Original Research Article

Response of Inorganic, Integrated and Organic Sources of Nutrients on Growth and Yield of Cabbage

Abstract

Organic manures and farm wastes are beneficial in recycling as nutrients in the form of compost into soil and can serve as an alternative to inorganic fertilizers (IFs). A field experiment was conducted at Nalanda College of Horticulture to evaluate inorganic, integrated and organic sources of nutrients for cabbage production. The soil of the experimental plot was clay loam having 7.47 pH, 0.21 EC (dSm^{-1}) and 0.62 % organic carbon, 262 kg, 14.60 kg and 142 kg ha^{-1} available N, P and K, respectively. The experiment comprised of seven treatments *viz*., T_1-100% (120:60:40 kg ha^{-1} of N, P_2O_5 and K_2O) from inorganic fertilizers (IFs); T_2-50 % NPK through IFs + 50 % N through FYM; T_3-50% N through FYM + 50 % N through VC; T_4- 1/3 of N each through FYM + VC + Neemcake; T_5-50% N through FYM + PSB + Azotobactor; T_6-(T_3+PSB + Azotobactor) and T_7-(T_4+PSB + Azotobactor) with three replications in Randomized Block Design (RBD). Result revealed that combined application of organic manures alone, or in combination with inorganic fertilizers, significantly differed in growth parameters, yield attributes and yield of cabbage and exerted significant positive effects on nutrient [nitrogen (N), phosphorus (P), potassium (K) and sulfur (S)] uptakes. Among different treatments, T_2 (integration of 50% NPK through inorganic fertilizers and 50% N through organic manures) recorded significantly maximum number of wrapped leaves during all three years, but were found at par with T_1. T_2 recorded significantly highest head yield per plot and finally yield (470.7, 430.2 and 371.4 qha^{-1}) in all three consecutive years respectively. Although, among 100% organic sources, T_6 (T_3+biofertilizers; PSB & Azotobactor) recorded significantly highest head yield (371.5, 310.3 and 311.3 q ha^{-1}) in all three consecutive years respectively over rest of the organic sources. T_6 observed maximum soil organic carbon (0.66%), available P (43.67 kg ha^{-1}), K (180.04 kg ha^{-1}) and S 19.04 kg ha^{-1} as compared to 100 % inorganic fertilizer sources, integrated sources and other organic sources. On the basis of results of this three years experiment it is concluded that T_2-50 % NPK through IF + 50 % N through FYM, can be

adopted for most economic crop production, but T_6 (50% N as FYM+50% N as VC + PSB and Azotobacter) considered best for long term sustainable cabbage production.
Keywords: Cabbage, Head, FYM, Vermicompost, Neemcake, Organic manures, Inorganic, Integrated, Fertilizer, Nutrient uptake

