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Effect of Soil Application of Cattle Urine on Growth and Yield of Spinach in Lateritic Soil

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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.

Application of GRDF and RDF recorded significantly higher plant height and at 15 DAS. While application of 100% RDN through cattle urine recorded significantly higher spinach plant height which was closely followed by 75% RDN + 25 % RDN through cattle urine and 25% RDN + 75 % RDN through cattle urine. Application of GRDF (40:40:40 kg ha^{-1} N, P_2O_5 and K_2O + 10 t ha^{-1} FYM) reported significantly higher plant height (6.10 cm) which was statistically at par with RDF (40:40:40 kg ha^{-1} N, P_2O_5 and K_2O) (5.5 cm) and 75% RDN through cattle urine (4.90 cm) at 15 DAS. But at 60 DAS significantly higher (29.83 cm) plant height of spinach was recorded in the treatment received 100 % RDN through cattle urine which was statistically at par with all other treatments except absolute control. Significantly higher leaf area (104.67 cm^2) of spinach was recorded with the application of 100% RDN through cattle urine which was found to be on par with the application of 25 % RDN +75 % RDN through cattle urine (100.33 cm^2), 50 % RDN + 50 RDN through cattle urine (88.00 cm^2) and 75% RDN + 25 % RDN through cattle urine (85.00 cm^2) at 60 DAS of spinach.

The magnitude of increase in leaf area (49.33 to 100 cm^2) was found higher with the application of 25 % RDN + 75% RDN through cattle urine than application of 100% RDN through cattle urine (63 to 104.67 cm^2).Cattle urine application for the substitution of 100 % RDN through cattle urine reported five times increase in leaf area over control while 1.5 times over GRDF (40:40:40 kg ha^{-1} N, P_2O_5 and

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K_2O + 10 t ha^{-1} FYM) at 45 DAS. Chlorophyll content in spinach was found to be increased in all the periods studied with the application of cattle urine for substitution of nitrogen either @ 100 ,75, 50, and 25 % while chlorophyll content was found to be increased from 30 DAS to 45 DAS. Yield of spinach was significantly higher (117.29 and 281.63 g pot^{-1}) with application of 100% RDN through cattle urine which was statistically at par with GRDF (40:40:40 kg ha^{-1} N, P_2O_5 and K_2O + 10 t ha^{-1} FYM) (101.71 and 188.90 g pot^{-1}) at first and second cut.

Keywords Cattle urine, Spinach, Yield, Lateritic soil.

INTRODUCTION

Integrated nutrient management system not only offers balanced fertilization but also maintain soil health. Among the different components of integrated nutrient management, organic sources of nutrients like are having paramount importance in good soil health. In the Integrated nutrient management organic component, that too locally and easily available may be either solid or liquid in the country and in every state need to include after assessing their composition. In case of liquid organic sources like cattle urine, pig urine, sheep and goat urine or even human urine can also be used under integrated nutrient management. The cattle urine can be included in the integrated nutrient management component as a source of not only nutrients but also growth promoting substances. In India farmers pay good attention for the collection and utilization of cattle dung in the form of farm yard manures but very little or no attention has been given in collection and utilization of cattle urine. Further in India almost every farmer is having cow, buffalo, goat, sheep for his daily livelihood. Therefore, with 2 cows per farmer approximately 10-15 l of urine is being produced daily which contains 1 kg nitrogen, 0.5 kg phosphorus and 1 kg potassium so, the liquid waste from cattle must be assessed for its utilization either through soil or foliar application for different crops in various soils. Hence it is necessary to tap this important source of nutrients along with growth promoting substances. Cattle urine contains 95 % water, 2.5 % urea and 2.5 % minerals, hormones and enzymes. Total nitrogen in cattle urine ranged from 6.8 to 21.1 g N lit^{-1} of which on an average 69% was urea 7.3% allontoin, 5.8% uric acid, 0.5% zanthin + hypozanthin nitrogen and % as ammonia (Sandukhan *et al*. 2018). Mostly pH of cattle urine reported to be alkaline in nature so it can be used as source of nutrient and overall growth promoting substances on slightly acidic soil. The use of urine as source of nutrients has been tested, gaining popularity and accepted partially in Finland, South Africa, Israel, Sweden and China (Pradhan *et al*. 2009).

