



E-ISSN: 2663-1067

P-ISSN: 2663-1075

NAAS Rating (2025): 4.74

www.hortijournal.com

IJHFS 2025; 7(10): 155-159

Received: 04-07-2025

Accepted: 07-08-2025

Abdul Rahman M

Ph.D. Scholar, Department of Horticulture, School of Agricultural Sciences, Nagaland University, Lumami, Nagaland, India

Laishram Hemanta

Assistant Professor, Department of Horticulture, School of Agricultural Sciences, Nagaland University, Lumami, Nagaland, India

Rokolhuü Kreditsu

Associate Professor, Department of Horticulture, School of Agricultural Sciences, Nagaland University, Lumami, Nagaland, India

Animesh Sarkar

Associate Professor, Department of Horticulture, School of Agricultural Sciences, Nagaland University, Lumami, Nagaland, India

Chandan Suravi Maiti

Professor, Department of Horticulture, School of Agricultural Sciences, Nagaland University, Lumami, Nagaland, India

Greeshma Baby

Ph.D. Scholar, Department of Floriculture and Landscaping, College of Agriculture, Vellayani, Thiruvananthapuram, Kerala, India

Kivi H Yeptho

Ph.D. Scholar, Department of Horticulture, School of Agricultural Sciences, Nagaland University, Nagaland, India

Corresponding Author:**Laishram Hemanta**

Assistant Professor, Department of Horticulture, School of Agricultural Sciences, Nagaland University, Lumami, Nagaland, India

Comparative evaluation of eco-friendly inputs on NPK uptake in *Lilium* cv. Brindisi

Abdul Rahman M, Laishram Hemanta, Rokolhuü Kreditsu, Animesh Sarkar, Chandan Suravi Maiti, Greeshma Baby and Kivi H Yeptho

DOI: <https://www.doi.org/10.33545/26631067.2025.v7.i10c.417>

Abstract

A study entitled “Comparative Evaluation of Eco-Friendly Inputs on NPK Uptake in *Lilium* cv. Brindisi” was conducted during 2022-23 and 2023-24 in the Experimental cum Research Farm, SAS, Nagaland University, Medziphema Campus, Nagaland. In the first experiment, treatments were T₀ (Control), T₁ [Effective Microorganisms (EM)], T₂ (Jeevamrutha), T₃ (Bokashi), T₄ (Panchagavya), T₅ (Azotobacter + Phosphotika), T₆ (EM + Green leaf manure), T₇ (Jeevamrutha + Green leaf manure), T₈ (Panchagavya + Green Leaf Manure), T₉ (Azotobacter + Phosphotika + Green leaf manure) and T₁₀ (Bokashi + Green leaf manure). The treatment T₆ (EM + Green leaf manure) displayed the highest percentage of nitrogen (4.62%) and potassium (3.06%) content on plants, while T₇ (Jeevamrutha + Green leaf manure) exhibited maximum phosphorus (0.102%) content on plants. The highest content of nitrogen (2.38 %) and phosphorus (0.076%) was recorded in T₇ (Jeevamrutha + Green leaf manure), while the maximum potassium (2.20 %) in bulbs was recorded in T₂ (Jeevamrutha). The results revealed that the combined application of Effective microorganisms (EM) and Jeevamrutha in combination with green leaf manure (T₆ and T₇) help maximize the nutrient uptake by leaves as well as in the bulbs.

Keywords: Eco-friendly inputs, EM, jeevamrutha, *Lilium*, bulbs

1. Introduction

Bulbous plants constitute one of the most important groups of floriculture industry and are valued for beauty, fragrance and brilliant colours. Lily undoubtedly is one of the most pretty bulbous plants grown for its fascinating spikes. It is a popular cut flower having multi utility in bouquets and flower arrangement. The demand for cut lily is gaining momentum with the increasing aesthetic sense and higher socio-economic standard of the people. Its elegant flower spikes, which have rich variation of colours, are the main reasons for its ever increasing demand. *Lilium* is one of the ten most superior cut flowers in the world (Kumar and Jasmine, 2020) [13]. *Lilium* belongs to the family Liliaceae, comprising of about 110 species. It is mostly propagated vegetatively by bulbs and is cultivated commercially for cut flowers and potted plants.

