



International Journal of Research in Agronomy

E-ISSN: 2618-0618

P-ISSN: 2618-060X

© Agronomy

www.agronomyjournals.com

2024; 7(8): 579-583

Received: 07-05-2024

Accepted: 11-07-2024

Paluchani Meghana Reddy

Department of Agronomy, College
of Agriculture, Vijayapur,
University of Agricultural Sciences,
Dharwad, Karnataka, India

BT Nadagouda

Professor, Department of
Agronomy, College of Agriculture,
Vijayapur, University of
Agricultural Sciences, Dharwad,
Karnataka, India

RA Nandagavi

Senior Scientist, Department of
Agronomy, AICRP for Dryland
Agriculture, Regional Agricultural
Research Station, Vijayapur,
University of Agricultural Sciences,
Dharwad, Karnataka, India

Shivalingappa Hotkar

Scientist, Department of Plant
Pathology, Krishi Vigyan Kendra
(KVK), Vijayapur, Karnataka,
India

Corresponding Author:

Paluchani Meghana Reddy

Department of Agronomy, College
of Agriculture, Vijayapur,
University of Agricultural Sciences,
Dharwad, Karnataka, India

The effect of various organic nutrient management techniques on growth attributes of pearl millet

Paluchani Meghana Reddy, BT Nadagouda, RA Nandagavi and Shivalingappa Hotkar

DOI: <https://doi.org/10.33545/2618060X.2024.v7.i8h.1321>

Abstract

In Kharif 2021, a field experiment was carried out at the College of Agriculture, Vijayapur, to examine the “Effect of different organic nutrient management practices on growth attributes of pearl millet”. With 12 treatments, each replicated three times, the experiment was set up in CRBD. These treatments included foliar sprays of jeevamrutha at 10% and 20% in comparison to RDF (50:25:10 NPK kg ha⁻¹ + 2.5 t FYM ha⁻¹) and various levels of FYM (2.25, 2.5, and 5.0 t ha⁻¹), vermicompost (1.25 and 2.5), and FYM at varying levels (2.25, 2.5, and 5.0 t ha⁻¹). Results showed that the RDF application considerably increased growth attributes. However, among organic nutrient management methods, FYM soil application at 5 t ha⁻¹ and a foliar 20% jeevamrutha spray at 45 DAS recorded noticeably higher growth traits for the pearl millet crop, including plant height, the number of green leaves per plant, the number of tillers per plant, the accumulation of dry matter, the crop's growth rate and relative growth rate, and the SPAD values.

Keywords: FYM, Jeevamrutha, organics, pearl millet, vermicompost

Introduction

Pearl millet (*Pennisetum glaucum* L.) belongs to the grass family *Graminaceae*. The world's tropics and subtropics are home to the plant genus *Pennisetum*. Pearl millet has an extremely high photosynthetic efficiency since it is a C₄ plant. The primary reason for pearl millet's widespread cultivation in arid and semi-arid locations is its greater adaptability to water stress and nutrient-depleted soils than other cereal crops. India is the largest pearl millet producer in the world, producing 10.86 million tonnes annually on an area of 7.65 million hectares with a 1420 kg ha⁻¹ average productivity. It is primarily grown in the states of Rajasthan, Gujarat, Maharashtra, Haryana, Uttar Pradesh, and Karnataka.

The use of organics, among the various agronomic management approaches, is of immense important in rainfed areas in order to produce healthy plants. Building and maintaining an active and rich soil type is essential, despite the fact that they have a lower concentration of nutrients and need more labour to handle, they have seen a significant growth in their use as a nutrition source over inorganic fertilizer (Kannan *et al.*, 2005) [5]. By increasing the activity of soil microflora and fauna, organic liquid manures like jeevamrutha help in the quick growth of soil fertility (Devakumar *et al.*, 2014) [1]. These functions both as fertilizer and a biopesticide and they serve an important function in stimulating plant development and giving the plant system immunity.

