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Nitrogen use efficiency in tomato (*Lycopersicon esculentum* L.) and French bean (*Phaseolus vulgaris* L.) as influenced by coating of urea with neem oil and graded levels of nitrogen

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ABSTRACT

In a pot-culture study, 'Arka Shrestha' tomato and 'Arka Komal' French bean were raised on red sandy-loam to compare urea coated with neem oil (2% w/w, NOCU) and prilled urea (PU) applied at 60, 80 and 100% of recommended N dose. To facilitate direct measurement of N use parameters, urea enriched with ^{15}N (1 atom per cent excess) was used as the source of N. Compared to 'no urea' control, the application of N significantly increased dry matter production, fruit/pod yield as well as the parameters of N use. Prilled urea coated with neem oil (NOCU) was superior to PU in both the crops and produced 21% and 9% higher yield compared to the latter. Increasing the dose of N significantly increased dry matter production, yield and all parameters of N use. However, the interaction effects showed that N applied as NOCU at 80% the of recommended dose produced fruit/pod yield *at par* with that obtained at 100% of the recommended dose applied as PU in both crops. Corresponding fertilizer utilization achieved was 14.9% and 59.0% when 80% of N was applied as NOCU compared to 11.5% and 30.1 obtained when 100% of N was applied as PU in tomato and French bean, respectively.

Key words: Neem coated urea, nitrogen use efficiency, tomato, French bean

INTRODUCTION

Application of fertilizer nitrogen to soil is subjected to transformation losses due to presence of urease in the soil. To overcome such losses, coating/ blending urea with neem oil / products is a convenient and effective method. Melicans, or bitters, present in neem (*Azadirachta indica* L.) products, when blended with urea, inhibit nitrification and volatilization culminating in reduced leaching losses in soil (Devakumar and Goswami, 2002; Suri *et al*, 2004). Accumulation of ammoniacal and other mineralized nitrogen, owing to microbial immobilization by lowered rates of nitrification in top soil layers, facilitates its availability to the crop subsequently (Singh *et al,* 1989). Since treating urea with neem oil enhances nitrogen-use efficiency of the applied fertilizer and as the red sandy soils of Bangalore exhibit definite activity of urease enzyme, prilled urea coated with neem oil (2% w/w, NOCU) was compared to prilled urea (PU) at different levels of recommended N levels using 'Arka Shreshtha' tomato and 'Arka Komal' French bean in a pot-culture experiment.

MATERIAL AND METHODS

The experimental soil was red sandy-loam (*Typic Haplustalf*) with pH 5.9, organic carbon at 0.3%, cation exchange capacity of 8.7 cmol (p^+)/kg, urease activity of 2.03 µg NH_4^+/g/hr and alkaline permanganate mineralizable N of 220 kg/ha. In a completely randomized factorial design with 3 replications, the first factor consisted of 2 forms of urea: (i) prilled urea (PU) and (ii) urea coated with 2.0% (w/w) neem oil (NOCU). The second factor involved 3 N levels at 60, 80 and 100% of recommended dose for application to the crops. Pots were filled with 10 kg of 4 mm sieved soil, and, 25 day-old tomato seedlings were planted and seeds of French bean sown to raise 2 seedlings in each pot. Superphosphate and muriate of potash had been incorporated in to the soil earlier. Soon after the seedlings established seeds germinated, urea was broadcast on soil-surface. The fertilizer dose given to the crops was 180:150:120 and 80:100:40 N : P : K kg/ha for tomato and French bean crops, respectively. To facilitate direct measurement of N-use, urea enriched with ^{15}N (1 atom per cent excess) was used. In the case of NOCU, the required

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quantity of ^{15}N -enriched urea was blended by triturating in a quartz pestle and mortar. Fruits/pods were harvested from time to time and dry leaves collected to estimate total dry matter. At the last harvest, shoots were parts into stem, leaf and fruit/pod. The root was washed free of adhering soil. All the plant separates were cleaned with tap water, rinsed with distilled water and dried in an oven at 70° C to estimate dry matter and N content. Abundance of ^{15}N was estimated using ratio mass spectrometer (CE Instruments Flash EA-1112 Series Thermoquest). Values for different plant separates were pooled to obtain uptake of N and other parameters of N-use by the crops. The treatment sum of squares was partitioned into Control *vs*. N application, PU *vs*. NOCU and 60 *vs*. 80 *vs*. 100% of recommended N dosage and their interactions were studied as described by Cochran and Cox (1966).