Introduction

Vegetables play an important role in human nutrition as they are sources of bioactive nutrient molecules such as dietary fiber, vitamins, minerals and non-nutritive phytochemicals including phenolic compounds, flavonoids and bioactive peptides **[Ulger et al, 2018].** The cole crops are nutritious, popular and inexpensive winter season vegetables in India which include cabbage, cauliflower, broccoli, turnips, etc. Cabbage (*Brassica oleracea* var. *capitata* L.) is one of the most important cool season leafy vegetables in India, as well as in the world, belongs to the family Cruciferae. These cruciferous vegetables are naturally enriched with fiber, nutrients *viz.,* P, K, Mg, Mn, choline, etc. Vitamins, like vitamin B, C and K and antioxidants *viz.*, glucosinolates, isothiocyanates, carotenoids and flavonoids found in cole crops, and have significant roles in human health **[Sharma and Prasad, 2018].** Thus, by increasing the production of this vegetable crop, nutritional demand of the country can be fulfilled to some extent. In India it is grown in an area of 0.432 million ha that produced 10.04 million tons in the year 2022-23 [DAFF 2024], which is quite low in comparison with some other Asian countries like China. To achieve better yield, a novel but sustainable technology should be adopted for cabbage cultivation. In the last few decades, our food production has increased due to substantial intensification of cropping, introduction of high yielding varieties (HYVs), expansion of irrigation facilities, and higher use of chemical fertilizers and pesticides. However, this modern agricultural practice has led to severe problems of soil organic matter decline and widespread soil fertility depletion which are closely associated with fertilizer nutrient imbalance, nutrient gap between plant use and fertilizer application and mining out scarce native soil nutrients to support plant growth and yield **[Panaullah et al., 2006; Rijpma and Islam 2015].** With the advancement of time, nutrient balance is becoming more negative because most of our farmers are much interested in using chemical fertilizers and are not intended to apply organic manures. Therefore, to minimize the nutrient depletion, it is high time to apply the organic sources of plant nutrients, *viz.,* farm yard manure (FYM), green manure, solid wastes along with chemical fertilizers, because these manures can reduce the negative balance whose magnitude depends on the types and amounts of manures used. An integrated approach involving organic manures, biological resources and chemical fertilizers can go a long way to improve crop productivity and to maintain soil fertility. Considering these facts, the present investigation was carried out to assess the performance of 100% inorganic, integrated and different organic nutrient sources for improving growth and yield of cabbage.

Table 1. Nutrient composition of different organic manures with moisture percentage

Organic manures	**Nutrient content (%)**		
	N	**P_2O_5**	**K_2O**
Farm yard manure (FYM)	0.45	0.23	0.42
Vermicompost (VC)	1.21	0.61	0.91
Neemcake (NK)	4.91	1.0	1.21

Materials and Methods

Experimental Site and Soil

This study was conducted at Research Farm of Nalanda College of Horticulture Noorsarai (Bihar agricultural University Sabour, Bhagalpur) Bihar during three consecutive *rabi* season of 2017, 2018 and 2019. Nalanda College of Horticulture Noorsarai and fall under Zone III (b) of Bihar (Middle Gangetic Plain of India). The soil of the experimental plot was clay loam having 7.47 pH, 0.21 EC (dSm-1) and 0.62 % soil organic carbon, 262 kg, 14.60 kg and 142 kg ha^{-1} available N, P and K, respectively. Soil pH (1:2.5 soil: water) was measured by glass electrode pH meter method **[Jackson, 1973],** and organic matter was determined by Walkley and Black method **[Walkley and Black 1934].** The content of total N was measured by semi-micro Kjeldahl method **[Bremner and Mulvaney 1982]** and available P was determined by Olsen method **[Olsen et al., 1954].** The exchangeable K was determined by flame photometer after extraction with 1 N NH_4OAc at pH 7 **[Knudsen et al., 1982],** and available S was measured by extracting soil samples with $CaCl_2$ solution (0.15%) followed by measuring the turbidity by spectrophotometer **[Williams and Steinbergs, 1959].**

