Original Research Article

Effect of Cattle Urine Application on Soil Properties of Lateritic Soils under Spinach Cultivation

ABSTRACT

The experiment was undertaken to study effect of soil application of cattle urine on growth and yield of spinach in Lateritic soil at wire house of Division of Soil Science and Agriculture Chemistry RCSM College of Agriculture Kolhapur during*rabi*- 2020. There are total seven nitrogen substitution treatments through urea and cattle urine. The treatment consist of absolute control, recommended dose of fertilizers (40:40:40 kg ha^{-1}N, P_2O_5 and K_2O), general recommended dose of fertilizers (40:40:40 kg ha^{-1}N, P_2O_5 and K_2O + FYM @ 10 t ha^{-1}), 75% RDN-urea + 25% N-cattle urine, 50% RDN-urea + 50 % N-cattle urine, 25 % RDN-urea + 75 % N- cattle urine, 100 % RDN-cattle urine replicated thrice in complexly randomized design.

It could be observed from the data that pH and EC of lateritic soil was increased with the application of cattle urine for nitrogen substation. Significantly higher pH (7.67) and EC (1.01dsm^{-1}) oflateritic soil was reported with the application of 100% RDN through cattle urine at first of spinach (46 DAS).Decreasing trend in soil EC was observed at second cut of spinach in all the treatments under study while non-significant results were obtained for soil reaction (pH) at second cut. Significantlyhigher(1.40%)and(1.07 %) organic carbon in lateritic soil was reported with the application of 100 % RDN throughcattle urine at first and second cuts of spinach. Calcium carbonate content in lateritic soil at both the cuts of spinach were recorded non-significant result due to the application of nitrogen through fertilizer and cattle urine.Significantlyhigher~~(253.93$kgha^{-1}$)~~soilavailablenitrogen (253.93 and 184.97 $kgha^{-1}$), phosphorus (30.72 and 29.10 $kgha^{-1}$) and potassium (313.43 and 303.00 $kgha^{-1}$) were recorded at first and second cuts of spinach with the application of 100% RDN through cattleurine respectively.Significantly higher DTPA Fe (26.55 and 24.30 mg kg^{-1}), Mn (23.39 and 21.70 mg kg^{-1}), Zn (7.09 and 3.84 mg kg^{-1}) and Cu (12.01 and 9.12 mg kg-1) were recorded at first and second cuts of spinach with the application of 100% RDN through cattleurine respectively~~with the application of100%RDNthoroughcattleurine~~. Further it can be seen from the data that DTPA availability of metallic micronutrients were higher in those treatments received cattle urine for either substitution of nitrogen @ 25,50, 75 or 100 percent.

Key word: Cattle urine, nutrient availability spinach, lateritic soil.

Introduction

In the present scenario, depletion of soil organic matter, declining soil fertility, physical and chemical degradation of soil, biological sickness in soil, increasing

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multinutrientdeficiencies on various crops, mining of nutrients, imbalanced fertilization, etc are the important challenges under intensive cultivation system.These constraints related to soil are persisted due to the use of nutrients only through chemical fertilizers without manures and biofertilizers. Therefore integrated nutrient management is the important way to enhance nutrient use efficiency, soil fertility and to mitigate the multi nutrient deficiencies. Integrated Nutrient Management refers to the maintenance of soil fertility and plant nutrient supply at an optimum level for sustaining the desired productivity through optimization of the benefits from all possible sources of organic, inorganic and biological components in an integrated manner.Amongthedifferentcomponentsofintegratednutrientmanagement, organicsourcesofnutrientsneedtobefocused considering region wise availability of crop residues. IntheIntegratednutrientmanagement, organic component may be either solid or liquid that too locally and easily available in every state of the country need to be included after assessing their composition. Incase of liquid organic sources waste like cattle urine, pig urine, sheep and goat urine or evenhuman urine can also be used under integrated nutrient management.The cattle urine can beincluded in the integrated nutrient management component as a source of not only nutrients butalso growth promoting substances.

