__Original Research Article__

Effect Of Different Liquid Organic Manures On The Nutrient Release Pattern In Radish Grown Soil

ABSTRACT

~~The~~ 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 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~~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 ~~was~~ 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

Radish is a root vegetable crop and it is grown for its young tuberous roots where even shoots are used as ~~vegetable~~ 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 (Kumar *et al*., 2014). Radish is a good source of ~~vitamin C~~vitamin C and supplies a variety of minerals like calcium, potassium, and phosphorous. The pink skin radish is generally ~~rich~~ richer in ascorbic acid than white skin radish (Singh and Bhandari, 2015). The characteristic pungent flavor of radish is due to ~~is~~ its othiocyanate (Kushwah, 2016). It is used for neurological headaches, chronic diarrhea, urinary complaints, sleeplessness, and piles (Singh and Bhandari, 2015).

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 ~~the~~ 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 (Mali *et al*., 2018). 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 (Diacono and Mon-temurro, 2010) . However, a single organic source of nutrient supplementation may not cope ~~up~~ with the nutrient demand of crops. Integration of different organic nutrient sources and/or liquid organic manures ~~help~~ helps to solve the dual problem of supplementation of sufficient nutrients besides synchronized nutrient availability as per crop demand associated with variable nutrient release ~~pattern~~ 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~~radish-grown soil.

2 MATERIALS AND METHODS

~~Present~~ 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 ~~during~~ in late *Kharif* 2020. The experiment was laid out in the Randomized Block

Design with nine treatments which were replicated three times. The ~~treatment~~ treatments employed were, T_1 (100% RDN through FYM), T_2 (50% RDN through FYM + ~~one time~~one-time application of Jeevamrutha), T_3 (50% RDN through FYM + ~~two time~~two-time application of Jeevamrutha), T_4 (75% RDN through FYM + ~~one time~~one-time application of Jeevamrutha), T_5 (75% RDN through FYM + ~~two time~~two-time application of Jeevamrutha), T_6 (50% RDN through FYM + ~~one time~~one-time application of Panchagavya), T_7 (50% RDN through FYM + ~~two time~~two-time application of Panchagavya), T_8 (75% RDN through FYM + ~~one time~~one-time application of Panchagavya) and T_9 (75% RDN through FYM + ~~two time~~two-time application of Panchagavya). ~~Recommended~~ The recommended dose of Nitrogen (RDN- 50 kg ha^{-1}) was supplied through FYM in equal proportion on an N content basis ~~prior to~~before 15 days of sowing. Two ~~lquid~~ liquid formulations (Panchagavya and Jeevamrutha) were applied one at the time of sowing and the second at 30 days ~~aftersowing~~ 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. ~~Experimental~~ 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. ~~Available~~ The available nitrogen content of the soil 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 ~~with respect to~~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 (1984). 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.

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

3 Results and discussion:

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**

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 at 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.

Slight variation in pH was observed compare 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*. (2011), Kumawat *et al*. (2013) and Narkhede *et al.* (2017). 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*. (2011), Kumawat *et al*. (2013) and Narkhede *et al*. (2017). Variations in organic carbon content in soil compare to initial soil data this was due to, Patel *et al*. (2018) 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*. (2017) reported that addition of farm waste and organic manures increased the status of organic carbon and available NPK of the soil.

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@	**7.16**	**5.83**	**4.30**	**5.34**	**3.52**	**4.19**	**3.58**	**3.68**	**7.26**	**5.72**	**5.45**	**4.42**

5%												

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 (2013) in groundnut, Vajantha *et al*. (2013), Amareswar and Sujathamma, (2015), Yogananda *et al*. (2015), Patel *et al*. (2018) and Gangadhar *et al*. (2019).

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**

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 (1986), 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*. (2009) noticed that application of liquid organic manures maintains soil health and productivity by improving physical, chemical and biological properties of soil.