Since there is currently a significant difference between the amount of nutrients applied and the amount of nutrients utilised by the crop, nutrient mining is a significant issue for agricultural productivity. Farmers using fertilizers indiscriminately without knowing the soil fertility status and poor nutrient management are two of the main causes of reduced productivity. Numerous studies have demonstrated the effectiveness of nitrogen fertilization in increasing millet production, as well as the relationship between a sufficient nitrogen supply and vigorous vegetative growth. It also responds effectively to phosphorus that has been applied (Malik *et al.*, 1990) [7]. Farmyard manure improves the crop's nitrogen usage efficiency, as well as the status of organic carbon, accessible nitrogen, P₂O₅ and trace elements in the soil, while reducing the

negative impacts of salinity, soil acidity, and alkalinity. Vermicompost improves humus content, lowers the C: N ratio, and provides a variety of readily available nutrients for plants, including nitrate, phosphate, potassium, calcium, and magnesium. (Talashikar *et al.*, 1999) ^[12].

Materials and Methods

A field experiment was carried out during *Kharif*, 2021 at College of Agriculture farm, Vijayapur, Karnataka on vertisol with pH 8.32 and EC 0.22 dS m⁻¹. The soil had a medium level of P₂O₅ that was readily available. (31 kg ha⁻¹) and organic carbon (0.47%), while having low levels of available N (168 kg ha⁻¹) and high levels of available K₂O (410 kg ha⁻¹). The experimental site had coordinates of 16° 77' North, 75° 74' East, and an elevation of 516.29 metres above mean sea level. It was located in the Northern Dry Zone of Karnataka (Zone 3).

A fully randomised block design with three replications was used to set up the experiment. Twelve different combinations of organic manures, including jeevamrutha foliar sprays, vermicompost, and FYM, were used in the experiment's 12 treatments.

After the previous crop was harvested, the area had one ploughing and two harrowings. The plots were laid out and the land was treated to a good seedbed before sowing. The variety VPMV-9 was used and fertilizers were applied according to the treatments. The crop was sown on 26th July 2021 with a spacing of 45 × 10 cm. Harvesting was done on 25th October 2021. As the crop reached the milky dough stage, five randomly chosen and tagged plants from each treatment were picked and used individually for documenting various observations. The Bajra heads from the net plot were cut, sundried and threshing was done with threshing machine, grains per plot thus collected were winnowed, cleaned and weighed. Intercultivation was done to remove all weeds from the field in order to check crop weed competition.

The experiment's data was collected at various growth phases as well as upon harvest, and they were statistically analysed as per Gomez and Gomez's (1984) ^[3] instructions. The 'F' and 't' tests' level of significance was set at P=0.05. Critical difference (CD) values were computed at a 5% level of confidence if the F test is significant.

Results and Discussion

Growth parameters such as plant height (177.7 cm), the number of tillers per plant (4.01) the number of green leaves per plant (14.33) and SPAD values (38.52) were significantly higher in the treatment (T₁) with the recommended package of practices, compared to all other treatments. However, among various combinations of organic sources applied, the soil application of FYM @ 5 t ha⁻¹ + foliar application of 20% jeevamrutha at 45 DAS (T₅) recorded higher plant height (177.7 cm), the number of tillers per plant (4.01) the number of green leaves per plant (14.33) and SPAD values (38.52) than other organic sources (Table 1). Due to the polysaccharides and other organic chemicals that are released as organic matter breaks down and has a cementing effect, taller plants, more leaves, more tillers, and ultimately a higher yield are produced when FYM and jeevamrutha are applied together. The objective is to supply nutrients to crops in accordance with demand at various stages, which can increase agricultural productivity. Studies revealed that combining different organic sources produced improved

results and increased productivity than using them individually. (Shete *et al.*, 2010, Ghanshyam *et al.*, 2010, Meena and Ram, 2013, Sohu *et al.*, 2015 and Kiran *et al.*, 2016) ^[9, 2, 8, 11, 6].