In India farmers pay good attention for the collection andutilization of cattle dung in the form of farm yard manures but very little or no attention hasbeen given in collection and utilization of cattle urine. Further in India almost every farmer ishaving cow, buffalo,goat,sheep,etc.for hisdaily livelihood. Therefore,with 2cows perfarmer approximately10-15litersofurineisbeingproduced dailywhichcontains1 kgnitrogen, 0.5 kg phosphorus and 1 kg potassium so, the liquid waste from cattle must be assessed for itsutilizationeitherthroughsoilorfoliarapplicationfordifferentcropsinvarioussoils.Henceitis necessary to tap this important source of nutrients along with growth promoting substances.Cattle urine contains 95 per cent water, 2.5 per cent urea and 2.5 per cent minerals, hormonesand enzymes. Total nitrogen in cattle urine ranged from 6.8 to 21.1 gm N lit^{-1} of which on anaverage69%was urea7.3% allontoin,5.8%uricacid,0.5%zanthin+hypozanthinnitrogenand %asammonia.(Sandukhanetal,.2018).MostlypHofcattleurinereportedtobealkalineinnaturesoitcanbeusedassourceofnutrientandoverallgrowthpromotingsubstancesonslightlyacidicsoil.Theuseofurineassourceofnutrientshasbeentested,gainingpopularityand accepted partially in Finland, South Africa, Israel, Sweden and China (Pradhan et al, 2009).

Therefore, this study was undertaken to study the effect of cattle urine on properties of lateritic soils under spinach cultivation.

Material and Methods

The experiment was undertaken to study effect of soil application of cattle urine on growth and yield of spinach in Lateritic soil at wire house of Division of Soil Science and

Agriculture Chemistry RCSM College of Agriculture Kolhapur during*rabi*- 2020. There are total seven nitrogen substitution treatments through urea and cattle urine. The treatment consist of absolute control, recommended dose of fertilizers (40:40:40 kg ha^{-1}N, P_2O_5 and K_2O), general recommended dose of fertilizers (40:40:40 kg ha^{-1}N, P_2O_5 and K_2O + FYM @ 10 t ha^{-1}), 75% RDN-urea + 25% N-cattle urine, 50% RDN-urea + 50 % N-cattle urine, 25 % RDN-urea + 75 % N- cattle urine, 100 % RDN-cattle urine replicated thrice in complexly randomized design.

The lateritic soil was procured fromAgricultural Research Station,Radhanagari Tal. RadhanagariDist. Kolhapur. The soil was processed by pounding, grounding and allowed to pass through 2mm sieve. Total numbers of earthen pots were 21 with 33 cm diameter and 26 cm height were filled with 15 kg soil in each pot.

The experimental soil was characterized by red colour dominated by kaolinite clay which comes under *Alfisol* soil order. The soil was slightly acidic (pH: 6.2), EC: 0.23 dS m^{-1}, $CaCO_3$: 2.67 %, organic carbon: 0.87%. The $KMNO_4$-N (Subbiahand Asijia, (1956)), Bray-Kurtz-P (Bray and Kurtz, 1945) and NH_4OAC-K (Knudsen et al., 1982) in experimental soil was 235.2 kg ha^{-1}, 14.13 kg ha^{-1} and 204.96 kg ha^{-1} respectively.

The nitrogen levels were formulated as 25, 50, 75 and 100 per cent by considering recommended dose of nitrogen (40 kg ha^{-1}). The phosphorus through single super phosphate and potassium via muriate of potash were mixed thoroughly in soil before sowing. Further 50% N either through urea or cattle urine was applied as basal dose and remaining at 30 DAS. The substitution of cattle urine was done on the basis of nitrogen concentration. The quantity of cattle urine were 67, 135, 202 and 270 mls were used for the substitution of 25, 50, 75 and 100 per cent nitrogen. As per the treatments, calculated quantity of cattle urine was diluted ten times with tap water and applied uniformly over the soil. Sowing with ten seeds of spinach (Cv.All green) completed equidistantly in each pot. Plant height and number of leaves were measured periodically at 15, 30, 45 and 60 DAS. While chlorophyll content was also analyzed periodically at 15, 30, 45 and 60 DAS by selecting third leaf from top. (REFERENCE). Leaf area of fully grown and opened functional leaves from five randomly selected spinach plants per pot were measured by using graph paper tracing technique and expressed in cm^2. Further fully grown spinach leaves for yield and dry matter were harvested at 45 and 60 DAS.