Experimental Details

The experiments were laid out in a Randomized Block Design (RBD) with three replications. The sources of inorganic fertilizers were urea, diamonium phosphate (DAP) and muriate of potash (MOP), while the organic sources were farm yard manure (FYM), vermicompost, (VC) and neem cake (NK). The total seven treatments *viz.*, T_1-100% (120:60:40 Kgha^{-1} of N, P_2O_5 and K_2O) from inorganic fertilizers; T_2-50% NPK through IFs + 50 % N through FYM; T_3-50% N through FYM + 50 % N through VC; T_4- 1/3 of N each through FYM + VC + NK; T_5-50% N through FYM + PSB + Azotobacter; T_6-(T_3+PSB + Azotobacter) and T_7-(T_4+PSB + Azotobacter) were taken into study. The total number of plots was kept 21 and the size of the unit plot was 5m X 3m (15 m^2). The spacing between blocks was 1 m, and the plots were separated from each other by a space of 0.5 m bund. Cabbage variety-Neelu (F1) was used as test crop whose 25-day-old seedlings were transplanted in the experimental plots from November 25 to November 30 during all three respective *rabi* seasons. The line-to-line distance was 50 cm, and plant-to-plant distance was 45 cm. The seedlings were watered immediately after transplanting. Various intercultural operations including gap filling, weeding, irrigation, and organic pesticides application were done as and when required. Constant doses of N, P and K at the rate of 120, 60 and 40 Kg ha^{-1} were applied to each respective treatment. These nutrients were supplied from Urea, Diammonium Phosphate (DAP) and Muriate of Potash (MoP) in T_1 and 50 % from the same source of NPK in T_2.. 50% N through FYM + 50 % N through Vermicompost were applied in T_3, every 1/3 of N supplied through FYM + VC + NK in T_4, 50% N supplied through FYM in T_5 which was supplemented with PSB+Azotobacter at the rate of 15 ml each per plot; 50% N through FYM + 50 % N through VC were applied in T_6 which was supplemented with PSB+Azotobacter at the rate of 15 ml each per plot, and in T_7 every 1/3 of N supplied through FYM + VC + NK which was supplemented with PSB+Azotobacter at the rate of 15 ml each per plot. Urea fertilizer was applied in three equal splits as top dressing at 15, 30 and 50 DAT (days after transplanting) while the other chemical fertilizers were applied as basal doses at the time of land preparation before transplanting of seedlings. Organic manures viz., well rotten FYM, VC and NK were applied in the field and incorporated well into the soil. 10 days after incorporation of organic fertilizers field were prepared for transplanting. Farm yard manure and neemcake were collected from local farms and local markets and vermicompost were produced at College's Research Farm. Nutritional composition and moisture content of the manures under study are presented in Table 1. The cabbage crop was harvested in the month of

February every year, at full maturity. The data on growth and yield components such as plant height; leaf numbers (wrapped & unwrapped) length and diameter of head, thickness and length and of stalk, weight of head, and marketable yield were recorded at the time of harvesting of the crop. The representative head samples of cabbage from each plot were collected during harvesting for chemical analysis. Both plant samples and organic manures were prepared by drying them in an oven at 65ºC temperature for about 72 hours followed by grinding in a grinding machine. The ground samples were passed through a 20-mesh sieve, kept in paper bags and finally stored in desiccators for analysis of nutrient elements, *viz.* N, P, K and S. In plant samples and organic manures, the total N was determined by Kjeldahl digestion method **[Nelson and Sommers, 1973]** and total contents of P, K and S were determined by digesting the ground samples using HNO_3-$HClO_4$ (3:1) di-acid mixture as described by **[Piper 1966].** The total P and S contents were measured by colorimetric and turbidimetric procedures, respectively, with spectrophotometer, whereas total K was determined by flame photometer according to the protocols reported by **[Yamakawa, 1992].** Nutrient uptake by head samples was calculated as:

$$\text{Nutrient uptake } (\text{Kg ha}^{-1}) = \text{Nutrient content } (\%) \text{ x Total dried yield of cabbage } (\text{q ha}^{-1})$$

Statistical Analysis

The data collected on different aspect of experimentation, were analyzed with the help of computer applying analysis of variance technique given by **Gomez and Gomez (1984).**

Results and Discussion

Several studies have indicated that using organic manures and chemical fertilizers together can promote the growth and productivity of cole crops. Increased plant height, increased number of leaves, and larger curd or head sizes are signs of this **(Simarmata et al., 2016)** Because of the increasing costs, quick nutrient loss, and harmful environmental effects of inorganic fertilizers, organic manures combined with chemical fertilizers have gained international attention recently as a source of plant nutrients for the development of vegetable crops **(Roy and Kashem 2014).**

Growth Parameters of cabbage with 100% inorganic, integrated (application of organic manures with inorganic fertilizers) and 100% organic sources alone had significant effects on all the growth parameters of cabbage such as plant height, leaf numbers (wrapped & unwrapped) length and breadth of head, thickness and length and of stalk, weight of head, and marketable yield (Table 2, 3 and 4).

