34
T_4	50% RDNF + 50% N (FYM)	30.40	45.33	28.02	18.21
T_5	50% RDNF + 50% N (FYM) + Bio-fertilizer	31.60	51.02	36.56	22.76
T_6	100% N (PM) + Bio-fertilizer	29.07	40.50	24.11	14.35
T_7	100% N (FYM) + Bio-fertilizer	25.08	27.32	7.62	3.80
T_8	50% N (PM) + 50% N (FYM)	26.63	32.22	13.85	7.72
T_9	50% N (PM) + 50% N (FYM) + Bio-fertilizer	27.78	37.18	19.51	11.69
T_{10}	50% RDNF + 50% N (PM) + Bio-fertilizer	34.32	65.68	46.76	34.49
	CD (p=0.05)	3.42	5.48	---	---

Table.9 Effect of integrated nitrogen management on economic analysis

Symbol	Treatments	Total input cost (Rs. ha^{-1})	Gross returns (Rs. ha^{-1})	Net returns (Rs. ha^{-1})	B: C ratio
T_1	Control	120732	222577	101845	0.84
T_2	100% RDF	127918	388957	261039	2.04
T_3	50% RDNF + 50% N (PM)	130555	356747	226192	1.73
T_4	50% RDNF + 50% N (FYM)	133100	346737	213637	1.60
T_5	50% RDNF + 50% N (FYM) + Bio-fertilizer	134540	351243	214703	1.61
T_6	100% N (PM) + Bio-fertilizer	131220	326767	195547	1.49
T_7	100% N (FYM) + Bio-fertilizer	132455	311297	178842	1.35
T_8	50% N (PM) + 50% N (FYM)	131535	315097	184162	1.38
T_9	50% N (PM) + 50% N (FYM) + Bio-fertilizer	135735	325101	189366	1.39
T_{10}	50% RDNF + 50% N (PM) + Bio-fertilizer	134495	369248	234753	1.74

Regarding the number of leaves, it was observed that maximum number of leaves recorded in T_2 (8.98), followed by T_{10} (8.59) at 30 days after transplanting and at 60 days after transplanting maximum number of leaves was also recorded in T_2 (18.41) followed by T_{10} (18.05). At harvesting time the maximum number of leaves was observed in T_2 (24.95) followed by T_{10} (24.05). The increase in number of leaves in RDF treated plot could be attributed to timely supply of nutrients particularly nitrogen which is required for vegetative growth of plant in this treatment. Similar results have also been reported by Pawar and Barkule (2017) and Sharma *et al.*, (2018) (Table 6).

The observation on stem girth, leaf area, average head weight and head yield showed an increasing trend with higher level of inorganic doses (Table 7).

The maximum stem girth (10.11 cm) and leaf area (413.24 cm^2) was recorded with the application of 100% RDF alone which was at par with treatment T_{10}. Girth of stem was increased due to less retention in roots and more translocation of nutrients to aerial parts for synthesis of protoplasmic protein and other metabolites enabling the expansion of photosynthetic area. This might be due to the cell elongation by the presence of nitrogenous compounds by Chaterjee *et al.*, (2005).

The average weight of curd was influenced by the application of organic manures and inorganic fertilizers under different treatments indicate that the average curd weight was recorded maximum (345.19 gm). Whereas treatment T_8 and T_7 in which 100% N was applied through PM and FYM were at par and inferior to all treatments except the control. The effect of integrated use of organic manures have not resulted significant influence on yield of broccoli and highest yield was found (170.49 q ha^{-1}) under 100% RDF treated plots but it was statistically at par with T_{10} treatment. Further, it can be construed that integrated use of inorganic fertilizers, organic manures and nitrogen fixing bacteria have influenced the yield by combined application of these might have improved the availability of nutrients due to more uptake improved root zone environment, which resulted in increased marketable yield by Sharma *et al.,* (2018).

