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Effect of Different Liquid Organic Manures on the Nutrient Release Pattern in Radish Grown Soil

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Authors' contributions

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

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ABSTRACT

The study of nutrient release patterns from various organic manures is critical for ensuring enough nutrient availability to crop plants at the right time and in the right quantity. To assess the nutrient release pattern from several organic manures, including farm yard manure, panchagavya and jeevamrutha, a field experiment was conducted at organic farming block of Zonal Agricultural

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Research Station, V. C. Farm, Mandya during late *Kharif* 2020. The experiment consists of 9 treatments including different rates of recommended dose of nitrogen was applied through FYM and one- and two-times application of panchagavya and jeevamrutha in different combinations. The experiment was laid out in a Randomized Block Design with three replications. The release pattern of available nitrogen, phosphorus, potassium, calcium, magnesium, sulphur and micronutrients in soil applied with various organic manures at various days (15, 30, 45 DAS and at harvest). The study revealed that application of various organic manures showed substantial increase in primary (N, P and K) and secondary nutrient (S) release and there were no significant variations found in Ca, Mg, Fe, Mn, Cu and Zn release pattern. Based on the release rate of nutrients, it was found that there was consistent and stable release of N, P, K and S from 75% RDN through FYM + two time application of Panchagavya followed by 75% RDN through FYM + two time application of Jeevamrutha, compared to other treatments.

Keywords: Panchagavya; Jeevamrutha; radish; nitrogen; phosphorus; potassium and sulphur release rate.

1. INTRODUCTION

The investigation on nutrient release dynamics from diverse organic manures is pivotal in elucidating the intricate interplay between soil quality [1,2], climatic variables [3,4], and agronomic practices [5], thereby optimizing crop productivity in sustainable agricultural systems. In this study, conducted at the organic farming block of Zonal Agricultural Research Station, V. C. Farm, Mandya, during late Kharif 2020, the influence of different liquid organic manures, namely farmyard manure (FYM), panchagavya, and jeevamrutha, on the nutrient release pattern in radish-cultivated soil was meticulously examined.

Critical environmental factors, including soil quality [6,7], precipitation [8,9,10], temperature [11,12], relative humidity [13,14,15], and the overarching influence of climate change, were conscientiously considered throughout the experimental period [16,17]. These factors inherently influence soil physicochemical properties [18,19], microbial activity [20,21], and subsequently, nutrient mineralization and availability [22,23,24].

Radish is a root vegetable crop and it is grown for its young tuberous roots where even shoots are used as vegetables and consumed as either cooked or raw as salad. Different colored radishes are available in the market. The pink color is due to the presence of anthocyanin pigment. It is relished for its pungent flavor and is considered as an appetizer [25]. Radish is a good source of vitamin C and supplies a variety of minerals like calcium, potassium and phosphorous. The pink skin radish is generally richer in ascorbic acid than white skin radish [26]. The characteristic pungent flavor of radish is due to its thiocyanate [27]. It is used for neurological headaches, chronic diarrhea, urinary complaints, sleeplessness, and piles [26].

After the onset of the Green Revolution in India, farmers began utilizing chemical fertilizers to boost the production and productivity of different crops. The inadequate use of chemical fertilizers has adversely affected soil fertility, quality, biodiversity and human and soil health. Furthermore, it also increased soil acidity, deteriorated soil physical condition, decreased organic matter and created micronutrient deficiencies [28]. To solve these problems, the future of agriculture should be averted to organic farming. Because organic manure not only provides vital nutrients (both macro and micro nutrients), but it also improves the physical properties like bulk density, water holding capacity, infiltration rate, soil aeration and biological properties like improving microbial population and enzyme activity [29]. However, a single organic source of nutrient supplementation may not cope with the nutrient demand of crops. Integration of different organic nutrient sources and/or liquid organic manures helps to solve the dual problem of supplementation of sufficient nutrients besides synchronized nutrient availability as per crop demand associated with variable nutrient release patterns among different organic manures. Hence, the study was conducted to assess the effect of different liquid organic manures on the nutrient release pattern in radish-grown soil.