Growth Parameters and Yield of Cabbage

At Nalanda College of Horticulture (NCOH) farm, T_2-(50% NPK through IFs + 50 % N through FYM) observed maximum number of wrapped leaves (49.1, 31.9, 31.4) per head which was statistically at par with T_1 -100% (120:60:40 Kgha^{-1} of N, P_2O_5 and K_2O) having (45.4, 31.7, 30.4) leaves per head (table 1, 2 and 3). Among the 100% organic sources, the maximum number of wrapped leaves (37.3, 31, 30.1) per head was observed in T_6-50% N as FYM+50% N as VC+ PSB and azotobactor and the lowest was found in T_5 in all three consecutive years. Among all the treatments the maximum number of unwrapped leaves was observed 10.5 in first year in T_4, while 14.9, and 13.8 in second and third year in T_5. The minimum number of unwrapped leaves was observed (8.1) in T_2 in first year while (12.8 and 8.9) in T_1 in second and third year of study. T_2-(50% NPK through IFs + 50 % N through FYM) observed maximum head length and diameter (17.5, 16.5, 15.3 cm and 14.7, 12.9 11.8 cm) in all three respective years, which was statistically at par with T_1-100% IFs. Among the 100% organic sources, the maximum head length and diameter (16.1, 14.5, 15.2 cm and 14.3, 10.9, 11.9 cm) per head was observed in T_6-50% N as FYM+50% N as VC+ PSB and azotobactor and the lowest was found in T_5 in all three consecutive years. Application of 50% NPK through IFs in association with 50 % N through FYM (T_2) performed best result and observed maximum stock length (10.3, 8.1, 6.2 cm) and diameter (3.5, 2.9, 3.6 cm) in all three consecutive years. Stock length differed significantly but stock diameter did not differ significantly due to different nutrient sources. Among the 100% organic sources, the maximum stock length and diameter (9.6, 7.1, 5.9 cm and diameter (3.3, 2.5, 3.1 cm) was observed in T_6-50% N as FYM+50% N as VC+ PSB and azotobactor and the lowest was found in T_5 in all three consecutive years. Head weight of the cabbage significantly affected by inorganic, integrated use and organic manures and fertilizers (Table 2, 3, 4). Application of 50% NPK through IFs in association with 50 % N through FYM (T_2) performed best result regarding average cabbage head yield (1.176, 1.075, 0.928 kg) and finally yield (470.7, 430.2, 371.4 qha^{-1}) among all the nutrient sources. T_1 with (1.121, 0.003, 0.912 kg) average weight of cabbage head (table 2, 3, 4) and (448.7, 401.2, 364.8 qha^{-1}) of cabbage yield observed statistically similar to T_2. The integrated (integration of IFs with organic manures) management systems were found better compared to sole application of inorganic fertilizers in improving growth, yield and yield parameters of cabbage. The best cabbage head weight, head length, head diameter, number of wrapped leaves, and stock length and diameter obtained from the combined application of 50% NPK through IFs and 50% N through FYM (T_2), could be attributed to its balanced nutrient contents and continuous supply of essential plant nutrients.

The notable rise in cabbage production and yield might be ascribed to improved head growth and development, which results from the absorption of nutrients from both organic and inorganic sources. Prior research by **[Stamatoados et al. 1999; Chaudhary et al., 2018]** claimed that crop yields are increased when organic manures and mineral fertilizers are applied to the soil simultaneously because the efficiency of the mineral fertilizers is increased. The use of organic manures and inorganic fertilizers sustaining plant growth and development and increasing yield primarily based on providing nutrients to plants, **[Riba et al., 2018].** Among the 100% organic fertilizers the maximum head yield (387.7, 310.3, 311.3 q/ha^{-1}) was observed with the application of 50% N as FYM+50% N as VC+ PSB+azotobacter (Table 2, 3, 4) and the lowest was found in T_5 in all three consecutive years. The significantly maximum dry weight (67.83 qha^{-1}) of cabbage in third year of experiment was observed in T_2 which was statistically similar to T_1 (65.08 qha^{-1}) and T_6 (59.60 qha^{-1}). Among the 100% organic fertilizers the maximum dry weight (59.60 qha^{-1}) was observed with the application of 50% N as FYM+50% N as VC+ PSB + azotobacter (table 5) and the lowest (39.2 qha^{-}1) was found in T_5 in third year of crop harvest.