The total amount of dry matter produced is a sign of overall resource use efficiency and better light interception. The results on the total dry matter and its partitioning (leaf, stem, and reproductive sections) showed that the combination of different organic manures applied had a significant impact on the dry matter. There has been an improvement in the dry weight of the leaves (26.55 g plant⁻¹), stems (120.4 g plant⁻¹), and panicles. (97.04 g plant⁻¹) and total dry matter production of 243.9 g plant⁻¹ with the recommended package of practices (T₁) than all other treatments. However, among different combinations of organic sources applied, treatment (T₅) with soil application of FYM @ 5 t ha⁻¹ + foliar application of 20% jeevamrutha at 45 DAS recorded significantly higher stem dry weight, leaf dry weight, panicle dry weight and total dry matter production than other organic sources. Increased nutrition availability from organic and foliar sources as well as the efficient conversion of nutrients from organics may be the cause of this increased dry matter production. Additionally, the use of liquid organic manures has increased leaf area production, solar radiation absorption, photosynthesis, and consequently improved all growth parameters, leading to an increase in dry matter production. These results are similar to the findings of Shete *et al.* (2010) ^[9], Ghanshyam *et al.* (2010) ^[2], Meena and Ram (2013) ^[8], Sohu *et al.* (2015) ^[11] and Kiran *et al.* (2016) ^[6].

Crop growth rate and relative growth rate indicates the change in dry weight or logarithmic growth of plant over a period of time. The recommended package of practices recorded significantly higher CGR at 40-70 DAS (0.82 mg dm⁻² day⁻¹) and numerically the higher value of 1.18 mg dm⁻² day⁻¹ at 70-90 DAS. However, among the different organic nutrient management practices the soil application of FYM @ 5 t ha⁻¹ + foliar application of 20% jeevamrutha at 45 DAS recorded significantly higher CGR at 40-70 DAS (0.76 mg dm⁻² day⁻¹) and numerically higher value of 1.18 mg dm⁻² day⁻¹ at 70-90 DAS than other organic sources. This might be due to the foliar application of organics manures which contains macro and micro nutrients along with that vitamins and plant growth promoting substances and beneficial organisms. The soil application of vermicompost @ 1.25 t + FYM @ 2.25 t ha⁻¹ + Foliar spray of 10% jeevamrutha at 45 DAS recorded numerically higher value (24.22 mg g⁻¹ day⁻¹) of relative growth rate at 40-70 DAS and at 70-90 DAS numerically higher RGR of 13.68 mg g⁻¹ day⁻¹ was recorded with the soil application of vermicompost @ 2.5 t ha⁻¹ + Foliar spray of 20% jeevamrutha at 45 DAS as compared to other treatments.

Economic gain is one of the main factors in any technology's success and will not be embraced by the farming community unless it is economically viable. Economic analysis indicated that treatments receiving RDF recorded significantly higher net returns (₹ 22068 ha⁻¹) and BC ratio (2.05). However, among different organic nutrient management practices soil application of FYM @ 5 t ha⁻¹ + foliar spray of 20% jeevamrutha at 45 DAS recorded significantly higher net returns and BC ratio than other organic sources. This was attributed to higher grain yield and haulm yield of pearl millet due to the combined application of organics. These results are similar with the findings of Shwetha (2008) ^[10] and Kiran *et al.* (2016) ^[6].

Table 1: Growth attributes of pearl millet at harvest as influenced by different organic nutrient management practices

Treatments	Plant height (cm)	Number of green leaves plant ⁻¹	Number of tillers plant ⁻¹	Chlorophyll content (SPAD values)
T ₁ : Recommended package of practices	177.7	14.33	4.01	38.52
T ₂ : Soil application of vermicompost @ 2.5 t ha ⁻¹ + Foliar spray of 10% jeevamrutha at 45 DAS	164.2	11.10	3.67	31.43
T ₃ : Soil application of vermicompost @ 2.5 t ha ⁻¹ + Foliar spray of 20% jeevamrutha at 45 DAS	173.3	13.77	3.73	34.12
T ₄ : Soil application of FYM @ 5 t ha ⁻¹ + Foliar spray of 10% jeevamrutha at 45 DAS	155.1	12.87	3.53	31.31
T ₅ : Soil application of FYM @ 5 t ha ⁻¹ + Foliar spray of 20% jeevamrutha at 45 DAS	174.2	14.13	3.96	37.68
T ₆ : Soil application of vermicompost @ 1.25 t + FYM @ 2.25 t ha ⁻¹ + Foliar spray of 10% jeevamrutha at 45 DAS	158.0	11.87	3.44	26.20
T ₇ : Soil application of vermicompost @ 1.25 t + FYM @ 2.25 t ha ⁻¹ + Foliar spray of 20% jeevamrutha at 45 DAS	169.9	13.57	3.60	33.30
T ₈ : Foliar spray of 10% jeevamrutha at 30 DAS + Foliar spray of 20% jeevamrutha at 50 DAS	147.0	9.33	3.13	20.51
T ₉ : Soil application of vermicompost @ 1.25 t ha ⁻¹ + Foliar spray of 10% jeevamrutha at 45 DAS	157.8	11.03	3.45	23.17
T ₁₀ : Soil application of vermicompost @ 1.25 t ha ⁻¹ + Foliar spray of 20% jeevamrutha at 45 DAS	151.3	10.93	3.36	25.34
T ₁₁ : Soil application of FYM @ 2.5 t ha ⁻¹ + Foliar spray of 10% jeevamrutha at 45 DAS	150.1	11.23	3.47	26.38
T ₁₂ : Soil application of FYM @ 2.5 t ha ⁻¹ + Foliar spray of 20% jeevamrutha at 45 DAS	155.5	10.43	3.33	24.95
S.E _m ±	6.34	1.01	0.16	1.44
C.D. (P=0.05)	18.60	2.95	0.47	4.23