During the decades, the concept of using eco-friendly inputs has emerged as an important tool for maintaining soil fertility and productivity of crops. The program involves maximize biological inputs to crop production and minimize the use of inorganic amendments so as to create a much more sustainable pattern of crop production, not only ecologically but also environmentally (Wani *et al.*, 2017) [30]. It accelerates the non-conventional fertilizers sources of plant nutrients such as, green manure crops, crop rotation, crop residues, organic manures, FYM, sludges, oilcakes, blood meal, compost, phospho-compost, vermicompost, biogas slurry, agricultural wastes, press mud, biodynamic preparations, bio-fertilizers, bio enhancers etc. The proper development and quality of flowers are greatly prejudiced by several edaphic factors like soil type and accessibility of nutrients (Gopitha *et al.*, 2021) [5]. But in floriculture very limited work has been done on effective micro-organism (EM), jeevamrutha, panchakavya, EM-bokashi and green leaf manures in floriculture. This study aim to explore the impact of above mentioned inputs on the nutrient composition in plants, bulbs and soil.

Nagaland, popularly called the “Land of Festivals” requires plenty of cut flowers particularly winter season. The cut flower industry is steadily growing in the state and the cut flowers

have been cultivated. It is mainly cultivated in Kohima, Mokokchung, Wokha and Phek districts of Nagaland (Thirugnanavel *et al.*, 2019) ^[28]. The growth and development of *Lilium* is governed by its genetic makeup and the environmental factors of the growing region and various management practices. The *Lilium* cultivation is mainly restricted to cooler areas of Nagaland. Due to the efforts of researchers, the cultivation of *Lilium* is possible in plains with the development of new hybrids.

In the recent past some successful efforts have been made to at least partially substitute chemicals with natural substances to minimize the bad effects of the former. One such effort was made by Prof. Dr. Terou Higa in 1989, who isolated some beneficial microorganisms from the soil and called them Effective Microorganisms. Effective microorganisms culture consists of co-existing beneficial microorganisms, the main ones being the species of photosynthetic bacteria, viz. *Rhodospseudomonasplastris* and *Rhodobactersphacrodese*; lactobacilli, viz. *Lactobacillus plantarum*, *L. casei* and *Streptococcus lactis*; yeasts (*Saccharomyces spp.*), and Actinomycetes (*Streptomyces spp.*), which improve crop growth and yield by increasing photosynthesis, producing bioactive substances such as hormones and enzymes, controlling soil diseases and accelerating decomposition of lignin materials in the soil (Higa, 2003; Hussain *et al.*, 2002) ^[7, 8].

Liquid organic substances that are used in organic horticulture like Jeevamrut and Panchagavya are fermented products, which are used as plant growth enhancing substances prepared by using material available from farmers. The organic amendments Jeevamrut and Panchagavya are made from cow products namely, dung, urine, milk, curd and ghee (Sundaraman *et al.*, 2001; Xu, 2001; Selvaraj *et al.*, 2003). Utilization of organic liquid products such as Jeevamrutha and Panchagavya results in higher growth, yield and quality of crops and improve the soil physico-chemical and biological properties. They consist of various macro nutrients, essential micronutrients, many vitamins, essential amino acids, growth promoting factors like IAA, GA and beneficial microorganisms (Devakumar *et al.*, 2008; Xu, 2001) ^[26, 23, 3].

Biofertilizers play a significant role in modern agricultural to reduce the dependence on chemical fertilizers. They are considered as substitutes for pesticides and fertilizers, and have fewer deleterious effects on consumers (Yadav *et al.*, 2018) ^[32].