2. MATERIALS AND METHODS

The present investigation was carried out at at organic farming block of Zonal Agricultural

Research Station (ZARS) V. C. Farm, Mandya, University of Agricultural Sciences, Bangalore in late *Kharif* 2020. The experiment was laid out in the Randomized Block Design with nine treatments which were replicated three times. The treatments employed were, T_1 (100% RDN through FYM), T_2 (50% RDN through FYM + one-time application of Jeevamrutha), T_3 (50% RDN through FYM + two-time application of Jeevamrutha), T_4 (75% RDN through FYM + one-time application of Jeevamrutha), T_5 (75% RDN through FYM + two- time application of Jeevamrutha), T_6 (50% RDN through FYM + one-time application of Panchagavya), T_7 (50% RDN through FYM + two-time application of Panchagavya), T_8 (75% RDN through FYM + one-time application of Panchagavya) and T_9 (75% RDN through FYM + two-time application of Panchagavya). The recommended dose of Nitrogen (RDN- 50 kg ha^{-1}) was supplied through FYM in equal proportion on an N content basis before 15 days of sowing. Two liquid formulations (Panchagavya and Jeevamrutha) were applied one at the time of sowing and the second at 30 days after sowing at the rate of 500 L ha^{-1}.

A composite soil sample was collected from the experimental site (0-20 cm) before the experiment and was analyzed for chemical properties. The experimental soil was sandy loam in texture. The soil was neutral in reaction (pH 7.30) and medium in soluble salts (0.29 dS m^{-1}) and medium in organic carbon (5.24 g kg^{-1}) content. The available nitrogen content of soil the was low (302.24 kg ha^{-1}), medium in available P_2O_5 (43.30 kg ha^{-1}), available K_2O (210.66 kg ha^{-1}) and available sulphur (15.12 mg kg^{-1}). The exchangeable calcium and magnesium content of soil was 7.01 and 2.21 cmol (p^+) kg^{-1}, respectively. DTPA extractable iron, manganese, zinc and copper were 19.85, 10.69, 0.49 and 1.26 mg kg^{-1}, respectively. The FYM, Panchagavya and Jeevamrutha were analyzed concerning their chemical composition by adopting standard procedures and analytical data are presented in Table 1.

Chemical properties of the soil such as pH, EC, OC, available N, P_2O_5, K_2O, Ca, Mg, S, Fe, Mn, Zn, and Cu were determined as per the standard methods. Statistical analysis of the data recorded was done as per the method suggested by Gomez and Gomez [30]. The significance of variation among the treatments was observed by applying ANOVA. The level of significance used in “F” was P = 0.05. Critical difference (CD) values were calculated for the P = 0.05 whenever the “F” test was found significant.

3. RESULTS AND DISCUSSION

The soil chemical properties *viz*., pH, EC and OC of soil at 15, 30, 45 DAS and at harvest as influenced application of liquid organic manures are presented in Table 1. The data of chemical properties *viz*., pH, EC and OC of soil at 15, 30, 45 DAS and harvest of radish crop is given in Table 1 which indicated that soil chemical properties at different intervals were not affected significantly due to different treatments applied in this investigation.

Table 1. Chemical characters of Panchagavya, Jeevamruth and FYM

Parameter	Panchagavya	Jeevamrutha	FYM
Colour	Light brown	Light green	-
Odour	Fermented odour	Mild foul odour	-
pH	6.02	7.17	9.4
EC (dS m^{-1})	3.40	1.48	7.2
OC (%)	0.88	0.69	13.98
Nitrogen (mg L^{-1})	1240	910	0.49
Phosphorus (mg L^{-1})	196	156	0.17
Potassium (mg L^{-1})	888	632	0.46
Calcium (mg L^{-1})	156	178	0.82
Magnesium (mg L^{-1})	46	20	0.49
Sulphur (mg L^{-1})	566	543	0.31
Zinc (mg L^{-1})	1.19	3.91	13.80
Copper (mg L^{-1})	0.34	1.82	2.4
Iron (mg L^{-1})	27.87	29.80	142.24
Manganese (mg L^{-1})	1.69	10.40	63.58

Slight variation in pH was observed compared to initial data in all the treatments which might be due to an increase in bases by active degradation of organic matter solution and the beneficial influence of liquid organic manures that provide favourable environment for nutrient availability the results are in accordance with Ali et al. [31], Kumawat et al. [32] and Narkhede et al. [33]. Slight variation in EC was observed it might be due to faster release of bases and soluble organic fractions to the soil system by mineralization. This is similar to the findings of Ali et al. [31], Kumawat et al. [32] and Narkhede et al. [33]. Variations in organic carbon content in soil compare to initial soil data this was due to, Patel et al. [34] reported that the addition of organic matter to soil increased the root biomass production which in turn increases the carbon content in soil. Narkhede et al. [33] reported that addition of farm waste and organic manures increased the status of organic carbon and available NPK of the soil.