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Table 1: Chemical composition of cattle urine

Sr. no.	Parameters	Content

1	pH	7.90
2	EC (dS m^{-1})	20.41
3	Nitrogen (%)	0.05
4	Phosphorus (%)	0.004
5	Potassium (%)	0.03
6	Calcium (%)	0.08
7	Magnesium (%)	0.062
8	Sulphate (%)	0.035
9	Iron (ppm)	27.92
10	Manganese (ppm)	8.52
11	Zinc (ppm)	2.38
12	Cupper (ppm)	1.78
13	Chloride (ppm)	240

Results and discussion

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Soilreaction(pH)oflateriticsoilwasmeasuredat first(46 DAS)andsecond(70DAS)cutofspinach and it was ranged from 5.67 to 7.67 and 5.6 to 6.40 however for EC 0.79 to 1.01 and 0.32 to 0.48 d Sm^{-1} respectively**(Table 2)**. Itcanbeobserved fromthedatathat soil pHat first cut was decreased in absolute control (6.13), RDF (5.90),GRDF (5.67) over initial (6.2). However, inthose treatments where cattle urine was applied for nitrogen substitution recorded increase in thepH of lateritic soil. Significantly higher pH (7.67) of lateritic soil reported with the application of100% RDN through cattle urine which was closely followed and statistically on par with 25%RDN + 75 % RDN through cattle urine (7.10) Non-significant result for pH at second cut ofspinach were reported for treatment under study.Increase in soil pH was reported in cattle urine applied treatments which might be due to high pH (7.9) ofcattle urine at the time of application. Further cattle urine also contains appreciable amount ofbasic cations like calcium, magnesium, sodium and potassium. Bristow et al., (1992), Bhadauria(2002)andNwite(2013).Sredevi~~ G~~ and~~.,~~Srinivasmurthy~~C.A ~~(2009) also reported higher pH and EC of lateritic soil with the sole application of human urine.

Application of 100 % RDN through cattle urine recorded significantlyhigher (1.01dsm^{-1}) electrical conductivity of soil which was closely followed and statistically atpar with application of 25% RDN + 75 RDN through cattle urine (1.00 d Sm^{-1}), GRDF (40:40:40$Kgha^{-1}$N, P_2O_5andK_2O+10tha^{-1}FYM) (0.95dsm^{-1}) and50% RDN+50%

RDNthroughcattleurine (0.90 d Sm^{-1}). Decreasing trend and non-significant result for electrical conductivity wasrecorded at second cut. The electrical conductivity of soil was higher at first cut (46 DAS) andthereafteritwasreducedinsecondcut.Magnitudeofincreaseinelectricalconductivitywasfoundhigherinthosetreatmentreceivedcattleurinefornitrogensubstitution.Thismightbeduetohigherelectrical conductivity of cattle urine (20 d Sm^{1}) at the time of application. However, increase intheelectricalconductivityofsoilotherthancattleurineapplicationmightbeascribedtoirrigationwater having EC 0.2 d Sm^{-1}. Increase in the soil EC of treatment received cattle urine for nitrogensubstitution might be due to the presence of appreciable amount of basic cations and salts ofbicarbonateofcalcium,magnesium, sodium,andpotassium.Similarresultswerealsoreportedby Swati *et al.*,(2018).

