**Original Research Article**

# Effects of organic inputs on soil health with special reference to potash management


## Abstract

An experiment was conducted at the Instructional cum Research Farm and department of agronomy, Assam Agricultural University, Jorhat during *kharif* season in the year 2015 to study the effect of different organic inputs on soil health with special reference to potash management in scented paddy variety *Badshah bhog*. Organic fertilization improves the soil structure and texture, enhances the water holding capacity of the soil and increases the microorganism activity in the soil, thereby sustained soil fertility and productivity. Ten treatment combinations of organic inputs were laid out in Randomised Block Design (RBD) with three replications. The experimental field was acidic in reaction with sandy loam in texture. The results revealed that application of different treatment significantly influenced the soil health. Among different organic inputs, the highest available nitrogen, phosphorus and potassium in soil were recorded in enriched compost (100% RDK i.e., Recommended Dose of Potassium). The narrow C:N and C:P ratio in soil were found in enriched compost (100% RDK) and C:K ratio was found to be reduced in banana vermicompost (100% RDK). Banana vermicompost (100% RDK) was found to registered highest microbial biomass carbon (MBC), Dehydrogenase (DH) and Phosphomonoesterase (PMHes) activity but significantly *at par* with enriched compost (100% RDK). The organic inputs as a whole enhanced the physico-chemical and biological properties of soil. The study revealed that application of enriched compost (100% RDK) and banana vermicompost (100% RDK) were beneficial for potash management in organic cultivation of scented paddy to sustain soil health under agro-ecological situation of Assam.



**Key words**: Potassium, Organic inputs, Soil health, Scented paddy.


## Introduction

Potassium is the third most essential macronutrient, followed by nitrogen and phosphorus (Wani *et al.*, 2017a; Wani *et al.*, 2017b; Bano *et al.*, 2021b; Rather *et al.*, 2022d). It plays a crucial role in plant metabolism, such as photosynthesis, translocation of photosynthates, regulation of stomata, activation of plant enzymes and imparts resistance in plant against pest and diseases (Cakmark, 2005; Amtmann *et al.*,2008; Wang *et al.*, 2013; Zorb *et al.*, 2014; Wang and Wu, 2017; Martineau *et al.*, 2017; Bhat *et al.*, 2021; Hussain *et al.*, 2021; Rather *et al.*, 2022a). In India, around 72 per cent of agricultural land shows signs of low to medium status of available K (Hasan, 2002). As India is not blessed with reserve of K-bearing minerals, the whole consumption of K fertilisers has to be imported either in the form of MOP and $K_2SO_4$. This incurs a huge amount of fund every year. Application of these chemical fertilizers, in both intensive and extensive agriculture system also tends to create environmental pollution and soil health degradation (Rather *et al.*, 2022b). Therefore, for sustaining soil health as well as for efficient crop nutrition, research on proper source of bio potash is needed in the current organic production system. It also becomes very important to do research on depletion of K in soil and application of appropriate K rich organic inputs and translocation of K under organic crop production system (Bano *et al.*, 2018a; Rather *et al.*, 2022c). The present study is to find out the suitable potassium rich organic input(s) at optimum dose for sustaining the soil health under organic rice cultivation system.

## MATERIALS AND METHODS

To determine initial soil fertility status of the given organic block, composite soils samples were taken from top soil i.e. 0 to 15 cm layers before land preparation. Five composite samples were analysed. Every composite sample was randomly collected from ten sampling points, mixed thoroughly to 500 g as a composite sample. Similarly, after cop harvest, soil sample were collected from each plot and were air dried separately to determine chemical properties, biological properties and texture of the soil. For determination of biological properties including microbial biomass carbon (MBC), Dehydrogenase (DH) activity and Phosphomonoesterase (PMHes) activity, the soil samples were kept in refrigerator, immediately after collecting from the field. Soil chemical analysis *viz.* measurement of pH, organic carbon, Cation Exchange Capacity, available nitrogen, available phosphorus, available potassium, carbon to nitrogen ratio (C:N), carbon to phosphorus ratio (C:P) and carbon to potassium ratio (C:K) were carried out.