Available nitrogen, phosphorus and potassium content at 15, 30, 45 DAS and at harvest of radish has been presented in Table 3. The results revealed that higher soil N (326.58, 328.46, 332.13 and 336.46 kg ha^{-1}), P_2O_5 (52.11, 56.11, 59.65 and 61.92 kg ha^{-1}) and K_2O (231.13, 233.46, 236.13 and 239.46 kg ha^{-1}) content in soil was recorded in treatment T_9 (75% RDN through FYM + two time application of Panchagavya). Significant increase in available nitrogen, phosphorus and potassium content of soil was due to the increased multiplication of microbes which mineralize the nitrogen, phosphorus and potassium contained in the soil and applied organic manures. Application of FYM also contributing in supply of nitrogen, phosphorus and potassium to soil. Characterization study of liquid organic manures indicated that among the liquid organic manures, Panchagavya registered the highest N, P and K content and nitrogen fixers, PSB population which helps in solubilizing the nitrogen and phosphorous present in soil. Several reports supporting this observation had been made by Pradeep [35] in groundnut, Vajantha et al. [36], Amareswar and Sujathamma, [37], Yogananda et al. [38], Patel et al. [34] and Gangadhar et al. [39].

Exchangeable calcium and magnesium content in soil as influenced by application of liquid organic manures at 15, 30, 45 DAS and at harvest are presented in Table 4. The results revealed that calcium and magnesium content in soil did not vary significantly due to application of liquid organic manures at all the stages of crop growth. According to Haynes [40], liquid organic manures has the property of binding mineral particles like calcium and magnesium in the form of colloids of humus and clay, facilitating stable aggregates of soil particles for desired porosity to sustain plant growth. Manjunatha et al. [41] noticed that application of liquid organic manures maintains soil health and productivity by improving physical, chemical and biological properties of soil.

Table 2. Soil pH, electrical conductivity and organic carbon content as influenced by the application of liquid organic manures at different growth stages of radish

Treatment	Available N (kg ha^{-1})				Available P_2O_5 (kg ha^{-1})				Available K_2O (kg ha^{-1})			
	15 DAS	30 DAS	45 DAS	At harvest	15 DAS	30 DAS	45 DAS	At harvest	15 DAS	30 DAS	45 DAS	At harvest
T_1	7.38	7.43	7.45	7.49	0.33	0.35	0.38	0.39	5.23	5.79	5.88	5.97
T_2	7.42	7.47	7.49	7.52	0.32	0.35	0.36	0.37	5.05	5.35	5.52	5.64
T_3	7.43	7.48	7.50	7.53	0.37	0.39	0.42	0.44	5.11	5.71	6.10	6.17
T_4	7.44	7.51	7.51	7.56	0.36	0.38	0.39	0.41	5.15	5.75	5.83	5.89
T_5	7.46	7.55	7.59	7.62	0.38	0.40	0.42	0.46	5.30	5.84	6.21	6.33
T_6	7.41	7.45	7.48	7.51	0.31	0.33	0.34	0.35	5.13	5.73	5.86	5.94
T_7	7.42	7.47	7.49	7.52	0.34	0.37	0.39	0.42	5.26	5.86	6.13	6.28
T_8	7.40	7.43	7.46	7.48	0.33	0.34	0.35	0.36	5.18	5.78	5.89	5.91
T_9	7.39	7.45	7.50	7.51	0.35	0.36	0.37	0.40	5.43	5.93	6.34	6.52
S.Em±	0.33	0.34	0.34	0.34	0.02	0.02	0.02	0.03	0.23	0.26	0.27	0.27
CD@ 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 3. Available N, P_2O_5 and K_2O content of soil as influenced by application liquid organic manures at different growth stages of radish

