Print ISSN : 0972-8813
e-ISSN : 2582-2780

[Vol. 24(1) January-April 2026]

Pantnagar Journal of Research

(Formerly International Journal of Basic and Applied Agricultural Research ISSN : 2349-8765)

G.B. Pant University of Agriculture & Technology
Pantnagar, U.S. Nagar; Uttarakhand, Website : gbpuat.res.in/PJR

ADVISORY BOARD

Patron

Prof. Shivendra Kumar Kashyap, Ph.D., Vice-Chancellor, G.B. Pant University of Agriculture and Technology, Pantnagar, India

Members

Prof. S. K. Verma, Ph.D., Director Research, G.B. Pant University of Agri. & Tech., Pantnagar, India
Prof. Jitendra Kwatra, Ph.D., Director, Extension Education, G.B. Pant University of Agri. & Tech., Pantnagar, India
Prof. S.S. Gupta, Ph.D., Dean, College of Technology, G.B. Pant University of Agri. & Tech., Pantnagar, India
Prof. D. Kumar, Ph.D., Dean, College of Veterinary & Animal Sciences, G.B. Pant University of Agri. & Tech., Pantnagar, India
Prof. Alka Goel, Ph.D., Dean, College of Community Science, G.B. Pant University of Agri. & Tech., Pantnagar, India
Prof. R.S. Jadoun, Ph.D., Dean, College of Agribusiness Management, G.B. Pant University of Agri. & Tech., Pantnagar, India
Prof. Lokesh Varshney, Ph.D., Dean, College of Post Graduate Studies, G.B. Pant University of Agri. & Tech., Pantnagar, India
Prof. Avdhesh Kumar, Ph.D., Dean, College of Fisheries, G.B. Pant University of Agri. & Tech., Pantnagar, India
Prof. Subhash Chandra, Ph.D., Dean, College of Agriculture, G.B. Pant University of Agri. & Tech., Pantnagar, India
Prof. Ramesh Chandra Srivastava, Ph.D., Dean, College of Basic Sciences & Humanities, G.B.P.U.A.T., Pantnagar, India

