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ORGANIC AMENDMENTS INFLUENCING GROWTH, HEAD YIELD AND NITROGEN USE EFFICIENCY IN CABBAGE (*Brassica oleracea* var. *capitata* L.)

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Abstract*: Cabbage is heavy feeder of nutrients and demands adequate nitrogen for biomass production. Amount of dry matter produced per unit of nitrogen applied or absorbed can be judged by estimating the nitrogen use efficiency of different nutrient sources used for cabbage cultivation. Field experiments were conducted at UBKV, Pundibari, West Bengal, India to access the influence of different nutrient source on growth, head yield and nitrogen use efficiency in cabbage. The experiment comprised of 15 different nutrients source combining inorganic fertilizers, organic manures (farmyard manure and vermicompost) and Azophos biofertilizers were laid out in RBD with 3 replications. Growth and head attributes of cabbage were significantly influenced by different nutrient combination and vermicompost emerged as better organic nutrient source over farmyard manure. Inoculation with biofertilizers exerted more positive result over uninoculated treatments. The nutrient schedule comprising of higher amount of vermicompost (5 t/ha) along with 75% of recommended inorganic fertilizers in presence of biofertilizes inoculation emerged as potential nutrient source and resulted in many fold improvement in the form of vigorous growth, advanced head maturity, maximum curding percent and highest head yield as compared other nutrient combination. The different parameters of nitrogen use efficiency (PFP, AE, PUE and AR) were markedly enhanced by the same nutrient combination.*

Keywords*: Organic amendments; inorganic fertilizers; nitrogen use efficiency; cabbage growth and head yield.*

I. Introduction

Cabbage (*Brassica oleracea* var.*capitata* L.) is an important winter season vegetable grown throughout the country. The marketable head is an excellent source of vitamins, minerals and dietary fibers and consumed fresh as salad and cooked as vegetable or utilized as processed product. Cabbage is a heavy feeder of nutrients and to increase the head yield farmers are indiscriminately using the inorganic source of nitrogenous fertilizers. Though excess nitrogen increases the total dry biomass but it adversely affects the head quality by producing coarse and loose head, reduces keeping quality, enhances the nitrate nitrogen content of head and above all deteriorates the soil health (Chatterjee, 2009). Therefore, nitrogen management have significant influence on crop growth, head yield and soil health. Organic manures act as a store house of plant nutrients. They played direct role in supplying macro and micro nutrients and indirectly in improving the physical, chemical and biological properties of soil (Palaniappan and Siddeswaran, 1994). The incorporation of organic source of nutrients in the form of vermicompost, farmyard manure and biofertilizes is known to influence the availability and uptake of nitrogen thereby enhances the crop growth and yield (Bahadur *et al*., 2003; Chatterjee *et al.*, 2006; Sharma *et al*., 2012). Vermicompost is the product of ingested biomass by earthworm after undergoing physical, chemical and microbial transformations and available in the form of cast. Besides macro and micronutrients it also contains humic acids, plant growth promoting substances like auxins, gibberellins, and cytokinins (Krishnamoorthy and Vajrabhiah, 1986), N-fixing and P-solubilizing bacteria, enzymes and vitamins (Ismail, 1997). Application of farmyard manure also influenced the nitrogen availability and crop growth. Again azotobacter and phosphate solubilizing bacteria containing biofertilizess harbor beneficial micro organism and mobilizes nutritive elements from insoluble to soluble form (Bhattacharya *et al*., 2000). Estimation of nitrogen use efficiency of different nutrient sources will help to judge the amount of dry matter produced per unit of nitrogen applied or absorbed, which will not only augment the efficiency of different nutrient sources but will also minimize the ill effect of over use of chemicals. However under acid soil of eastern Himalayan region the use efficiency of applied nitrogen is very low due to over use of inorganic nitrogen source and poor activity of beneficial soil microbes in adverse situation. Keeping the above in view the present work was formulated to

determine the effect of diverse nutrient source on growth, head yield, nitrogen use efficiency and soil nitrogen balance of cabbage cultivation.