Treatment	Available N (kg ha^{-1})				Available P_2O_5 (kg ha^{-1})				Available K_2O (kg ha^{-1})			
	15 DAS	30 DAS	45 DAS	At harvest	15 DAS	30 DAS	45 DAS	At harvest	15 DAS	30 DAS	45 DAS	At harvest
T_1	313.02	316.89	319.22	322.22	46.73	49.06	51.61	52.94	218.66	222.26	224.66	228.33
T_2	315.88	318.76	320.76	323.76	47.15	50.02	53.00	55.64	222.14	225.81	228.81	231.48
T_3	316.77	319.75	323.08	326.42	48.01	50.35	55.14	58.03	224.18	226.78	231.82	234.82
T_4	320.67	323.55	326.88	328.22	50.36	52.69	54.35	55.39	226.97	229.04	230.53	232.53
T_5	322.65	325.53	330.53	334.20	51.56	54.48	57.16	59.39	227.44	230.84	234.17	236.84
T_6	317.39	320.78	322.44	325.11	48.68	51.75	55.17	56.84	223.92	225.58	227.25	230.92
T_7	318.20	321.08	325.08	329.41	49.97	52.12	56.91	58.42	224.06	226.72	229.72	233.72
T_8	324.12	326.33	328.00	331.33	51.87	53.87	55.82	57.62	230.48	232.15	233.93	234.26
T_9	326.58	328.46	332.13	336.46	52.11	56.11	59.65	61.92	231.13	233.46	236.13	239.46
S.Em±	2.39	1.95	1.43	1.78	1.18	1.40	1.20	1.23	2.42	1.91	1.82	1.47
CD@ 5%	7.16	5.83	4.30	5.34	3.52	4.19	3.58	3.68	7.26	5.72	5.45	4.42

Table 4. Exchangeable calcium and magnesium content of soil as influenced by application of organic manures at different growth stages of radish

Treatment	Exch. Ca [cmol (p$^+$) kg^{-1}]				Exch. Mg [cmol (p$^+$) kg^{-1}]			
	15 DAS	30 DAS	45 DAS	At harvest	15 DAS	30 DAS	45 DAS	At harvest
T_1	7.18	7.27	7.36	7.62	2.53	2.60	2.67	2.83
T_2	7.25	7.46	7.81	8.09	2.59	2.70	2.81	2.90
T_3	7.30	7.52	7.95	8.24	2.60	2.74	3.03	3.13
T_4	7.41	7.61	7.87	8.16	2.77	2.83	2.95	3.06
T_5	7.45	7.64	7.96	8.27	2.80	2.89	3.18	3.33
T_6	7.28	7.40	7.74	8.01	2.62	2.76	2.97	3.09
T_7	7.32	7.45	7.98	8.26	2.65	2.82	3.00	3.16
T_8	7.48	7.56	8.08	8.18	2.82	3.05	3.07	3.10
T_9	7.52	7.59	8.14	8.33	2.91	3.17	3.25	3.42
S.Em±	0.33	0.33	0.35	0.36	0.12	0.12	0.14	0.14
CD@ 5%	NS	NS	NS	NS	NS	NS	NS	NS

Available sulphur content in soil as influenced by application of liquid organic manures at 15, 30, 45 DAS and at harvest are presented in Fig. 1. Highest amount of sulphur (19.84, 23.94, 26.76 and 28.57 mg kg^{-1}, respectively) in the soil was recorded in T_9 (75% RDN through FYM + two times application of Panchagavya) and the lowest amount of sulphur in the soil (15.69, 17.11, 19.79 and 21.15 mg kg^{-1}, respectively) was recorded in T_1 (100% RDN through FYM). Increase in sulphur content might be ascribed to adsorption of S on organic matter and thereby reducing the leaching losses of sulphur. Microbial sulphur oxidation is whole beneficial to soil fertility, resulting in the formation of sulphate, the major S-ion used by plants, this was similar with the findings of Jat and Ahlawat (2010).

