

Original Research Article

Effect of Soil Application of Cattle Urine and Nitrogen Levels on Growth, Yield and Nutrient Uptake by Maize (Fodder) in Inceptisol

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ABSTRACT

The experiment was conducted to study the effect of soil application of cattle urine and nitrogen levels on growth, yield and nutrient uptake by maize (fodder) in Inceptisol at the Division of Soil Science and Agricultural Chemistry and Animal Husbandry and Dairy Science, College of Agriculture, Pune, during *Kharif*-2019. There were seven treatment viz., 1) Absolute control; 2) Recommended dose of fertilizers 100:50:50 kg ha⁻¹ N, P₂O₅ and K₂O; 3) General recommended dose of fertilizers 100:50:50 kg ha⁻¹ N, P₂O₅ and K₂O + FYM @ 5 t ha⁻¹; 4) 25% RDN + 75% N through cattle urine + FYM @ 5 t ha⁻¹; 5) 50% RDN + 50% N through cattle urine + FYM @ 5 t ha⁻¹; 6) 75% RDN + 25% N + FYM @ 5 t ha⁻¹; 7) 100% N through cattle urine + FYM @ 5 t ha⁻¹ and three replications in completely randomized design.

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Periodical plant height and number of functional leaves at 20, 40 and 60 DAS was found to be significantly higher with the soil application 50% RDN through urea + 50% N through cattle urine along with FYM @ 5t ha⁻¹. The magnitude of increase in the leaf area was found higher from 494 to 969 cm² at 40 to 60 DAS than 20 to 40 DAS (203 to 494 cm²) with the application of 75% RDN through urea + 25% N through cattle urine + FYM @ 5 t ha⁻¹. Soil application of 75% RDN through urea + 25% N through cattle urine with FYM @ 5 t ha⁻¹ reported significantly higher chlorophyll in fodder maize. Soil application of 75% RDN through urea + 25% N through cattle urine + FYM @ 5 t ha⁻¹ reported significantly higher nitrogen, phosphorous, potassium, iron, zinc and copper uptake by fodder maize. Similar treatment also recorded significantly higher green fodder (984 g pot⁻¹) and dry matter (423.11 g pot⁻¹) yield of maize.

Keywords; Cattle urine, N-levels, Yield, Nutrient uptake, Maize

INTRODUCTION

The expanded food needs of future must be met through intensive agriculture without much expansion in the arable land. The decline in growth rate of productivity of major crops as well as rate of resources under intensive cropping system have possibly resulted from deterioration in physical, chemical and biological quality of soils. Higher fertilizer cost, increased concern for long term soil productivity and ecological sustainability have stimulated a great deal of research on organic sources as substitute or supplement to chemical fertilizer. Since the amount of N or other nutrients that could be added through different organic sources alone is not sufficient to meet all the requirement different crops. Therefore integrated use of fertilizers, different nutrient sources of organic origin with biofertilizers can meet the nutrient demand of present intensive agriculture without causing ill effects on soil ecosystem. Balance fertilization is the key to improve soil physical, chemical and biological properties of soil, low productivity, enhance nutrient use efficiency and rectify and reclaim multi-nutrient deficiencies (Goswami, N. N. (2006)). In India farmer pay good attention for collection and utilization of cattle dung in the form of FYM but very little or no attention has been given in the collection and utilization of cattle urine. Cattle urine contains 95% water, 2.5% urea, 2.5% others (mineral salts, hormones and enzymes). Total N in the cattle urine ranged from 6.8-21.1 g N lit⁻¹ of which in average 69% was urea, 73% allantoin, 5.8% uric acid and 0.5% xanthin plus hypoxanthin, 1.3% free amino acid nitrogen and 2.8% on ammonia. This nutrient source is available to farmer free of cost in their own house, being organic in nature it is eco friendly has no adverse effect on ecosystem and human health. (Pradhan *et al* 2018).