Bokashi is made by using an organic material which inoculated with the EM. The concept of EM-Bokashi was discovered and developed by Professor Teruo Higa in 1980s at the University of the Ryukyus, Japan. Bokashi have been shown to increase plant nutrient uptake, growth and yield via different basic mechanisms such as changes in soil structure, nutrient solubility, root growth and morphology, plant physiology, and symbiotic relationships (Prisa, 2020) ^[17].

2. Materials and methods

A study entitled “comparative evaluation of eco-friendly inputs on npk uptake in *Lilium* cv. brindisi” was conducted during 2022-23 and 2023-24 in the Experimental cum Research Farm, SAS, Nagaland University, Medziphema Campus, Nagaland. In the first experiment, treatments were T₀ (Control), T₁ [Effective Microorganisms (EM)], T₂ (Jeevamrutha), T₃ (Bokashi), T₄ (Panchagavya), T₅

(Azotobacter + Phosphotika), T₆ (EM + Green leaf manure), T₇ (Jeevamrutha + Green leaf manure), T₈ (Panchagavya + Green Leaf Manure), T₉ (Azotobacter + Phosphotika + Green leaf manure) and T₁₀ (Bokashi + Green leaf manure).

2.1 Preparation application of eco-friendly inputs

2.1.1 Effective microorganisms (EM)

1 Litre of Maple EM1 and 1 kg of jaggery in 20 litres of water were taken to activate the EM stock solution. The mixture was left to sit in a plastic bucket with an airtight lid and was kept for a week for fermentation. After 7 days, the EM was activated. It was used within one month after activation. Activated EM was applied twice a month at 15 days interval from the day of planting at the rate of 1 L/m² (Anonymous, 2022a) ^[1].

2.1.2 Bokashi

Bokashi compost was prepared using an airtight bokashi bin. A layer of jaggery was placed at the bottom of the bin and a strainer lined with newspaper was positioned above it. Solid kitchen waste (approximately 2 cm thick) was added daily and sprayed with activated Effective Microorganisms (EM). The bin was kept airtight and stored indoors to maintain anaerobic conditions. Once the bin was filled, it was sealed and allowed to ferment for 15-20 days. After fermentation, the pickled waste showing white fungal growth was cured by layering with cocopeat (3-4 cm cocopeat and 2-3 cm fermented waste) in a separate container. The mixture was turned once every three days and allowed to mature for 20-30 days. The final compost was stored in a cool, dark place. The prepared bokashi was applied at 300 g m⁻², once during field preparation and again 30 days after planting (Anonymous, 2022b) ^[2].

2.1.3 Jeevamrutha

Jeevamrutha was prepared by mixing 10 kg of cow dung, 10 litres of cow urine, 2 kg of local jaggery, 2 kg of Besan flour and a handful of soil collected from the farm. All these were put in a 200 litres capacity plastic drum and mixed thoroughly and the volume was made up to 200 litres. The mixture was stirred well in a clockwise direction and kept in the shade covered with a wet jute bag. The solution was regularly stirred clockwise in the morning, afternoon and evening continuously for 7 days and it was used for soil application. Jeevamrutha was applied when the soil was wet near the root zone of the crop as per the treatments. It has a maximum 15-day shelf life. After planting bulbs in the primary field, it was applied twice, one month apart at the rate of 50ml/m² (Sutar *et al.*, 2019) ^[27].

2.1.4 Panchagavya

Panchagavya was prepared by mixing fresh cow dung (7 kg) and ghee (1 kg) in a plastic container and incubating for 2 days with daily stirring. On the 3rd day, cow urine (10 L) and water (10 L) were added, mixed thoroughly, and allowed to ferment for 13 days. Subsequently, milk (3 L), curd (2 L), tender coconut water (3 L), jaggery (3 kg), and 12 ripened bananas were added, and the mixture was fermented for an additional 6 days with regular stirring. The solution was kept in shade and covered to prevent contamination. After 21 days, the fermented material was filtered and used as required. Panchagavya was applied at 6% concentration at one-month intervals after bulb sprouting (Raghavendra *et al.*, 2014) ^[18].