Similarly, maximum accumulation of dry matter was observed (35.07) in treatment T_2 where recommended dose of nutrients substituted whereas closely followed by integrated treatment T_{10} (Table 8). It might be due to the release of sufficient quantity of nutrients by the process of mineralization at a constant level that in turn gave higher dry matter content by Shree *et al.,* (2014). Moreover, application of 100% RDF resulted in highest N (70.14 kg ha^{-1}) uptake by broccoli which was found to be statistically similar to T_{10} in which 50% N was supplied through poultry manure. The higher uptake might be due to improved physical and chemical properties in the root environment. Further, the growth promoting substances produced increased root development and uptake and availability of nutrients by Sharma *et al.,* (2008).

Maximum agronomic nitrogen use efficiency was recorded 53.41 in T_2 where recommended dose of NPK was substituted through inorganic fertilizers while, lower values was noticed in T_8 and T_7 treatments value 13.85 and 7.62, respectively. Apart from it, apparent nitrogen recovery (%) followed the similar trend as agronomic nitrogen use efficiency. Maximum apparent nitrogen recovery was also recorded 38.06 % in T_2 and minimum 3.80 % in T_7. Similarly, it was observed highest again in chemically fertilized plots in which maximum uptake was recorded while lowest recovery of nitrogen noticed in farmyard manure treated plot along with bio-fertilizer due to less mineralization of organic manure during crop growth period.

Economic analysis

The perusal of data pertaining to benefit: cost ratio (B: C) ratio revealed that maximum benefit B: C ratio (2.04) was obtained with the treatment T_2 in which 100% recommended dose of nutrients was applied through fertilizers followed by treatment combination T_{10} where half dose of recommended nitrogen was substituted through inorganic fertilizer and remaining half through poultry manure conjoint with bio-fertilizer (Table 9). On the other hand, minimum B: C ratio (0.84) was recorded in T_1 control. In T_2 treatment highest benefit: cost ratio was recorded due to maximum yield was obtained with least investment as compared to other treatments.

It may be concluded that supply of nutrients through integrated application of organic and inorganic sources resulted in better soil properties and plant growth parameters over the individual application. Among all the treatments, application of 50% RDNF + 50% N through poultry manure + bio-fertilizer was found to be the best for improving soil health and yield economics of sprouting broccoli but slightly decrease with RDF treated plot. Moreover, substantial improvement in soil fertility was recorded as the contents of available micronutrients *viz.,* Zn, Mn, Cu and Fe were significantly higher in case of the plots which received either FYM, poultry manure and bio-fertilizer in combination with chemical fertilizers than the plots which received only sole application of chemical fertilizer. Therefore, this treatment is recommended as beneficial for farmers on long term basis, as it resulted in saving 25% inorganic fertilizers for better net returns.

References

Anonymous. 2019. Package of Practices for cultivation of Vegetable Crops. Punjab Agricultural University, Ludhiana, pp 72-73.

Chapman, H.D. and Pratt, P.F. 1961. *Methods of analysis for soils, plants and waters*, University of California, Division of

Agricultural Sciences, U.S.A.

Chatterjee, B., Ghanti, P., Thapa, U. and Tripathy, P. (2005). Effect of organic nutrition in sprouting broccoli (*Brassica oleracea L.* var. *italica* Plenck.). *Vegetable Science.* 32:51-54.

Dilz, K. 1988. Efficiency of uptake and utilization of fertilizer nitrogen by plant. In: Jenkinson, D.S. and Smith, K.A. (ed). *Nitrogen efficiency in agricultural soils*. pp. 1–26. Elsevier Applied Science, London.

Ekta, N., Shailaja, P., Pant, S.C., Kumar, S., Pankaj, B., Bengia, M. and Nautiyal, B.P. 2017. Effect of organic manures and bio-fertilizers on growth, yield, quality and economics of Broccoli (*Brassica oleracea L.var. italic* PLECK) cv. Green head under high-hill conditions of Uttarakhand. *International Journal of Advanced Biological Research,* 7: 96-100.

Elnasikh, M.H. and Satti, A.A. 2017. Potentiality of organic manure in supporting sustainable agriculture in Sudan. *Environment and Natural Resources International Journal*, 2: 01-26.