Spinach is the most important leafy vegetable grown all over the world along with Indian subcontinent. It is rich in nutrients, minerals, vitamins, carbohydrates, dietary fiber, proteins and water. Further, spinach is an excellent source of vitamin A, vitamin C, vitamin K, folic acid, iron and calcium. Therefore, considering the present scenario, an experiment was conducted to assess the effect of soil application of cattle urine and nitrogen levels on growth and yield of spinach in lateritic soil.

MATERIALS 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 from Agricultural Research Station, Radhanagari Tal. Radhanagari Dist Kolhapur. The soil was processed by pounding, grounding and allowed to pass through 2 mm 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 color 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, Bray-Kurtz-P and NH_4OAC-K 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% 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 (Table 1). The quantity of cattle urine were 67, 135, 202 and 270 mls were used for the substitution of 25, 50, 75 and 100% 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. 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.

Table 1. Chemical composition of cattle urine.

Sl. 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

It could be observed from the data (Table 2) that application of cattle urine for the substitution of nitrogen either @ 25, 50, 75 and 100 % were recorded lower plant height than that of RDF (40:40:40 kg ha^{-1} N, P_2O_5 and K_2O) and GRDF (40:40:40 kg ha^{-1} N, P_2O_5 and K_2O + 10 t ha^{-1} FYM) up to 30 DAS. The height of spinach measured at 15 and 60 DAS were influenced significantly due to the application of cattle urine for nitrogen substitution along with nitrogen levels while non-significant result were recorded for height at 30 and 45 DAS. Significantly higher (6.10 cm) height was reported with the application of GRDF (40:40:40 kg ha^{-1} N, P_2O_5 and K_2O + 10 t ha^{-1} FYM) which was closely followed by RDF (40:40:40 kg ha^{-1} N, P_2O_5 and K_2O) (5.5 cm).

Number of leaves and leaf area of spinach at 15, 30, 45 and 60 DAS was significantly influenced by the soil application of cattle urine (Tables 3 and 4). However plant height of spinach was significantly influenced at only 15 and 30 DAS. Application of GRDF (40:40:40 kg ha^{-1} N, P_2O_5 and K_2O + 10 t ha^{-1} FYM) reported significantly higher plant height (6.10 cm) which was statistically at par with RDF (40:40:40

Table 2. Effect of soil application of cattle urine and nitrogen levels on plant height of spinach in lateritic soils.

Treatments	Plant height (cm)			
	15 DAS	30 DAS	45 DAS	60 DAS
Absolute control	3.2	9.50	24.57	20.47
RDF (40:40:40 kg ha^{-1})	5.50	11.40	21.90	26.00
GRDF (40:40:40 kg ha^{-1}) + 10 t ha^1	6.10	11.97	22.57	27.20
75% RDN + 25% RDN through cattle urine	4.90	10.20	25.53	27.60
50% RDN + 50% RDN through cattle urine	4.4	9.67	25.60	27.13
25% RDN + 75% RDN through cattle urine	3.93	9.93	24.23	29.30
100 % RDN through cattle urine	3.37	11.37	25.93	29.83
SE ±	0.421	1.053	1.95	0.808
CD at 5%	1.288	N/S	N/S	2.475

Table 3. Effect of soil application of cattle urine and nitrogen levels on number of leaves of spinach grown in lateritic soil.

