International Journal of Plant & Soil Science

Volume 35, Issue 18, Page 2088-2094, 2023; Article no.IJPSS.104043
ISSN: 2320-7035

Chemical and Biological Properties of Soil Affected by Biofertilizer Based Nutrient Management

V. M. Chaudhari [a++*], D. C. Barot [b#], Nisha Nadoda [b#] and N. K. Patel [c†]

[a] ASPEE College of Horticulture, Navsari Agricultural University, Navsari, India.
[b] College of Horticulture, Jagudan, SDAU, India.
[c] Department of Vegetable Science, ACHF, NAU, Navsari, Gujarat, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2023/v35i183496

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here:
https://www.sdiarticle5.com/review-history/104043

Original Research Article

Received: 01/06/2023
Accepted: 04/08/2023
Published: 11/08/2023

ABSTRACT

The present study entitled "Chemical and biological properties of soil affected by biofertilizer based nutrient management" was carried out at Vegetable Research Farm, Regional Horticultural Research Station, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari, Gujarat, India during *Rabi* season, 2019-2020. The experiment was laid out in Randomized Block Design (RBD) with three replications, which included 10 treatments *viz.*, T_1: 75% RDN + *Azospirillium* (5 l ha^{-1}), T_2: 100% RDN + *Azospirillium* (5 l ha^{-1}), T_3: 75% RDP + PSB (5 l ha^{-1}), T_4: 100% RDP + PSB (5 l ha^{-1}), T_5: 75% RDK + KMB (5 l ha^{-1}), T_6: 100% RDK + KMB (5 l ha^{-1}), T_7: 75% RDF + *Azospirillium* (5 l ha^{-1}) + PSB (5 l ha^{-1}) + KMB (5 l ha^{-1}), T_8: 100% RDF + *Azospirillium* (5 l ha^{-1}) + PSB (5 l ha^{-1}) + KMB (5 l ha^{-1}) , T_9: 100% RDF (200:75:37.5) NPK kg ha^{-1}

[++] Ph.D. Scholar;
[#] Research Scholar;
[†] Assistant Professor;
**Corresponding author: E-mail: vishalmansung2121@gmail.com;*

and T_{10}: *Azospirillium* (5 l ha^{-1}) + PSB (5 l ha^{-1}) + KMB (5 l ha^{-1}) to find out the response of bio-fertilizer based nutrient management in cauliflower. The study revealed that an application of 100% RDF + *Azospirillium* (5 l ha^{-1}) + PSB (5 l ha^{-1}) + KMB (5 l ha^{-1}) recorded superior for all chemical and biological properties.

Keywords: Bio fertilizers; nutrient management; cauliflower; soil improvement; soil properties.

1. INTRODUCTION

Soil is one of the most important part of success full productions of vegetable crops. It is a complex mixture of organic matter, liquids, gases and microorganisms that all work together to support life. It is the top layer of earth surface made up of organic remains, clay and rock materials on which plants grow. Soil has density of 1.6 g cm^{-3}. Soil is composed of four main components *viz.*, minerals, organic matter, water and air. These components are arranged in distinct layers or horizons, which make up the soil profile [1].

The vegetable crops have been well advocated in solving the problems of food security. They are reach source of minerals, vitamins, fibre and contain fair amount of protein as well as carbohydrates. Among vegetables, cauliflower (*Brassica oleraceae* var. *botrytis* L.) is essential Cole crop in the family of Brassicaceae. Cauliflower having chromosome number 2n = 18. The crop is a native of Mediterranean region and introduced in India at 1822 A. D., from England. Cauliflower was predominant due to its attractive appearance, good taste, source of minerals, protein, vitamins and high yielding capacity. Hundred gram edible portion of cauliflower has high protein (2.6 g), moisture (90.8 g), fat (0.4 g), carbohydrates (4.0 g), calcium (33.0 mg), phosphorous (57.0 mg), iron (1.5 mg), thiamine (0.04 mg), riboflavin (0.10 mg), vitamin C (56.0 mg) and (30 kcal) energy (Singh, 1998). In fact, cauliflower contains calcium nearly ten times as much as meat and four times as much as egg [2].