2.1.5 Green leaf manure

Fresh green leaves (Gulmohar) were harvested and incorporated into the main field 15 days before planting at a rate of 500g per m² (Rani *et al.*, 2021)^[19].

2.2 Nutrient analysis on leaves

Fully expanded index leaves collected from the sample plants at the time of spike emergence for leaf nutrient analysis. The leaf samples were thoroughly washed, cut and dried in a hot air oven. Dried leaf samples were then ground using a grinder machine. The samples were then analyzed for the determination of NPK contents. The result, thus, obtained was represented in terms of percentage on a dry weight basis.

2.2.1. Nitrogen

Nitrogen in plant sample was determined by KEL PLUS nitrogen estimation system (PELICAN Equipment). Pelicans KEL PLUS System are developed and designed to perform the Micro-Kjeldahl method (Jackson, 1973)^[10] for estimation of nitrogen.

2.2.2 Phosphorus and Potassium

One gram of oven-dried plant sample was taken and digested in a 100 ml conical flask with 10 ml of di-acid mixture (2:5) consisting of chemically pure concentrated perchloric acid and nitric acid, respectively. The digested material was filtered through Whatman no. 40 filter paper into a 100 ml volumetric flask, and the filtrate was diluted to volume as outlined by Johnson and Ulrich (1959). This solution was then used for the estimation of P and K.

The phosphorus content in the digested leaves sample was determined by vanadomolybdophosphoric acid yellow colour method using a spectrophotometer at 660 nm (Jackson, 1973)^[10].

For estimating potassium content, 10 ml aliquot of the filtrate was taken in a 100 ml volumetric flask and it was diluted to mark with distilled water. The potassium content in the extract was estimated by flame photometer (Jackson, 1973)^[10].

2.3 Nutrient analysis on bulbs

The bulbs were lifted from the ground 45 days after flowering. The maturity of bulbs was identified by the browning of leaves and wilting of plants. The corms were thoroughly washed, cut and dried in a hot air oven. Dried bulb samples were then ground using a grinder machine. The samples were then analyzed for the determination of NPK contents. The same method as mentioned earlier was followed for the nutrient analysis of the bulbs. The result, thus, obtained was represented in terms of percentage on a dry weight basis.

2.4 Statistical Analysis

The data on various observations recorded during the course of the investigation were statistically analyzed. Analysis of variance for different characters will be worked out. The appropriate standard error of mean (SEm ±) and the critical difference (C.D.) were calculated at a 5 per cent level of probability.

3. Results and Discussion

3.1 Nitrogen content on leaves

The pooled analysis of nitrogen content over two years

further highlighted the benefits of combining microbial and organic treatments. Treatment T₆ (Effective microorganisms + Green leaf manure) recorded the highest pooled nitrogen content at 4.62%. EM positively impacts nitrogen content because it can regulate the nitrogen cycle. It helps break down organic matter in the soil, allowing more nitrogen to be available for plants (Nayak *et al.*, 2020)^[15]. EM improves nitrogen uptake from organic material, especially when mixed with residues that have low C: N ratios (Sangakkara and Weerasekera, 2012)^[20]. Using EM with organic materials boosts nutrient breakdown, with fresh organic matter being more effective than compost. When paired with organic amendments, especially those with low C: N ratios, EM supports plant growth, yield, nodulation, and increases nitrogen in the rhizosphere (Sangakkara *et al.*, 2014)^[21].