EDITORIAL BOARD

Members

A.K. Misra, Ph.D., Ex-Chairman, Agricultural Scientists Recruitment Board, Krishi Anusandhan Bhavan I, New Delhi, India & Ex-Vice Chancellor, G.B.Pant University of Agriculture & Technology, Pantnagar
Anand Shukla, Director, Reefberry Foodex Pvt. Ltd., Veraval, Gujarat, India
Anil Kumar, Ph.D., Director, Education, Rani Lakshmi Bai Central Agricultural University, Jhansi, India
Ashok K. Mishra, Ph.D, Kemper and Ethel Marley Foundation Chair, W P Carey Business School, Arizona State University, U.S.A
Binod Kumar Kanaujia, Ph.D., Professor, School of Computational and Integrative Sciences, Jawahar Lal Nehru University, New Delhi, India
D. Ratna Kumari, Ph.D., Associate Dean, College of Community / Home Science, PJTSAU, Hyderabad, India
Deepak Pant, Ph.D., Separation and Conversion Technology, Flemish Institute for Technological Research (VITO), Belgium
Desirazu N. Rao, Ph.D., Honorary Professor, Department of Biochemistry, Indian Institute of Science, Bangalore, India
G.K. Garg, Ph.D., Ex-Dean, College of Basic Sciences & Humanities, G.B.Pant University of Agric. & Tech., Pantnagar, India
Humnath Bhandari, Ph.D., IRRI Representative for Bangladesh, Agricultural Economist, Agrifood Policy Platform, Philippines
Indu S. Sawant, Ph.D., Principal Scientist, ICAR National Research Centre for Grapes, Pune, India
Kuldeep Singh, Ph.D. , Director, ICAR - National Bureau of Plant Genetic Resources, New Delhi, India
Muneshwar Singh, Ph.D., Ex-Project Coordinator AICRP- LTFE, ICAR, Indian Institute of Soil Science, Bhopal, India
Omkar, Ph.D., Professor (Retd.), Department of Zoology, University of Lucknow, India
P.C. Srivastav, Ph.D., Professor (Retd.), Department of Soil Science, G.B. Pant University of Agriculture and Technology, Pantnagar, India
Prashant Srivastava, Ph.D., Soil Contaminant Chemist, CSIRO, Australia
Puneet Srivastava, Ph.D., Director, Water Resources Center, Butler-Cunningham Eminent Scholar, Professor, Biosystems Engineering, Auburn University, United States
R.K. Singh, Ph.D., Ex-Director & Vice Chancellor, ICAR-Indian Veterinary Research Institute, Izatnagar, U.P., India
Ramesh Kanwar, Ph.D., Charles F. Curtiss Distinguished Professor of Water Resources Engineering, Iowa State University, U.S.A.
S.N. Maurya, Ph.D., Professor (Retired), Department of Gynaecology & Obstetrics, G.B. Pant University of Agric. & Tech., Pantnagar, India
Sham S. Goyal, Ph.D., Professor Emeritus, Faculty of Agriculture and Environmental Sciences, University of California, Davis, U.S.A.
Umesh Varshney, Ph.D., Honorary Professor, Department of Microbiology and Cell Biology, Indian Institute of Science, Bangalore, India
V.D. Sharma, Ph.D., Dean Life Sciences, SAI Group of Institutions, Dehradun, India
V.K. Singh, Ph.D., Director, ICAR-Central Research Institute for Dryland Agriculture, Hyderabad, India
Vijay P. Singh, Ph.D., Distinguished Professor, Caroline and William N. Lehrer Distinguished Chair in Water Engineering, Department of Biological and Agricultural Engineering, Texas A & M University, U.S.A.
Nikitin Georgy, Ph.D., Vice-Rector cum Professor St. Petersberg State University of Veterinary Medicine St. Petersberg, Russia
Sanjay Jambhulkar, Ph.D., Ex-Scientific Officer 'H' Head Mutation Breeding Section Bhabha Atomic Research Centre, Mumbai Professor, Homi Bhabha National Institute, Mumbai
Vijay Kubsad, Ph.D., Adjunct Professor Washington State University USA
Kiran Tota-Maharaj, Ph.D., Professor Royal Agricultural University (RAU) Cirencester, Gloucestershire GL76JS England, UK
Ravindra P. Veeranna, Ph.D., Dean, Xavier University, College of Veterinary Sciences, Aruba
Javed Akhtar, Ph.D., University of Technology and Applied Sciences, Muscat
Basant Maheshwari, Ph.D., Western Sydney University, Australia
Vijay P. Singh, Ph.D. Professor Emeritus, Texas A&M University College station, Texas, USA
Sanjay Sharma, Ph.D. Director, Uttarakhand Council of Biotechnology
Krishna Nemali, Ph.D. Controlled Environment Agriculture Extension Specialist

Editor-in-Chief

K.P. Raverkar, Professor, G.B. Pant University of Agriculture and Technology, Pantnagar, India

Managing Editor

S.K. Guru, Ph.D., Professor, G.B. Pant University of Agriculture and Technology, Pantnagar, India

Assistant Managing Editor

Jyotsna Yadav, Ph.D., Research Editor, Directorate of Research, G.B. Pant University of Agriculture and Technology, Pantnagar, India

Technical Manager

S.D. Samantaray, Ph.D., Professor & Head, Department of Computer Engineering, G.B. Pant University of Agriculture and Technology, Pantnagar, India

Development

Dr. S.D. Samantaray, Professor & Head
Brijesh Dumka, Developer & Programmer

PANTNAGAR JOURNAL OF RESEARCH

Vol. 24(1) January-April, 2026

CONTENTS

Indian mustard: Phytoremediation tool for soil health management (Review) **1**
M.L. DOTANIYA, C.K. DOTANIYA, KULDEEP KUMAR, JAKIR HUSSAIN, R.K. DOUTANIYA, H.M. MEENA and MANJU LATA

From profile to problems: A study on socio-economic status and constraints of rural women in dairy farming **14**
ADITI PATHAK and ARPITA SHARMA KANDPAL

Diversification and intensification in rice–wheat cropping system for enhancing productivity under *Tarai* zone of Uttarakhand **20**
PESALA SANTHA KUMAR, DINESH KUMAR SINGH, SUBHASH CHANDRA, ROHITASH SINGH and AJEET PRATAP SINGH

Sensor based nitrogen application impact on productivity, economics and nutrient uptake in maize **25**
AMIT BHATNAGAR and AJAY KUMAR

Association of germination and seedling vigour attributes with green forage yield in oat (*Avena sativa* L.) genotypes through correlation and path coefficient analysis **31**
DEVYANI RAMOLA, AKRITI BALLABH SANSKRITI JOSHI, MANISH MEHRA and BIRENDRA PRASAD