Organic carbon and calcium carbonate

Application of nitrogen through ureaandcattleurinesignificantlyinfluencedorganiccarboninlateriticsoilatfirstandsecondcutofspinach**(Table 3)**.Therangeof organic carbon content was 0.88 to 1.40 percent and 0.57 to 1.07 percent at first cut (45 DAS)andsecondcut(70DAS)ofspinachinlateriticsoilrespectively.Significantlyhigher(1.40%)and(1.07 %) organic carbon in lateritic soil was reported with the application of 100 % RDN throughcattle urine at first and second cut of spinach. Which was found to be on par with the applicationof25%RDN+75%RDN(1.32and 1.00%)andGRDF(1.27 and1.04%)atfirstand second cutof spinach respectively. Organic carbon content in lateritic soil was found to be increased in allthe treatment except absolute control (0.88%) and RDF (0.93) over initial (0.87 %) at first cut ofspinach but reduced at second cut of spinach. In case of GRDF (1.27 and 1.04 %) organic carbonwas found to be higher at first and second cut of spinach. Higher organic carbon in cattle urineappliedtreatmentatfirstcutofspinachduetohighersuspendedorganicmatterpresentinthecattle urine.Furtherreductiontrendinorganiccarbon atsecondcutofspinachmightbeduetothelossofCO_2duringtheoxidationoforganicmatter.However,incaseofGRDFtreatmenthigherorganiccarbonatfirstandsecond cutmightbeduetoascribedbytheapplicationofFYM@10tha^{-1}.

Cattleurinecontainssuspendedorganicmatterwhichmightbethereasonforhigher organic carbon in soil at first cut. However, application of GRDF (40:40:40 Kg ha^{-1} N, P_2O_5

andK$_2$O+10tha^{-1}FYM)alsoreportedhigherorganiccarboninsoilduetoFYM. Reductiontrendinsoil organic carbon at second cut in all cattle urine applied treatment also reported due to the lossofcarbonintheformofCO$_2$duringtillageoperationanddecompositionoforganicmatter(Reena Sharma et al., 2016).Calcium carbonate content in lateritic soil at both the cuts of spinach were recorded non-significant result due to the application of nitrogen through fertilizer and cattle urine.

Soil available nutrients

Significantlyhigher(253.93kgha^{-1})soilavailablenitrogen (253.93 and 184.97 kgha^{-1}), phosphorus (30.72 and 29.10 kgha^{-1}) and potassium (313.43 and 303.00 kgha^{-1}) were recorded at first and second cuts of spinach with the application of 100% RDN through cattleurine respectively**(Table 4)**. Soil available nitrogen was found increased inall the treatments except absolute control (155.73 Kg ha^{-1}), RDF (176.60 kg ha^{-1}) and GRDF(187.06kgha^{-1})over initial(235.2.kgha^{-1}).Whilesoilavailablephosphorouswasincreasedinallthe treatments over initial (14.13 kg ha^{-1}) at first cut of spinach. Similar increase in trend in soilavailablepotassiumreportedinallthe treatmentsexceptabsolute controlatfirstcut. Further it could be noticed from the data that availability nitrogen, phosphorus and potassium in soil were decreased at second cut of spinach taken at 45 DAS which might be ascribed to uptake by spinach.

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Significantimprovements for total nitrogen available phosphorus and exchangeable calcium and magnesiumwith the application of urine in maize cultivation were reported by Veeresha*et al.*,(2014). TheyconcludedthatapplicationofFYM@12tha^{-1}alongwithcattleurine@34.300litha^{-1}wasfoundsuperiorforhighersoilavailabilityofnitrogen,phosphorous,andpotassium. Powelletal.,(1998)studied urine effect on soil properties under pear millet cultivation and concluded that urineapplication for nitrogen substitution had positive effect on pH, nutrient availability and yield ofpearlmillet.Increaseinthesoilavailabilityofnitrogenandpotassiumwiththeapplicationofcattleurine was reported by Khanal*et al.*(2013).