II. Materials and Methods

The field experiment was conducted at the Instructional Farm of UBKV, Pundibari, Coochbehar, West Bengal, India during winter season (November to February) of 2005-06 and 2006-07. The site is located at 89°23′53″ E longitude and 26°19′86″ N latitude and at 43 m above mean sea level. The area is situated at 26°19'86" N latitude and 89°23'53" E longitude, at an elevation of 43 meter above mean sea level. The area is characterized by high relative humidity and a prolonged winter with high residual soil moisture. The temperature range of this area varies from minimum of 7-8°C to maximum of 24-33.2°C. The annual rainfall ranges between 2100 to 3300 mm, 80% of which is received through south-west monsoon during July-September. The soil was a sandy loam (61, 20, 18% sand, silt and clay respectively) with pH 5.71. The initial soil organic carbon was 0.83% and available N, P and K contents were 154.28, 21.17 and 124.48 kg ha^{-1} respectively. The treatment consisted of 15 combinations of different nutrient sources and was laid out in randomized block design with three replications. The treatments were selected for sole and combined application of varied levels of vermicompost and farmyard manure (FYM) along with 100% and 75% of recommended dose of inorganic fertilizers in presence and absence of biofertilizes along with a control (no manure or fertilizer). The combinations were T_1-Control ; T_2-100% Recommended Fertilizer Dose (R.F.D) (150N:80P:75K kg/ha) ; T_3-100% R.F.D + 8 Mt/ha FYM + biofertilizes ; T_4-100% R.F.D+2.5 Mt/ha vermicompost +biofertilizes ; T_5 -100% R.F.D + 4 Mt/ha FYM +1.25 Mt/ha vermicompost + biofertilizes ; T_6 -75% R.F.D + 8 Mt/ha FYM ; T_7-75% R.F.D + 8 Mt/ha FYM + biofertilizes ; T_8-75% R.F.D + 2.5 Mt/ha vermicompost ; T_9-75% R.F.D + 2.5 Mt/ha vermicompost + biofertilizes ; T_{10}-75% R.F.D + 4 Mt/ha FYM + 1.25 Mt/ha vermicompost + biofertilizes ; T_{11} -75% R.F.D + 16 Mt/ha FYM ; T_{12} -75% R.F.D +16 Mt/ha FYM + biofertilizes ; T_{13} -75% R.F.D + 5 Mt/ha vermicompost ; T_{14}-75% R.F.D + 5 Mt/ha vermicompost + biofertilizes and T_{15}-75% R.F.D + 8 Mt/ha FYM + 2.5 Mt/ha vermicompost + biofertilizes. The field was ploughed thoroughly to get fine tilth of the soil and the recommended dose of inorganic fertilizers was applied in the form of urea (N-46%), single super phosphate (P-16%) and muriate of potash (K-60%). Full dose of P and K along with half N were applied as basal and rest N was top dressed at two equal splits of 30 and 45 days after transplanting. Vermicompost and farmyard manure were applied to the respective plots at the time of transplanting. The biofertilizes *Azophos* containing *Azotobacter chroococcum* and Phosphate Solubilizing Bacteria (*Acinetobacter sp*) with standard microbial population ($\times 10^8$) was applied as seedling root dipping (250g/litre water) just before transplanting using rice gruel as an adhesive. Cabbage (cv. Golden Acre) seeds were sown in the nursery beds during first week of October and healthy seedlings of four weeks old were transplanted in the main field during first fortnight of November for both the years in 3 m x 3 m plots with a spacing of 60 cm within and between rows. The crop was raised adopting standard cultural practices. The observations were recorded on ten randomly selected plants from each plot on different growth attributes and yield characters (Table 1). The use efficiency of applied nitrogen was worked out in terms of partial factor of productivity (PFP), agronomic efficiency (AE), physiological use efficiency (PUE) and apparent recovery (AR) by employing the following formula used by Dua *et al*.(2009) and Sharma & Banik (2012).

