Original Research Article

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

ABSTRACT

The experiment was conducted to study 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, P_2O_5 and K_2O; 3) General recommended dose of fertilizers 100:50:50 kg ha^{-1} N, P_2O_5 and K_2O + 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.

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 @ 5 t ha^{-1}. The magnitude of increase in the leaf area was found higher from 494 to 969 cm^2 at 40 to 60 DAS than 20 to 40 DAS (203 to 494 cm^2) 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. Similar treatment also found superior for nitrogen, phosphorous, potassium, iron, zinc and copper uptake by fodder maize.

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

1. 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, (2006)). In India farmers pay good attention to the 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 on 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 (Sandhukhan et al., 2018. 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). Therefore, the use of cattle urine alongside or in combination with chemical fertilizers can increase the productivity of soil and crop. The use cattle urine would allow farmers to cut downdependency and costs on fertilizers. Large amount of nitrogen rich cattle urine is being wasted in the rural India which can be used as supplement to urea(Sharma et.al. 2016).

Maize has an important place in the food grain basket of India and is the third most important versatile food grain crop due to its importance in food, feed, corn starch, etc[]. As per the Xthfive year plan of the 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

Pot culture 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, MPKV during *Kharif*-2019. There were seven treatment *viz.*, **1)** Absolute control; **2)** Recommended dose of fertilizers 100:50:50 kg ha^{-1} N, P_2O_5 and K_2O; **3)** General recommended dose of fertilizers 100:50:50 kg ha^{-1} N, P_2O_5 and K_2O + 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.

The 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 ($CaCO_3$: 2.20%) with pH: 7.90, EC: 0.23 d Sm^{-1} and organic carbon: 0.52%. The alkaline $KMnO_4$- N, Olsen's P and NH_4OAC-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.

Treatment wise required quantity of N, P_2O_5, and K_2O through urea, single super phosphate and murate of potash were mixed thoroughly with soil. The nitrogen @ 50% N along with 100% P_2O_5, 100% K_2O and FYM @ 5 t ha^{-1}were mixed at the time of sowing as basal dose and the remaining 50 % N either through urea or cattle urine was applied at 30 DAS of maize. The soil

$KMnO_4$-N, Olsen's-P and N-*N*NH_4OA-K was analyzed by using methods given by Subbia and Asijia, 1956, Olsen *et al.*, 1954 and Knudsen *et al.*, 1982 respectively. The soil $CaCO_3$ content was assessed by rapid titration method as prescribed by Jackson, 1973. The truthful maize seed of variety African tall was procured from the Division of Animal Husbandry and Dairy Science, College of Agriculture, Pune. There were total eight seed seeds sown equidistantly and four plants were maintained per pot throughout experiment. Cattle urine was analyzed for nutrient composition (Table 1) before every soil application by following standard methods. During the 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 the four plants. The leaf area (cm^2) was calculated by multiplying length of leaf (cm) and width (cm) x 0.75 correction factor as given by Tanko and Hassan [?]. 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 the composite samples of the fodder maize.

Table.1 Nutrient composition in cattle urine

Sr. No	Parameter	Before 1st soil application	Before 2nd 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

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 at each growing stage was found higher with the application of 50% RDN through urea + 50% N through cattle urine+FYM @ 5t ha^{-1}.

Periodical leaf area of maize was found to increase 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 cm^2), 40 DAS (494 cm^2) and 60 DAS (969 cm^2) 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 cm^2) respectively. The magnitude of increase in the leaf area was found higher from 494 to 969 at 40 to 60 DAS than from 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 cm^2) was higher as compared to 20 to 40 DAS (162 to 421 cm^2) with the application of 50% N through urea + 50% N through cattle urine+FYM @ 5 t ha^{-1}.

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. 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. Further, Iqbal et al. also reported that the 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.

The results of the study also obtained a corresponding result that increased urine use can promote the components of plant growth such as improving the functions of plants due to presence of auxin in cattle urine. The use of cattle urine is known to enhance absorption of nutrients andvegetative growth of sorghum[]. Cattle urine contains considerable amount of nitrogen & potassium and its application as soil amendment has led to high growth in maize (Aisha *et al*., 2011).

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 the 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, cattle urine contains kinetin which might have increased the cytokinins in the leaf as a consequences there was increase in chlorophyll in leaf and photosynthetic activity (Gopakkali and Sharanappa 2013). Tamaraker et al.[?] 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.[?] also reported similar effect of cow urine @ 4% and NAA @ 50 ppm recording higher chlorophyll content in leaves.

Nutrient uptake

Macronutrients and micronutrients

Soil application of 75% RDN through urea + 25% N through cattle urine + FYM @ 5 t ha^{-1} recorded significantly the highest nitrogen (7.49 g pot^{-1}), phosphorous (3.68 g pot^{-1}) and potassium (9.0 g pot^{-1}) uptake among the treatments. The application of 100% N through cattle urine + FYM @ 5 t ha^{-1} recorded the second highest values of 6.31, 3.54 and 8.45 g pot^{-1} uptake of nitrogen, phosphorous and potassium respectively The 50% RDN through urea + 50% N through cattle urine + FYM @ 5 t ha^{-1} had values of 5.85, 2.43 and 7.48 g pot^{-1} of nitrogen, phosphorus and potassium respectively.. Lower uptake of nitrogen (0.79 g pot^{-1}), phosphorous (0.26 g pot^{-1}) and potassium (1.43 g pot^{-1}) were recorded by maize from the Absolute control (Table 4).

Higher uptake of nitrogen, phosphorous and potassium by fodder maize was recorded from the cattle urine treatments which were rich in nitrogen, phosphorous, potassium, calcium and magnesium that stimulated growth of maize (**Table 4**). Pradhan et al.[?] reported that the application of 1200 L ha^{-1} cattle urine increased total nitrogen, available phosphorous, exchangeable calcium and magnesium and improvemed soil texture and structure. Nwite et al. [?] observed the improvement in the rate of mineralization and stimulated growth of maize with the application of cattle urine. Application of urine increased nitrogen concentration in grass and enhanced concentration of potassium in grass and clover (Ledgord*et al*. 1982).

The highest 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}. All the cattle urine based treatments recorded higher values of the micronutrients uptake than the control treatment**(Table 4**). Higher uptake of micronutrients by maize with cattle urine application might be due to presence of nutrients, enzymes, growth stimulants and hormones[]. Auxin present in cattle urine might have played a role in root formation by increasing the number and length of roots to enhance nutrients adsorption. Increased urine use can increase the components of plant growth such as improving the functions of plants with higher absorption of nutrients (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 the highest 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} recording green fodder of 924.8 g pot^{-1} and dry matter of 397.67 g pot^{-1} **(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 the rest of the treatments. Cattle urine application in soil for the substitution of nitrogen might have improved the fertility of soil as it contains considerable amount of nitrogen, potassium, calcium, magnesium and sulphate with hormones, enzymes and certain growth promoting substances which enhance plant height, number of functional leaves and leaf area leading to more photosynthetic activity and thereby resulting in higher green and dry fodder yield. Verma[?] reported that the application of nitrogen @ 150 kg ha^{-1} through urine recorded higher biological and curd yield of broccoli. Higher agronomic yield parameters of maize and improved fertility status of soil by using cattle urine was reported by Nwite[?]. Similar results have been reported (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.

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

Give 'key' to the abbreviations in the tables.

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}	984.00	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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