DTPA extractable micronutrient such as, iron, manganese, zinc and copper content of soil at 15, 30, 45 DAS and at harvest of radish crop did not vary significantly due to application of liquid organic manures (Fig. 2.). DTPA-Fe content ranged from 20.31, 21.59, 23.55 and 25.91 to 23.34, 25.72, 27.92 and 29.93 mg kg^{-1}, DTPA-Mn content ranged from 10.51, 14.65, 15.64 and 17.08 to 12.19, 16.63, 19.77 and 20.94 mg kg^{-1}, DTPA-Zn content ranged from 0.50, 0.54, 0.64 and 0.67 to 0.58, 0.63, 0.73 and 0.76 mg kg^{-1} and DTPA-Cu 1.25, 1.32, 1.41 and 1.50 to 1.59, 1.65, 1.75 and 1.84 mg kg^{-1} at 15, 30, 45 DAS and at harvest, respectively in T_6 (50% RDN through FYM + one time application of Panchagavya) and T_5 (75% RDN through FYM + two time application of Jeevamrutha).

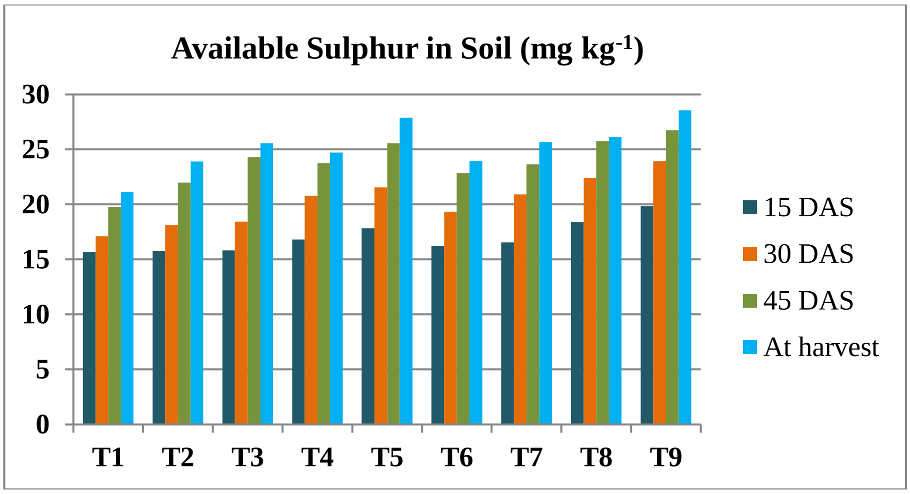

Fig. 1. Available sulphur content in soil as influenced by application of liquid organic manures at different growth stages of radish

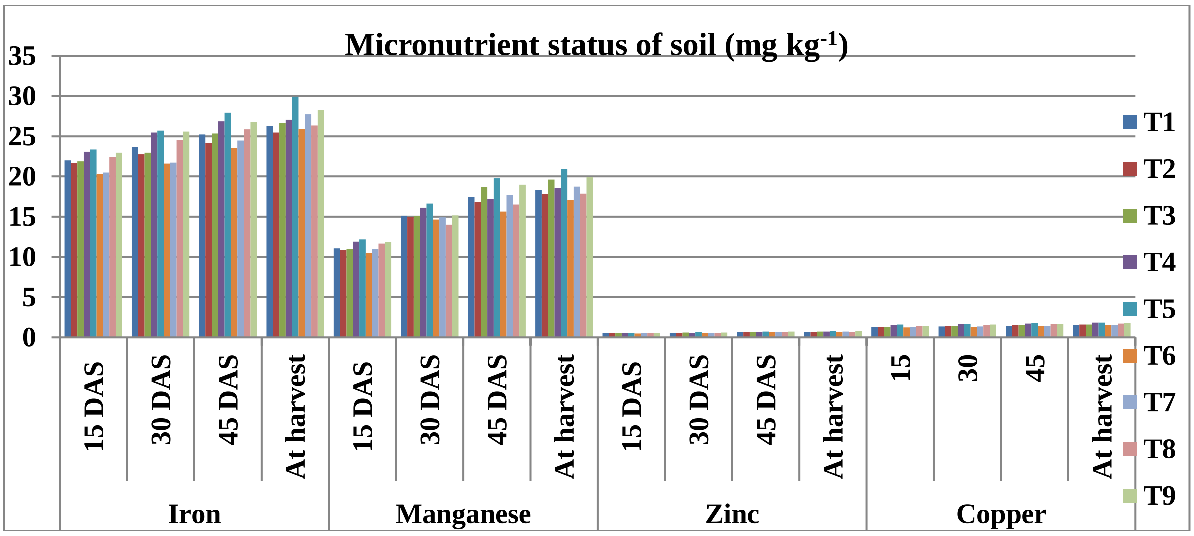

Fig. 2. Micronutrient status of soil as influenced by application liquid organic manures at different growth stages of radish