$$\text{PFP (kg dry head/kg N applied)} = Y_f/N_a$$

$$\text{AE (kg dry head/kg N applied)} = (Y_f - Y_c)/N_a$$

$$\text{PUE (kg dry head/kg N applied)} = (Y_f - Y_c)/(N_{upf} - N_{upc})$$

$$\text{AR (\%)} = \frac{N_{upf} - N_{upc}}{N_a} \times 100$$

Where Y_f = dry head yield (kg/ha) from fertilized plot ; Y_c = dry head yield (kg/ha) from control plot ; N_a= amount of N applied (kg/ha) ; N_{upf} = nitrogen uptake (kg/ha) in fertilized plot and N_{upc} = nitrogen uptake (kg/ha) in control plot. While computing the above indices the amount of nitrogen added through fertilizers as well as through farmyard manure and vermicompost were considered. The mean N (on dry matter basis) and dry matter content of farmyard manure was 0.78% and 34.20% where as for vermicompost 2.12% and 42.40% respectively. The initial surface (20 cm) soil samples were collected prior to the layout of the treatments to access the initial fertility status of the soil. Soil samples were also drawn after harvest for studying the post harvest fertility of soil. The collected soil samples were dried, powered and sieved for chemical analysis. The available nitrogen in the soil was estimated by modified Macro Kjeldahl method (Jackson, 1967). The total uptake of nitrogen was worked out from the dry matter production and estimated nitrogen content of dry fruits and plant residues (Tandon, 1999). Nitrogen balance sheet was worked out by comparing the applied nitrogen and total removal of nitrogen by the different treatment combination.

III. Results and Discussion

A. Growth attributes

The observation recorded on plant height at 30 days after transplanting (DAT) revealed that the treatment containing sole inorganic fertilizers recorded maximum plant height (10.67 cm). In contrast, the treatments involving combination of inorganic and organic sources of nutrients recorded lower plant height at this stage. However at head maturity stage, unlike 30 DAT the plant height showed significant differences and the treatments, combining inorganic and organic sources of nutrients recorded significantly higher plant height compared to control and sole inorganic fertilizers. The enhancement of plant height with 100% inorganic fertilizers at 30 DAT may be due to the direct effect of higher amount of inorganic nitrogen, which is an integral part of protein and chlorophyll molecules. The data on days to head maturity showed significant differences among control, sole inorganic fertilizers and combined use of different source of nutrients. Integration of different nutrients source significantly reduced the maturity days compared to control or $N_{150}P_{80}K_{60}$. The earliest maturity of head (73 days) was recorded for the plants received 75% of recommended inorganic fertilizers along with vermicompost (5 t/ha) and seedling root inoculation with biofertilizes which was 12% and 10% advancement over the control and $N_{150}P_{80}K_{60}$ respectively. Earliness in head maturity in vermicompost loaded treatments could be attributed to enhanced vegetative growth coupled with adequate reserved food material which facilitated early differentiation of vegetative buds and subsequently early maturity of marketable head. The result clearly showed that organic manures along with reduced level of inorganic fertilizers performed better over individual application of 100% inorganic fertilizers for all the growth attributes. Again, among the organic manures, vermicompost emerged as better growth medium over farmyard manure. Addition of biofertilizes under reduced inorganic fertilizers and higher organic manures showed significant positive results over uninoculated treatments. Significant positive influence of vermicompost on cabbage growth attributes was previously reported by Zhenyu and Yongliang (2012) and Ghuje *et al.*, (2007).

Table 1: EFFECT OF DIFFERENT SOURCES OF NUTRIENTS ON GROWTH AND YIELD ATTRIBUTES OF CABBAGE (POOLED MEAN OF 2 YEARS)

Treatments*	Plant height (cm)		Days to head maturity	Percent marketable head	Head weight (g)	Head yield (t/ha)	Harvest Index (%)
	30 DAT	At head maturity					
T_1	7.51	14.34	82.00	42.38	687.18	7.13	44.31
T_2	10.67	16.18	80.00	56.28	912.26	11.88	52.27
T_3	9.81	19.21	79.00	62.53	1383.37	20.65	61.23
T_4	10.20	20.46	78.00	67.34	1417.28	21.38	64.88
T_5	9.94	19.89	79.00	64.21	1394.48	21.18	63.11
T_6	8.21	17.22	78.00	61.04	1166.43	16.39	57.13
T_7	8.43	17.36	77.00	64.11	1231.44	17.60	57.92
T_8	8.75	17.72	77.00	65.73	1281.44	19.33	59.45
T_9	8.83	18.58	76.00	68.43	1357.32	21.54	61.41
T_{10}	8.87	18.12	77.00	65.58	1301.22	19.75	64.68
T_{11}	8.92	18.84	76.00	69.23	1442.62	23.74	69.84
T_{12}	8.98	19.61	76.00	71.72	1487.36	25.57	72.42
T_{13}	9.13	21.11	74.00	72.21	1470.76	24.04	70.14
T_{14}	9.37	23.39	73.00	79.43	1547.34	27.86	77.41
T_{15}	9.24	21.97	74.00	76.26	1503.44	26.46	74.68
SEm (±)	0.18	0.98	1.49	1.98	66.42	0.85	2.21
CD (P=0.05)	0.52	2.78	4.23	5.60	188.47	2.41	6.23