RESULTS AND DISCUSSION

Effect of N application

Both tomato and French bean responded significantly to N application by way of increased (i) fruit and dry matter production, (ii) N content of the plant and (iii) N uptake by the plant (Tables 1 and 2). The positive response to nitrogen application may be attributed to low levels of available nitrogen in the soil.

Table 1. Effect of N application, coating of urea with neem oil and graded doses of N on fruit yield, dry matter and parameters of N use in tomato cv. Arka Shreshtha

Treatment	Fruit yield (g/pot)	Shoot dry matter (g/pot)	N content (%)	N uptake (g/pot)	Ndff (%)	Fertilizer N uptake (mg/pot)	Fertilizer utilization (%)
Control vs. N application							
Control	295.00	40.20	0.410	0.160	-	-	-
N application	441.60	69.50	0.600	0.420	-	-	-
SEm (±)	10.74	1.76	0.008	0.012	-	-	-
CD *(P=0.05)*	23.41	3.84	0.017	0.025	-	-	-
Prilled urea(PU) vs. neem oil coated urea (NOCU)							
PU	399.90	62.70	0.540	0.340	22.10	66.50	10.00
NOCU	483.30	76.30	0.660	0.510	24.60	116.90	17.10
SEm (±)	5.74	0.94	0.004	0.006	0.23	10.46	0.21
CD *(P=0.05)*	17.69	2.90	0.013	0.019	0.71	4.49	0.63
Levels of nitrogen (percentage of recommended dose)							
60% N dose	384.20	63.90	0.510	0.290	19.90	56.30	11.50
80% N dose	429.20	68.90	0.580	0.410	22.10	77.90	11.90
100% N dose	511.50	75.70	0.700	0.530	28.00	140.90	17.20
SEm (±)	7.03	1.15	0.005	0.008	0.28	1.78	0.25
CD *(P=0.05)*	21.67	3.55	0.016	0.023	0.87	5.50	0.77

Table 2. Effect of N application, coating of urea with neem oil and graded doses of N on pod yield, dry matter production and parameters of N use in French bean var. Arka Komal

Treatment	Pod yield (g/pot)	Dry matter (g/pot)	N content (%)	N Uptake (g/pot)	Ndff (%)	Fertilizer N uptake (mg/pot)	Fertilizer utilization(%)
Control vs. N application							
Control	57.40	26.20	1.170	0.340	-	-	-
N application	72.30	38.10	1.390	0.570	-	-	-
SEm (±)	1.39	0.36	0.011	0.009	-	-	-
CD *(P=0.05)*	3.02	0.79	0.024	0.019	-	-	-
Prilled urea(PU) vs. neem oil coated urea (NOCU)							
PU	69.30	35.30	1.310	0.490	23.90	110.50	39.20
NOCU	75.30	41.00	1.470	0.640	25.70	176.60	60.20
SEm (±)	0.74	0.19	0.006	0.005	0.12	2.10	0.66
CD *(P=0.05)*	2.28	0.60	0.018	0.014	0.37	6.46	2.02
Levels of nitrogen (percentage of recommended dose)							
60% N dose	63.20	40.00	1.270	0.520	20.50	111.10	50.90
80% N dose	71.00	37.00	1.390	0.550	24.40	148.60	51.10
100% N dose	82.60	37.40	1.520	0.620	24.70	170.90	47.00
SEm (±)	0.91	0.24	0.007	0.006	0.15	2.57	0.80
CD *(P=0.05)*	2.80	0.73	0.022	0.018	0.45	NS	2.48