Maize has an important place in the food grain basket of our country and is the third most important versatile food grain crop due to its importance in food, feed, corn starch, etc. As per the Xth five year plan Government of India, the demand for green fodder will reach to 1.170 million tones and 650 million tones of dry forage and 150 million tones of concentrate feed in 2025. Green forage are rich and cheapest source of carbohydrates, proteins, vitamins and minerals for dairy animals. Therefore this study was undertaken to assess the effect of cattle urine through soil application for nitrogen substitution on growth, yield and nutrient uptake by fodder maize in Inceptisol

MATERIAL AND METHODS

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Pot culture experiment was conducted to study the on effect of soil application of cattle urine and nitrogen levels on growth, yield and nutrient uptake by maize (fodder) in Inceptisol at the Division of Soil Science and Agricultural Chemistry and Animal Husbandry and Dairy Science, College of Agriculture, Pune, MPKV during *Kharif*-2019. There were seven treatment viz., **1)** Absolute control; **2)** Recommended dose of fertilizers 100:50:50 kg ha⁻¹ N, P₂O₅ and K₂O; **3)** General recommended dose of fertilizers 100:50:50 kg ha⁻¹ N, P₂O₅ and K₂O + FYM @ 5 t ha⁻¹; **4)** 25% RDN + 75% N through cattle urine + + FYM @ 5 t ha⁻¹; **5)** 50% RDN + 50% N through cattle urine+ + FYM @ 5 t ha⁻¹; **6)** 75% RDN + 25% N + FYM @ 5 t ha⁻¹; **7)** 100% N through cattle urine + + FYM @ 5 t ha⁻¹ and three replications in completely randomized design. Nitrogen substitutions as per treatment were carried out on the basis of nitrogen content (basal dose 0.35 and 30 DAS 0.45 per cent) (table 1) . In order to substitute 25, 50, 75 and 100 per cent nitrogen, 80 and 65, 160 and 130, 240 and 195, 320 and 260 ml of cattle urine was diluted ten times with tap water at each application and applied to soil as basal dose and 30 DAS.

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The required quantity of surface soil up to depth 15 cm was collected from the farm survey number 57, plot number 3, Division of Animal Husbandry and Dairy Science, College of Agriculture, Pune. The experimental soil was characterized by black colour dominated by *montmorillonite* clay with high coefficient of expansion and shrinkage which comes under the *Typic Haplustept*. The soil was moderately calcareous (CaCO₃: 2.20%) with pH: 7.90, EC: 0.23 d Sm⁻¹ and organic carbon: 0.52%. The alkaline KMnO₄- N, Olsen's P and NH₄OAC-K in the experimental soil were 35.32 and 558.00 kg ha⁻¹ respectively. The pots with diameter 41 cm and height 38 cm with approximately 30 kg soil capacity were used for this experiment. The collected soil were processed and allowed to pass through 2 mm sieve. This soil was filled in 21 pots @ 25 kg soil in each pot.

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Treatment wise required quantity of N, P₂O₅, and K₂O through urea, single super phosphate and murate of potash were mixed thoroughly with soil. The nitrogen @ 50% N along with 100% P₂O₅, 100% K₂O and FYM @ 5 t ha⁻¹ were mixed at the time of sowing as basal dose and remaining 50 % N either through urea or cattle urine was applied at 30 DAS of maize. The soil KMnO₄-N, Olsen's-P and N-NH₄OA-K was analyzed by using methods given by Subbia and Asijia, 1956, Olsen *et al.*, 1954 and Knudsen *et al.*, 1982 respectively. The soil CaCO₃ content was assessed by rapid titration method as prescribed by Jackson, 1973. The truthful maize seed of variety African tall was procured from Division of Animal Husbandry and Dairy Science, College of Agriculture Pune. There were total eight seed seeds sown equidistantly and

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four plants were maintained throughout experiment. Cattle urine was analyzed for nutrient composition before every soil application by following standard method (Table 2). During soil application of cattle urine, due care was taken by considering foliage of maize at respective growth stage. The height of the plant was measured from the base to the top. The number of fully opened functional leaves of four plants from each pot were counted and recorded. The length of fully opened functional leaf was measured from the base of leaf to the tip and width at middle portion for four plants. The leaf area (cm²) was calculated by multiplying length of leaf (cm) and width (cm) x 0.75 correction factor as given by Tanko and Hassan (2016). The four plants from each pot was harvested and immediately weighed in gram pot⁻¹. The four maize plants from each pot were cut down at harvest and weighed fresh. The composite samples from each pot were air dried, oven dried and accordingly percent dry matter was calculated. Nitrogen, phosphorous and potassium were analyzed from composite sample of fodder maize. The nutrient concentration was analyzed by digesting composite fodder maize sample. The nutrient uptake was calculated by using dry matter and nutrient concentration and expressed in g pot⁻¹ for N, P and K.