Genetic divergence and yield trait impact in French bean (*Phaseolus vulgaris* L.) **43**
BHAWANA MAMGAIN, B.P. NAUTIYAL , S.C. PANT, VAISHALI THAPA, HEIGRUJAM RIYASANA and MAYANK

Arabic-gum based edible coatings preserving the post-harvest quality of Guava fruits **48**
ESHA TEWARI and OMVEER SINGH

Efficacy of catechol and plant growth regulators on the vegetative growth and flowering of African Marigold (*Tagetes erecta* L. cv. Pusa Narangi Gainda) **59**
SURYANSH SRIVASTAVA, AFSAR AHMAD, MD. RAMJAN and KHAN BILAL MUKHTAR AHMED

Host response of diverse pulse genotypes to root-knot nematode (*Meloidogyne incognita*) **67**
SAROJ YADAV, EKTA RATHORE and ANIL KUMAR

Effect of egg size on egg quality traits, fertility, hatchability and day-old chick weight **75**
ISLAM UDDIN SHEIKH, AZMAT ALAM KHAN, ARNAB JYOTI KALITA, SHEIKH ADIL HAMID, IRFAN AKRAM BABA, HENNA HAMADANI, BUSHRA ZAFFER and INSHA AFZAL

Pathomorphological studies on verminous pneumonia in a Gaddi goat **81**
SWASTI SHARMA, SONALI MISHRA and R.D. PATIL

Pathological findings in congestive heart failure in dog: A case report **85**
MUNISH BATRA and STUTI SINGH

Histopathological and haematological evaluation of the ameliorative effect of piperine on quinalphos-induced subacute toxicity in Swiss Albino Mice 89
PREETI SINGH, VINOD KUMAR, PREETI BAGRI and DEEPIKA LATHER

Phytochemical screening and antioxidant activities of locally available medicinal plants 99
PREETI BAGRI, VIJEYTA TIWARI, ARCHANA LOHIYA and VINOD KUMAR

Natural Farming Inputs (NFIs) as sustainable alternatives for enhancing the growth and development of Chickpea (*Cicer arietinum* L.) 108
SHAIFALI and A.K. SHARMA

Integrating Bayesian Calibration, Hierarchical Spatial Regression, and Structural–Temporal Models to Explain and Predict Wheat Yield in the Tarai–Bhabar Belt of Uttarakhand, India 114
NEHA BHATT and VINOD KUMAR

Phytochemical characterization and immuno-antioxidant potential of *Moringa oleifera* leaf extract in chicken lymphocytes 128
ANAMITRA RUJ, SONU AMBWANI and LATA PALIWAL

Biochemical changes associated with triclosan exposure in the freshwater fish *Cyprinus carpio* 140
MADHU SHARMA, YASHPAL, RIJUL RANA, DEEKSHA, DEEPIKA THAKUR and TARANG KUMAR SHAH

Assessment of awareness among respondents towards Pradhan Mantri Jan Dhan Yojana: A study in Haryana 148
MEGHA GOYAL, SUMAN GHALAWAT, MINAKSHI, ATUL DHINGRA and MINI

Youth perception and constraints in agri-entrepreneurship: A factor analytic study 156
JYOTI, SUMAN GHALAWAT, MEGHA GOYAL, NEELAM KAUSHAL, SUNIL KUMAR and VIKRANT HOODA

Design of Object Detection Model Using Deep Learning for Autonomous Driving in Adverse Weather Conditions: A GAN-Based Restoration and Depth-Aware Fusion Framework 165
MUMUKSHU BHATT, SUBODH PRASAD, RAJESH SINGH, ASHOK KUMAR and POOJA TAMTA

A novel mechanical purification approach for *Grewia optiva* Fibre-Reinforced epoxy composites: Effect of fibre geometry on structural performance 172
DEEPA SINGH , NEERAJ BISHT, TARUN KUMAR SAXENA and KAMAL RAWAT

Evaluating Long-Term rainfall and temperature trends across the Shipra River basin 184
POONAM SINGH, MOHAN LAL, DHEERAJ KUMAR, P. K. SINGH and GOVIND VERMA

Rainfall-runoff modelling using soft computing techniques for various watersheds of Madhya Pradesh, India 196
SEEMA KUSHWAHA and PRAVENDRA KUMAR

Prevalence and associated risk factors of functional constipation among the selected adult population of Pantnagar, U.S. Nagar, Uttarakhand, India 204
JYOTI SINGH, NEETU DOBHAL, ARCHANA KUSHWAHA, N.C SHAHI and SABBU SANGEETA

Tracking nutritional transitions: A comparative study of child malnutrition (0–5 years) trends across districts of Madhya Pradesh 212
SHALINI CHAKRABORTY

Determinants influencing tourist selection of rural tourism destinations using Garrett Ranking Technique: Evidence from Supi village, Uttarakhand 221
NEHA PANDEY and KAMAL UPRETI

https://doi.org/10.67063/pjr.vol.24.issue.01.15

Natural Farming Inputs (NFIs) as sustainable alternatives for enhancing the growth and development of Chickpea (*Cicer arietinum* L.)