Treatments	Number of leaves (per plant)			
	15 DAS	30 DAS	45 DAS	60 DAS
Absolute control	3	5	8.67	5.67
RDF (40:40:40 kg ha^{-1})	3.67	6.33	9.67	7.33
GRDF (40:40:40 kg ha^{-1}) + 10 t ha^{1}	4	6.67	11.33	8.67
75% RDN + 25% RDN through cattle urine	3.67	6.00	11	7.33
50% RDN + 50% RDN through cattle urine	4	6.67	12.33	8.00
25% RDN + 75% RDN through cattle urine	4	6.67	12	7.67
100 % RDN through cattle urine	4	7.00	13	8.33
SE ±	0.178	0.333	0.701	0.535
CD at 5%	0.546	1.021	2.148	1.637

kg ha^{-1} N, P_2O_5 and K_2O) (5.5 cm) and 75% RDN through cattle urine (4.90 cm) at 15 DAS. But at 60 DAS significantly higher (29.83 cm) plant height of spinach was recorded in the treatment received 100 % RDN through cattle urine which was statistically at par with all other treatments except absolute control.

Significantly higher leaf area (104.67 cm^2) of spinach was recorded with the application of 100% RDN through cattle urine which was found to be on par with the application of 25 % RDN +75 % RDN through cattle urine (100.33 cm^2), 50 % RDN + 50 RDN through cattle urine (88.00 cm^2) and 75% RDN + 25 % RDN through cattle urine (85.00 cm^2) at 60 DAS of spinach (Table 4). The magnitude of increase in leaf area (49.33 to 100 cm^2) was found higher with the application of 25 % RDN + 75% RDN through cattle urine than application of 100% RDN through cattle urine (63 to 104.67 cm^2). Cattle urine application for the substitution of 100 % RDN through cattle urine reported five times increase in leaf area over control while 1.5 times over GRDF (40:40:40 kg ha^{-1} N, P_2O_5 and K_2O + 10 t ha^{-1} FYM) at 45 DAS. However, at 60 DAS leaf area of spinach were found to be increased three times and almost more than two times with application of 100 % RDN through cattle urine, 25% RDN + 75 % RDN through cattle urine, 50 % RDN + 50 % RDN through cattle urine, 75 % RDN + 25% RDN through cattle urine over control.

Table 4. Effect of soil application of cattle urine and nitrogen levels on leaf area of spinach grown in lateritic soil.

Treatments	Leaf area (cm^2)	
	45 DAS	60 DAS
Absolute control	26.00	44.33
RDF (40:40:40 kg ha^{-1})	44.00	46.33
GRDF (40:40:40 kg ha^{-1}) + 10 t ha^{1}	50.67	58.00
75% RDN + 25% RDN through cattle urine	46.00	85.00
50% RDN + 50% RDN through cattle urine	51.00	88.00
25% RDN + 75% RDN through cattle urine	49.33	100.33
100 % RDN through cattle urine	63.00	104.67
SE±	6.034	10.79
CD at 5%	18.48	33.062

Chlorophyll content was found to be increased in all the treatments at 30, 45 and 60 DAS over absolute control treatment (Table 5). Higher values of chlorophyll in spinach were recorded at 45 DAS than 30 and 60 DAS in all the treatment under study. Further, chlorophyll content was found increased consistently from 30 to 45 DAS in all treatments. The magnitude of increase in chlorophyll content was found higher with the application of GRDF (40:40:40 kg ha^{-1} N, P_2O_5 and K_2O + 10 t ha^{-1} FYM) followed by 75 % RDN + 25 % RDN through cattle urine and 100 % RDN through cattle urine. Application of 25 % RDN + 75% RDN through cattle urine recorded significantly higher chlorophyll content which was found to be at par with application of 100 % RDN through cattle urine (38.61 mg/100 gm), 50% RDN + 50% RDN through cattle urine (35.33 mg/100 g) 75% + 25 %

Table 5. Effect of soil application of cattle urine and nitrogen levels on chlorophyll content in spinach grown in lateritic soil.