*Treatment details are given in the text. RFD: Recommended fertilizer dose;VC: vermicompost; FYM: farmyard manure; S.Em-Standard error of the mean; CD-Critical difference

B. Yield attributes and yield

The yield attributing characters were significantly influenced by combined application of inorganic and organic sources of nutrients. The results (Table 1) indicated that 75% of recommended inorganic fertilizers along with higher amount of organic manures have exerted positive influence and surpassed the treatments $N_{150}P_{80}K_{60}$ and control. Application of 75% of recommended inorganic fertilizers along with vermicompost (5 t/ha) and seedling inoculation with biofertilizes resulted in maximum percent of marketable head (79.43%), head weight (1547.34 g), head yield (27.86 ton /ha) and harvest index (77.41%).This treatment recorded 44% and 26% more marketable head, 56% and 41% higher head weight and 74% and 57% greater head yield over control and $N_{100}P_{60}K_{60}$ respectively. The findings suggested that irrespective of treatments, reduction of 25% of recommended inorganic fertilizers is possible only when higher amount of organic manures and biofertilizes were combined. The results further revealed that among the 75% inorganic fertilizers treatment combination,

yield attributes were significantly influenced by the form and level of the organic manures and higher levels of vermicompost emerged as better growth medium over higher levels of farmyard manure. As the treatment T_{14} recorded 4% higher head weight and 8% greater head yield over the treatment T_{142}. This could be attributed to increased availability of nutrients in the soil that might lead to synthesis and accumulation of more photosynthetes and subsequently higher head weight and more head yield in cabbage (Ghuje *et al*., 2007).

C. Nitrogen use efficiency

Partial factor of productivity

The pooled results showed that presence of higher amount of organic manures gradually increases the partial factor of productivity of applied nitrogen (Fig. 1A).The highest value (20.98 kg dry head /kg N applied) was observed for the treatment containing 75% of recommended inorganic fertilizer along with vermicompost (5 t/ha) and seedling inoculation with biofertilizes. The result indicated that use of higher amount of organic manures can transform the applied nitrogen into economic yield more efficiently compared to the plots received sole inorganic fertilizers. It further showed that partial factor of productivity does not increased much when 25% nitrogen was reduced with same amount of organic manures but showed distinct difference when levels of organic manures were doubled. Again seedling dipping with biofertilizes had enhanced the partial factor of productivity when higher amount of vermicompost was used instead of farmyard manure.

Agronomic efficiency

The agronomic efficiency of different nutrient combination (Fig. 1B) showed an increasing trend with increased level of organic manures and the highest value (17.46 kg dry head/kg N applied) was recorded when plants were treated with 75% of recommended inorganic fertilizers along with vermicompost (5 t/ha) and seedling inoculation with biofertilizes. This might be due to better availability of nitrogen as per crop requirement and reduced loss of nitrogen leading efficient uptake and utilization of applied nitrogen. In contrast the lowest agronomic efficiency (1.91 kg dry head/kg N applied) by sole inorganic fertilizers indicated decreased response of applied nitrogen towards dry head yield of cabbage. The result further indicated that reduced rate of inorganic nitrogen along with lower level of organic manures failed to improve the agronomic efficiency, but increased level of organic manures enhanced the agronomic efficiency under reduced level of inorganic nitrogen. This could be due to the fact that added organic manures not only acted as source of nutrients but also had influenced their availability slowly and steadily throughout the crop growth as per crop demand and reduced N loss leading to efficient uptake and utilization of applied nitrogen (Singh et al., 2009). Among different organic manures, biofertilizes inoculation with vermicompost had marked influence over farmyard manure on agronomic efficiency. Under 75% of inorganic fertilizers treatment combination, biofertilizes inoculation with highest level of vermicompost (T_{14}) recorded 21% improvement in agronomic efficiency over the highest level farmyard manure (T_{12}). This could be attributed to the fact that presence of biofertilizess under vermicompost based medium might have enhanced the uptake of applied nitrogen by contributing the growth hormone like auxins and cytokinins besides fixing the atmospheric nitrogen and mobilizing the phosphorus of the soil better than FYM, which results in higher absorption of nitrogen (Chatterjee, 2009)

