

Chemical and biological properties of soil affected by biofertilizer based nutrient management

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.*, T₁: 75% RDN + *Azospirillum* (5 l ha⁻¹), T₂: 100% RDN + *Azospirillum* (5 l ha⁻¹), T₃: 75% RDP + PSB (5 l ha⁻¹), T₄: 100% RDP + PSB (5 l ha⁻¹), T₅: 75% RDK + KMB (5 l ha⁻¹), T₆: 100% RDK + KMB (5 l ha⁻¹), T₇: 75% RDF + *Azospirillum* (5 l ha⁻¹) + PSB (5 l ha⁻¹) + KMB (5 l ha⁻¹), T₈: 100% RDF + *Azospirillum* (5 l ha⁻¹) + PSB (5 l ha⁻¹) + KMB (5 l ha⁻¹), T₉: 100% RDF (200:75:37.5) NPK kg ha⁻¹ and T₁₀: *Azospirillum* (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 + *Azospirillum* (5 l ha⁻¹) + PSB (5 l ha⁻¹) + KMB (5 l ha⁻¹) recorded superior for all chemical and biological properties.

Key words: 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 (Neupane *et al.*, 2020).

The vegetable crops have been well advocated in solving the problems of food security. They are rich 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 (Anon., 2020).

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 (Mishra and Dash, 2014). 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 (Gupta *et al.*, 2015).

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 NamakSatyagrah, ‘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 *VerticUstochrepts* 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 (1985). 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 below in Randomized Block Design

T₁: 75% RDN + *Azospirillum* (5 l ha⁻¹)

T₂: 100% RDN + *Azospirillum* (5 l ha⁻¹)

T₃: 75% RDP + PSB (5 l ha⁻¹)

T₄: 100% RDP + PSB (5 l ha⁻¹)

T₅: 75% RDK + KMB (5 l ha⁻¹)

T₆: 100% RDK + KMB (5 l ha⁻¹)

T₇: 75% RDF + *Azospirillum* (5 l ha⁻¹) + PSB (5 l ha⁻¹) + KMB (5 l ha⁻¹)

T₈: 100% RDF + *Azospirillum* (5 l ha⁻¹) + PSB (5 l ha⁻¹) + KMB (5 l ha⁻¹)

T₉: 100% RDF (200:75:37.5 kg ha⁻¹)

T₁₀: *Azospirillum* (5 l ha⁻¹) + PSB (5 l ha⁻¹) + KMB (5 l ha⁻¹)

2.1 Soil Analysis

The soil samples from surface 0 to 22.5 cm depth were drawn randomly in a zigzag 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.

2.1.1 Initial

The soil sample was collected at 0 to 22.5 cm depth covering entire area by moving zigzag 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), P₂O₅ (kg ha⁻¹), K₂O (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.

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 (Nelson and Sommers, 1982)

Available N (kg ha ⁻¹)	261.24	Alkaline potassium permanganate method (Subbiah and Asija, 1956)
Available P ₂ O ₅ (kg ha ⁻¹)	39.66	Olsen's method (Olsen <i>et al.</i> , 1954)
Available K ₂ O (kg ha ⁻¹)	362.47	Flame photometric method (Knudsen, 1982)
Biological properties		
Microbial count (10 ⁶ CFU g ⁻¹)	1.8	Dilution method (Patel and Patel, 2015)

2.1.2 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), P₂O₅ (kg ha⁻¹), K₂O (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.

2.2 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% P₂O₅) and muriate of potash (60% K₂O). 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 *Azospirillum* (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.

Table 2.: Required quantity of chemical fertilizer as per treatment

Treatments	Required quantity of chemical fertilizer
T ₁ : 75% RDN + <i>Azospirillum</i> (5 l ha ⁻¹)	326.1 kg urea ha ⁻¹
T ₂ : 100% RDN + <i>Azospirillum</i> (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 + <i>Azospirillum</i> (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 + <i>Azospirillum</i> (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 : <i>Azospirillum</i> (5 l ha ⁻¹) + PSB (5 l ha ⁻¹) + KMB (5 l ha ⁻¹)	NA

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 + *Azospirillum* 5 l ha⁻¹ + PSB 5 l ha⁻¹ + KMB 5 l ha⁻¹ (T₈) and lowest available N

(257.89 kg ha⁻¹), P (42.65 kg ha⁻¹) and K (366.52 kg ha⁻¹) in T₁₀ (*Azospirillum* 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 T₈ (100% RDF + *Azospirillum* 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.* (2018) and Choudhary *et al.* (2012) in Cauliflower.