DTPA Fe, Mn, Zn and Cu in lateritic soil as influenced by nitrogen application through cattle urine andureawererangedfrom8.39to24.30and17.81to21.70mgkg^{-1}, 16.94 to 23.39 mgkg^{-1} and 17.81 to 21.70 mgkg^{-1}, 3.06 to 7.09 and 2.41 to 3.84mgkg^{-1} and 10.22 to

12.01 and 6.32 to 9.12 mgkg^{-1}atfirstandsecondcutofspinach respectively. **(Table 5 and 6)**Significantly higher DTPA Fe (26.55 and 24.30 mg kg^{-1}), Mn (23.39 and 21.70 mg kg^{-1}), Zn (7.09 and 3.84 mg kg^{-1}) and Cu (12.01 and 9.12 mg kg^{-}1) were recorded with the application of100%RDNthoroughcattleurine**(Table 5)**. Further it can be seen from the data that DTPA availability of metallic micronutrients were higher in those treatments received cattle urine for either substitution of nitrogen @ 25,50, 75 or 100 percent.

The concentration of DTPA extractable Fe, Mn, Zn and Cu was higher at first cut while itwas decreased at harvest (second cut) which might be due to the uptake by spinach crop andalkalinity formed by the application of cattle urine for the substitution of nitrogen. Addition ofcattleurinecontainingFe(27.92mgkg^{-1}), Mn(8.52mgkg^{-1}),Zn(2.38mgkg^{-1})andCu(1.78mgkg^{-1}) for the substitution of nitrogen might have increased their concentration at first cut overinitial.Furtherorganiccarboncontentinthecattleurinemighthaveenhancedmicrobialpopulationinthesoilwhich leads tohigherDTPAmetallicmicronutrientavailabilityatfirstcut.

Further the increasein soil pH(Table 8.1) followed by urine application may haveenhancedsoilorganicmatterdegradation(Shandetal,2000and2002).StevensonandCole(1999)also reported release of metallic micronutrient in soil from organometallic complex. Further theyconcluded that the addition of cations through urine could have displaced some metal ions fromsoil cation exchange sites so that they were temporarily solubilized before being reabsorbed onexchangesiteortakenupbyplantormicrobes.Micronutrientsavailabilityandbuildupinsoilwashigherwithcattleurineapplicationwhichmightbeduetoenhancedmicrobialpopulation.Furthercattle urine used in experiment was rich in organic carbon which acts as a food for microbesthereby acceleration in native microbial population which enhances the rate of decompositionresultinginbettertransformationofnutrientandtherebyenhanceditsbuildupinsoil.(PathakandRam,2013).Similarresults werealsorecordedbyKansaletal.,(1981).

Conclusions:

It could be concluded from the present study that cattle urine can be used as a liquid source of nitrogen in lateritic soil. Application of 100% RDN through cattle urine was found beneficial for soil available nutrients and DTPA extractable metallic micronutrients.

References

Bhadauria H, (2002), Cow Urine – A Magical Therapy. Vishwa Ayurveda Parishad. *International journal of Cow Science*,1:32-36

Bray, RH & Kurtz, LT 1945, Determination of total, organic, and available forms of phosphorus in soils. Soil Science, 59: 39-45.

Bristow AW, Whithead DC, Cockburn JE (1992) Nitrogenous constituents in the urine of cattle, sheep and goats. J. of Sci.Food andAgril., 59.387-394.

Kansal B. D. Singh B, Bajaj K.,L. and ~~G.~~ Kaur G. (1981). Effect of different levels of nitrogen and farm yard manure on yield and quality of spinach.Qualitas Plantarum Plant Foods for Human Nutrition 31(2):163-170

Khanal, A., Shakya, S.M. and Sharma, S.C. (2013) Utilization of urine waste to produce quality cauliflower. *The J. of Agril. and Environ.* 12,91-96.

Knudsen, D., Peterson, G.A. and Pratt, P.F. (1982) Lithium, sodium potassium. *In: Methods ofSoil Analysis*,part-2.Page,A.L.(Ed.)Madison,Wisconsin,USA,225-245.

Nwite, J.N. (2015) Effect of different urine sources on soil chemical properties and maize yield in Abakaliki, South eastern Nigeria. *Intl. J. of Ad.Agril. Res.*3,31-36.

Pathak, R. K. and R.A.Ram (2013) Bio-enhancers: A potential tool to improve soil fertility, planthealth inorganic production of horticultural crops. *Progressive Horticulture* 44,237-254.