Physiological use efficiency

The physiological use efficiency (Fig. 1C) of different nutrient combination showed gradual increase with increased level of nitrogen absorbed. Higher physiological use efficiency was observed where higher amount of vermicompost was used over higher amount of farmyard manure, irrespective of biofertilizes inoculation. The highest value of PUE (29.65 kg dry head/kg nitrogen) was recorded for the treatment containing 75% of recommended inorganic fertilizer along with higher level of vermicompost (5 t/ha) and seedling inoculation with biofertilizes, which was 71% higher over sole application of chemical fertilizers ($N_{150}P_{80}K_{60}$). The superior value of physiological use efficiency under higher organic manure combination could be the result of higher yield under higher organic manure containing treatments, which reflected the better conversion of source to sink by these treatments.

Apparent recovery

The apparent recovery (Fig. 1D) showed an increasing trend with the increased level of organic manure application and the highest apparent recovery (58.88%) was recorded for the treatment containing 75% of recommended inorganic fertilizers along with vermicompost (5 t/ha) and seedling root inoculation with biofertilizes. The increased apparent recovery is the expression of nitrogen uptake by the fertilized plants rather than the amount of nitrogen applied and the addition of more amount of organic manure not only acted as source of nitrogen but also influenced their availability. The result further showed that under reduced inorganic fertilizers treatment combination where nitrogen was substituted through higher amount of vermicompost recorded the higher values of apparent recovery compared to the treatments where nitrogen was substituted through higher amount of farmyard manure. Addition of higher amount of vermicompost might have converted

the applied nitrogen to economic yield attributes much better compared to sole application of inorganic fertilizers and farmyard manure as source of organic manures.

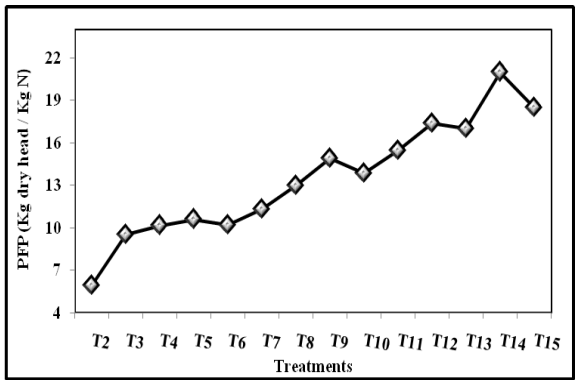

Fig.1A Partial factor of productivity (kg dry head/kg of N applied)

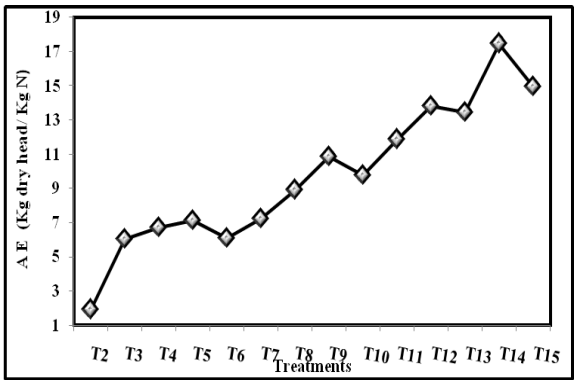

Fig.1B Agronomy efficiency (kg dry head/kg of N applied)

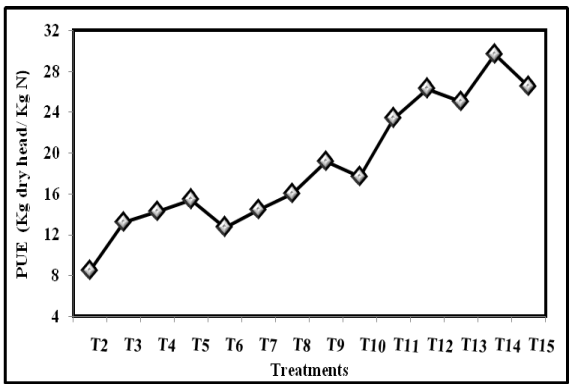

Fig.1C Physiological use efficiency (kg dry head/kg of N applied)