*DAS- Days after sowing

Table 2: Total dry matter and its partitioning at harvest as influenced by different organic nutrient management practices

Treatments	Dry matter production (g plant ⁻¹)			
	Leaves	Stem	Panicles	Total dry matter production
T ₁ : Recommended package of practices	26.55	120.4	97.04	243.9
T ₂ : Soil application of vermicompost @ 2.5 t ha ⁻¹ + Foliar spray of 10% jeevamrutha at 45 DAS	23.56	105.8	85.33	214.7
T ₃ : Soil application of vermicompost @ 2.5 t ha ⁻¹ + Foliar spray of 20% jeevamrutha at 45 DAS	25.56	109.6	88.87	223.9
T ₄ : Soil application of FYM @ 5 t ha ⁻¹ + Foliar spray of 10% jeevamrutha at 45 DAS	23.44	100.7	81.70	205.8
T ₅ : Soil application of FYM @ 5 t ha ⁻¹ + Foliar spray of 20% jeevamrutha at 45 DAS	26.23	118.6	89.55	234.5
T ₆ : Soil application of vermicompost @ 1.25 t + FYM @ 2.25 t ha ⁻¹ + Foliar spray of 10% jeevamrutha at 45 DAS	22.89	104.3	80.08	207.3
T ₇ : Soil application of vermicompost @ 1.25 t + FYM @ 2.25 t ha ⁻¹ + Foliar spray of 20% jeevamrutha at 45 DAS	25.22	106.2	86.37	217.8
T ₈ : Foliar spray of 10% jeevamrutha at 30 DAS + Foliar spray of 20% jeevamrutha at 50 DAS	22.11	92.69	73.47	188.2
T ₉ : Soil application of vermicompost @ 1.25 t ha ⁻¹ + Foliar spray of 10% jeevamrutha at 45 DAS	23.56	99.65	77.07	200.2
T ₁₀ : Soil application of vermicompost @ 1.25 t ha ⁻¹ + Foliar spray of 20% jeevamrutha at 45 DAS	23.30	99.25	75.90	198.4
T ₁₁ : Soil application of FYM @ 2.5 t ha ⁻¹ + Foliar spray of 10% jeevamrutha at 45 DAS	23.44	101.2	75.66	200.3
T ₁₂ : Soil application of FYM @ 2.5 t ha ⁻¹ + Foliar spray of 20% jeevamrutha at 45 DAS	23.83	98.11	76.03	197.9
S.E _m ±	0.83	5.08	4.49	6.42
C.D. (P=0.05)	2.44	14.91	13.17	18.83

*DAS- Days after sowing

Table 3: Crop growth rate (CGR) and Relative growth rate (RGR) at different growth stages as influenced by different organic nutrient management practices