3.2 Phosphorus content on leaves

The combined data from both years confirmed that T₇ (Jeevamrutha + Green leaf manure) consistently recorded the highest average phosphorus content at 0.102%. This was followed by T₆ (Effective microorganisms + Green leaf manure) with 0.095% and T₈ (Panchagavya + Green leaf manure) at 0.089%. Jeevamrutha includes beneficial microorganisms, such as phosphate-solubilising bacteria, that turn insoluble phosphorus into forms plants can use. These microbes produce organic acids and enzymes that help with phosphorus solubilization and mineralisation (Sindhu *et al.*, 2013; Silva *et al.*, 2023)^[25, 24]. Using jeevamrutha enhances soil structure, increases microbial populations, and boosts the availability of macro and micronutrients. When paired with organic matter, like green leaf manure, it creates a nutrient-rich environment that fosters microbial growth and phosphorus cycling. This combined approach improves phosphorus use in agriculture, decreases the need for chemical fertilizers, and supports sustainable farming practices (Vibha and Lingaraju, 2020; Silva *et al.*, 2023)^[29, 24].

3.3 Potassium content on leaves

The combined data from both years confirmed the effectiveness of T₆ (Effective microorganisms + Green leaf manure) and T₇ (Jeevamrutha + Green leaf manure), with potassium contents of 3.06% and 3.0%, respectively. The increase in available potassium results from the combined effects of EM and green leaf manure. Effective microorganisms, including beneficial strains like lactic acid bacteria, phototrophic bacteria and actinomycetes, aid in nutrient breakdown and microbial activity in the rhizosphere. This process improves potassium availability and uptake (Sangakkara *et al.*, 2014)^[21]. Simultaneously, green leaf manure supplies substantial amounts of organic matter and nutrients as it decomposes. This not only enhances soil structure and microbial populations but also promotes the gradual release of potassium. Meena *et al.* (2014)^[14] and Sindhu *et al.* (2013)^[25] report similar findings.

3.4 Nitrogen content on bulbs

The Pooled data showed that T₇ (Jeevamrutha + Green leaf manure) had the highest nitrogen content at 2.38%, which was significantly better than the other treatments. T₆ (Effective microorganisms + Green leaf manure) followed with 2.15%, and T₂ (Jeevamrutha) had 2.12%. The

consistent superiority of T₇ (Jeevamrutha + green leaf manure) across seasons demonstrates that using Jeevamrutha alongside green leaf manure enhances microbial activity. This process accelerates organic matter decomposition, leading to better nitrogen uptake in bulbs. Together, they improve organic matter breakdown, resulting in enhanced nitrogen absorption in plants (Khan *et al.*, 2025) ^[12]. Findings from the study by Selvaprabu *et al.* (2024) ^[22] indicate that organic farming practices, such as using jeevamrutha and green leaf manures, can effectively raise nitrogen content and overall nutrient levels in onion bulbs.

3.5 Phosphorus content on bulbs

The combined data from the two years showed that T₇ (Jeevamrutha + Green leaf manure) consistently had the highest phosphorus content at 0.076%. This was statistically comparable to T₆ (EM + Green leaf manure) at 0.074%. T₂ (Jeevamrutha) followed at 0.071. The lowest pooled phosphorus content was again in T₀ (Control) at 0.041%. The consistently higher values in T₆ (EM + Green leaf manure) and T₇ (Jeevamrutha + Green leaf manure) across both years emphasise the combined benefits of liquid organic manures and green leaf manure in maintaining soil phosphorus levels and improving the nutrient composition of the bulbs.

3.6 Potassium content on bulbs

The pooled analysis for both years showed that T₂ (Jeevamrutha) had the highest potassium content in bulbs at 2.20%. This was comparable to T₁ (Effective microorganisms, 2.17%) and T₇ (Jeevamrutha + Green leaf manure, 2.11%). The use of Jeevamrutha, either on its own or with green leaf manure, has been shown to significantly

improve the potassium (K) content in bulbs. This is due to its rich microbial diversity, enzyme activity, and ability to break down nutrients. Jeevamrutha contains beneficial microorganisms like phosphate-solubilising bacteria (PSB) and potassium-solubilising microorganisms (KSM). These microorganisms convert insoluble forms of phosphorus, such as tricalcium phosphate and potassium, like mica and feldspar, into forms that plants can use. They do this through the release of organic acids, enzymes and chelating agents (Han and Lee, 2006) ^[6]. Additionally, adding green leaf manure supplies a steady amount of organic matter. This matter undergoes microbial decomposition which releases humic and fulvic acids that help in breaking down nutrients and chelation (Aulakh *et al.*, 2022) ^[13].