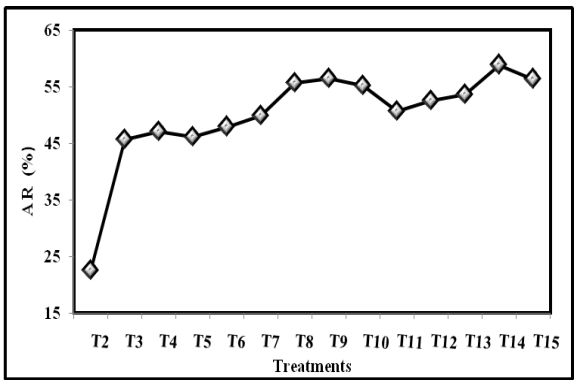

Fig.1D Apparent recovery (%) (kg dry head/kg of N applied)

Fig. 1(A-D) Nutrient us efficiency of cabbage as influence by different nutrient sources (treatment details are given in the text).

Nitrogen balance sheet

The nitrogen balance sheet was worked out (Table 2) by comparing the applied nitrogen and total removal of nitrogen by the different treatment combination. The result showed that with the increasing levels of organic manures either vermicompost or farmyard manure the removal of nitrogen was increased and application of highest level of vermicompost (5t/ha) and 75% of recommended inorganic fertilizers in presence of seedling inoculation with biofertilizes registered the highest nitrogen removal (173.14 kg /ha) where as control plots recorded the lowest removal of nitrogen (73.07 kg/ha). The increased availability of nitrogen under combined nutrient sources could be attributed to favourable soil environment which enhanced the process of mineralization resulted in higher uptake of nitrogen by the plants (Barani and Anburani 2004). The nitrogen balance (applied – uptake) was found positive for all the nutrient combinations. The highest actual and apparent nitrogen gain for combined application of higher level of vermicompost and reduced level of inorganic fertilizers in presence of biofertilizes inoculation showed the soil enriching effect of applied nitrogen through vermicompost which gradually improved the available status of nitrogen due to higher rate of mineralization of vermicompost. The control plot and sole chemical fertilizers ($N_{150}P_{80}K_{60}$) recorded maximum actual loss and apparent loss of nitrogen respectively. The findings established that diverse nutrients source combining inorganic and organic sources of nutrients in presence of biofertilizes will help to enrich the soil and will enhance the availability of soil nitrogen for sustainable production of cabbage in eastern Himalayan region.

IV. Conclusion

The experimental results suggested that nutrient combination from different source have significant role on crop growth and head yield of cabbage. Judicious combination of higher amount of vermicompost and seedling inoculation with biofertilizes in presence of reduced level of inorganic fertilizer can enhance the nitrogen use efficiency of applied nutrients. Substitution of 25% recommended inorganic fertilizers dose is possible when higher amount of organic manures and biofertilizes were combined together. The nutrient schedule comprising of 75% recommended inorganic fertilizers and vermicompost (5 t/ha) along with seedling

root dipping of biofertilizes may be practiced to achieve desired yield, nutrient use efficiency and sustainability of the production system.

TABLE 2: SOIL NITROGEN BALANCE AS INFLUENCE BY DIFFERENT NUTRIENT SOURCES

Treatments*	A	B	C	D	E= (A+B)-C	F= D-A	G= D-E
T_1	154.28	0.00	73.07	71.48	81.21	-82.80	-9.73
T_2	154.28	150.00	106.84	151.32	197.44	-2.96	-46.12
T_3	154.28	171.36	151.24	161.19	174.40	6.91	-13.21
T_4	154.28	172.48	154.17	166.79	172.59	12.51	-5.80
T_5	154.28	171.92	152.31	164.38	173.89	10.10	-9.51
T_6	154.28	146.36	143.22	157.41	157.42	3.13	-0.01
T_7	154.28	146.36	146.10	163.34	154.54	9.06	8.80
T_8	154.28	147.48	155.18	164.29	146.58	10.01	17.71
T_9	154.28	147.48	156.40	170.32	145.36	16.04	24.96
T_{10}	154.28	146.92	154.23	168.53	146.97	14.25	21.56
T_{11}	154.28	167.72	158.05	172.28	163.95	18.00	8.33
T_{12}	154.28	167.72	161.19	173.12	160.81	18.84	12.31
T_{13}	154.28	169.95	164.32	173.53	159.91	19.25	13.62
T_{14}	154.28	169.95	173.14	178.42	151.09	24.14	27.33
T_{15}	154.28	168.84	168.27	175.23	154.85	20.95	20.38

*Treatment details are given in the text. A: Initial soil N (kg/ha); B: Applied N (kg/ha); C: N Uptake by plants (kg/ha); D: Available soil N after tomato harvest; E: Expected soil N balance (kg/ha); F: Actual soil N gain/loss (kg/ha);G: Apparent soil N gain/loss(kg/ha).

