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Influence of Slow Release Nitrogen Fertilizer on Soil Enzymes, Yield and Nutrient Uptake of Maize Grown on Inceptisol

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ABSTRACT

The field experiment entitled, "Influence of slow release nitrogenous fertilizers on soil enzymes, yield and nutrient uptake of maize on Inceptisol" was conducted during 2015-16 and 2016-17 in randomized block design. The treatment consist of control, GRDF, 100% recommended dose of nitrogen through Crotonylidene diurea (CDU), neem coated urea (NCU) and sulphur coated urea (SCU), 50% recommended dose of nitrogen through urea plus 50% RDN through NCU, CDU and SCU. These treatments are replicated thrice. The urease enzyme activity in both the year and pooled mean at 30 DAS were increased and decreased at 90 DAS. The treatment of RDN-CDU, NCU and SCU and their combinations 50% +50% RDN were recorded the less values of urease enzyme activity. The application of nitrogen to maize crop through neem coated urea was recorded significantly higher soil available nitrogen at 30 days after sowing. The nitrogen application to maize crop through NCU, SCU and CDU were equally beneficial for higher grain and straw yield. The total uptake of nitrogen, phosphorus and potassium by maize was significantly higher in recommended dose of nitrogen through neem coated urea. The soil pH and electrical conductivity (EC) was significantly influenced by slow release nitrogen fertilizer. The soil organic carbon and calcium carbonate content did not influenced by the slow release nitrogenous fertilizers. The use of neem coated urea (NCU), Crotonylidene diurea (CDU) and sulphur coated (SCU) alone or in combination with urea performed better than urea alone, by increasing nitrogen use efficiency through controlled urea hydrolysis. Treating urea with neem and sulphur has the potential to increase nitrogen use efficiency, grain and straw yield of maize grown on Inceptisol.

Keywords : Yield, NCU, CDU, SCU, Enzymes, Nutrient uptake)

I. INTRODUCTION

The role of nitro in increasing the crop production has been now well established. Nitrogen in soils is present mainly in three form *viz.*, organic ($R-NH_2$), ammonical (NH_4-N) and nitrate (NO_3^-). Urea is one of the most popular nitrogenous fertilizer used in India. Nitrogen use efficiency (NUE) is usually less for annually cultivated crops and cereals. The large amount of nitrogen is lost through denitrification, runoff, volatilization, immobilization and leaching. There are many management practices that can increase fertilizer use efficiency among which the use of enhanced efficiency nitrogenous fertilizers (EENF) is one. Different types of coated urea fertilizers are coming into the market apart from commonly used prilled urea. The difference in release of N from these fertilizers are of major concern to improve the NUE. The release pattern of nitrogen from coated urea fertilizers help in understanding the nitrogen availability over a period of time. The NUE can be increased if the release of nitrogen from these coated urea fertilizers coincide with nitrogen demand of the crop. The advantages of coated urea fertilizers are minimization of leaching and volatilization losses of nitrogen, delay in nitrification and prolonged N supply. Keeping in view the studies pertaining to effect of slow release nitrogenous fertilizers on yield, nutrient uptake of maize grown on Inceptisol are studied.

II. METHODS AND MATERIAL

Field experiments on maize was conducted on same site during 2015-16 and 2016-17 at Research Farm of Mahatma Phule Krishi Vidyapeeth, Rahuri. The soils of experimental was clay texture with low available nitrogen (158.3 kg ha^{-1}), medium in available phosphorus (15.0 kg ha^{-1}) and high in available potassium (430 kg ha^{-1}). The soil reaction was alkaline in reaction (pH 8.0). The experiments consist of Absolute control, GRDF (120:60:40 kg N:P_2O_5:K_2O ha^{-1} + 10 t ha^{-1} FYM), RDN-crotonylidene diurea (CDU), RDN-Neem coated urea (NCU), RDN-Sulphur coated urea (SCU), 50% NDN-urea + 50% N NCU, 50% RDN-urea + 50% N-CDU, 50% RDN-urea + 50% N SCU, 50% RDN-NCU + 50% N-CDU, 50% RDN-NCU + 50% N-SCU and 50% N-CDU + 50% N-SCU. These treatments were replicated thrice and statistical method used was randomized block design.

III. RESULTS AND DISCUSSION

The nitrogen requirements of all the field crops are comparatively higher than other nutrients. However, the use efficiency of applied nitrogen through fertilizer are less because of hydrolysis of nitrogen fertilizer and their transformation by means of soil chemical reactions in soil or by microbial activity. This might be mismatched with nitrogen requirement of crop as per their crop growth stage and influenced the yield of field crops.