Table 1: Effect of eco-friendly inputs on nutrient content on plants (%)

Treatments	Nutrient content (%)								
	N			P			K		
	2022-23	2023-24	Pooled	2022-23	2023-24	Pooled	2022-23	2023-24	Pooled
T ₀	2.52	2.94	2.73	0.050	0.068	0.059	1.38	2.04	1.71
T ₁	3.89	4.57	4.23	0.065	0.095	0.080	2.38	3.23	2.80
T ₂	3.88	4.62	4.25	0.070	0.092	0.081	2.12	3.22	2.67
T ₃	2.80	3.22	3.01	0.054	0.071	0.063	1.62	2.42	2.02
T ₄	3.08	3.78	3.43	0.062	0.076	0.069	1.86	2.64	2.25
T ₅	3.22	3.50	3.36	0.060	0.085	0.072	2.06	2.76	2.41
T ₆	4.20	5.04	4.62	0.076	0.115	0.095	2.61	3.52	3.06
T ₇	4.06	4.88	4.47	0.082	0.121	0.102	2.56	3.43	3.00
T ₈	3.64	3.92	3.78	0.070	0.109	0.089	2.28	3.16	2.72
T ₉	3.71	4.06	3.88	0.068	0.102	0.085	2.20	3.07	2.64
T ₁₀	3.08	3.64	3.36	0.056	0.077	0.067	2.02	2.58	2.30
SEm±	0.05	0.06	0.04	0.001	0.004	0.002	0.03	0.05	0.03
CD at 5%	0.14	0.16	0.11	0.002	0.010	0.005	0.08	0.14	0.08

Table 2: Effect of eco-friendly inputs on nutrient content of bulbs (%)

Treatments	Nutrient content (%)								
	N			P			K		
	2022-23	2023-24	Pooled	2022-23	2023-24	Pooled	2022-23	2023-24	Pooled
T ₀	1.21	1.27	1.24	0.041	0.041	0.041	1.53	1.56	1.55
T ₁	1.96	2.08	2.02	0.067	0.071	0.069	2.11	2.23	2.17
T ₂	2.09	2.16	2.12	0.069	0.073	0.071	2.18	2.22	2.20
T ₃	1.38	1.38	1.38	0.052	0.052	0.052	1.56	1.59	1.58
T ₄	1.63	1.74	1.69	0.054	0.060	0.057	1.72	1.83	1.78
T ₅	1.72	1.76	1.74	0.052	0.055	0.054	1.67	1.65	1.66
T ₆	2.14	2.15	2.15	0.072	0.075	0.074	1.98	2.07	2.02
T ₇	2.34	2.42	2.38	0.070	0.081	0.076	2.13	2.09	2.11
T ₈	1.95	1.72	1.84	0.061	0.069	0.065	1.92	1.94	1.93
T ₉	1.76	1.88	1.82	0.061	0.064	0.063	1.87	1.91	1.89
T ₁₀	1.52	1.59	1.55	0.044	0.058	0.051	1.63	1.66	1.65
SEm±	0.02	0.03	0.02	0.001	0.001	0.001	0.02	0.02	0.01
CD at 5%	0.07	0.09	0.05	0.002	0.003	0.002	0.05	0.06	0.04

Conclusion

From the overall experiment it can be concluded that the combined application of Effective microorganisms (EM) and Jeevamrutha in combination with green leaf manure (T₆ and T₇) help maximize the nutrient uptake by leaves as well as in the bulbs. It is observed that, the treatment T₆ (EM + Green leaf manure) displayed the highest percentage of nitrogen (4.62%) and potassium (3.06%) content on plants, while T₇ (Jeevamrutha + Green leaf manure) exhibited maximum phosphorus (0.102%) content on plants. In bulbs

the highest content of nitrogen (2.38 %) and phosphorus (0.076%) was recorded in T₇ (Jeevamrutha + Green leaf manure), while the maximum potassium (2.20 %) in bulbs was recorded in T₂ (Jeevamrutha).