The utilization of bio-fertilizers to improve the soil with advantageous microorganisms as well as to mobilize the nutritionally important elements like P, K and micronutrients like Zn and Mo from non-available to available forms through biological processes resultant in enhanced production of vegetables offer an alternative. The use of bio-fertilizers in combination with chemical fertilizers and organic manures offers a great opportunity to increase the production as well as the quality of cauliflower [3]. Bio-fertilizers can symbiotically associate with plant roots and microorganisms can readily and safely convert the complex organic material into simple compounds, and easily taken up by the plants. It increases crops yield by 20 to 30%, replaces chemical nitrogen and 25% phosphorus as well as stimulates plant growth [4].

2. MATERIALS AND METHODS

A field experiment was conducted during *Rabi* 2019-20 at Vegetable Research Farm, Regional Horticultural Research Station, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari. Navsari is geographically situated at 20° 37’ North latitude and 72° 54’ East longitude at an altitude of about 11.98 meter above the mean sea level. It is about 12 km away from the great historical place “The Dandi” on the Arabian Sea coast, where the Father of our Nation “The Mahatma Gandhi” launched a The Namak Satyagrah, ‘The Dandi March’ in the year of 1930.

The soil of South Gujarat is locally known as ‘*black cotton soil*’. As per the soil taxonomy, the experimental soil belongs to order *Inceptisols*, sub-order *Ochrepts*, great soil group *Vertic Ustochrepts* under the soil series of Jalalpor (South Gujarat). The experimental soil was deep black, having well drainage as well as good water holding capacity.

The observations on soil parameters were recorded before Transplanting and after harvesting of crop and subjected to statistical analysis of variance technique as described by Panse and Sukhatme [5]. The analysis of variance for experiment was done by Randomized Block Design (RBD). The data collected from all growth and yield attributes analysis for proper interpretation. The treatment differences were tested by F test at 5% level of significance.

2.1 Treatments Detail

Research conducted with 10 treatments along with three replication which given in Randomized Block Design:

T_1: 75% RDN + *Azospirillium* (5 l ha^{-1})
T_2: 100% RDN + *Azospirillium* (5 l ha^{-1})
T_3: 75% RDP + PSB (5 l ha^{-1})
T_4: 100% RDP + PSB (5 l ha^{-1})
T_5: 75% RDK + KMB (5 l ha^{-1})
T_6: 100% RDK + KMB (5 l ha^{-1})
T_7: 75% RDF + *Azospirillium* (5 l ha^{-1}) + PSB (5 l ha^{-1}) + KMB (5 l ha^{-1})
T_8: 100% RDF + *Azospirillium* (5 l ha^{-1}) + PSB (5 l ha^{-1}) + KMB (5 l ha^{-1})
T_9: 100% RDF (200:75:37.5 kg ha^{-1})
T_{10}: *Azospirillium* (5 l ha^{-1}) + PSB (5 l ha^{-1}) + KMB (5 l ha^{-1})

2.2 Soil Analysis

The soil samples from surface 0 to 22.5 cm depth were drawn randomly in a zig zag way before planting the crop and a composite sample was prepared. The field representative sample was used for the analysis of physico-chemical and biological properties of soil depicted in Table 1.

2.2.1 Initial

The soil sample was collected at 0 to 22.5 cm depth covering entire area by moving zig zag way of the experimental field before transplanting. Mixing all soil homogenously and prepared final sample by discard the one half soil part. Then the sample was ground with a wooden pestle and sieved through 2 mm sieve and analyzed for N (kg ha^{-1}), P_2O_5 (kg ha^{-1}), K_2O (kg ha^{-1}), organic carbon (%), particle density (g cm^{-3}), bulk density (g cm^{-3}), soil pH and microbial count content (CFU g^{-1}) as per the method narrated in Table 1.

2.2.2 After harvest

After final harvest, soil samples were collected from each treated plot of all the replications as per standard procedure at depth 0 to 22.5 cm for the estimation of N (kg ha^{-1}), P_2O_5 (kg ha^{-1}), K_2O (kg ha^{-1}), organic carbon (%), particle density (g cm^{-3}), bulk density (g cm^{-3}), soil pH and microbial count content (CFU g^{-1}). The samples were ground with a wooden pestle separately and sieved through 2 mm sieve and analyzed.

2.3 Manure and Fertilizer Application

Full dose of FYM (20 t ha^{-1}) was applied at the time of land preparation. The inorganic fertilizers were supplied to crop through neem coated urea (46% N), single super phosphate (16% P_2O_5) and muriate of potash (60% K_2O). Entire P, K and 50% N was applied as a basal dose and remaining 50% N as top dressing in two split doses 30 days after transplanting and at 45 days after transplanting as per the treatments to the respective plots. Required quantity of chemical fertilizer as per treatment depicted in Table 2. Bio-fertilizers such as *Azospirillium* (5 l ha^{-1}), PSB (5 l ha^{-1}) and KMB (5 l ha^{-1}) were applied in soil after 15 days of first and second dose of chemical fertilizers application.