Soil pH was determined by Glass electrode pH meter (Jackson, 1973), organic carbon was determined using the Walkley and Black method, CEC was determined using an Ammonium Acetate 1 M, (pH 7.0) extraction and expressed in c mole $(p^+)$/kg soil. Available and total nitrogen were determined by Kjeldahl method, available phosphorus and potassium were determined by Bray's and Flame Photometric method respectively. Total P was measured colorimetrically using vanadomolybdate and total K was extracted using neutral normal $NH_4OAc$ and subsequently determined by flame photometrically. The soil texture was determined by International Pipette Method (Piper, 1966). DH activity, PMHes activity and MBC were determined by Chloroform fumigation extraction technique (Vance *et al.*, 1987). The experimental field was occupied by *Sali* paddy prior to initiation of this experiment. The texture of the soil was sandy loam with initial pH of the soil being acidic (5.26). The organic carbon was observed to be high (0.77%). The Cation exchange capacity (CEC) value of 6.50 c mole $(p^+)$/kg soil indicated medium in range. The available N and P were found to be medium (287.39 and 26.58 kg/ha) but available K was in low range (125.26 kg/ha). The initial MBC, DH activity and PMHes activity were recorded 869.60 µg/g dry soils, 37.59 µg TPF/g/day and 33.86 µg PNP/g/hr respectively. This may be due to continuous application of organic inputs during the last 5 years.

The field experiment was performed at the organic cultivation block, Instructional cum Research (ICR) farm of AAU, Jorhat during *kharif* season, 2015. The traditional *Joha* paddy var. *Badshah bhog* was taken as a test crop. The experimental design adopted was Randomized Block Design (RBD). There were three replications consisting of 10 different treatments. These are $T_1$: Enriched compost as basal dose (100% RDK), $T_2$: Azolla compost as basal dose (100% RDK), $T_3$: Banana vermicompost as basal dose (100% RDK), $T_4$: Soil application of Banana extract as basal dose (100% RDK), $T_5$: Enriched compost + Banana vermicompost (50% RDK of each), $T_6$: Banana vermicompost + Azolla compost (50% RDK of each), $T_7$: Banana vermicompost + Banana extract spray at PI stage (50% RDK of each), $T_8$: Azolla compost + Banana extract spray at PI stage (50% RDK of each), $T_9$: Banana extract soil application + Banana extract spray at PI stage (50% RDK of each) and $T_{10}$: Control (no manure and fertilizer). The plot size was 4m × 3m, with 50 cm distance between the plots and 100 cm distance between the replications. Basal dose of organic inputs was applied two days before transplanting and sprayed at all the afore-mentioned critical stages.

Transplanting of scented paddy var. *Badshah bhog* was done during mid of July, 2015 and harvested at the end of November, 2015. Thirty-one-day old seedlings were transplanted at 20×20 cm plant and row spacing, with about three seedlings per hill. Paddy biomass production including grains and straw was observed. Biomass production per hectare was calculated during harvesting from each of the plots excluding the two rows of border plants. Paddy plants were cut about 15 cm above the ground surface. The samples were manually separated into paddy grains and straw. The samples were sun dried for 2 days and weights of paddy grain and paddy straw were immediately taken at each plot sampling unit.

The observed data were statistically analysed using analysis of variance (ANOVA) given by Cochran and Cox (1962) at 5 per cent probability level.