Table.1 Nutrient composition in cattle urine

Sr. No	Parameter	Before 1 st soil application	Before 2 nd soil application	Average
1	pH	7.09	8.50	7.63
2	EC (dSm ⁻¹)	16.71	18.65	18.45
3	OC (%)	1.67	1.56	1.81
4	N (%)	0.35	0.45	0.57
5	P (%)	0.052	0.008	0.048
6	K (%)	0.84	0.64	0.86
7	Ca (%)	0.02	0.010	0.014
8	Mg (%)	0.042	0.054	0.044
9	SO ₄ (%)	0.035	0.052	0.040
10	Fe (ppm)	23.00	11.00	27.67
11	Mn(ppm)	0.012	0.013	0.012
12	Zn (ppm)	0.011	0.011	0.011
13	Cu (ppm)	0.012	0.013	0.012
14	Colour	Indian yellow	Indian yellow	

RESULT AND DISCUSSION

Growth

Soil application of 50% RDN through urea + 50% N through cattle urine along with FYM @ 5t ha⁻¹ recorded significantly higher plant height at (61, 107 and 149 cm) and number

of functional leaves (7, 9 and 11) at 20, 40 and 60 DAS of maize respectively (table 2). This was found to be closely followed by application of 75% RDN through urea + 25% N through cattle urine + FYM @ 5t ha⁻¹. However the magnitude of increase in maize plant height each growing stage was found higher with the application of 50% RDN through urea + 50% N through cattle urine+FYM @ 5t ha⁻¹.

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Periodical leaf area of maize was found to be increased consistently in all the treatments of cattle urine and nitrogen application but the magnitude of increase was found to be higher between 40 to 60 DAS than 20 to 40 DAS (table 3). Application of 75% RDN through urea + 25% N through cattle urine with FYM @ 5 t ha⁻¹ recorded significantly higher leaf area at 20 DAS (203 cm²), 40 DAS (494 cm²) and 60 DAS (969 cm²) which was followed by the application of 50% N through urea + 50% N through cattle urine+FYM @ 5 t ha⁻¹ (162, 421 and 666 cm²) respectively. The magnitude of increase in the leaf area was found higher from 494 to 969 at 40 to 60 DAS than 20 to 40 DAS (203 to 494) with the application of 75% RDN through urea + 25% N through cattle urine + FYM @ 5 t ha⁻¹. However the increase in leaf area between 40 to 60 DAS (421 to 666 cm²) was higher as compare to 20 to 40 DAS (162 to 421 cm²) with the application of 50% N through urea + 50% N through cattle urine+FYM @ 5 t ha⁻¹.

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Cattle urine contains essential nutrients along with auxin and growth hormones which might have accelerated the cell growth and enlargement that might have increased vegetative growth of maize. Sharma et al 2016 reported highest biological yield of broccoli (sum of curd, shoot and root weights) 36.7 t/ha with the foliar application of nitrogen @150kg/ha through urine. Similar results were also recorded by Iqbal *et al.* (2014). They reported that application of 75% RDN along with three foliar sprays @ 10%, taken at 25, 45 and 65 DAS recorded higher plant height, number of functional leaves and fodder yield of maize.

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The results of the study also obtained a corresponding result that increased urine use can increase the components of plant growth such as improving the functions of plants due to presence of auxin in cattle urine. However use of cattle urine enhanced absorption of nutrients thereby maximum growth of vegetative growth of sorghum. Further, high growth of maize caused by cattle urine application with its hormone that stimulated growth of plant and it also contain considerable amount of nitrogen & potassium (Aisha *et al.*, 2011).

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Soil application of 75% RDN through urea + 25% N through cattle urine with FYM @ 5 t ha⁻¹ reported significantly higher chlorophyll content 3.24, 3.45 and 3.68 g fresh weight⁻¹ which was followed by the application of 50% RDN through urea+ 50 % N through cattle urine +

FYM @ 5 t ha⁻¹ (2.97, 3.32 and 3.55 g fresh weight⁻¹) at 20, 40 and 60 DAS respectively (**table 3**). Application of nitrogen either @ 25, 50 and 75% through cattle urine reported higher synthesis of chlorophyll at 40 and 60 DAS than rest of the treatments. It could be observed from the data that chlorophyll synthesis in cattle urine applied treatments for the substitution of nitrogen was doubled at 20, 40 and 60 DAS of maize (fodder) than absolute control.

The increase in chlorophyll in maize (fodder) might be due to magnesium, nitrogen, phosphorous and potassium content in cattle urine along with certain growth hormones. Further Panchagavya and cattle urine contains kinetin which might have increase the cytokinins in the leaf as a consequences there was increase in chlorophyll in leaf and developed of photosynthetic activity for large period. (Gopakkali and Sharanappa 2013). Tamaraker *et al.* (2016) also observed similar results with cow urine application @ 5 and 10% concentration, which significantly improved all vegetative parameter of gladiolus *viz.* earlier 50% emergence of corms, plant height, number of leaves, length and width of leaf. Further Chute *et al.* (2017) also reported similar effect of cow urine @ 4% and NAA @ 50 ppm recorded higher chlorophyll.