The effect of application of liquid organic manures on soil micronutrient status did not vary significantly. However slight increase in micronutrient content was observed. The difference was only because of varied levels of micronutrient composition of Panchagavya and Jeevamrutha. Jeevamrutha showed more micronutrient content hence more increase of micronutrients was observed in 75% RDN through FYM + two times application of Jeevamrutha. The increase in available Fe, Mn, Zn and Cu upon addition of organic manures might be due to intensified microbial population and reduction in pH of soil and also formation of stable complexes with organic ligands. This might have decreased the susceptibility of micronutrients to adsorption, fixation or precipitation reaction in soil resulting in greater availability. The increased soil micronutrient status with the addition of organic manures to the soil was reported by Kumawat et al. [32] and Jain et al. (2014).

4. CONCLUSION

The results underscored a discernible enhancement in the release dynamics of primary nutrients (nitrogen, phosphorus, and potassium) and secondary nutrient sulfur (S) upon the application of various organic manures. Notably, negligible variations were observed in the release patterns of calcium (Ca), magnesium (Mg), iron (Fe), manganese (Mn), copper (Cu), and zinc (Zn) across the treatments.

Of particular significance was the identification of treatment combinations eliciting a consistent and stable release of key nutrients. Specifically, the synergistic application of 75% recommended dose of nitrogen through FYM, supplemented with double applications of panchagavya, demonstrated a commendable release profile of nitrogen, phosphorus, potassium, and sulfur. Similarly, the treatment regimen comprising 75% recommended dose of nitrogen via FYM, coupled with double applications of jeevamrutha, exhibited comparable efficacy in nutrient release dynamics.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Araya-Alman M, Olivares B. Acevedo-Opazo C. Relationship between soil properties and banana productivity in the two main cultivation areas in venezuela. J Soil Sci Plant Nutr. 2020;20(3):2512-2524. Available:https://doi.org/10.1007/s42729-020-00317-8
2. Campos BO. Banana production in venezuela: Novel solutions to productivity and plant health. Springer Nature; 2023. Available:https://doi.org/10.1007/978-3-031-34475-6
3. Cortez A, Olivares B, Parra R, Lobo D, Rodríguez MFY, Rey JC. Description of meteorological drought events in localities of the central mountain range, Venezuela. Ciencia, Ingenierias Aplicaciones. 2018;1 (1):22-44. Available:http://dx.doi.org/10.22206/cyap.2018.vlil.pp23-45.
4. Campos-Olivares B, Hernandez R, Coelho R, Molina JC Pereira Y. Analysis espacial del indice hidrico: un avance en la adopcion de decisiones sostenibles en los territorios agricolas de Carabobo, Venezuela. Revista Geografica de America Central. 2018;60(1):277-299. DOI: https://doi.org/10.15359/rgac.60-1.10
5. Rodriguez MF, Cortez A, Olivares B, Rey JC, Parra R, Lobo D. Spatio-temporal analysis of precipitation in the state of Anzoategui and its surroundings. Agron. Trop. 2013;63(1-2):57-65. Available:https://n9.cl/14iow
6. Calero J, Olivares BO, Re JC, Lobo D, Landa BB, Gomez JA. 2022, Correlation of banana productivity levels and soil morphological properties using regularized optimal scaling regression. Catena. 2008: 105718. Available:https://doi.org/10.1016/j.catena.2021.105718.
7. Lobo D, Olivares B, Rey JC, Vega A, Rueda-Calderon A. Relationships between the Visual Evaluation of Soil Structure (VESS) and soil properties in agriculture: A meta-analysis. Sci. Agropecu. 2023;14–1:67-78. Available:https://doi.org/10.17268/sci.agropecu.2023.007
8. Olivares B, Parra R, Cortez A. Rodriguez MF. Patterns of rainfall homogeneity in climatic stations of the Anzoategui state, Venezuela. *Rev. Multiciencias*. 12 (Extraordinario): 2012:11-17. Available:https://n9.cl/xbslq
9. Olivares B, Torrealba J, Caraballo L. Variability of the precipitation regime in the period 1990-2009 in the location of El

Tigre, Anzoategui state, Venezuela. Rev. Fac. Agron. (LUZ). 2013;30(1):19-32.
Available:https://n9.cl/mic0l