SHAIFALI[1] and A.K. SHARMA[2]

[1]Department of Biological Sciences, College of Basic Sciences and Humanities, G. B. Pant University of Agriculture and Technology, Pantnagar-263145 (U. S. Nagar, Uttarakhand), [2]Sri Sri University, Cuttack - 754006

[*]Corresponding author's email id: shaifaliazad@gmail.com

ABSTRACT: Natural farming is an ecologically sustainable production system that relies on locally available biological resources to improve soil health, crop growth and agro-ecosystem resilience while minimising dependence on chemical inputs. The present study evaluated the effectiveness of selected natural farming inputs (NFIs), namely Panchagavya, Jeevamruth and Amritpani on the growth and development of chickpea (*Cicer arietinum* L.) cultivar PG-186 under greenhouse conditions. Eleven treatments were assessed, and all NFI-based applications significantly enhanced plant growth compared to the control and farmyard manure (FYM). Among the evaluated inputs, Panchagavya proved most effective, resulting in superior biomass accumulation, nutrient uptake and biochemical attributes. Notably, Panchagavya application significantly increased plant height (54.51 ± 1.19 cm), fresh biomass (9.27 g) and dry biomass (3.05 g) over the control. Overall, the results highlight the potential of NFIs, particularly Panchagavya, as sustainable and efficient alternatives to conventional inputs for improving chickpea growth and productivity.

Keywords: Amritpani, Chickpea, Jeevaamruth, Panchagavya, Sustainable Yield

Natural farming is an ancient yet regenerative agricultural approach grounded in ecological interaction among soil, crops, livestock and microorganisms aimed at developing self-sustaining agro-ecosystems (Sharma *et al*., 2023). This system enhances soil fertility and overall soil health through the incorporation of beneficial microbial communities and organic resources, thereby reducing reliance on synthetic fertilisers. In recent years, natural farming has gained considerable attention and adoption in India as well as globally due to its sustainability and environmental benefits (Duddigan *et al*., 2022). The use of organic inputs such as farmyard manure, compost, neem cake, vermicompost and poultry manure has long been practiced as a viable alternative to chemical fertilisers, contributing to nutrient supply, soil organic carbon maintenance, and favourable soil physical conditions (Kumar *et al*., 2020; Islam *et al*., 2024). Recent advancements in natural farming emphasize the use of fermented liquid bio-inputs and effective microorganisms, particularly formulations derived from cow dung and urine, to increase nutrient availability, microbial activity and crop productivity (Sarma *et al*., 2024).

Natural farming inputs (NFIs) such as panchagavya, jeevamruth, and amritpani are widely used bovine-based fermented preparations that improve soil structure, microbial diversity and rhizospheric interactions. These inputs contain diverse microbial consortia, including nitrogen-fixing, phosphate-solubilising and plant growth–promoting microorganisms, which facilitate nutrient cycling, root development, plant vigour, and yield stability while reducing dependency on chemical agrochemicals (Gohil *et al*., 2023). Chickpea (*Cicer arietinum* L.), a major pulse crop of the Fabaceae family, is a vital source of plant-based protein, minerals, and micronutrients, particularly in semi-arid and temperate regions. Globally, chickpea ranks second in acreage and third in production among pulse crops, with India contributing the largest share of the estimated 11.5 million tonnes annual production (Merga and Haji, 2019). Given its nutritional and economic importance, the present study aimed to evaluate the individual effects of selected NFIs on the growth and development of chickpea under controlled conditions, with a focus on their microbial efficacy and potential as sustainable alternatives to conventional fertilisation

practices.