Nutrient uptake

Macronutrients and micronutrients

Soil application of 75% RDN through urea + 25% N through cattle urine + FYM @ 5 t ha⁻¹ reported significantly higher nitrogen (7.49 g pot⁻¹), phosphorous (3.68 g pot⁻¹) and potassium (9.0 g pot⁻¹) uptake which was followed by 50% RDN through urea + 50% N through cattle urine + FYM @ 5 t ha⁻¹ (5.85, 2.43 and 7.48 g pot⁻¹) respectively. However, application of 100% N through cattle urine + FYM @ 5 t ha⁻¹ recorded 6.31, 3.54 and 8.45 g pot⁻¹ uptake of nitrogen, phosphorous and potassium. Lower uptake of nitrogen (0.79 g pot⁻¹), phosphorous (0.26 g pot⁻¹) and potassium (1.43 g pot⁻¹) by maize recorded with no application of any nitrogen fertilizer or cattle urine (Absolute control).

Higher uptake of nitrogen, phosphorous and potassium by fodder maize was reported with cattle urine which was rich in nitrogen, phosphorous, potassium, calcium and magnesium that stimulated growth of maize (**table 4**). Pradhan *et al.* (2018) reported application of 1200 L ha⁻¹ cattle urine. Further they concluded that application of cattle urine in soil recorded higher total nitrogen, available phosphorous and exchangeable calcium and magnesium along with improvement in soil texture and structure. Nwite *et al.* (2015) also concluded improvement in the rate of mineralization which has stimulated growth of maize. Application of urine increased nitrogen concentration in grass and enhanced concentration of potassium in grass and clover

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(Ledgordet *et al.* 1982). Singh *et al.* (2014) concluded that application of cattle slurry@ 10 kg /10m² plot or 12 kg / 10 m² recorded at par results for yield and uptake of maize (fodder).

Significantly higher iron (1082 mg pot⁻¹), zinc (150.70 mg pot⁻¹) and cooper (17.35 mg pot⁻¹) uptake by maize were reported with the application of 75% RDN through urea + 25% N through cattle urine + FYM @ 5 t ha⁻¹. While 100 percent N application through cattle urine was followed after this for iron uptake by maize (**table 4**). Higher uptake of micronutrients by maize with cattle urine application might be due to presence of nutrients, enzymes, growth stimulants and hormones which enhanced growth rate and uptake. Auxin present in cattle urine might have played role in root formation by increasing the number and length of roots. Increased urine use can increase the components of plant growth such as improving the functions of plants with higher absorption of nutrients. Similar results were also reported by Pradhan *et al.* (2018) and Nwite *et al.* (2015).

Green fodder and dry matter yield

Soil application of 75% RDN through urea + 25% N through cattle urine with FYM @ 5 t ha⁻¹ recorded significantly higher green fodder (984 g pot⁻¹) and dry matter (423.11 g pot⁻¹) yield of maize which was closely followed and statistically at par with the application of 100% RDN through cattle urine + FYM @ 5 t ha⁻¹ (924.8 and 397.67 g pot⁻¹) respectively (**table 5**). Further 50% N application through cattle urine along with 50% RDN through urea also recorded moderate green fodder (833.62 g pot⁻¹) and dry matter (358.43 g pot⁻¹) yield than rest of the treatments. Cattle urine application in soil for the substitution of nitrogen might have improved fertility of soil. As it contains considerable amount of nitrogen, potassium, calcium, magnesium and sulphate with hormones, enzymes and certain growth promoting substances which enhances plant height, number of functional leaves and leaf area leading to more photosynthetic activity thereby resulting in higher green and dry fodder yield. Higher leaf area and nutrient uptake might have contributed for higher yield. Verma (1989) reported that application of nitrogen @ 150 kg ha⁻¹ through urine recorded higher biological and curd yield of broccoli which was followed by application of nitrogen @ 50 kg ha⁻¹. Higher agronomic yield parameters of maize and improved fertility status of soil by using cattle urine was reported by Nwite (2015). Similar results were also quoted by Nelson *et al.* (2009), Singh *et al.* (2014).