Nutrient content and uptake by cabbage

The present work suggests that the nutrients (N, P, K and S) content and uptake by cabbage varied significantly due to inorganic fertilizers, combined application of organic manures with inorganic fertilizers and 100% organic manures (Table 5). At NCOH farm, after the third year of cabbage crop harvest, the nutrient content (N, P, K and S) was estimated, which were varied from 2.38 to 2.68 %, 0.36 to 0.4 %, 2.77 to 3.02 % and 0.350 to 0.403% respectively. The maximum values for all the nutrients (N, P K and S) content (Table 5) were found in T_6 (50% N as FYM+50% N as VC+ PSB+azotobacter) while the minimum values were observed in T_1 treatment. N content differed significantly due to different sources of organic manures and inorganic fertilizers. Highest N content (2.68%) was found in T_6 which was statistically identical with T_7 (2.66%). P content didn't differ significantly due to different sources of organic manures and inorganic fertilizers, although maximum P content (0.4%) was found in T_6 followed by T_7 while lowest was found in T_1. Like P, K content also didn't differ significantly due to different sources of organic manure and inorganic fertilizers (Table 5) although maximum K content (3.02%) was found in T_6 followed by T_7 while lowest (2.77) was found in T_1. Same treatment T_6 recorded maximum S content (0.403) while lowest (0.350) was found in T_1. Uptake of all the nutrient elements (N, P K and S) differed significantly due to different sources of organic manure and inorganic fertilizers and varies 100.53 to 163, 15.23 to 26.24, 116.8 to 188.5 and 14.83 to 24.36 kg ha^{-1}) respectively. T_2-(50% NPK through IFs + 50 % N through FYM) observed significantly maximum N uptake (163.00 kg ha^{-1}) which was statistically at par with T_1 (154.49) and T_6 (159 kg ha^{-1}). Similarly T_2-(50% NPK through IFs + 50 % N through FYM) recorded significantly highest P, K and S uptake which were (26.24, 188.5 and 24.36 kg ha^{-1}) respectively (Table 5). Similar with this result, **Jahan et al. [2014]** also found better nutrient uptakes in cauliflower with combination of chemical fertilizers and compost (vermicompost). Among 100% organic sources T_6 showed better performance in nutrient uptake (159.00, 24.00, 179.5, and 23.95 $kgha^{-1}$) N, P, K and S respectively. The combination of organic and inorganic nutrient sources (T_2) improved N, P, K and S uptake over single use of chemical fertilizers.

Soil chemical properties

Soil fertility analysis of the post-harvest soil was carried out and the effect of different treatments on soil chemical properties like pH, EC, SOC, available N, P, K and S after harvesting of cabbage shown in the Table 6. The reduction in pH was more over initial value in the plots receiving organic fertilizers viz., T_3, T_4, T_5, T_6, and T_7. The maximum reduction in pH of the soil in the plots receiving organic manures may be due to the production of organic acids, during decomposition of organic manures which neutralize the sodium salts present in the soil and increase the hydrogen ions concentration. **Maurya and Ghosh, [1972]; Swarup and Singh [1989]** also reported a decrease in the soil pH by 0.3 to 0.9 unit after continuous application of chemical fertilizer along with green manure and FYM. Maximum (0.14) of the EC value recorded in the treatment T_4 with application of 1/3 of N each through FYM + VC + Neemcake. However, the least EC values were noticed in the plots receiving chemical fertilizers alone.