Treatments	Chlorophyll (mg/100 g)		
	30 DAS	45 DAS	60 DAS
Absolute control	25.00	26.67	21.00
RDF (40:40:40 kg ha^{-1})	26.33	31.67	25.67
GRDF (40:40:40 kg ha^{-1}) + 10 t ha^{1}	27.67	34.33	27.67
75% RDN + 25% RDN through cattle urine	28.00	33.67	27.33
50% RDN + 50% RDN through cattle urine	32.61	35.33	28.33
25% RDN + 75% RDN through cattle urine	36.67	39.33	29.33
100 % RDN through cattle urine	33.33	38.67	31.67
SE ±	1.30	1.558	1.48
CD at 5%	3.99	4.773	4.533

RDN through cattle urine (33.67 mg/g) and GRDF (40:40:40 kg ha^{-1} N, P_2O_5 and K_2O + 10 t ha^{-1} FYM) (34.33 mg/100 g) at 45 DAS. Whereas at 30 DAS, 25 % RDN + 75 % RDN through cattle urine treatment recorded higher chlorophyll content (36.67 mg/100 g) which was statistically at par and closely followed by 100 % RDN through cattle urine (33.33 mg/100 g) and 50 % RDN + 50 % RDN through cattle urine (32.61 mg/100 g). However, chlorophyll content in spinach was found significantly higher (31.67) with the application of 100 % RDN through cattle urine which was on par with 25 % RDN + 75 % RDN through cattle urine (29.33), 50 % RDN + 50 % RDN through cattle urine (28.33), 75 % RDN + 25 % RDN through cattle urine (27.33) at 60 DAS. Chlorophyll content in spinach was found to be increased in all the periods studied with the application of cattle urine for substitution of nitrogen either @ 100, 75, 50 and 25 % while chlorophyll content was found to be increased from 30 DAS to 45 DAS.

The reduction trend in plant height at initial period might be due to alkaline pH (7.9) of cattle urine during application which disturbed availability of nutrient to plants from soil. However, at later period decomposition process of organic matter present in soil and cattle urine might have reduced pH of soil and increased nutrient availability thereby enhanced plant might at 60 DAS. Further cattle urine not only contains mineral nutrients essential for plant growth but also contains auxins that may have exerted hormonal effect on the cell elongation there by increase plant height. Similar results were also reported by Yogeeshappa and Srinivasamurthy (2017) for 24 tomato in red, lateritic and black soils of Karnataka. This result are in accordance with Jonson *et al*. (1997). Pichardo *et al*. (2001). Sridevi *et al*. (2009). Application 100% RDN through cattle urine synthesized higher chlorophyll content which might be due to presence of calcium, magnesium potassium and some trace elements enhanced photosynthetic activity. Similar result for maize (fodder) was also reported by Janjal *et al*. (2020).

Yield and dry matter

The effect of soil application of cattle urine for nitrogen substitution along with nitrogen levels through urea in lateritic soil were assessed for yield of spinach at first cut (46 DAS) and second cut (70 DAS) (Table 6). It could be observed from the data spinach yield was ranged from 25.87 to 117.29 g pot^{-1} for first cut and 113.20 to 281.63 g pot^{-1} at second cut as influenced by nitrogen substitution through cattle urine and urea. Yield of spinach was significantly higher (117.29 g pot^{-1}) with application of 100% RDN through cattle urine which was statistically at par with GRDF (40:40:40 kg ha^{-1} N, P_2O_5 and K_2O + 10 t ha^{-1} FYM) (101.71 g pot^{-1}) at first cut. Similar treatment (100 % RDN through cattle urine) reported significantly higher (281.63 g pot^{-1}) yield of spinach which was found to be at par with 25 % RDN + 75 % RDN through cattle urine (273.03) , 50 % RDN + 50 % RDN through cattle urine (219.70 g pot^{-1}), 75% RDN + 25 % RDN cattle urine and GRDF (40:40:40 kg ha^{-1} N, P_2O_5 and K_2O + 10 t ha^{-1} FYM) (188.90 g pot^{-1}). The yield of spinach recorded in first cut was found higher in all the treatment than second cut. The fresh yield of spinach obtained with application of 100% RDN through cattle urine, 75 % RDN through cattle urine and GRDF (40:40:40 kg ha^{-1} N, P_2O_5 and K_2O + 10 t ha^{-1} FYM) reported almost 4 to 4.5 times higher yield than absolute control at first cut. In case of second cut 100 % RDN through cattle urine recorded 1.5 times higher yield than GRDF (40:40:40 kg ha^{-1} N, P_2O_5 and K_2O + 10 t ha^{-1} FYM) and 2.5 times than absolute control.