Conclusions

It could be concluded from this pot culture experiment that soil application of 75% RDN through urea + 25% N through cattle urine + FYM @ 5 t ha⁻¹ was found beneficial for green fodder and dry matter yield. Further, similar treatment also found superior for nitrogen, phosphorous, potassium, iron, zinc and copper uptake by fodder maize.

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Table.2 Effect of soil application of cattle urine and nitrogen levels on plant height and number of functional leaves of fodder maize in Inceptisol.

Treatments	Plant height (cm) DAS			Number of functional leaves		
	20 DAS	40 DAS	60 DAS	20 DAS	40 DAS	60 DAS
Absolute control	38	65	97	4	6	8
RDF	42	70	105	5	7	9
GRDF + FYM @ 5t ha ⁻¹	42	70	97	5	7	7
25%RDN+75%N CU+FYM@5 t ha ⁻¹	57	83	121	6	8	10
50%RDN+50%N CU+FYM@5 t ha ⁻¹	61	107	149	7	9	11
75%RDN+25%N CU+FYM@5 t ha ⁻¹	60	93	131	6	9	11
100% N CU+FYM@5 t ha ⁻¹	52	86	120	6	7	9
S.E. ±	2.63	2.39	2.52	0.48	0.37	0.37
CD at 5%	8.066	7.34	7.74	1.49	1.15	1.15

Table.3 Effect of soil application of cattle urine and nitrogen levels on leaf area and chlorophyll in fodder maize in Inceptisol.

Treatments	Leaf area (cm ²)			Chlorophyll (g fresh weight ⁻¹)		
	20 DAS	40 DAS	60 DAS	20 DAS	40 DAS	60 DAS
Absolute control	126	174	330	1.26	1.40	1.62
RDF	112	238	367	1.74	1.95	2.15
GRDF + FYM @ 5 t ha ⁻¹	137	247	326	1.96	2.20	2.47
25% RDN + 75 % N CU + FYM @ 5 t ha ⁻¹	119	311	620	1.49	3.17	3.40
50% RDN + 50% N CU + FYM @ 5 t ha ⁻¹	162	421	666	2.97	3.32	3.55
75% RDN+ 25% N CU + FYM @ 5 t ha ⁻¹	203	494	969	3.24	3.45	3.68
100% N CU + FYM @ 5 t ha ⁻¹	137	348	501	2.40	2.92	3.01
S.E. ±	11.8	14.61	18.27	0.049	0.031	0.043
CD at 5%	36.24	44.74	55.97	0.151	0.095	0.132

Table.4 Effect of soil application of cattle urine and nitrogen levels on nutrient uptake by fodder maize in Inceptisol.

A) Macronutrient uptake:

Treatments	Macronutrient uptake (g pot ⁻¹)			Micronutrient uptake (mg pot ⁻¹)			
	N	P	K	Fe	Mn	Zn	Cu
Absolute control	0.79	0.26	1.43	79	15.12	54.72	10.84
RDF	1.63	0.56	3.42	172	26.47	64.20	18.25
GRDF + FYM @ 5 t ha ⁻¹	2.35	0.84	3.87	273	41.17	66.93	10.51
25% RDN + 75 % N CU + FYM @ 5 t ha ⁻¹	3.23	2.13	5.21	402	58.45	93.06	11.17
50% RDN + 50% N CU + FYM @ 5 t ha ⁻¹	5.85	2.43	7.48	592	72.98	126.93	13.97
75% RDN+ 25% N CU + FYM @ 5 t ha ⁻¹	7.49	3.68	9.00	1082	90.89	150.70	17.35
100% N CU+ FYM @ 5 t ha ⁻¹	6.31	3.54	8.45	1,075	61.56	129.32	13.30
S.E. ±	0.35	0.06	0.29	28.31	2.85	4.90	1.27
CD at 5%	1.09	0.20	0.89	86.7	8.74	15.02	3.89

Table.5 Effect of soil application of cattle urine and nitrogen levels on yield of fodder maize in Inceptisol.

Treatments	Fodder yield (g pot ⁻¹)	
	Green fodder	Dry matter
Absolute control	156.77	67.40
RDF	351.22	151.02
GRDF + FYM @ 5 t ha ⁻¹	435.46	187.24
25% RDN + 75 % N CU + FYM @ 5 t ha ⁻¹	599.75	257.88
50% RDN + 50% N CU + FYM @ 5 t ha ⁻¹	833.62	358.43
75% RDN+ 25% N CU + FYM @ 5 t ha ⁻¹	984	423.11
100% N CU+ FYM @ 5 t ha ⁻¹	924.81	397.67
S.E. ±	28.46	12.36
CD at 5%	87.16	37.47

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