3. RESULTS AND DISCUSSION

3.1 Chemical Properties of Soil Affected by Biofertilizer Based Nutrient Management

3.1.1 Available N, P and K (kg ha^{-1})

Data recorded on available N, P and K after harvesting of crop is displayed in Fig. 1 The available N, P and K in soil after harvesting of crop was non significantly influenced by different treatment. The highest N (301.31 kg ha^{-1}), P (48.18 kg ha^{-1}) and K (397.14 kg ha^{-1}) was observed in treatment 100% RDF + *Azospirillium* 5 l ha^{-1} + PSB 5 l ha^{-1} + KMB 5 l ha^{-1} (T_8) and lowest available N (257.89 kg ha^{-1}), P (42.65 kg ha^{-1}) and K (366.52 kg ha^{-1}) in T_{10} (*Azospirillium* 5 l ha^{-1} + PSB 5 l ha^{-1} + KMB 5 l ha^{-1}). The results for available N, P and K showed that, the treatment T_8 (100% RDF + *Azospirillium* 5 l ha^{-1} + PSB 5 l ha^{-1} + KMB 5 l ha^{-1}) was noted maximum available N, P and K than other treatments it may be due to biofertilizer have tendency to convert non available form of nutrient in available form in soil . Similar results were obtained by Devi et al*.* [11] and Choudhary et al*.* [12] in Cauliflower.

3.1.2 Organic carbon (%)

Non significant differences among treatments were recorded in the Fig. 2 for organic carbon in soil after harvest. The treatment T_8 (100% RDF + *Azospirillium* 5 l ha^{-1} + PSB 5 l ha^{-1} + KMB 5 l ha^{-1}) recorded maximum organic carbon (0.69%). The minimum organic carbon (0.61%) was recorded in T_{10} *i.e., Azospirillium* 5 l ha^{-1} + PSB 5 l ha^{-1} + KMB 5 l ha^{-1}. It may be due to high amount of organic matter in the soil receiving by integrated supply of chemical fertilizers and biofertilizers at bulk quantity which ultimately increased organic carbon of soil [13]. Same result recorded by Ojha et al. [14] in Radish and Kafle et al*.* [15] in Potato.

Table 1. Initial chemical and biological properties of the soil (0 to 22.5 cm depth)

Particulars	Value	Method used for analysis
Chemical properties		
Soil pH	7.10	Potentiometric Piper (1966)
Organic carbon (%)	0.59	Walkley and Black Method [6]
Available N (kg ha^{-1})	261.24	Alkaline potassium permanganate method [7]
Available P_2O_5 (kg ha^{-1})	39.66	Olsen's method [8]
Available K_2O (kg ha^{-1})	362.47	Flame photometric method [9]
Biological properties		
Microbial count (10^6 CFU g^{-1})	1.8	Dilution method [10]

Table 2. Required quantity of chemical fertilizer as per treatment

Treatments	Required quantity of chemical fertilizer
T_1: 75% RDN + *Azospirillium* (5 l ha^{-1})	326.1 kg urea ha^{-1}
T_2: 100% RDN + *Azospirillium* (5 l ha^{-1})	434.8 kg urea ha^{-1}
T_3: 75% RDP + PSB (5 l ha^{-1})	352.5 kg SSP ha^{-1}
T_4: 100% RDP + PSB (5 l ha^{-1})	434.8 kg SSP ha^{-1}
T_5: 75% RDK + KMB (5 l ha^{-1})	46.87 kg MOP ha^{-1}
T_6: 100% RDK + KMB (5 l ha^{-1})	62.5 kg MOP ha^{-1}
T_7: 75% RDF + *Azospirillium* (5 l ha^{-1}) + PSB (5 l ha^{-1}) + KMB (5 l ha^{-1})	326.1 kg urea ha^{-1} 352.5 kg SSP ha^{-1} 46.87 kg MOP ha^{-1}
T_8: 100% RDF + *Azospirillium* (5 l ha^{-1}) + PSB (5 l ha^{-1}) + KMB (5 l ha^{-1})	434.8 kg urea ha^{-1} 434.8 kg SSP ha^{-1} 62.5 kg MOP ha^{-1}
T_9: 100% RDF (200:75:37.5 kg ha^{-1})	434.8 kg urea ha^{-1} 434.8 kg SSP ha^{-1} 62.5 kg MOP ha^{-1}
T_{10}: *Azospirillium* (5 l ha^{-1}) + PSB (5 l ha^{-1}) + KMB (5 l ha^{-1})	NA