Disclaimer (Artificial intelligence)

The author(s) hereby declare that generative Artificial Intelligence (AI) technologies, such as Large Language Models, were used during the preparation and/or editing of this manuscript.

Details of AI usage:**Name and version of the AI tool:** Grammarly**Purpose of use:** Used only for language improvement, grammar correction and formatting assistance.**References**

- Anonymous. *Effective Microorganism*. 2022a. https://agritech.tnau.ac.in/ta/org_farm/orgfarm_effective%20microorganism.html. Last accessed on 18/9/2023.
- Anonymous. *How to use Trustbin indoor kitchen waste Bokashi composter*. 2022b. <https://www.trustbasket.com/pages/how-to-use-trustbin-indoor-kitchen-waste-bokashi-composter>. Last accessed on 18/9/2023.
- Aulakh CS, Sharma S, Thakur M, Kaur P. A review of the influences of organic farming on soil quality, crop productivity and produce quality. *J Plant Nutr*. 2022;45(12):1884-1905.
- Devakumar N, Rao GGE, Shubha S, Imrankhan N, Gowda SB. *Activities of Organic Farming Research Centre*. Navile, Shimoga: Univ. Agri. Sci., Bangalore; 2008.
- Gopitha G, Kannan M, Sankari A, Santhi R. Effect ointegrated nutrient management on flower quality and physiological parameters of *Nerium (Nerium oleander L.)*. *J Pharmacogn Phytochem*. 2021;10(1):1847-1851.
- Han HS, Lee KD. Effect of co-inoculation with phosphate and potassium solubilizing bacteria on mineral uptake and growth of pepper and cucumber. *Plant Soil Environ*. 2006;52(3):130.
- Higa T. Kyusei nature farming and environmental management through effective microorganisms - the past, present and future. In: Seventh International Conference on Kyusei Nature Farming. Christchurch, New Zealand; 2003.
- Hussain T, Anjum AD, Tahir J. Technology of beneficial microorganisms. *Nat Farm Environ*. 2002;3:1-14.
- Iriti M, Scarafoni A, Pierce S, Castorina G, Vitalini S. Soil application of effective microorganisms (EM) maintains leaf photosynthetic efficiency, increases seed yield and quality traits of bean (*Phaseolus vulgaris* L.) plants grown on different substrates. *Int J Mol Sci*. 2019;20(9):2327.
- Jackson ML. *Soil Chemical Analysis*. New Delhi: Prentice-Hall of India Private Limited; 1973. p. 82-86.
- Johnson CM, Ulrich A. Analytical methods for use in plant analysis. California Agricultural Experiment Station Bulletin. 1959;766.
- Khan MTA, Momen MBH, Tanvir MRR, Islam MR. Dynamics of nitrogen mineralization by organic and inorganic amendments through enzyme activity of microbial community in laboratory incubation. *CarakaTani J Sustain Agric*. 2025;40(2):231-250.
- Kumar GA, Jasmine AJ. Assessment of different lily types for suitability for commercial and landscaping use. *Int J Curr Microbiol App Sci*. 2020;9(12):2777-2782.
- Meena VS, Maurya BR, Verma JP. Does a rhizospheric microorganism enhance K⁺ availability in agricultural soils? *Microbiol Res*. 2014;169(5-6):337-347.
- Nayak N, Sar K, Sahoo BK, Mahapatra P. Beneficial effect of effective microorganism on crop and soil - a review. *J Pharmacogn Phytochem*. 2020;9(4):3070-3074.