Similar finding was also observed by **[Chaudhary et al., 1992; 2018].** The maximum organic carbon (0.66 %) was noticed in T_6 receiving 50 % N through FYM+50 % N through VC + PSB+Azotobactor while lowest (0.57 %) was measured with the treatment T_1. The improvement in organic matter content of soil in the treatment receiving organic manureS is attributed to direct incorporation of the organic matter in the soil. Soil organic carbon reported by **Swarup and Yaduvanshi, [2000],** significantly lower in inorganic fertilizer treatments as compared to the treatments involving fertilizer with organic sources. These results corroborated with the finding of **Numbiar and Abrol [1989], Bhandari et al. [1992], More [1994] and Chaudhary et al. [2018].**

Conclusions

Nowadays, sustainable agriculture is becoming more and more popular as mainstream agriculture because it can effectively maintain crop productivity and at the same time enhancing soil sustainability through judicious use of fertilizers & manures that contain the right balance of organic and inorganic materials. Based on the findings of this three-year study, it can be said that using organic manures in conjunction with inorganic fertilizers significantly improved cabbage production, growth components, and yield characteristics while also improving nutrient uptake (N, P, K, and S). The T_6 treatment (50 % N through FYM + 50 % N through VC + PSB + azotobacter) performed the best out of all the treatments that used 100% organic manure. Overall, it was found that the integrated nutrient management (T_2) strategy, which consists of 50% NPK from inorganic fertilizers and 50% N from FYM, was a good choice for cabbage production in terms of growth and yield. On the basis of results of this three years experiment it is concluded that T_2-50 % NPK through IF + 50 % N through FYM, can be adopted for most economic crop production, but T_6 (50% N as FYM+50% N as VC + PSB and Azotobactor) considered best for long term sustainable cabbage production.

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Table 2. No. of leaves (unwrapped and wrapped), head and stock's length and diameter and head yield as influenced by the application of inorganic, integrated and organic nutrient sources (First year *rabi* 2016-17)

Treatments	No. of Unwrapped	No. of wrapped	Head length	Head diameter	Stock length	Stock Diameter	Head weight	Head weight

	leaves	leaves	(cm)	(cm)	(cm)	(cm)	(g)	(q ha^{-1})
T_1	9.6	45.4	16.6	14.6	10.0	3.2	1121.7	448.7
T_2	8.1	49.1	17.5	14.7	10.3	3.5	1176.7	470.7
T_3	9.7	41.2	15.6	13.4	8.5	3.0	903.3	361.3
T_4	10.5	40.5	15.3	14.3	8.4	3.2	882.0	352.8
T_5	10.3	36.3	14.1	11.0	8.4	2.8	710.0	284.0
T_6	8.4	37.3	16.1	14.3	9.2	3.2	928.7	387.3
T_7	9.5	38.8	16.0	14.2	9.6	3.3	968.3	371.5
SEm±	0.8	2.2	0.6	0.6	0.6	0.1	78.9	31.6
C D at 5%	1.7	4.8	1.3	1.4	1.3	NS	172.1	68.8

Table 3. No. of leaves (unwrapped and wrapped), head and stock's length and diameter and head yield as influenced by the application of inorganic, integrated and organic nutrient sources (Second year *rabi* 2017-18)

Treatments	No. of Unwrapped leaves	No. of wrapped leaves	Head length (cm)	Head diameter (cm)	Stock length (cm)	Stock Diameter (cm)	Head weight (g)	Head weight (q ha^{-1})
T_1	12.8	31.7	16.4	12.3	8.0	2.7	1003.1	401.2
T_2	12.9	31.9	16.5	12.9	8.1	2.9	1075.6	430.2
T_3	13.3	30.3	14.0	10.3	7.1	2.5	560.0	224.0
T_4	14.4	30.6	14.4	10.3	7.3	2.5	528.2	211.3
T_5	14.9	29.0	13.1	8.8	6.6	2.3	411.9	164.8
T_6	14.0	31.0	14.5	10.9	7.1	2.5	775.8	310.3
T_7	14.6	27.9	14.3	10.3	6.8	2.3	620.2	248.1
SEm±	0.9	2.0	1.0	1.0	0.7	0.3	77.5	31.0
C D at 5%	1.9	4.3	2.2	2.2	1.4	NS	168.9	67.6