Treatments	Crop growth rate (mg dm ⁻² day ⁻¹)		Relative growth rate (mg g ⁻¹ day ⁻¹)	
	40-70 DAS	70-90 DAS	40-70 DAS	70-90 DAS
T ₁ : Recommended package of practices	0.82	1.18	23.68	12.43
T ₂ : Soil application of vermicompost @ 2.5 t ha ⁻¹ + Foliar spray of 10% jeevamrutha at 45 DAS	0.68	1.11	23.76	13.66
T ₃ : Soil application of vermicompost @ 2.5 t ha ⁻¹ + Foliar spray of 20% jeevamrutha at 45 DAS	0.71	1.16	23.32	13.68
T ₄ : Soil application of FYM @ 5 t ha ⁻¹ + Foliar spray of 10% jeevamrutha at 45 DAS	0.68	1.04	24.10	13.09
T ₅ : Soil application of FYM @ 5 t ha ⁻¹ + Foliar spray of 20% jeevamrutha at 45 DAS	0.76	1.18	23.26	13.07
T ₆ : Soil application of vermicompost @ 1.25 t + FYM @ 2.25 t ha ⁻¹ + Foliar spray of 10% jeevamrutha at 45 DAS	0.67	1.06	24.22	13.40
T ₇ : Soil application of vermicompost @ 1.25 t + FYM @ 2.25 t ha ⁻¹ + Foliar spray of 20% jeevamrutha at 45 DAS	0.70	1.11	23.57	13.34
T ₈ : Foliar spray of 10% jeevamrutha at 30 DAS + Foliar spray of 20% jeevamrutha at 50 DAS	0.63	0.93	24.10	12.90
T ₉ : Soil application of vermicompost @ 1.25 t ha ⁻¹ + Foliar spray of 10% jeevamrutha at 45 DAS	0.66	1.01	24.05	13.08
T ₁₀ : Soil application of vermicompost @ 1.25 t ha ⁻¹ + Foliar spray of 20% jeevamrutha at 45 DAS	0.65	0.99	23.61	12.92
T ₁₁ : Soil application of FYM @ 2.5 t ha ⁻¹ + Foliar spray of 10% jeevamrutha at 45 DAS	0.67	0.99	23.77	12.76
T ₁₂ : Soil application of FYM @ 2.5 t ha ⁻¹ + Foliar spray of 20% jeevamrutha at 45 DAS	0.65	0.98	23.53	12.84