- Pandit NR, Schmidt HP, Mulder J, Hale SE, Husson O, Cornelissen G. Nutrient effect of various composting methods with and without biochar on soil fertility and maize growth. *Arch Agron Soil Sci*. 2020.
- Prisa D. EM-Bokashi addition to the growing media for the quality improvement of *Kalanchoe Blossfeldiana*. *Int J Multidiscip Sci Adv Technol*. 2020;1(2):54-59.
- Raghavendra KV, Gowthami R, Shashank R, Harish Kumar S. Panchagavya in organic crop production. *Pop Kheti*. 2014;2(2):233-236.
- Rani TS, Umareddy R, Ramulu C, Kumar TS. Green manures and green leaf manures for soil fertility improvement: A review. *J Pharmacogn Phytochem*. 2021;10(5):190-196.
- Sangakkara UR, Weerasekera P. Impact of effective microorganisms on nitrogen utilisation in food crops [Internet]. 2012.
- Sangakkara UR, Wijesinghe DB, Attanayake KB. Soil quality and crop yields as affected by microbial inoculants in nature farming. *Building Organic Bridges*. 2014;3:987-990.
- Selvaprabu P, Sundaram V. Integrated plant nutrient management on bulb quality and nutrient uptake of *Aggregatum onion (Allium cepa var. aggregatum)*. *Int J Plant Soil Sci*. 2024;36(8):494-502.
- Selvaraj J, Ramaraj B, Devarajan K, Seenivasan N, Senthilkumar S, Sakthi E. Effect of organic farming on growth and yield of thyme. Articles and Abstracts of Nation. Sem. Prod. Utiliz. Med. Pl. 2003;13-14.
- Silva LID, Pereira MC, Carvalho AMXD, Buttrós VH, Pasqual M, Dória J. Phosphorus-solubilizing microorganisms: A key to sustainable agriculture. *Agriculture*. 2023;13(2):462.
- Sindhu SS, Phour M, Choudhary SR, Chaudhary D. Phosphorus cycling: prospects of using rhizosphere microorganisms for improving phosphorus nutrition of plants. In: *Geomicrobiology and biogeochemistry*. Berlin, Heidelberg: Springer Berlin Heidelberg; 2013. p. 199-237.
- Sundaraman SR, Selvam R, Ramakrishna M. *Handbook on organic farming. Natural way of farming movement communication Bulletin*. Prajetha, NGO network, KongalNagaram, Tamil Nadu; 2001.
- Sutar R, Sujith GM, Devakumar N. Growth and yield of Cowpea (*Vigna unguiculata* L. Walp) as influenced by jeevamrutha and panchagavya application. *Legume Res*. 2019;42(6):824-828.
- Thiruganavel A, Deka BC, Walling N, Rangnamei L. Performance of Asiatic and Oriental *Lilium* hybrids under lower altitudes of Nagaland. *Int J Curr Microbiol App Sci*. 2019;8(4):2242-2246.
- Vibha G, Lingaraju HG. Jeevamrutha: Organic liquid formulations for sustainable agriculture practices: A review. *J Sci Technol*. 2020;5(5):135-139.
- Wani MA, Wani SA, Ahmad MS, Lone RA, Gani G, FU K. Integrated nutrient management (INM) approaches in flower crops. *Int J Curr Microbiol App Sci*. 2017;6(3):254-265.
- Xu HL. Effects of a microbial inoculant and organic fertilizers on the growth, photosynthesis and yield of sweet corn. *J Crop Prod*. 2001;3(1):183-214.
- Yadav RS, Singh V, Pal S, Meena SK, Meena VS, Sarma BK, Singh HB, Rakshit A. Seed bio-priming of baby corn emerged as a viable strategy for reducing mineral fertilizer use and increasing productivity. *Sci Hortic*. 2018;241:93-99.