## ***RESULTS AND DISCUSSION***

The physico-chemical properties of soil are presented in Table I. The pH of the soil ranging between 5.35-5.18 was not influenced significantly by organic inputs. Soil pH was highest (5.35) with application of enriched compost and lowest (5.18) in soil application of banana extract. This might probably be due to differential releasing behaviour of different organic acids from different organic inputs after application. The OC of soil was significantly influenced by organic inputs. Enriched compost (0.84%) exhibited the highest organic carbon, which was *at par* with 50% banana vermicompost + 50% azolla compost (0.82%) and banana vermicompost (0.81%). The lowest organic carbon (0.73%) was recorded in control. The increase in OC of soil under organic farming was quite obvious, owing to the fact that carbonaceous materials contributed to soil OC after their decomposition. These observations are in agreement with the findings of Singh and Chandra (2011). Addition of higher quantity of organic manures and/or longer period of organic farming practice was responsible for build-up of OC in soil. The CEC exhibited highly significant relation with enriched compost {7.48 c mole $(p^+)$/kg}, remaining *at par* with vermicompost by banana pseudostem {7.39 c mole $(p^+)$/kg} and 50% vermicompost by banana pseudostem + 50% azolla compost {7.23 c mole $(p^+)$/kg}. The lowest CEC {6.55 c mole $(p^+)$/kg} was recorded in control. This observed increase in CEC might be due to improvement of organic matter content in soil after decomposition of organic materials. A slight increase in soil organic matter can enhance the CEC of the soil to a great extent. The increase in CEC, as a result of incorporation of organic manures into the soil has also been reported by several workers (Swarup and Ghosh, 1979; Yaduvanshi *et al.*, 1985; Singh, 1993; Mahantaa *et al.*, 2012; Bano *et al.*, 2021b and Padder *et al.*, 2021).

It was also observed that available nitrogen exhibited an increasing trend with application of organic inputs over control. Significantly higher available soil nitrogen was recorded with enriched compost (309.25 kg/ha), which was *at par* with vermicompost by banana pseudostem (308.53 kg/ha), azolla compost (302.22 kg/ha), 50% vermicompost by banana pseudostem + 50% azolla compost (302.15 kg/ha) and 50% enriched compost + 50% vermicompost by banana pseudostem (298.82 kg/ha). The lowest (268.84 kg/ha) was recorded in control. The increased availability of nitrogen in soil might be mainly due to its direct addition and slow release of the nutrient through organic manures. Application of enriched compost resulted in the highest $P_2O_5$ content (40.04 kg/ha) in soil, which was *at par* with vermicompost by banana pseudostem (38.76 kg/ha), 50% vermicompost by banana pseudostem + 50% azolla compost (34.92 kg/ha) and 50% enriched compost + 50% vermicompost by banana pseudostem (34.77 kg/ha). The lowest $P_2O_5$ (22.28 kg/ha) was observed in control. The organic acids released during microbial decomposition of organic matter further helped in the solubility of native phosphates, resulting in increase of phosphorus. Moreover, addition of *azospirillum* and phosphate solubilizing bacteria (PSB) acted in combination to qualify enriched compost to be the best for improving soil chemical properties. Application of enriched compost resulted in the highest $K_2O$ content (158.05 kg/ha) in soil which was *at par* with vermicompost by banana pseudostem (157.19 kg/ha), 50% enriched compost + 50% vermicompost by banana pseudostem (157.16 kg/ha) and 50% vermicompost by banana pseudostem + 50% azolla compost (156.79 kg/ha). The lowest $K_2O$ (138.17 kg/ha) was observed in control. This observed trend of higher availability of potassium in soil might be due to the reduction of fixation of K owing to the fact of beneficial effect of organic manures and also interaction of organic matter with K clay to release K from the non-exchangeable fraction to available form (Reddy and Reddy, 1998). The effects of organic inputs on C:N, C:P and C:K ratio are presented in Table II. The C:N ratio ranges from 22.89:1 to 15.74:1 and lowest was recorded in enriched compost. The highest C:P ratio (37.78:1) was recorded in the treatment 50% azolla compost + 50% banana extract spray at PI stage and the highest C:K ratio (25.76:1) was recorded in soil application of banana extract. Lowering of the C:N ratio of soil indicated an increase in labile fraction of organic matter due to application of organic inputs like enriched compost, vermicompost, azolla etc. Similar results were reported by Goyal *et al.* (1999) and Liu *et al.* (2017).