Yield

The grain yield of maize was significantly influenced by slow release nitrogenous fertilizers during 2015-16, 2016-17 and pooled mean (Table 1). The application of recommended dose of nitrogenous to maize through neem coated urea was recorded significantly higher grain yield (72.44 q ha^{-1}) and statistically on par with recommended dose of nitrogen through sulphur coated urea (71.84 q ha^{-1}) and crotonylidene diurea (69.01 q ha^{-1}) respectively during 2015-16. Similar trend was observed during 2016-17 and pooled mean. The higher grain yield of maize in neem, sulphur and crotonylidene diurea might be associated with the slow release of nitrogen in soil, it was absorbed by the maize crop through out its critical grow stages (Blaylock *et al.*, 2005). The stover yield of maize was showed the similar trend to that of grain yield.

Nutrient uptake

The application of nitrogen to maize crop as RDN-NCU recorded the significantly higher nitrogen uptake during 2015-16, 2016-17 and pooled mean (122.75, 131.45 and 127.10 kg ha^{-1} respectively) followed by RDN-CDU (113.10, 102.90 and 108.0 kg ha^{-1} respectively). The higher uptake of nitrogen by maize might be because of coating reduce the contact with soil particles, restrict the activity of micro organisms and also urease enzyme activity phosphorus uptake of maize was found similar to that of nitrogen uptake. The higher phosphorus uptake might be because of slow release nitrogen enhanced the vegetative growth and biomass, which increased biomass promote phosphorus uptake. The recommended dose of nitrogen through NCU recorded significantly higher potassium uptake during both the year of experimentation and pooled mean (88.80, 87.91 and 87.99 kg ha^{-1} respectively) and on par with RDN-SCU (83.80, 83.38 and 83.59 kg ha^{-1} respectively). The potassium uptake was increased due to increased nitrogen uptake and has synergistic effect between nitrogen and potassium.

Soil enzyme

Urease enzyme is unique among soil enzymes and greatly influenced the fate and performance of important fertilizer like urea. The urease enzyme activity during both the year and pooled mean at 30 DAS were 37.98, 30.34 and 34.16 µg NH_4-N g^{-1} soil h^{-1} and decreased at 90 DAS (Table 3). The treatment of RDN-CDU, NCU and SCU and their combinations as 50% + 50% RDN were recorded the less values of urease enzyme activity in soil during both the year. This might be because of coating of urea fertilizer. The coating material inhibiting the activity of urease enzyme by avoiding the direct contact with urea (Xiaoguang *et al.*, 2004).

Dehydrogenazes are generally present in upper layer of soils, plays the major role in the energy production of organisms. The soil dehydrogenase enzyme activity was found statistically on par with each other in treatment 50% RDN-urea + 50% NCU, 50% RDN-urea + 50% CDU and 50% RDN-urea + 50% SCU at 90 DAS during 2015-16 (1.46, 1.42 and 1.43 µg TPF g^{-1} soil hr^{-1} respectively), 2016-17 (1.51, 1.49 and 1.49 µg TPF g^{-1} soil hr^{-1} respectively) and pooled mean (1.48, 1.45 and 1.46 µg TPF g^{-1} soil h^{-1} respectively) (Quireshi *et al.*, 1995).

Soil available nutrients

The soil available nitrogen was increased at 30 DAS with the application of nitrogen through neem coated urea was found significant to recorded the higher content of soil available nitrogen at 30 DAS during 2015-16, 2016-17 and pooled mean (232.06, 223.70 and 227.88 kg ha^{-1} respectively) and decreased at 90 DAS (196.33, 203.84 and 200.09 kg ha^{-1} respectively). Similar treatment showed soil available phosphorus content higher at 30 DAS (27.08, 34.42 and 30.75 kg ha^{-1} respectively.

IV. CONCLUSION

The application of nitrogen through neem coated, sulphur coated and crotonylidene diurea to maize are equally beneficial for higher grain and stover yield. The total uptake of nitrogen, phosphorus and potassium by maize was significantly influenced by RDN-SCU. The treatments of RDN-CDU, NCU and SCU and their combinations as 50% N-CDU/ NCU/ SCU and 50% RDN were reduce the urease enzyme activity.