Table 4. No. of leaves (unwrapped and wrapped), head and stock's length and diameter and head yield as influenced by the application of inorganic, integrated and organic nutrient sources (Third year *rabi* 2017-18)

Treatments	No. of Unwrapped leaves	No. of wrapped leaves	Head length (cm)	Head diameter (cm)	Stock length (cm)	Stock Diameter (cm)	Head weight (g)	Head weight (q ha^{-1})
T_1	8.9	30.4	15.2	11.4	5.6	3.1	912.1	364.8
T_2	10.3	31.4	15.3	11.8	5.6	3.6	928.4	371.4
T_3	10.6	29.6	15.2	10.7	6.2	3.0	710.7	284.3
T_4	12.0	27.6	14.7	11.1	5.8	2.9	549.3	219.7
T_5	13.8	25.4	12.9	8.9	5.7	2.7	488.2	195.3
T_6	10.0	30.1	15.2	11.9	5.9	3.1	778.3	311.3
T_7	11.7	27.2	13.1	9.5	5.0	2.7	610.8	244.3
SEm±	1.5	1.9	1.1	0.6	0.7	0.4	66.1	26.5
C D at 5%	3.2	4.2	2.3	1.2	1.5	NS	144.2	57.7

Table 5. Nutrient content and uptake by cabbage heads as influenced by the application of inorganic, integrated and organic nutrient sources (third year crop data)

Treatments	Total Dry weight (q/ha^{-1})	Nutrient content (%) in cabbage				Nutrient uptake (Kg ha^{-1}) by cabbage			
		N	P	K	S	N	P	K	S
T_1	65.08	2.38	0.360	2.77	0.350	154.49	23.67	180.6	22.91
T_2	67.83	2.39	0.387	2.78	0.360	163.00	26.24	188.5	24.36
T_3	53.51	2.47	0.380	2.83	0.387	130.72	20.47	148.9	20.26
T_4	41.47	2.61	0.390	2.99	0.390	108.48	16.11	124.2	16.15
T_5	39.22	2.56	0.390	2.97	0.380	100.53	15.23	116.8	14.83
T_6	59.60	2.68	0.400	3.02	0.403	159.00	24.00	179.5	23.95
T_7	47.13	2.66	0.393	3.01	0.377	124.36	18.63	142.1	17.76
SEm±	5.11	0.05	0.047	0.12	0.022	12.36	3.68	12.8	2.41
C D at 5%	11.14	0.10	NS	NS	0.047	26.95	8.03	28.0	5.25

Table 6. Soil properties as influenced by the application of inorganic, integrated and organic nutrient sources after three year of cabbage crop harvest

Treatments	EC	pH	Soil Organic Carbon	Available N	Available P	Available K	Available S
T_1	0.11	7.51	0.57	242.74	32.36	167.13	18.09
T_2	0.12	7.48	0.62	270.70	35.29	171.09	19.82
T_3	0.13	7.44	0.65	278.55	42.54	168.36	20.45
T_4	0.14	7.42	0.64	266.40	40.07	161.00	20.77
T_5	0.12	7.45	0.64	224.53	39.46	152.27	19.45
T_6	0.13	7.42	0.66	270.63	43.67	180.04	19.06
T_7	0.14	7.43	0.65	272.80	41.25	171.95	19.04
SEm±	0.01	0.15	0.04	12.66	6.00	11.45	1.76
C D at 5%	NS	NS	0.08	27.60	NS	24.95	NS