Effect of coating urea with neem oil

Between PU and NOCU, the latter produced significantly higher fruit/pod yield, dry matter production, N content, N uptake, Ndff, fertilizer N uptake as well as fertilizer N utilization (Tables 1 and 2). This may be attributed to delayed dissolution and hydrolysis of urea to ammonia by neem oil present in NOCU leading to continuous and steady supply of nitrogen (Singh and Singh, 1989; Vyas *et al*, 1991; and Upadhyay and Patel, 1992). Nitrification of the ammonia evolved was also inhibited by neem oil leading to longer persistence of applied urea resulting in better supply of nitrogen and its utilization by the crop at later stages (Biddappa and Sarkunanan, 1981). According to Prasad *et al* (1999), neem products act as dual-purpose inhibitors of

Table 3. Interaction effect of type of urea and levels of N on fruit/pod weight, dry matter production and parameters of N use in tomato and French bean

Type of urea	Level of N (% recommended dose)					
	Tomato			French bean		
	60	80	100	60	80	100
			Fruit/pod weight (g/pot)			
Prilled urea	343.3	371.70	484.7	62.3	68.60	77.0
Neem oil coated urea (NOCU)	425.0	486.70	538.3	64.1	73.50	88.3
SE m (±)		9.95			1.28	
CD *(P=0.05)*		30.65			3.95	
			Dry matter (g/pot)			
Prilled urea	59.6	59.90	68.3	38.2	34.70	32.9
Neem oil coated urea (NOCU)	67.9	77.90	83.1	41.8	39.30	41.8
SE m (±)		1.63			0.34	
CD *(P=0.05)*		5.02			1.03	
			N content (%)			
Prilled urea	0.48	0.520	0.61	1.23	1.27	1.44
Neem oil coated urea (NOCU)	0.54	0.640	0.79	1.30	1.50	1.60
SE m (±)		0.007			0.010	
CD *(P=0.05)*		0.022			0.031	
			N uptake (g/pot)			
Prilled urea	0.21	0.310	0.41	0.49	0.480	0.52
Neem oil coated urea (NOCU)	0.37	0.500	0.66	0.56	0.630	0.73
SE m (±)		0.011			0.008	
CD *(P=0.05)*		0.033			0.025	
			Ndff (%)			
Prilled urea	19.4	21.60	25.2	19.1	26.00	23.4
Neem oil coated urea (NOCU)	20.5	22.60	30.7	21.9	22.80	25.9
SE m (±)		0.40			0.26	
CD *(P=0.05)*		1.23			0.80	
			Fertilizer N uptake (mg/pot)			
Prilled urea	47.2	58.60	93.7	96.5	125.40	109.5
Neem oil coated urea (NOCU)	65.4	97.30	188.2	125.6	171.70	232.4
SE m (±)		2.52			3.63	
CD *(P=0.05)*		7.78			11.18	
			Nitrogen fertilizer utilization (%)			
Prilled urea	9.6	9.00	11.5	44.3	43.10	30.1
Neem oil coated urea (NOCU)	13.3	14.90	23.0	57.6	59.00	63.9
SE m (±)		0.35			0.34	
CD *(P=0.05)*		1.09			1.03	

both ammonia volatilization and simultaneous nitrification. All these factors facilitated supply of N from NOCU for longer time to the crop, in comparison to PU which dissipated faster in the soil when applied.

Effect of N levels

Among the different levels of N tested in tomato, increasing N dosage significantly improved fruit yield, dry matter production and all parameters of N use, irrespective of the type of urea applied (Table 1). Similar trend was also observed for pod yield and N use parameters in French bean (Table 2).

Interaction effects

In tomato, interaction effects (Table 3) conformed to the main effects. In French bean too, a similar trend was evident. However, it is not clear as to why dry matter production showed a significant decline with increasing levels of N applied as PU. When N was applied as NOCU, dry matter production at 80% level showed a significant reduction of 39.3 g/pot compared to 41.8 g/pot at both 60 and 100% N levels. Neem oil coated urea (NOCU) at 80% level of recommended dose produced fruit/pod yield close to that obtained at 100% of the recommended dose applied as PU in both the crops. Results indicate that coating urea prills with neem oil holds promise reducing fertilizer input considerably, without any loss in yield. This has both economic and ecological implications. Further field studies are suggested to be undertaken before extending the results to growers.

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