Powell, J.M., IKpe, F.N., Somda Z. C. and Fernandez-Rivera S. (1998) Urine effects on soil chemical properties and the impact of urine and dung on pearl millet yield. Expt.Agril. 34,259-276.

Reena Sharma, Shree Chandra Shah, Keshav Raj Adhikari, Pradeep Shah and Jiban Shrestha (2016) Effect of cattle urine and FYM on Yield of Broccoli and soil properties. J. of AgriSearch 3 (3):157-160.

Sadhukhan,R.,Bohra,J.S.andChoudhury~~,~~S.(2018)Effect offertilitylevelsandcowurinefoliarspray on growth and yield of wheat. *Int.l J. of Curr.Microb. andApp.Sci.*7,907-912.

Shand C.A., Williams, Smith S and ~~M.E.~~ Young M.E. (2000) Temporal changes in Carbon, Phosphorusand nitrogen concentration in soil solution following application of synthetic sheep urinetosoilundergrass, Plantand Soil.222:1-3.

Shand C.A., Williams, Smith S and ~~M.E.~~ Young M.E. (2002) Sheep urine affects soil solution nutrient composition and roots; difference between field and sward box soils and the effects of synthetic and natural sheep urine. Soil Biol. and Biochem. 34 (2) 163-171.

Sredevi G.,Srinivasmurthy C.A(2009) Influence of human urine combined with farm yard manure and chemical fertilizer on french bean and maize cropping sequence in

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lateritic soils of Karnataka,India. Intel J. of Plant Pro. 1735-6814.
StevensonF.J. andM.A.ColeM.A.(1999)Micronutrientsandtoxicmetals,p.369-418
Subbiah, B.V. and Asijia, G.L. (1956) A rapid procedure for the estimation of available nitrogeninsoils.*CurrentScience*25,259-260.

Swati Swayamprabha Pradhan, S., Verma, S., Kumari, S. and Yashwant Singh. (2018) Bio-efficacy of cow urine on crop production: A review *Intl. J. of Chem. Studies*6,298-301.

VeereshaSharanappa and P. GopakkaliP. (2014) Effect of organic production practices on yield andsoil health of irrigated maize as influenced by various levels of FYM and cattle urine application. *Environ.and Ecol.* 32,627-630.

Table:2 EffectofsoilapplicationofcattleurineandnitrogenlevelsonpHandelectricalconductivityoflateriticsoilunder spinachcultivation

Treatment	pH(1:2.5)		EC(dSm^{-1})	
	Ist Cut	IInd Cut	Ist Cut	IInd Cut
Absolutecontrol	6.13	6.03	0.79	0.32
RDF(40:40:40 kgha^{-1})	5.90	6.17	0.78	0.45
GRDF(40:40:40kg ha^{-1})+ 10t ha^{1}	5.67	5.6	0.95	0.43

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75%RDN+25% RDN: CU	6.20	5.67	0.80	0.38
50%RDN+50% RDN: CU	6.43	5.77	0.90	0.39
25%RDN+75% RDN: CU	7.10	6.03	1.00	0.40
100% RDN: CU	7.67	6.40	1.01	0.48
SE$\pm$	0.283	0.236	0.057	0.075
CDat 5%	0.867	N/S	0.174	N/S
Initial–soil(1:2.5)	6.2	-	0.23	-
Cattleurine(d Sm^{-1})	7.9	-	20.00	-

Table: 3 Effectofsoilapplicationofcattle urineandnitrogenlevelsonorganiccarbonandcalciumcarbonatecontent oflateritic soil underspinach cultivation.