S.E _m ±	0.03	0.09	0.66	1.10
C.D. (P=0.05)	0.10	NS	NS	NS

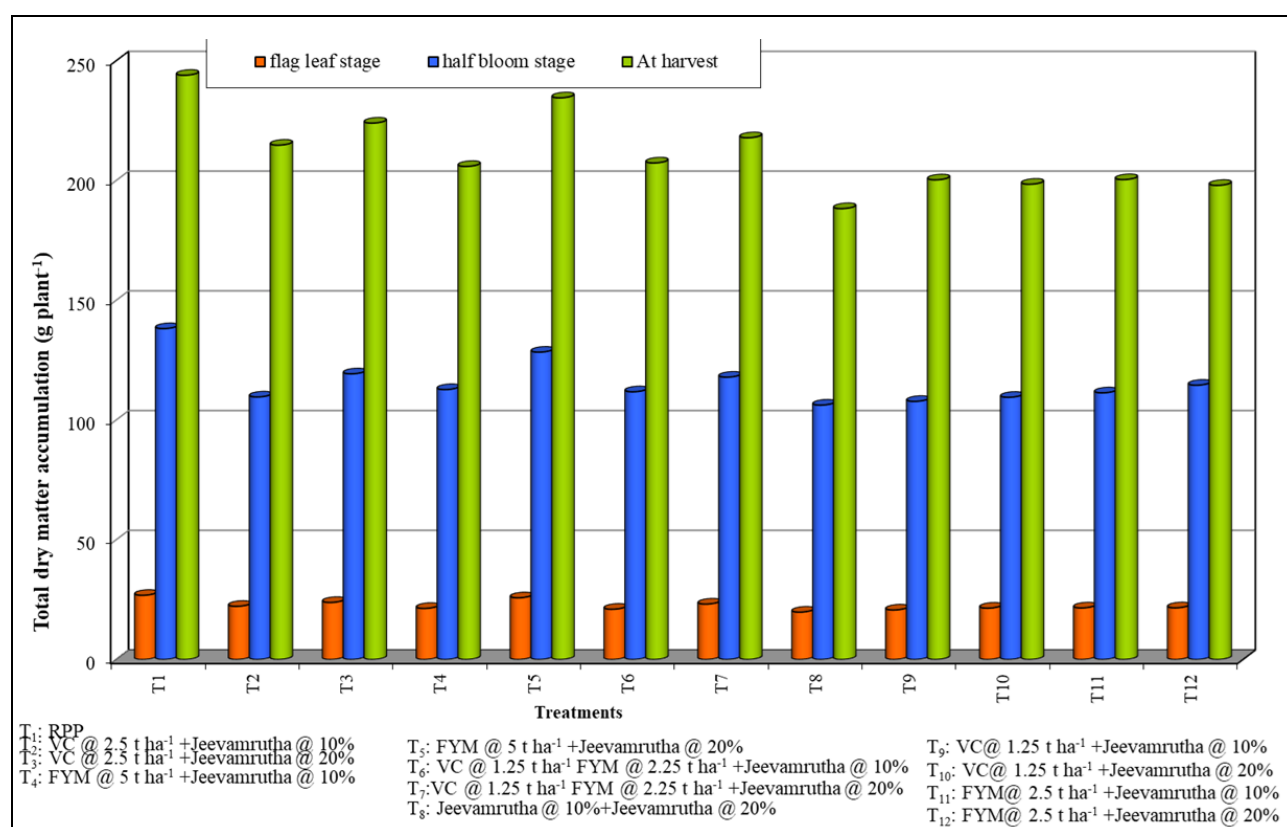
DAS – Days after sowing

NS – Non significant

Table 4: Net returns and B:C of pearl millet as influenced by different organic nutrient management practices

Treatments	Net returns (ha ⁻¹)	B: C
T ₁ : Recommended package of practices	22068	2.05
T ₂ : Soil application of vermicompost @ 2.5 t ha ⁻¹ + Foliar spray of 10% jeevamrutha at 45 DAS	11844	1.49
T ₃ : Soil application of vermicompost @ 2.5 t ha ⁻¹ + Foliar spray of 20% jeevamrutha at 45 DAS	13013	1.53
T ₄ : Soil application of FYM @ 5 t ha ⁻¹ + Foliar spray of 10% jeevamrutha at 45 DAS	13039	1.60
T ₅ : Soil application of FYM @ 5 t ha ⁻¹ + Foliar spray of 20% jeevamrutha at 45 DAS	17567	1.79
T ₆ : Soil application of vermicompost @ 1.25 t + FYM @ 2.25 t ha ⁻¹ + Foliar spray of 10% jeevamrutha at 45 DAS	10553	1.47
T ₇ : Soil application of vermicompost @ 1.25 t + FYM @ 2.25 t ha ⁻¹ + Foliar spray of 20% jeevamrutha at 45 DAS	13206	1.57
T ₈ : Foliar spray of 10% jeevamrutha at 30 DAS + Foliar spray of 20% jeevamrutha at 50 DAS	7868	1.64
T ₉ : Soil application of vermicompost @ 1.25 t ha ⁻¹ + Foliar spray of 10% jeevamrutha at 45 DAS	8958	1.44
T ₁₀ : Soil application of vermicompost @ 1.25 t ha ⁻¹ + Foliar spray of 20% jeevamrutha at 45 DAS	10687	1.52
T ₁₁ : Soil application of FYM @ 2.5 t ha ⁻¹ + Foliar spray of 10% jeevamrutha at 45 DAS	12048	1.63
T ₁₂ : Soil application of FYM @ 2.5 t ha ⁻¹ + Foliar spray of 20% jeevamrutha at 45 DAS	13067	1.67
S.E _m ±	2045	0.10
C.D. (P=0.05)	5997	0.31

*DAS- Days after sowing

**Fig 1:** Total dry production per plant of pearl millet at different growth stage as influenced by different organic sources application**Ethical Statement**

“Not Applicable”

Copyright Statement

“The article does not contain any copyrights protected material”.

Authorship Statement

Paluchani Meghana Reddy*: The student who has conducted the research work as part of her M.Sc. (Agri.) work.

B. T. Nadagouda ¹ and R. A. Nandagavi ²: Involved in finalization of research topic, technical guidance and corrected the drafts of research work.Shivalingappa Hotkar ³: Technical guidance, Manuscript editing & proof reading.**Submission Declaration**

“We hereby declare that

1. That the article is an original work carried out by the authors.
2. That the work is done within the previous five years of the submission.
3. That the work is in no way contravenes the publication ethics of the Journal.
4. That while preparing the manuscript copying and or

plagiarizing has been avoided.