The status of different parameters of soil biological properties after harvesting the crop are illustrated and presented in Table III. Application of vermicompost by banana pseudostem resulted in the highest MBC content (973.44 µg/g dry soil) in soil, which was *at par* with enriched compost (966.97 µg/g dry soil). The lowest MBC content (836.26 µg/g dry soil) in soil was recorded in control. DH activity exhibited highest trend (64.35 µg TPF/g/day) with the application of vermicompost by banana pseudostem in soil, being *at par* with enriched compost (64.21 µg TPF/g/day) and 50% enriched compost + 50% vermicompost by banana pseudostem (60.46 µg TPF/g/day). The control showed lowest DH activity (48.30 µg TPF/g dry soil) in soil. Furthermore, application of vermicompost by banana pseudostem also resulted in the highest PMEse activity (75.75 µg PNP/g/hr**)** in soil, which was *at par* with enriched compost (75.29 µg PNP/g/hr). PMEse activity in control showed lowest value (55.05 µg PNP/g/hr) in soil. These trends indicated that application of organic inputs increased the organic matter content in soil, further improving the soil physical and chemical properties, and ultimately the soil biological properties. Brkljaca *et al.* (2019)

reported that higher inputs of organic matter in agricultural soils improves the soil organic carbon and enzymatic activity. In a long-term organic farming trial, continuous enhancement in microbial population of *actinomycetes,* bacteria, BGA and fungi were recorded over the years due to the application of organic amendments with notable enhancement in dehydrogenase enzyme activity.

## *Conclusion*

Field experimentation on potassium management in organic cultivation of scented paddy through different organic sources (enriched compost, vermicompost by banana pseudostem, banana extract) indicated advantageous improvement in soil physical, chemical and biological status, as compared to no external nutrient supplementation. Organic fertilization improves the soil organic carbon, CEC, available N, $P_2O_5$ and $K_2O$, microbial biomass carbon, DH and PMHes activity as compared to control (no manure and fertilizer). The best treatment for soil improvement was found to be the application of enriched compost amongst all the different organic sources studied, closely followed by vermicompost by banana pseudostem. Hence, organic inputs like enrich compost, vermicompost by banana pseudostem or banana extract with rich K content could be an excellent source of bio-K for efficient K management as well as improving the soil health under organic cultivation of paddy.

**References**


Amtmann, A., Troufflard, S. and Armengaud, P. (2008). The effect of potassium nutrition on pest and disease resistance in plants. *Physiol. Plantarum*, 133: 682–691.

Bano, H., Lone, F. A., Bhat, J. I., Rather, R. A., Malik, S. and Bhat, M. A. (2018a). Hokersar Wet Land of Kashmir: its utility and factors responsible for its degradation. *Plant Arch*, 18: 1905-1910.

Bano, H., Rather, R.A., Bhat, J.I., Bhat, T.A., Azad, H., Bhat, S.A., Hamid, F. and Bhat, M.A. (2021b). Effect of pre-sowing treatments using phytohormones and other dormancy breaking chemicals on seed germination of *Dioscorea deltoidea* Wall. Ex Griseb.: an Endangered Medicinal Plant Species of North Western Himalaya. *Eco. Env. & Cons.*, 27: 253-260.

Bhat, R.A., Bhat, Z.A., Rafiq, S., Nazki, I.T., Khan, F.U., Neelofar., Rather, Z.A., Masoodi, N., Altaf, Q., Rather, R.A., (2021). Influence of Growing Media on Vegetative, Floral and Bulb Parameters of Crown Lily (*Fritillaria Imperialis* L.). *Acta Scientific Agriculture*, 5(4):56-60

Brkljaca, M., Kulisic, K. and Andersen, C. B. (2019). Effect of land management practices on soil organic carbon and organic nitrogen content. *Agriculturae Conspectus Scientificus,* 84(**2**):135-142.

Cakmark, I. (2005). The role of potassium in alleviating detrimental effects of abiotic stresses in Plants. *J. Plant Nutri. Soil Sci.* 168:521-530.