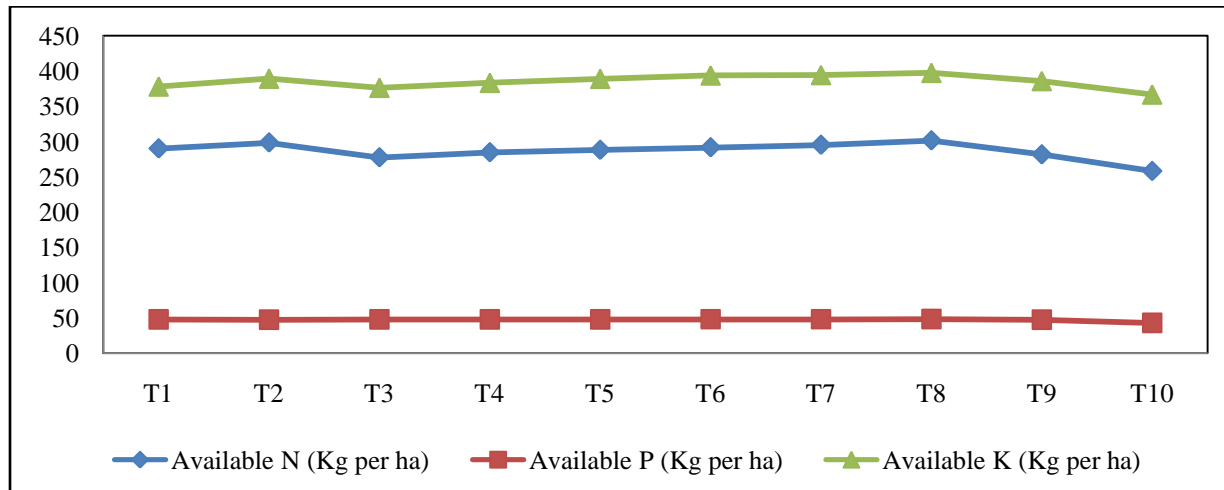


Fig 1. Available N, P and K of soil after harvesting affected by biofertilizer based nutrient management

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 T₈ (100% RDF + *Azospirillum* 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 T₁₀ *i.e.*, *Azospirillum* 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 (Citak and Somnez, 2011). Same result recorded by Ojha *et al.* (2019) in Radish and Kafle *et al.* (2019) in Potato.

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 + *Azospirillum* 5 l ha⁻¹ + PSB 5 l ha⁻¹ + KMB 5 l ha⁻¹ (T₈) and minimum soil pH (6.7) in T₃ (75% RDP + PSB 5 l ha⁻¹). The results for soil pH showed that, the treatment T₈ was recorded maximum soil pH and minimum soil pH by T₃. Same result recorded by Ojha *et al.* (2019) in Radish and Kafle *et al.* (2019) in Potato.