MATERIALS AND METHODS

Experiment design

A pot experiment was conducted under controlled glasshouse conditions in the Department of Biological Sciences to evaluate the effects of natural farming inputs (NFIs), their microbial communities (MC), and microbial-free filtrates (MFF) on chickpea growth. The experiment was maintained at a temperature of 25–28°C with a 16/8 h light–dark photoperiod and approximately 60% relative humidity. Pots (2 kg capacity) were filled with a sterilised sand-soil mixture (3:1, w/w) having a pH of 7.15 and electrical conductivity of 65.1 µS. Four surface-sterilised seeds of chickpea (*Cicer arietinum* L.) cultivar PG-186 were sown per pot. At 15 days after sowing, seedlings were treated with the respective natural farming inputs (NFIs), microbial communities, and microbial-free filtrates through soil drenching, with 50 mL applied to each pot. Plants were harvested 45 days after treatment for physiological, biochemical, and nutrient analyses. The experiment comprised of eleven treatments: Control (T_1); Farm Yard manure(T_2); Panchagavya (T_3); Panchagavya microbial community (T_4); Panchagavya microbial-free filtrate (T_5); Jeevamruth (T_6); Jeevamruth microbial community (T_7); Jeevamruth microbial-free filtrate (T_8); Amritpani (T_9); Amritpani microbial community (T_{10}) and Amritpani microbial-free filtrate (T_{11}). Each treatment was replicated three times and arranged in a completely randomized block design.

Preparation of NFIs, MC and MFF

Panchagavya, Jeevamruth, and Amritpani were prepared following the methods described by Jain *et al*. (2014), Maity *et al*. (2020) and Shekh *et al*. (2018). For microbial communities (MC) preparation, 10 mL of each NFI was inoculated into 40 mL of N+P medium (nutrient broth and potato dextrose broth) and incubated at 27°C for 24 h, maintaining an optical density (OD) of 0.1. For microbial-free filtrate (MFF) preparation, each NFI was centrifuged at 12,000 rpm, the supernatant was filtered through Whatman No. 1 filter paper to remove debris, and subsequently passed through a 0.22 µm membrane filter under vacuum to eliminate associated microorganisms.

Plant Growth Characteristics

Plants were harvested 45 days after treatment and thoroughly washed with tap water to remove adhering soil particles. Root and shoot lengths, along with fresh biomass, were recorded. Dry matter accumulation was determined after oven-drying the samples at 65°C for 24 h.

Biochemical analysis

Estimation of Chlorophyll

Leaf chlorophyll content was estimated following Arnon (1949) by homogenising 0.1 g fresh leaf tissue in 10 mL of 80% acetone, incubating in the dark for 24 h, and recording absorbance at 663 nm (*Chl a*) and 645 nm (*Chlb*).

Estimation of Phosphorus and Potassium

Phosphorus content was estimated using the vanadomolybdate reagent method as described by Jackson (1973) and further detailed by Sharma and Sharma (2019). Potassium content was measured using a flame photometer Sharma and Sharma, (2019).

Statistical analysis

All data are expressed as mean ± standard error (SE), with three replicates per treatment (n = 3). Plant growth and biochemical parameters were analysed using one-way analysis of variance (ANOVA). Treatment means were separated using Tukey's honestly significant difference (HSD) test at a significance level of $p < 0.05$.

RESULTS AND DISCUSSION

Effect of NFIs on vegetative characters

Shoot length, Shoot fresh and dry weight

The application of natural farming inputs (NFIs) significantly improved vegetative growth parameters of chickpea compared to the control and farmyard manure treatments. Among the evaluated NFIs, Panchagavya (T_3) produced the maximum shoot length (54.51 ± 1.19 cm), showing statistically

significant results over all other treatments (Table 1). This was followed by Panchagavya microbial communities (T_4; 50.33 ± 0.57 cm) and Jeevamruth (T_6; 49.01 ± 0.71 cm), which were statistically comparable and markedly higher than the remaining treatments. The enhanced shoot elongation under Panchagavya application may be attributed to the presence of bioactive compounds, enzymes, and growth-promoting substances that stimulate cell division and elongation (Panchal *et al*., 2017). Similarly, Panchagavya application resulted in the highest shoot fresh weight (9.27 g) and dry weight (3.05 g), which were significantly superior to all other treatments (Table 1). The Panchagavya microbial community (T_4) ranked second, recording fresh and dry weights of 7.42 g and 2.08 g, respectively. The observed increase in biomass under Panchagavya and its microbial formulations can be ascribed to the availability of essential nutrients and growth-promoting metabolites that enhance biomass accumulation and overall plant vigour (Panda *et al*., 2020)