Cochran, W.G. and Cox, G.M. (1962). Experimental design. John wiiley and sons, Inc., New York.

Goyal, S., Chander, K., Mundra, M.C. and Kapoor, K.K. (1999). Influence of inorganic fertilizers and organic amendments on soil organic matter and soil microbial properties under tropical conditions. *Biol. Fert. Soils* 29:196-200.

Hasan, R. (2002). Potassium status of soils in India. *Better Crops International* 16:3-5.

Hussain, S.M., Hussain, K., Malik, A.J., Hussaini, A.M., Farwah, S., Rashid, M., Rather, R.A., (2021), Development of a Novel In-vitro Protocol for Micro propagation of

Tomato Male Sterile Line (Shalimar FMS-1) of Kashmir Valley India. *Acta Scientific Agriculture*, 5(**4**):61-69

Jackson, M.L. (1973). Soil chemical analysis. Prentice Hall of India Pvt. Ltd. New Delhi.

Liu, Z., Rong, Q., Zhou, W. and Liang, G. (2017). Effects of inorganic and organic amendment on soil chemical properties, enzyme activities, microbial community and soil quality in yellow clayey soil. *PLoS ONE* 12(**3**): e0172767

Mahantaa, K., Jha, D.K., Rajkhowa, D.J. and Kumar, M. (2012). Microbial enrichment of vermicompost prepared from different plant biomasses and their effect on rice (*Oryza sativa* L.) growth and soil fertility. *Biol. Agri. Hort.* 28(**4**): 241-250.

Martineau, E., Domec, J.C., Bosc, A., Denoroy, P., Fandino, V.A., Lavres, J. J. and Meille, L. J. (2017). The effects of potassium nutrition on water use in field-grown maize (*Zea mays* L.). Environ. *Exp. Bot.*, 134: 62–71.

Padder, S.A., Mansoor, S., Bhat, S.A., Baba, T. R., Rather, R.A., Wani, S. M., Popescu S. M. *et al*. (2021). Bacterial Endophyte Community Dynamics in Apple (Malus domestica Borkh.) Germplasm and Their Evaluation for Scab Management Strategies." *Journal of Fungi*, 7: 923. https://doi.org/10.3390/jof7110923

Piper, C.S. (1966). Soil and plant analysis. Hans Publication, Bombay. 3rd Ed., pp. 49-54.

Rather, R.A., Wani, A.W., Mumtaz, S., Padder, S.A., Khan, A.H., Almohana, A.I., Almojil, S.F., Alam, S.S. and Baba, T.R. (2022a). Bioenergy: a foundation to environmental sustainability in a changing global climate scenario. *Journal of King Saud University-Science*, 34(**1**):101734. https://doi.org/10.1016/j.jksus.2021.101734.

Rather, R.A., Bano, H., Firoz, A., Mohammed, A.H., Bhat, M.A., Padder, S.A., Nafees, H. and Hakeem, K.R. (2022c). The Assessment of Morphological Diversity of *Colchicum luteum* L., an Economically Important Threatened Medicinal Plant of Kashmir Himalaya. *Sustainability*, 14(**3**):1327. https://doi.org/10.3390/su14031327.

Rather, R.A., Bano, H., Padder, S.A., Baba, T.R., Ara, S., Lone, F.A. and Nazir, S., (2022d). Impact of Anthropogenic Pressure on Physico-chemical Characteristics of Forest Soils of Kashmir Himalaya. *Bulletin of Environmental Contamination and Toxicology*, pp.1-10. https://doi.org/10.1007/s00128-022-03458-x

Rather, R.A., Bano, H., Padder, S.A., Perveen, K., Al Masoudi, L.M., Alam, S.S. and Hong, S.H., (2022b). Anthropogenic Impacts on Phytosociological Features and Soil Microbial Health of Colchicum luteum L. An Endangered Medicinal Plant of North Western Himalaya. *Saudi Journal of Biological Sciences*, https://doi.org/10.1016/j.sjbs.2022.01.011

Reddy, B.G. and Reddy, M.S. (1998). Effect of organic manures and nitrogen levels on soil available nutrient status in maize-soybean cropping system. *J. Indian Soc. Soil Sci.* 46(3): 474-476.