10. Cortez A, Olivares B, Munetones AY, Casana S. Strategic elements of organizational knowledge management for innovation. Case: Agrometeorology Network. Revista Digital de Investigacion en Docencia Universitaria. 2016;10(1):68-81.
Available:http://dx.doi.org/10.19083/ridu.10.446
11. Guevara E, Olivares B, Oliveros Y, López L. Estimation of thermal comfort index as an indicator of heat stress in livestock production in the Guanipa plateau, Anzoátegui, Venezuela. Revista Zootecnia Tropical. 2013;31(3):209-223.
Available:https://n9.cl/ovcu9
12. Olivares B, Rey JC, Lobo D, Navas-Cortes JA, Gomez JA, Landa BB. Fusarium wilt of bananas: A Review of agro-environmental factors in the venezuelan production system affecting its development. Agron., 2021a;11(5):986.
Available:https://doi.org/10.3390/agronomy11050986
13. Hernandez R, Pereira Y, Molina JC, Coelho R, Olivares B, Rodríguez K. Calendario de siembra para las zonas agrícolas del estado Carabobo en la República Bolivariana de Venezuela. Sevilla, Spain, Editorial Universidad Internacional de Andalucía. 2017;247 .
Available:https://n9.cl/sjbvk.
14. Zingaretti ML, Olivares B. Analysis of the meteorological drought in four agricultural locations of Venezuela by the combination of multivariate methods. UNED Res. J., 2018;10(1):181-192.
Available:http://dx.doi.org/10.22458/urj.v10i1.2026
15. Olivares B, Paredes F, Rey J, Lobo D, Galvis-Causil S. The relationship between the normalized difference vegetation index, rainfall, and potential evapotranspiration in a banana plantation of Venezuela. SAINS TANAH – J. Soil Sci. Agroclimatol. 2021b; 18(1):58-64.
Available:http://dx.doi.org/10.20961/stjssa.v18i1.50379
16. Rodriguez MF, Olivares B. Cortez A, Rey JC, Lobo D. Natural physical characterization of the indigenous community of Kashaama for the purposes of sustainable land management. Acta. Nova. 2015;7(2):143-164.
Available:https://n9.cl/hakdx
17. Hernandez R, Olivares B, Arias A, Molina JC, Pereira Y. Agroclimatic zoning of corn crop for sustainable agricultural production in Carabobo, Venezuela. Revista Universitaria de Geografía. 2018ª;27(2): 139-159.
Available:https://n9.cl/l2m83
18. Hernandez R, Olivares B. Ecoterritorial sectorization for the sustainable agricultural production of potato (*Solanum tuberosum* L.) in Carabobo, Venezuela. Agric. Sci. Technol., 2019;20(2): 339-354.
Available:https://doi.org/10.21930/rcta.vol20_num2_art:1462
19. Olivares B, Rey JC, Lobo D, Navas-Cortes JA, Gomez JA, Landa BB. Machine learning and the new sustainable agriculture: Applications in banana production systems of venezuela. Agric. Res. Updates. 2022a;42:133-157
20. Hernandez R, Olivares B. Application of multivariate techniques in the agricultural land's aptitude in Carabobo, Venezuela. Tropical and Subtropical Agroecosystems. 2020;23(2):1-12.
Available:https://n9.cl/zeedh
21. Olivares BO, Rey JC, Perichi G. Lobo D. Relationship of microbial activity with soil properties in banana plantations in Venezuela. Sustainabil. 2022b;14: 13531.
Available:https://doi.org/10.3390/su142013531
22. Hernandez R, Olivares B, Arias A, Molina JC, Pereira Y. Identification of potential agroclimatic zones for the production of onion (*Allium cepa* L.) in Carabobo, Venezuela. J. Selva, Andina, Biosph. 2018b;6(2):70-82.
Available:http://www.scielo.org.bo/pdf/jsab/v6n2/v6n2_a03.pdf
23. Hernandez R, Olivares B, Arias A, Molina JC, Pereira Y. Eco-territorial adaptability of tomato crops for sustainable agricultural production in Carabobo, Venezuela. Idesia. 2020;38(2): 95-102.
Available:http://dx.doi.org/10.4067/S07183429202000020095
24. Olivares BO, Vega A, Calderon MAR, REY JC, Lobo D, Gomez JA, Landa BB. identification of soil properties associated with the incidence of banana wilt using supervised methods. Plants, 2022c;11: 2070.