Root length, Root fresh and dry weight

Application of Panchagavya (T_3) resulted in maximum root length (30.97 cm), followed by Jeevamruth (T_6; 28.15 cm). The Panchagavya-derived microbial community (T_4) also significantly enhanced root elongation (27.47 cm), reflecting a strong stimulatory effect on root system development. The increased root extension observed across all NFI treatments (Table 1) suggests that these inputs act as nutrient-rich substrates that promote root proliferation. As reported by Hodge *et al*. (2004), plant roots respond to localised nutrient enrichment by increasing elongation and branching to optimise nutrient uptake. Panchagavya (T_3) also recorded the highest root fresh weight (4.35 g) and dry weight (0.95 g), followed by the Panchagavya microbial community (T_4), which yielded fresh and dry weights of 3.55 g and 0.84 g, respectively. Overall, Panchagavya and its associated microbial community were most effective in increasing root biomass, highlighting their potential to stimulate root growth and development. The improved root architecture observed under Panchagavya treatment likely facilitated greater water and nutrient uptake, contributing to enhanced plant vigour (Chaudhari *et al*., 2023). Furthermore, the balanced nutrient composition of these inputs ensures adequate

Table 1: Effect of NFIs on vegetative growth of chickpea cultivar PG-186

Treatment	Plant length (cm)	Plant fresh weight (g)	Plant dry weight (g)	Root length (cm)	Root fresh weight (g)	Root dry weight (g)
T_1: Control	30.49±0.98a	3.14±0.09a	0.92±0.04a	16.66±0.33a	1.10±0.03a	0.37±0.02a
T_2: Farm Yard manure	36.00±0.60b	5.29±0.13b	1.09±0.04b	22.09±0.07b	1.37±0.02a	0.42±0.01a
T_3: Panchagvya	54.51±1.19f	9.27±0.04g	3.05±0.10h	30.97±0.49g	4.35±0.03f	0.95±0.01f
T_4: Panchagvya microbial Communities	50.33±0.57e	7.42 ±0.28f	2.08±0.03g	27.47±0.18f	3.55±0.19e	0.84±0.01d
T_5: Panchagvya microbial free filtrate	44.02±1.02cd	6.16±0.07ef	1.84±0.03f	25.36±0.22cde	2.99±0.03d	0.67±0.02c
T_6: Jeevamruth	49.01±0.71e	6.88±0.07ef	1.69±0.02e	28.15±0.62f	2.93±0.03d	0.82±0.004de
T_7: Jeevamruth microbial communities	46.53±0.84de	5.90±0.04cd	1.52±0.01ef	26.08±1.53def	2.82±0.08cd	0.74±0.03d
T_8: Jeevamruthmicrobial free filtrate	38.46±0.67b	5.87±0.06cd	1.36±0.03cd	24.70±0.64bc	2.56±0.03c	0.67±0.02c
T_9: Amritpani	47.40±0.56de	6.84±0.06ef	1.42±0.02cd	25.74±0.84de	2.90±0.01d	0.76±0.03de
T_{10}: Amritpani microbial communities	39.87±1.01bc	6.21±0.36d	1.25±0.02bc	23.40±0.36bcd	1.92±0.04b	0.68±0.02c
T_{11}: Amritpani microbial free filtrate	37.57±0.73b	5.41±0.11b	1.15±0.01b	22.25±0.12bcde	1.75±0.02b	0.54±0.01b
SD(m)	0.83	0.15	0.039	0.63	0.06	0.01
CD(5%)	2.45	0.45	0.11	1.87	0.20	0.053

All parameters are presented as mean ± standard error (n = 3). Different superscript letters indicate significant differences ($P < 0.05$) among treatments, while identical letters denote no significant difference

availability of essential elements necessary for optimal plant growth, physiological processes and overall development (Singh *et al*., 2024).

Effect of NFIs on chlorophyll content in chickpea

Panchagavya (T_3) showed a pronounced positive effect on chlorophyll accumulation in chickpea (Table 2), leading to a significant increase in both chlorophyll *a* and chlorophyll *b* contents. The enhanced concentration of photosynthetic pigments under Panchagavya treatment may be associated with the presence of plant growth–promoting phytohormones, particularly kinetin, which plays a key role in chlorophyll synthesis and stability. The inclusion of coconut water during Panchagavya preparation, a known source of kinetin, likely contributed to the elevated chlorophyll content observed in this study (Khatua *et al*., 2025).