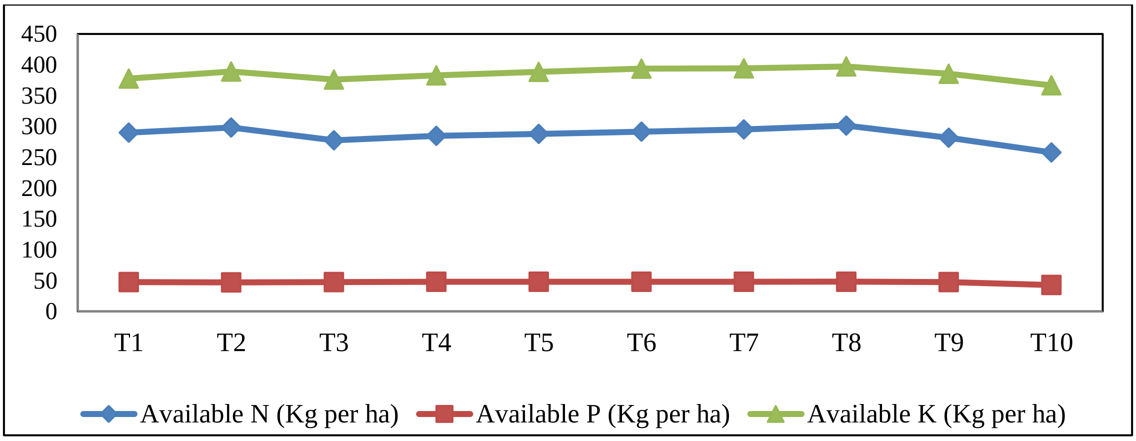

Fig. 1. Available N, P and K of soil after harvesting affected by biofertilizer based nutrient management

3.1.3 Soil pH

The results regarding soil pH after harvesting of crop are present in Fig. 2**.** The soil pH after harvesting of crop was non significantly influenced by different treatment. Maximum soil pH (7.2) was observed in treatment 100% RDF + *Azospirillium* 5 l ha^{-1} + PSB 5 l ha^{-1} + KMB 5 l ha^{-1} (T_8) and minimum soil pH (6.7) in T_3 (75% RDP + PSB 5 l ha^{-1}). The results for soil pH showed that, the treatment T_8 was recorded maximum soil pH and minimum soil pH by T_3. Same result recorded by Ojha et al. [14] in Radish and Kafle et al. [15] in Potato.