5. That the article, in part of full, has not been previously published and is not under consideration for publication elsewhere.
6. That the article has been approved by all authors for submission to the Journal.
7. That there is no conflict of interest among the authors or any other individual or organisation etc.
8. That if accepted, the article will not be published elsewhere

in the same form, in English or in any other language, including electronically without the written consent of the Journal of Crop and Weed.

9. That all persons/establishments who have contributed to the said work in terms of financial/intellectual and other helps have been duly acknowledged.
10. That all author(s) has/have given consent for publishing the article in Journal's website as open access."

Sl. No.	Name	Designation	Institute	Specialization	Email ID
1.	Dr. Farhana Zaman	Associate Professor	Bangladesh Agricultural University (BAU), Bangladesh	Field Crop Production, Allelopathy, Weed Management	fzamen@bau.edu.bd
2.	Dr. Chin-Jen Hou	Associate Professor	National chiayi University, Taiwan	Crop production	houecj@mail.ncyu.edu.tw
3.	Dr. Vishram Ram	Professor	Central Agricultural Institute, Imphal	Natural resource management	ramvishramceu@gmail.com
4.	Dr. A. Renukadevi	Assistant Professor	Tamil Nadu Agriculture University, Coimbatore	Soil Fertility	renu_remsan@yahoo.co.in

References

1. Devakumar N, Shubha S, Gouder SB, Rao GGE. Microbial analytical studies of traditional organic preparations beejamrutha and jeevamrutha. In: Proceedings of Building Organic Bridges. 4th ISOFAR Scientific Conf. Istanbul, Turkey; c2014. p. 639.
2. Ghanshyam, Rakesh K, Jat RK. Productivity and soil fertility as affected by organic manures and inorganic fertilizers in greengram (*Vigna radiata*)-wheat (*Triticum aestivum*) system. Indian Journal of Agronomy. 2010;55(1):16-21.
3. Gomez KA, Gomez AA. Statistical procedure for agricultural research. An International Rice Research Institute Book. Willy Inter Science Publication; c1984. p. 680.
4. Indiatat. Selected state-wise area, production, and productivity of pearl millet in India, Ministry of Agriculture and Farmers Welfare, Govt. of India [Internet]; c2021. Available from: <https://www.indiatat.com/table/agriculture-data-production-productivity-g/1409248>
5. Kannan PA, Saravanan S, Krishnakumar, Natrajan SK. Biological properties of soil as influenced by different organic manures. Research Journal of Agriculture and Biological Sciences. 2005;1:181-183.
6. Kiran, Satyanarayana R, Rameshkumar C. Effect of nutrient management practices through organics on growth, yield & economics of chickpea under rainfed condition. Green Farming. 2016;7(4):880-883.
7. Malik AS, Singh J, Faroda AS. Effect of integrated agronomic practices on pearl millet production under rainfed condition. Crop Research. 1990;3:21-26.
8. Meena BS, Ram B. Effect of integrated nutrient management on productivity, soil fertility, and economics of chickpea (*Cicer arietinum* Linn.) varieties in vertisols. Annals of Agricultural Research. 2013;34:225-230.
9. Shete PG, Adhav SL, Kushare YM. Response of rabi greengram (*Vigna radiata* L.) to land configuration and inorganic fertilizer with and without FYM. International Journal of Plant Sciences. 2010;5(2):498-501.
10. Shwetha BN. Effect of nutrient management through the organic in soybean-wheat cropping system [M.Sc. Thesis]. Dharwad (India): University of Agricultural Sciences; c2008.
11. Sohu I, Gandahi AW, Bhutto GR, Sarki MS, Gandahi R. Growth and yield maximization of chickpea (*Cicer arietinum*) through integrated nutrient management applied to rice-chickpea cropping system. Sarhad Journal of Agriculture. 2015;31:131-138.
12. Talashikar SC, Bhargarath PP, Mehta VP. Changes in chemical properties during composting of organic residue as influenced by earthworm activity. Journal of the Indian Society of Soil Science. 1999;47:50-53.