Singh, P.K. (1993). Effect of continuous application of manure and nitrogen fertilizer on some properties of acid Inceptisol. *J. Indian Soc. Soil Sci.* 41 (3): 430-423.

Singh, R. and Chandra, S. (2011). Performance of basmati rice-based cropping system under different mode of nutrient management. *Indian J. Agron*. 81(4): 336-339.

Swarup, A. and Ghosh, A.B. (1979). Effect of intensive cropping and manuring on soil properties crop yields. *Indian J. Agril. Sci.* 49: 938-944.

Vance, E.D., Brookes, P.C., and Jenkison, D.S. (1987). Chloroform fumigation direct extraction procedure. *Soil Biol. Biochem*. 19(6): 703-707.

Wang, M., Zheng, Q., Shen, Q. and Guo, S. (2013). The critical role of potassium in plant stress response. *Int. J. Mol. Sci.*, 14: 7370–7390.

Wang, Y. and Wu, W. H. (2017). Regulation of potassium transport and signaling in plants. *Curr. Opin. Plant Biol.*, 39:123–128.

Wani, M.Y., Ganie, N.A., Rather, R.A., Rani, S. and Bhat, Z.A. (2017b). Seri biodiversity: An important approach for improving quality of life. *Journal of Entomology and Zoology Studies*, 6(**1**): 1053-1056.

Wani, M.Y., Mir, M.R., Mehraj, S., Rather, R. A., Ganie, NA., Baqual, M.F., Sahaf, K.A and Hussain, A. (2017a). Effect of different types of mulches on the germination and seedling growth of mulberry (*Morus* Sp.). *International Journal of Chemical Studies,* 6(**1**):1364-37672.

Yaduvanshi, H.S., Tripathi, B.R. and Kanwar, B.S. (1985). Effect of continuous manuring on some soil properties of an Alfisol. *J. Indian Soc. Soil Sci.* 33: 700-703.

Zorb, C., Senbayram, M. and Peiter, E. (2014). Potassium in agriculture-Status and perspectives. *J. Plant Physiol.* 171: 656–669.

**Table I. Effect of organic inputs on physico-chemical properties of soil at harvest**

| Treatments | pH | Organic carbon (%) | CEC [c mol $(P^+)$/kg] | Available N (kg/ha) | Available $P_2O_5$ (kg/ha) | Available $K_2O$ (kg/ha) |
|---|---|---|---|---|---|---|
| $T_1$: Enriched compost (100% RDK) | 5.35 | 0.84 | 7.48 | 309.25 | 40.04 | 158.05 |
| $T_2$: Azolla compost (100% RDK) | 5.21 | 0.78 | 7.05 | 302.22 | 33.96 | 152.15 |

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|---|---|---|---|---|---|---|
| $T_3$: Banana vermicompost (100% RDK) | 5.34 | 0.81 | 7.39 | 308.53 | 38.76 | 157.19 |
| $T_4$: Soil application of Banana extract (100% RDK) | 5.18 | 0.76 | 7.10 | 291.85 | 27.67 | 152.26 |
| $T_5$: Enriched compost + Banana vermicompost (50% RDK of each) | 5.24 | 0.80 | 7.15 | 298.82 | 34.77 | 157.16 |
| $T_6$: Banana vermicompost + Azolla compost (50% RDK of each) | 5.22 | 0.82 | 7.23 | 302.15 | 34.92 | 156.79 |
| $T_7$: Banana vermicompost + Banana extract spray at PI stage (50% RDK of each) | 5.32 | 0.78 | 7.03 | 290.48 | 27.74 | 151.30 |
| $T_8$: Azolla compost + Banana extract spray at PI stage (50% RDK of each) | 5.19 | 0.77 | 6.76 | 282.68 | 26.80 | 149.67 |
| $T_9$: Banana extract soil application + Banana extract spray at PI stage (50% RDK of each) | 5.27 | 0.74 | 6.69 | 284.57 | 25.51 | 150.35 |
| $T_{10}$: Control (no manure and fertilizer) | 5.21 | 0.73 | 6.55 | 268.84 | 22.28 | 138.17 |
| S.Ed (±) | 0.07 | 0.02 | 0.15 | 6.00 | 2.60 | 2.53 |
| CD (5%) | NS | 0.05 | 0.31 | 12.61 | 5.45 | 5.32 |
| CV (%) | 1.58 | 3.75 | 2.58 | 2.50 | 10.17 | 2.04 |