Table 6. Effect of soil application of cattle urine and nitrogen levels on fresh yield and dry matter of spinach grown in lateritic soil.

Treatments	Yield (g pot^{-1})		Dry matter (g pot^{-1})	
	First cut	Second cut	First cut	Second cut
Absolute control	25.87	113.20	5.46	6.31
RDF (40:40:40 kg ha^{-1})	60.87	183.00	5.94	6.56
GRDF (40:40:40 kg ha^{-1}) + 10 t ha^{1}	101.71	188.90	7.78	7.85
75% RDN + 25% RDN through cattle urine	53.90	216.10	7.87	7.93
50% RDN + 50% RDN through cattle urine	60.37	219.70	7.96	8.62
25% RDN + 75% RDN through cattle urine	92.83	273.03	8.13	8.98
100 % RDN through cattle urine	117.29	281.63	9.58	13.07
SE ±	10.456	30.58	0.533	1.001
CD at 5%	32.023	93.66	1.634	3.064

Devakumar *et al*. (2014) reported higher store yield of maize with the application of panchgavya and cow urine. However, Powell *et al*. (1998) also concluded that urine application for nitrogen substitution had positive effect on pH, nutrient availability and yield of pearl millet.

Dry matter accumulation in spinach as influenced by nitrogen substitution through cattle urine and urea was ranged from 5.46 to 9.58 g pot^{-1} at first cut while 6.31 to 13.07 g pot^{-1} at second cut. Dry matter accumulation in spinach was found slightly higher than that of first cut (46 DAS) however the magnitude of increase was reported to be higher (9.58 to 13.07 g pot^{-1}) with the application of 100 % RDN through cattle urine. Application of 100% RDN through cattle urine recorded significantly higher dry matter accumulation (9.58 g pot^{-1}) which was statistically on par with the application of 25 RDN + 75 % cattle urine (8.13 g pot^{-1}) at first cut. However, at second cut of spinach 100 % RDN through cattle urine reported significantly higher dry matter than rest of the treatment. Similarly application of 25 % RDN + 75 % RDN cattle urine (8.98 g pot^{-1}) and GRDF (40:40:40 kg ha^{-1} N, P_2O_5 and K_2O + 10 t ha^{-1} FYM) (8.85 g pot^{-1}) were reported almost similar dry matter at second cut. As evident from experimental findings that the application of nitrogen increased the growth and dry matter production of spinach grown in lateritic soil. Cattle urine was further effective in increasing the growth and yield of spinach. The increased growth and dry matter is produced due to efficient availability of nitrogen from soil and its ultimate uptake and translocation to the different part of plant. Many research worker like Mirza and Reddy (1989), Kumar *et al*. (1996), Singh *et al*.(2008) and Manoj Kumar Singh (2014) reported similar results. Soil and leaf fertilization of lettuce crop with cow urine was studied by Nelson *et al*. (2009) and reported consistent increase the performance of lettuce in terms of fresh leaf mass, dry leaf mass, stem mass, stem length, fresh and dry root mass with enhanced concentration of cattle urine. They also concluded that the highest yield was obtained with the concentration of 1.25 % (17 t ha^{-1}) applied to leaves with 1.01 (14.92 t ha^{-1}) applied to soil than control. Sandhukhan *et al*. (2018) reported that application of 50, 75 and 100 % cow urine spray recorded 2.69, 18.01, and 27.21 % higher grain yield of wheat. Reena Sharma *et al*. (2016) studied cattle urine effect on broccoli and concluded that foliar application of cattle urine 150 kg ha^{-1} recorded higher biological yield followed by soil application.

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