Ghayal, R.G., Vaidya, K.P. and Tapkeer, P.B. (2017). Effect of different organic manures and inorganic fertilizers on chemical properties of cucumber (*Cucumis sativus* L.) in lateritic soils of konkan. *International Journal of Chemical Studies*, 5: 1626-1630.

Kumar and Biradar 2017. Integrated nutrient management studies for protected cultivation of broccoli (*Brassica oleracea* var. *italica* L.). *International Journal of Chemical Studies*, 5: 225-227.

Kumar, M.Y. and Singh, Y.V. (2012). Effect of integrated nutrient management on rice yield, nutrient uptake and soil fertility status in reclaimed sodic soils. *Journal of the Indian Society of Soil Science,* 60: 132-137.

Kumar, N.S. and Veeraragavathathan, D. (2003). Role of integrated nutrient management on the nutrient content of plant tissues in brinjal (*Solanum melongena L.*) cv. Palur-1. *South Indian Horticulture,* 51:163-167.

Lindsay, W.L. and Norvell, W.A. 1978. Development of DTPA Soil test method for zinc, iron, manganese and copper. *Soil Science Society of America Journal*, 42: 421-428.

Liu, M., Zhang, L., Ser, S.L., Cumming, J.R. amd Ku, K.M. 2018. Comparative phytonutrient analysis of broccoli by-products: The potentials for broccoli by-product utilization. *Molecules*, 4: 23-900.

Merwin, H.D. and Peech, M. 1951. Exchangeability of soils potassium in the sand, silt and clay fractions as influenced by the nature of complementary exchangeable cations. *Soil Science Society of America Proceedings*, 15: 125-128.

Novoa, R. and Loomis, R.S. 1981. Nitrogen and plant production. *Plant Soil*, 58: 177-204.

Olsen, S.R., Cole, C.V., Watanabe, F.S. and Dean, L.A. 1954. Estimation of available phosphorus by extraction with sodium bicarbonate, *United States Department of Agriculture Circular*, 939: 1-19.

Pawar, R. and Barkule, S. (2017). Study on effect of integrated nutrient management on growth and yield of cauliflower (*Brassica oleracea var. botrytis* L.). *Journal of Applied and Natural Science,* 9: 520-525.

Subehia, S. K. and Sepehya, S. (2012). Influence of long term nitrogen substitution through organics on yield, uptake and nutrient losses from upland farming system in the middle mountains region of Nepal. *Nutrient*

Cycling in Agro-ecosystems, 86: 241-253.

Sharma, C., Kang, B.S., Kaur, R., Singh, S.K. and Aulakh, K. (2018). Effect of integrated nutrient management on growth, yield and quality of broccoli (*Brassica oleracea L. var. italica*). *International Journal of Chemical Studies*, 6: 1296-1300.

Sharma, A., Parmar, DK., Kumar, P., Singh, Y. and Sharma, R.P. (2008). Azotobacter soil amendment integrated with cow manures reduces need for NPK fertilizers in sprouting broccoli. *International Journal of Vegetable Science*, 14: 273-285.

Sharma, U. and Subehia, S.K. 2014. Effect of long-term integrated nutrient management on rice (*Oryza sativa* L,) - wheat (*Triticum aestivum* L.) productivity and soil properties in north-western Himalaya. *Journal of the Indian Society of Soil Science*, 62: 248-254.

Shree, S., Singh, V.K., Kumar, R. (2014). Effect of integrated nutrient management on yield and quality of cauliflower (*Brassica oleracea L.* var. *botrytis*). *An International Quarterly Journal of Life Sciences*. 9: 1053-1058.

Subbiah, B.V. and Asija, G.L. 1965. A rapid procedures for the estimation of available nitrogen in soils. *Current Science*, 25: 259-260.

Sur, P., Mandal, M. and Das, D.K. (2010). Effect of integrated nutrient management on soil fertility and organic carbon in cabbage (*Brassica oleracea* var. capitata) growing soils. *Indian Journal of Agricultural Sciences*, 80: 38-00.

Walkley, A. and Black, A. 1934. An examination of the Degtjareff method for determining soil organic matter and a proposed modification of the chromic acid titration method. *Soil Sciences*, 37: 27-38.

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