**Table II. Effect of organic inputs on C:N, C:P and C:K ratio of soil at harvest**

| **Treatments** | **C:N** | **C:P** | **C:K** |
|---|---|---|---|
| $T_1$: Enriched compost (100% RDK) | 15.74 | 26.49 | 23.66 |
| $T_2$: Azolla compost (100% RDK) | 16.53 | 37.16 | 20.84 |
| $T_3$: Banana vermicompost (100% RDK) | 16.72 | 29.49 | 15.24 |
| $T_4$: Soil application of Banana extract (100% RDK) | 19.21 | 33.97 | 25.76 |

| | | | |
|---|---|---|---|
| $T_5$: Enriched compost + Banana vermicompost (50% RDK of each) | 19.04 | 31.70 | 22.09 |
| $T_6$: Banana vermicompost + Azolla compost (50% RDK of each) | 16.86 | 34.48 | 21.49 |
| $T_7$: Banana vermicompost + Banana extract spray at PI stage (50% RDK of each) | 21.44 | 30.00 | 17.76 |
| $T_8$: Azolla compost + Banana extract spray at PI stage (50% RDK of each) | 22.03 | 37.78 | 23.45 |
| $T_9$: Banana extract soil application + Banana extract spray at PI stage (50% RDK of each) | 22.89 | 33.21 | 21.82 |
| $T_{10}$: Control (no manure and fertilizer) | 22.60 | 35.64 | 24.86 |
| S.Ed (±) | 1.44 | 1.58 | 2.09 |
| CD (5%) | 3.02 | 3.33 | 4.38 |
| CV (%) | 9.11 | 5.88 | 11.77 |

**Table III. Effect of organic inputs on biological properties of soil at harvest**

| Treatments | Microbial biomass carbon (µg/g dry soil) | DH activity (µg TPF/g/day) | PMHes activity (µg PNP/g/hr) |
|---|---|---|---|
| $T_1$: Enriched compost (100% RDK) | 966.97 | 64.21 | 75.29 |
| $T_2$: Azolla compost (100% RDK) | 938.66 | 54.36 | 70.01 |

| | | | |
|---|---|---|---|
| $T_3$: Banana vermicompost (100% RDK) | 973.44 | 64.35 | 75.75 |
| $T_4$: Soil application of Banana extract (100% RDK) | 890.66 | 51.98 | 66.74 |
| $T_5$: Enriched compost + Banana vermicompost (50% RDK of each) | 950.30 | 60.46 | 70.04 |
| $T_6$: Banana vermicompost + Azolla compost (50% RDK of each) | 946.03 | 57.14 | 67.82 |
| $T_7$: Banana vermicompost + Banana extract spray at PI stage (50% RDK of each) | 903.86 | 56.43 | 67.62 |
| $T_8$: Azolla compost + Banana extract spray at PI stage (50% RDK of each) | 884.04 | 50.57 | 64.96 |
| $T_9$: Banana extract soil application + Banana extract spray at PI stage (50% RDK of each) | 876.71 | 48.79 | 65.71 |
| $T_{10}$: Control (no manure and fertilizer) | 836.26 | 48.30 | 55.05 |
| S.Ed (±) | 77.49 | 2.28 | 2.42 |
| CD (5%) | 162.8 | 4.79 | 5.09 |
| CV (%) | 10.35 | 5.02 | 4.37 |