Table 1. Effect of slow release nitrogenous fertilizer on yield and total nutrient uptake by kharif maize grown on Inceptisol

(Pooled mean)

Sr. No	Treatment	Yield (q ha^{-1})		Nutrient uptake (kg ha^{-1})		
		Grain	Stover	N	P	K
1.	Control	37.89	83.33	51.40	28.90	48.72
2.	GRDF	70.50	105.0	101.77	48.08	70.80
3.	RDN-CDU	68.83	106.0	108.0	52.57	78.77
4.	RDN-NCU	73.02	111.5	127.10	57.92	87.99
5.	RDN-SCU	72.59	107.40	120.49	56.52	83.59
6.	50% RDN-Urea + 50% NCU	65.65	104.1	117.78	50.46	77.15
7.	50% RDN-Urea + 50% CDU	62.70	100.0	105.54	45.28	69.81
8.	50% RDN-Urea + 50% SCU	64.81	100.9	107.69	46.98	70.72
9.	50% RDN-NCU + 50% CDU	58.82	95.37	96.42	39.63	62.35
10.	50% RDN-NCU + 50% SCU	61.75	100.0	99.84	44.69	67.08
11.	50% RDN + 50% SCU	51.10	87.50	82.83	36.83	56.05
	SE ±	1.98	4.03	3.49	1.35	2.55
	CD 5%	5.67	11.52	9.98	3.86	7.28

Table 2. Effect of slow release nitrogenous fertilizer on soil urease and dehydrogenase enzyme activity at different growth stages of maize grown on Inceptisol

(Pooled mean)

Sr. No.	Treatment	Urease (µg NH_4-N g^{-1} soil h^{-1})			Dehydrogenase (µg TPF g^{-1} soil h^{-1})		
		30 DAS	90 DAS	At harvest	30 DAS	90 DAS	At harvest
1.	Control	18.21	16.48	6.61	0.95	1.27	1.18
2.	GRDF	34.16	34.02	13.21	1.20	1.51	1.44
3.	RDN-CDU	21.43	17.72	7.10	0.98	1.32	1.21
4.	RDN-NCU	26.76	24.51	9.28	1.10	1.43	1.35
5.	RDN-SCU	25.25	20.72	8.31	1.06	1.41	1.29
6.	50% RDN-Urea + 50% NCU	32.11	31.29	11.30	1.18	1.48	1.40
7.	50% RDN-Urea + 50% CDU	28.77	28.40	9.99	1.12	1.45	1.36
8.	50% RDN-Urea + 50% SCU	30.19	28.61	10.47	1.14	1.46	1.39
9.	50% RDN-NCU + 50% CDU	24.68	18.79	8.23	1.03	1.37	1.26
10.	50% RDN-NCU + 50% SCU	22.18	21.17	8.45	1.08	1.42	1.32
11.	50% RDN + 50% SCU	26.05	17.91	7.93	1.00	1.32	1.24
	SE ±	0.60	0.71	0.31	0.01	0.02	0.01
	CD 5%	1.71	2.02	0.89	0.04	0.05	0.04

Table 3. Effect of soil available nitrogen, phosphorus and potassium in maize grown on Inceptisol

(Pooled mean)

Sr. No.	Treatment	Soil av. Nitrogen (kg ha^{-1})		Soil av. Phosphorus (kg ha^{-1})		Soil av. Potassium (kg ha^{-1})	
		30 DAS	At harvest	30 DAS	At harvest	30 DAS	At harvest
1.	Control	162.03	150.28	15.93	13.71	383	334
2.	GRDF	179.94	157.60	16.73	14.65	427	360
3.	RDN-CDU	216.38	177.38	27.09	20.25	519	459
4.	RDN-NCU	227.88	204.69	30.75	21.94	549	498
5.	RDN-SCU	222.66	184.94	28.41	20.27	532	468
6.	50% RDN-Urea + 50% NCU	202.27	176.35	25.28	18.80	472	440
7.	50% RDN-Urea + 50% CDU	189.73	171.62	22.98	17.21	513	416
8.	50% RDN-Urea + 50% SCU	194.43	174.16	23.44	17.91	595	435
9.	50% RDN-NCU + 50% CDU	180.32	163.86	18.38	15.80	461	396
10.	50% RDN-NCU + 50% SCU	185.02	167.57	21.01	16.60	472	413
11.	50% RDN + 50% SCU	176.14	162.17	18.67	15.48	461	388
	SE ±	3.24	4.39	6.89	0.40	19.68	7.56
	CD 5%	9.25	12.55	2.53	1.15	56.25	21.59

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