Effect of NFIs on phosphorus and potassium uptake in chickpea

Phosphorus and potassium uptake data are presented in Table 2. Among the evaluated natural farming inputs, Panchagavya (T_3) proved to be the most effective bio-nutrient source, resulting in the highest phosphorus (4.12±0.02%) accumulation in chickpea plants. Enhanced phosphorus content was also observed under the Panchagavya-derived microbial community (3.66%) and Jeevamruth (3.59%) treatments. Similarly, Panchagavya-treated plants recorded the maximum potassium content (5.25%), followed by Amritpani (4.57%) and the Panchagavya microbial community (4.51%), highlighting their strong influence on potassium uptake. These results align with earlier findings by Beaulah (2002), who reported that the integrated application of Panchagavya with organic amendments such as poultry manure and neem cake significantly improved nutrient concentrations in *Moringa oleifera* leaves and pods.

CONCLUSION

The present study demonstrates that natural farming inputs (NFIs) serve as effective and sustainable alternatives for improving the growth and development of chickpea under glasshouse. Application of NFIs, including their microbial communities and microbial-free filtrates, significantly enhanced shoot and root growth, biomass accumulation, and overall biochemical health compared to the control and farmyard manure. Among the treatments, Panchagavya and its associated microbial communities exhibited the greatest growth-promoting effects, followed by Jeevamruth. The superior performance of Panchagavya is attributed to its rich consortium of beneficial microorganisms and bioactive metabolites derived from cow-based components. Overall, the findings highlight the microbial- and metabolite-

Table 2: Effect of NFIs on chlorophyll content and phosphorus and potassium uptake

Treatments	Chl*a* (mg/g FW)	Chl*b* (mg/g FW)	Nutrients%	
			Phosphorus%	Potassium%
T_1: Control	0.49±0.009a	0.25±0.003a	1.38±0.02a	1.95±0.07a
T_2: Fram Yard manure	0.62±0.006b	0.30±0.005b	1.92±0.02b	3.04±0.02b
T_3: Panchagavya	1.11±0.01h	0.74±0.007g	4.12±0.02g	5.25±0.10i
T_4: Panchagavya microbial Communities	1.00±0.013gh	0.49±0.008ef	3.66±0.08f	4.51±0.06gh
T_5: Panchagavya microbial-free filtrate	0.89±0.019d	0.42±0.01cd	2.57±0.05d	4.04 ±0.10ef
T_6: Jeevamruth	1.06±0.006gh	0.52±0.004f	3.59±0.05f	4.07±0.07h
T_7: Jeevamruth microbial communities	0.97±0.003ef	0.48±0.002de	2.89±0.06e	3.61±0.10de
T_8: Jeevamruthmicrobial-free filtrate	0.88±0.006de	0.40±0.025cd	2.05±0.04c	3.14±0.06cd
T_9: Amritpani	1.00±0.021gh	0.44±0.009d	3.09±0.05e	4.57±0.08fg
T_{10}: Amritpani microbial communities	0.83±0.003d	0.42±0.015cd	2.18±0.03c	3.78±0.07def
T_{11}: Amritpani microbial-free filtrate	0.73±0.02c	0.36±0.009bc	2.17±0.03c	3.56±0.18bc
SD(m)	0.012	0.011	0.045	0.08
CD (5%)	0.03	0.03	0.13	0.26

All parameters are presented as mean ± standard error (n = 3). Different superscript letters indicate significant differences ($P < 0.05$) among treatments, while identical letters denote no significant difference

mediated functionality of NFIs and confirm their potential to enhance chickpea productivity and resilience in sustainable agricultural systems.

Future perspectives

While the present study was conducted under controlled glasshouse conditions, future research should focus on multi-season field validation to assess the consistency and scalability of NFI-mediated benefits under diverse soil and climatic conditions. Molecular characterisation of the microbial communities associated with Panchagavya and Jeevamruth using metagenomics or amplicon sequencing would provide deeper insights into key functional taxa responsible for metabolite production and plant growth promotion. Additionally, metabolomic profiling of NFIs and rhizosphere soils could help identify specific bioactive compounds responsible for the observed physiological and biochemical improvements. Such integrated microbial and metabolite-based approaches will strengthen the scientific basis of natural farming inputs and support their wider adoption in sustainable and climate-resilient agricultural systems.

ACKNOWLEDGMENTS

The authors wish to thank all the members of the Rhizosphere Biology Lab and the Head, Department of Biological Sciences, CBSH, GBPUAT, Pantnagar, for providing the necessary facilities. The first author is also thankful to UGC, New Delhi, for the financial support.