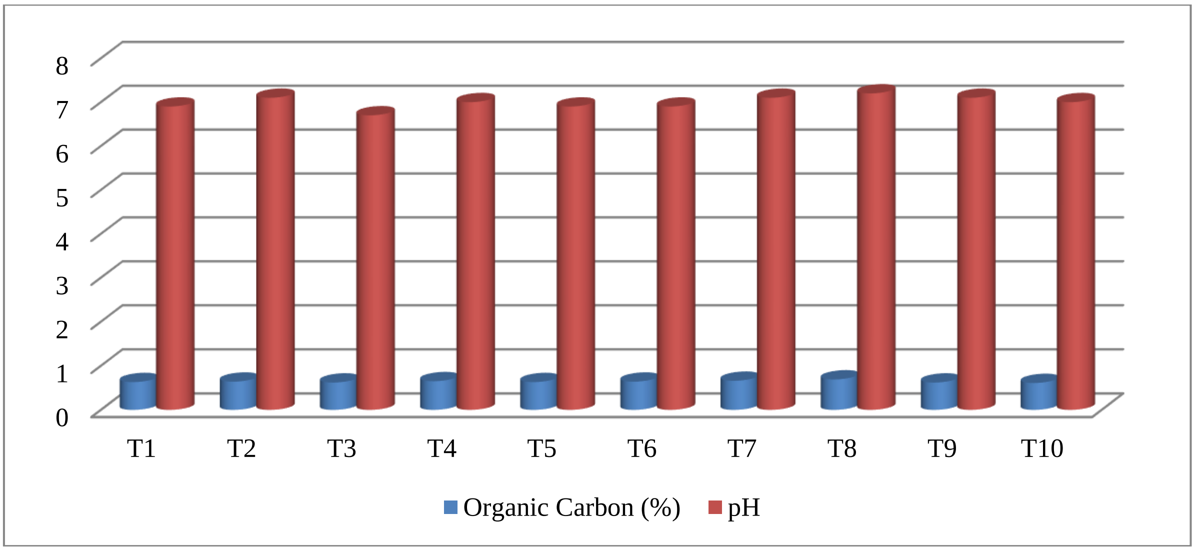

Fig. 2. Organic carbon and soil pH of soil after harvesting affected by biofertilizer based nutrient management

3.2 Biological Properties of Soil Affected by Biofertilizer Based Nutrient Management

3.2.1 Microbial count (CFU g^{-1})

Significant differences among treatments were recorded in the Fig. 3 for microbial count in soil after harvest. The treatment T_8 (100% RDF + *Azospirillium* 5 l ha^{-1} + PSB 5 l ha^{-1} + KMB 5 l ha^{-1}) recorded maximum microbial count (3.93×10^{-6} CFU g^{-1}) which was statistically significant over all other treatments and it was at par with four treatments *i.e.,* T_2 (3.57×10^{-6} CFU g^{-1}), T_3 (3.57×10^{-6} CFU g^{-1}), T_7 (3.90×10^{-6} CFU g^{-1}) and T_{10} (3.77×10^{-6} CFU g^{-1}). The least microbial count (2.77×10^{-6} CFU g^{-1}) was recorded in T_9 *i.e.*, 100% RDF (200:75:37.5 NPK kg ha^{-1}). The results for microbial count showed that, the treatment T_8 (100% RDF + *Azospirillium* 5 l ha^{-1} + PSB 5 l ha^{-1} + KMB 5 l ha^{-1}) recorded maximal microbial count among other treatments. The increase in microbial count of soil in treatment T_8 might be due to application of bio-fertilizers registered a significant increase in total microbial population over uninoculated control [16]. These findings are in line with Bhardwaj et al*.* [17], Devi and Kumar [18] as well as Devi et al*.* [16] in cauliflower and Verma et al*.* [19] in cabbage who found the increase in microbial count of in soil with application of combination of bio-fertilizers and inorganic fertilizers [20].

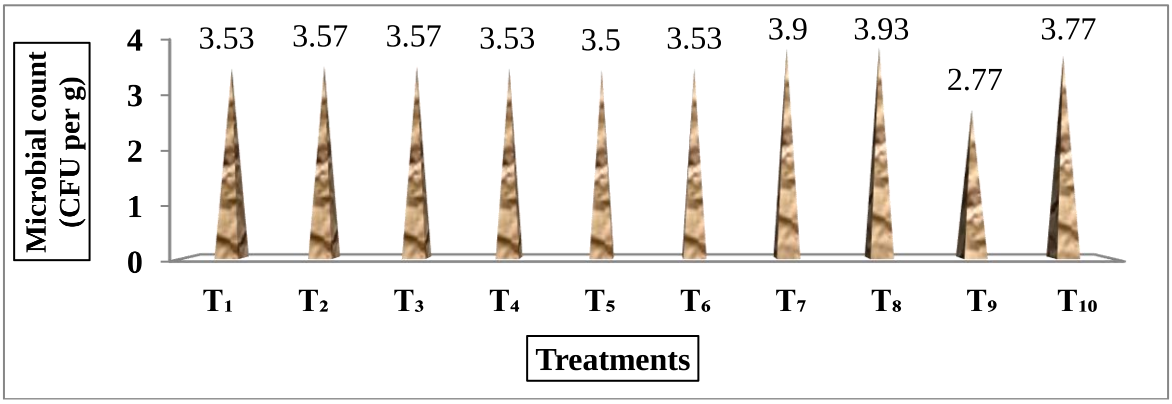

Fig. 3. Microbial count of soil after harvesting affected by biofertilizer based nutrient management