Treatment	Organiccarbon(%)		$CaCO_3$(%)	
	I[st] Cut	II[nd] Cut	I[st] Cut	II[nd] Cut
Absolutecontrol	0.88	0.57	4.00	2.67
RDF(40:40:40 $kgha^{-1}$)	0.93	0.70	5.53	4.93
GRDF(40:40:40$kgha^{-1}$)+ 10t ha^{1}	1.27	1.04	5.30	4.83
75%RDN +25% RDN: CU	1.12	0.95	4.13	3.13
50%RDN +50% RDN: CU	1.27	0.97	4.50	3.60
25%RDN +75% RDN: CU	1.32	1.00	5.57	5.20
100% RDN: CU	1.40	1.07	8.57	5.57
SE $\pm$	0.078	0.041	1.282	0.818
CDat5%	0.24	0.127	N/S	N/S
Initial–soil(%)	0.87	-	2.67	-
-Cattleurine(Cappm)	1.67	-	800	-

Table: 4 Effectofsoilapplicationofcattle urineandnitrogenlevelsonavailablenitrogen,phosphorusandpotassiuminlateriticsoilunderspinachcultivation

Treatments	Nitrogen (kg ha^{-1})		Phosphorous (kgha^{-1})		Potassium (kgha^{-1})	
	Ist Cut	IInd Cut	Ist Cut	IInd Cut	Ist Cut	IInd Cut
Absolutecontrol	155.73	142.83	15.35	12.93	141.53	115.17
RDF(40:40:40 kgha^{-1})	176.60	145.60	16.98	14.55	247.71	291.60
GRDF(40:40:40 kgha^{-1})+10tha^{1}	187.06	166.87	24.25	20.21	349.63	334.67
75%RDN+25%RDN: CU	236.20	165.13	26.68	22.64	266.00	239.80
50%RDN+50% RDN: CU	246.77	168.30	28.29	28.29	279.43	263.67
25%RDN+75% RDN: CU	245.63	174.53	29.86	29.11	282.70	274.67
100% RDN: CU	253.93	184.97	30.72	29.10	313.43	303.00
SE ±	6.227	5.736	1.858	1.756	33.172	19.611
CDat5%	19.071	17.567	5.689	5.378	101.59	60.06
Initial soil(kgha^{-1})	235.2	-	14.13	-	204.96	-
Cattle urine (%)	0.05	-	0.004	-	0.03	-

Table:5 : Effect of soil application of cattle urine and nitrogen levels on iron and manganeses availability in lateritic soil under spinach cultivation.

Treatment	Fe(mgkg^{-1})		Mn(mg kg^{-1})	
	Ist Cut	IInd Cut	Ist Cut	IInd Cut
Absolutecontrol	18.39	20.92	16.94	17.81
RDF(40:40:40 kgha^{-1})	20.62	22.80	20.36	18.61
GRDF(40:40:40kgha^{-1})+ 10t ha^{1}	25.09	26.39	22.87	20.36
75%RDN +25% RDN: CU	20.84	22.56	21.48	18.82
50%RDN +50% RDN: CU	21.62	25.54	21.84	19.43
25%RDN +75% RDN: CU	22.73	25.81	22.61	20.09
100% RDN: CU	24.30	26.55	23.39	21.7
SE ±	0.697	0.99	0.54	0.441
CDat 5%	2.135	3.032	1.655	1.352
Initial-Soil	32.40	-	26.2	-
Cattleurine	27.92	-	8.52	-

Table: 6: Effect of soil application of cattle urine and nitrogen levels on Zinc and copperavailabilityinlateritic soilunderspinachcultivation.

Treatment	Zn(mgkg^{-1})		Cu (mg kg^{-1})	
	Ist Cut	IInd Cut	Ist Cut	IInd Cut
Absolutecontrol	3.06	2.41	10.22	6.32
RDF(40:40:40kgha^{-1})	4.25	2.51	10.52	7.96
GRDF(40:40:40 kg ha^{-1})+10t ha^{1}	6.43	2.83	11.31	8.74
75%RDN+25% RDN: CU	3.85	2.67	10.92	8.37
50%RDN+50% RDN: CU	5.70	2.69	11.16	8.63
25%RDN+75% RDN: CU	5.95	2.92	11.31	8.67
100% RDN: CU	7.09	3.84	12.01	9.12
SE	0.082	0.233	0.136	0.31
CDat5%	0.252	0.714	0.416	0.95
Initial–Soil(ppm)	2.8	-	17.5	-
cattleurine(ppm)	2.38	-	1.78	-

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