References

[1] Bahadur A, J Singh, A K Upadhyay, K P. Singh. 2003. Effect of organic manures and biofertilizers on growth, yield and quality attributes of broccoli. Veg. Sci., 30 (2): 192-194.

[2] Barani P and A A Anburani. 2004. Influence of vermicomposting on major nutrients in bhendi var. Arka Anamika, South Ind. Hort., 52 (1/6): 170-174.

[3] Bhattacharya P, R K Jain and M K Paliwal. 2000. Biofertilizers for vegetables. Indian Hort., (July-September issue). ICAR publication. New Delhi. pp 31-33.

[4] Chatterjee R, P Choudhari and S Bandhopadhayay. 2006. Influence of integrated use of organic and inorganic sources of nutrients on green yield of palak cv Pusa Bharati in terai zone of West Bengal. Env. & Eco., 24(S):722-723.

[5] Chatterjee R. 2009. Production of vermicompost from vegetable wastes and its effect on integrated nutrient management of vegetable production, Ph.D. Thesis, Uttar Banga Krishi Viswavidyalaya, Pundibari, Coochbehar, West Bengal, India.

[6] Dua V K, S S Lal and P M Govindakrishnan. 2009. Nutrient requirement of french bean (*Phaseolus vulgaris*) in potato (*Solanum tuberosum*)-french bean intercropping. Indian J. Agril. Sci., 79 (5): 329-333.

[7] Ghuje T D, A K Gore and S B Jadhav. 2007. Effect of organic and inorganic nutrient sources on growth yield and quality of cabbage. J Soils & Crops., 17(1):89-92.

[8] Gomez A K and A A Gomez. 1984. Statistical procedures for agricultural research, A Wiley inter-science publication, John Wiley and sons, New York.

[9] Ismail S A. 1997. Vermicology the biology of earthworms. Orient Longman, Hyderabad, India, pp 92.

[10] Jackson M L. 1967. Soil chemical analysis, Prentice Hall of India Pvt. Ltd, New Delhi, India

[11] Krishnamoorthy R V, and S N Vajrabhiah. 1986. Biological activity of earthworm casts, an assessment of plant growth promoter levels in casts, Proceedings of the Indian Academy of Science (Animal Science) 95, 341–351.

[12] Palaniappan S P and K Siddeswaran. 1994. Integrated nutrients management in rice based cropping systems. Proceedings of the XIII National Symposium on integrated input management for efficient crop production, February 22-25, 1994. TNAU, Coimbatore, India, pp 41-53.

[13] Panse G and P V Sukhatme. 2000. Statistical methods for agricultural workers, ICAR Publications, New Delhi, India.

[14] Sharma, J. P, P Rattan and K Sanjeev. 2012. Response of vegetable crops to use of integrated nutrient management practices. J Food & Agril. Sci., 2(1): 15-19.

[15] Sharma R C and P B Banik. 2012. Effect of integrated nutrient management on baby corn-rice cropping system: economic yield, system productivity, nutrient use efficiency and soil nutrient balance, Indian J Agril. Sci., 82 (3): 220-224.

[16] Singh D K, J K Singh and Lal singh. 2009. Real time nitrogen management for higher N use efficiency in transplanted rice under temperate Kashmir conditions. Indian J. Agril. Sci., 79 (10): 772-775.

[17] Tandon H L S. 1999. Methods of Analysis of Soil, Plants, Waters and Fertilizers, Fertiliser Development and Consultation Organization, New Delhi, India.

[18] Zhenyu Lu and Yongliang Ma. 2012. Effect of vermicompost on soil fertility and growth, quality of cabbage.*Chinese Agricultural Science Bulletin* http://en.cnki.com.cn/Journal_en/D-D000-ZNTB-2005-12.htm. Accessed 25 October, 2013.

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