4. CONCLUSIONS

From the results of investigation, it was inferred that soil application of 100% RDF (200:75:37.5) NPK kg ha^{-1} + *Azospirillium* 5 l ha^{-1} + PSB 5 l ha^{-1} + KMB 5 l ha^{-1} (T_8) were more effective for all chemical and biological properties. In chemical properties minimum N,P,K and organic carbon in soil after harvesting is observed in T_{10} *i.e., Azospirillium* 5 l ha^{-1} + PSB 5 l ha^{-1} + KMB 5 l ha^{-1} where soil pH after harvesting is recorded minimum in T_3 (75% RDP + PSB 5 l ha^{-1}). The least microbial count was recorded in T_9 *i.e*., 100% RDF (200:75:37.5 NPK kg ha^{-1}) and at par with four treatments *i.e.,* T_2, T_3, T_7 and T_{10}.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Neupane B, Aryal K, Chhetri L, Regmi S. Effect of integrated nutrient management in early season cauliflower production and it residual effect on soil properties. J. Agril. and Natural Resources.2020;3(2): 353-365.
2. Anonymous. Indian Horticulture Production at a Glance. Nation Horticulture Board, Ministry of Agriculture, Government of India. 2020;15-297.
3. Mishra P, Dash D. Rejuvenation of bio-fertilizer for sustainable agriculture and economic development. J. Sust. Develop. 2014;11(1):41-61.
4. Gupta G, Parihar SS, Ahirwar NK, Snehi SK, Singh V. Plant growth promoting rhizobacteria. J. Microb. Biochem. 2015;7:96-102.
5. Panse VG, Sukhatme PV. Statistical methods for agricultural workers (4th Eds.). ICAR Publication, New Delhi. 1985;pp. 87-89.
6. Nelson DW, Sommers LE. Total carbon, organic carbon and organic matter. J. American Soc. Agron.1982;2(2): 539-547.
7. Subbiah BV, Ashija GL. A rapid procedure for the estimation of nitrogen in soils. J. Curr. Sci.1956;25:259-260.
8. Olsen SR, Cole CV, Watanabe FS, Dean LA. Estimation of available phosphorus in soils by extraction sodium with bicarbonate. U.S. Department of Agricultural.1954;18-19.
9. Knudsen D, Peterson GA, Pratt PF. Lithium, sodium and potassium methods of soil analysis. J. Agron.1982;9(2): 403-429.
10. Patel RJ, Patel RK. Experimental Microbiology (9th eds.). Aditya publication, Amravati, M.H.2015;1:145-147.
11. Devi M, Spehia RS, Menon S, Mogta A, Verma A. Influence of integrated nutrient management on growth and yield of cauliflower and soil nutrient status. Int. J. Chem. Studies. 2018;6(12): 2988-2991.
12. Choudhary S, Soni AK, Jat NK. Effect of organic and inorganic nutrients on growth, yield and quality of cauliflower. Ind. J. of Horti. 2012;69:550-554.
13. Citak S, Sonmez S. Effects of different organic manure applications on the macro nutrient contents of soil in different growing seasons. J. of Agricul. Scie and Technolo. 2011;5: 157–163.
14. Ojha RB, Pandeand K, Khatri K. Nutrient risk anagement using organic manures in radish production at Rampur, Chitwan, Nepal. Adv. in Ecol. and Environ. Res. 2019;21-31.
15. Kafle K, Shriwastav CP, Marasini M. Influence of integrated nutrient management practices on soil properties and yield of potato in an Inceptisol of Khajura, Banke. Int. J. of Applied Sci. and Biotechnol. 2019;7(3): 365-369.
16. Devi M, Upadhyay GP, Garima, Spehia RS. Biological properties of soil and nutrient uptake in cauliflower as influenced by integrated nutrient management. J. Phytochem. 2017;6(3): 325-328.
17. Bhardwaj SK, Sharma SD, Kumar P. Effect of conjoint use of bio-organics and chemical fertilizers on yield and soil properties under french bean cauliflower based cropping system. J. Agron. Soil Sci. 2012;58(7):759-763.
18. Devi S, Kumar V. Effect of organic bio-fertilizers and inorganic amendments on mineral composition and biological properties of soil during cultivation of cauliflower. Asian J. Basic Sci. 2016;4(2):20-26.

19. Verma R. Maurya BR, Meena VS, Dhotaniya ML, Deewan P, Jajoria M. Enhancing production potential of cabbage and improves soil fertility status of indo-gangetic plain through application of bio-organics and mineral fertilizer. Int. J. Curr. Microbiol. App. Sci. 2017;6(3): 301-309.
20. Piper CS. Soil and Plant Analysis. Hans Publisher, Bombay.1966;133-136.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/104043