Available:https://doi.org/10.3390/plants11152070

25. Kumar S, Sutanu M, Kumar S, Singh HD. Efficacy of organic manures on growth and yield of radish (*Raphanus sativus* L.) cv. Japanese White. Int. J. Plant Sci., 2014;9(1):57-60.
26. Singh KP. Bhandari RR. Vegetable crops production technology. First edition Bagbazar, Nepal. 2015:308.
27. Kushwah L. Effect of organic manures, inorganic fertilizers and their combinations on growth, yield and quality of radish (*Raphanus sativus* L.). M. Sc. (Ag) thesis. Rajmata Vijayaraje Scindia Krishi Vishwa Vidhyalaya, Gwalior, India; 2016.
28. Mali DL, Singh V, Sarolia DK, Teli SK, Chittora A, Dhakar R. Effect of organic manures and bio-fertilizers on growth and yield of radish (R*aphanus sativus* L.) *cv*. Japanese white. Int. J. Chem. Stud. 2018;6(2):1095-1098
29. Diacono M, Montemurro F. Long term effects of organic amendments on soil fertility. A review. Agron. Sustain. Dev. 2010;30:401–422.
30. Gomez KA, Gomez AA. Statistical procedures for agricultural research. 2nd Ed. John Wiley Sons, New York; 1984.
31. Ali MN, Ghatak S. Ragul T. Biochemical analysis of panchagavya and sanjibani and their effect in crop yield and soil health. J. Crop Weed. 2011;7(2):84-86.
32. Kumawat RN, Mahajan SS, Santra P. Effect of panchgavya on soil chemical properties of groundnut (*Arachis hypogaea*) rhizosphere and crop productivity in western Rajasthan. J. Food Legumes. 2013;26(2):39-43.
33. Narkhede WN, Khandare SK, Nayak Khazi GS. Effect of organic and inorganic nutrient sources and their integrated nutrient management on productivity, economic efficiency, available N, P, K and microbial population in soybean (*Glycine max*) – onion (*Allium cepa*) cropping sequence. Indian J. Agron. 2017;62 (2):147–154
34. Patel DM, Patel IM, Patel BT, Singh NK. Patel CK. Effect of panchgavya and jivamrut on yield, chemical and biological properties of soil and nutrients uptake by *Kharif* groundnut (*Arachis hypogaea* L.). Int. J. Chem. Stud. 2018;6(3):804-809.
35. Pradeep Gopakkali. Development of liquid organic manures and their evaluation for organic production of Chilli and Onion. Ph.D. Thesis, University of Agricultural Sciences, Bangalore; 2013.
36. Vajantha B, Umadevi M, Patnaik MC, Rajkumar M. Micronutrient status of soils under ashwagandha grown farmer fields in Andhra Pradesh. Asian J. Soil Sci. 2013;8(1):143-147.
37. Amareswari PU, Sujathamma P. Effect of vermicompost, jeevamrutha, panchagavya and mulching on the cost benefit ratio in french bean. Hort. Flora Res. Spectr. 2015;4(4):333-336.
38. Yogananda SB, Devakumar N, Shruti MK, Ningaraju. Growth and yield of cowpea as influenced by different sources of organic manures, Nat. Symp. Org. Agric. Sust. Food Sec*. Challenges Opp*., Tamilnadu, India. 2015:113.
39. Gangadhar, K., Devakumar, N., Vishwajith AND Lavanya, G. Growth, yield and quality parameters of chilli (*Capsicum annuum* L.) as influenced by Appllication of different organic manures and decomposers. Int. J. Chem. Stud. 2019;8(1):473-482.
40. Haynes RJ. The decomposition process mineralization, immobilization, humus formation and degradation. In: Haynes, R. J. (ed.), Mineral nitrogen in the plant-soil system. Academic press, New York. 1986:75-98.
41. Manjunatha GS, Upperi SN, Pujari BT, Yeledahalli NA. Kuligod AVB. Effect of farm yard manure treated with jeevamrutha on yield attributes and economics of sunflower (*Helianthus annuus* L.). Karnataka J. Agric. Sci. 2009;22(1):342-348.

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