REFERENCES

Beaulah, A. (2002). Growth and development of moringa (*Moringa oleifera* Lan.) under organic and inorganic systems of culture. Doctoral Thesis, Tamil Nadu Agriculture University, Coimbatore, 250P.

Arnon, D. T. (1949). Copper enzyme in isolated chloroplasts, polyphenol oxidase in *Beta vulgaris*. *Plant Physiol*ogy, 24: 1-15.

Chaudhari, V., Patel, N., Barot, D. and Nadoda, N. (2023). Role of bio stimulants in *solanaceous* vegetable crops: A review. *International Journal of Advanced Biochemistry Research*, 7 (2S): 178-183.

Duddigan, S., Collins, C.D., Hussain, Z., Osbahr, H., Shaw, L.J., Sinclair, F., Sizmur, T., Thallam, V. and Winowiecki, L. A. (2022). Impact of zero budget natural farming on crop yields in Andhra Pradesh, SE India. *Sustainability*, 14(3): 1689.

Gohil, R.B., Raval, V.H., Panchal, R.R. and Rajput, K.N. (2023). Plant growth-promoting activities and effect of fermented panchagavya isolate *Klebsiella sp*. PG-64 on *Vigna radiata*. *World Journal of Microbiology and Biotechnology*, 39(2): 41.

Hodge, A. (2004). The plastic plant: root responses to heterogeneous supplies of nutrients. *New Phytologist*, 162(1): 9-24.

Islam, S. and Raihan, A. (2024). Exploring the effectiveness of human waste compost in improving agricultural soil: a comparative study with poultry manure, cow dung, and vermicompost. *Journal of Agriculture Sustainability and Environment*, 2997: 271.

Jackson, M.C. (1973). Soil chemist analysis. Prentice Hall Pvt. Ltd, India

Jain, P., Sharma, R.C., Bhattacharyya, P. and Banik, P. (2014). Effect of new organic supplement (Panchgavya) on seed germination and soil quality. *European Medicines Agency*, 186(4): 1999-2011.

Khatua, S., Singh, V., Kumar, A. and Raj, A. (2025). Influence of organic manures and panchagavya on growth and yield of wheat (*Triticum aestivum* L.). *Journal of Advances in Biology and Biotechnology*, 28(10): 250-258.

Kumar, K., Verma, G., Veer, R., Kumar, S. and Kumar, P. (2020). Exploitation of Panchagavya, benefits and eco-friendly management of plant diseases: A review. *Journal of Entomology and Zoology Studies,* 8(4): 2360-2364.

Maity, P., Rijal, R. and Kumar, A. (2020). Application of liquid manures on growth of various crops: A review. *International Journal of Current Microbiology and*

Applied Science, 11(5): 1601-1611.

Merga, B. and Haji, J. (2019). Economic importance of chickpea: Production, value, and world trade. *Cogent Food & Agriculture*, 5(1):1615718.

Panchal, P., Patel, P.H., Patel, A. G. and Desai, A. (2017). Effect of Panchagavya on growth, yield and economics of chickpea (*Cicer arietinum*). *International Journal of Chemical Studies*, 5(2): 265-267.

Panda, D., Padhiary, A.K. and Mondal, S. (2020). Effect of panchagavya and jeevamrit on growth and yield of tomato (*Solanum lycopersicum* L). *Annals of Plant and Soil Research*, 22(1): 80-85.

Sarma, H.H. and Dutta, S.K. (2024). Method of preparation of various inputs used in natural farming. *Vigyan Varta*, 5(7): 88-94.

Sharma, I. P. and Sharma, A. K. (2019). Mycorrhizal colonisation and phosphorus uptake in the presence of PGPRs along with nematode infection. *Symbiosis,* 77(2): 185-187.

Sharma, S.K., Ravisankar, N., Jain, N.K. and Sarangi, S.K. (2023). Natural farming: current status, research and case studies. *Indian Journal of Agronomy*, 68(22): 1-15.

Shekh, M.A., Mathukia, R.K., Sagarka, B.K. and Chhodavadia, S.K. (2018). Evaluation of some cow-based bio-enhancers and botanicals for organic cultivation of summer groundnut. *International Journal of Economic Plants*, 5(1): 43-45.

Singh, K., Singh, B., Pavithran, N., Fayaz, A., and Kaundal, M. (2024). Panchagavya: A Novel Approach for the Sustainable Production of Crops. *Current Journal of Applied Science and Technology*, 43: 35 45.

Received: December 22, 2025
Accepted: January 28, 2026