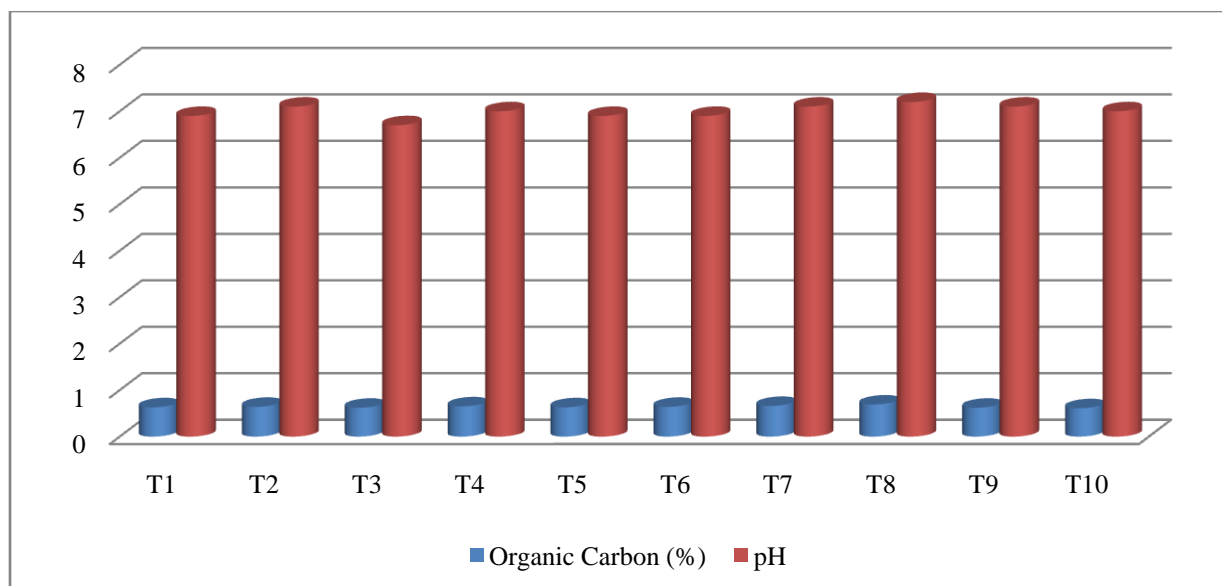


Fig 2. Organic carbon and soil pH of soil after harvesting affected by biofertilizer based nutrient management

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 T₈ (100% RDF + *Azospirillum* 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., T₂ (3.57×10^6 CFU g⁻¹), T₃ (3.57×10^6 CFU g⁻¹), T₇ (3.90×10^6 CFU g⁻¹) and T₁₀ (3.77×10^6 CFU g⁻¹). The least microbial count (2.77×10^6 CFU g⁻¹) was recorded in T₉, i.e., 100% RDF (200:75:37.5 NPK kg ha⁻¹). The results for microbial count showed that, the treatment T₈ (100% RDF + *Azospirillum* 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 T₈ might be due to application of bio-fertilizers registered a significant increase in total microbial population over uninoculated control (Devi *et al.*, 2017). These findings are in line with Bhardwaj *et al.* (2012), Devi and Kumar (2016) as well as Devi *et al.* (2017) in cauliflower and Verma *et al.* (2017) in cabbage who found the increase in microbial count of in soil with application of combination of bio-fertilizers and inorganic fertilizers.

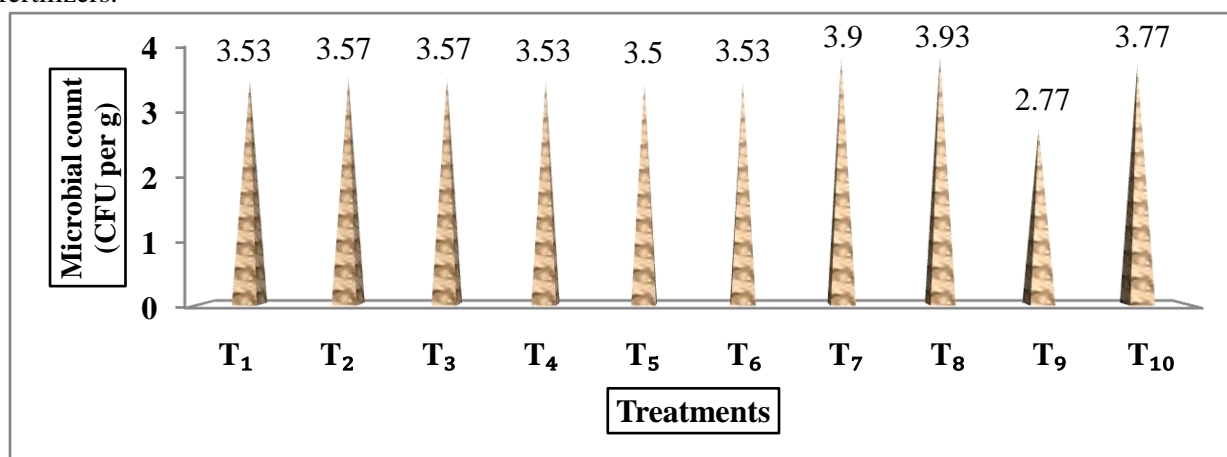


Fig3. Microbial count of soil after harvesting affected by biofertilizer based nutrient management

Conclusions

From the results of investigation, it was inferred that soil application of 100% RDF (200:75:37.5) NPK kg ha⁻¹ + *Azospirillum* 5 l ha⁻¹ + PSB 5 l ha⁻¹ + KMB 5 l ha⁻¹ (T₈) 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 T₁₀. *i.e.*, *Azospirillum* 5 l ha⁻¹ + PSB 5 l ha⁻¹ + KMB 5 l ha⁻¹ where soil pH after harvesting is recorded minimum in T₃ (75% RDP + PSB 5 l ha⁻¹). The least microbial count was recorded in T₉. *i.e.*, 100% RDF (200:75:37.5 NPK kg ha⁻¹) and at par with four treatments *i.e.*, T₂, T₃, T₇ and T₁₀.

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