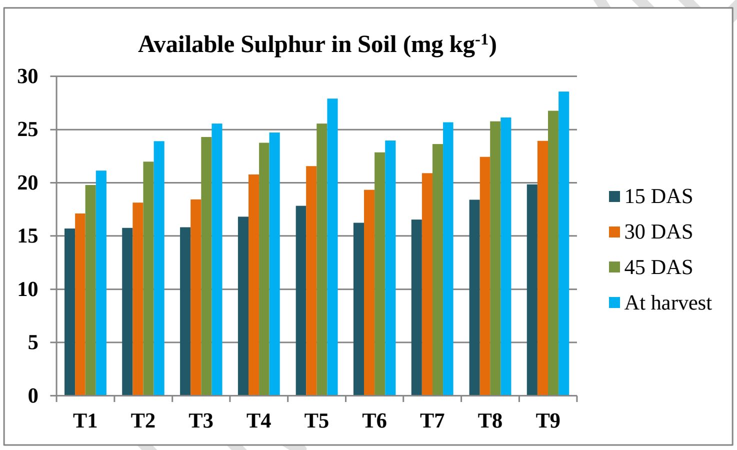

Fig. 1: Available sulphur content in soil as influenced by application of liquid organic manures at different growth stages of radish

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).

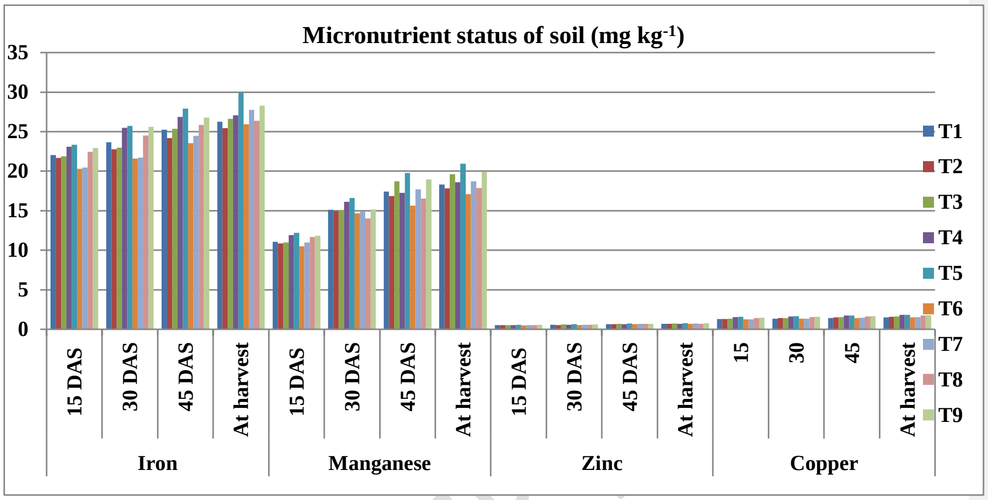

Fig 2: Micronutrient status of soil as influenced by application liquid organic manures at different growth stages of radish

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).

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*. (2013) and Jain *et al*. (2014).

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The investigation on nutrient release dynamics from diverse organic manures is pivotal in elucidating the intricate interplay between soil quality (Araya-Alman et al. 2020; Campos, 2023), climatic variables (Cortez et al. 2018; Campos-Olivares et al. 2018), and agronomic practices (Rodriguez et al. 2013), 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 (Calero et al. 2022; Lobo et al. 2023), precipitation (Olivares et al. 2012; Olivares et al. 2013; Cortez et al. 2016), temperature (Guevara et al. 2013; Olivares et al. 2021a), relative humidity (Hernanez et al. 2017; Zingaretti and Olivares, 2018; Olivares et al. 2021b), and the overarching influence of climate change, were conscientiously considered throughout the experimental period (Rodriguez et al. 2015; Hernandez et al. 2018a). These factors inherently influence soil physicochemical properties (Hernandez and Olivares, 2019; Olivares et al. 2022a), microbial activity (Hernandez and Olivares, 2020; Olivares et al. 2022b), and subsequently, nutrient mineralization and availability (Hernandez et al. 2018b; Hernandez et al. 2020; Olivares et al. 2022c).

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.

Conclusion:

Application of organic manures including liquid organic manures like Panchagavya and Jeevamrutha provided a significant improvement on soil chemical properties and contributed to the availability of plant nutrient. The prominent increase in N, P2O5, K2O, and is a benefit from the application of the different liquid organic manures, even though pH, EC, OC, Ca, Mg and micronutrients were not affected by the application of liquid organic manures. Clearly, liquid organic manures can be a useful tool to improve soil fertility and nutrient status in soil.

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