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Relative competency of urea in augmenting physiological and agronomic traits of baby corn (*Zea mays*)

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ABSTRACT

Nitrogen is indispensable for aggrandizing productivity of crop but the losses associated due to swift transformation and release pattern are subjected to various losses leading to pitiful amount left for crop uptake, pollution and resource wastage. Present study was conducted to evaluate the efficacy of coated urea and nitrogen rates on baby corn growth, yield and NUE. The experiment comprised varieties PHM-1 and HM-4, coated urea (NCU, ZCU, SCU and PU) and nitrogen levels @180, 150, 120 kg N/ha along with the control. The study revealed that PHM-1 obtained significantly higher plant height, no. of cobs and weight of dehusked cob that led to significant increase of 18.47 and 19.67 % higher husked and dehusked cob yields over HM-4 which attained 12.6% higher fodder yield over latter. The baby corn cob yield and fodder yield were significantly higher in coated urea over prilled urea. The husked and dehusked yield of baby corn was higher in neem-coated urea over prilled urea by 14.81 and 14.37% respectively. However, a reduction of 59.9% in total fodder yield was recorded in control when compared to 180 kg N ha. Also, NPK uptake was higher then PHM-1 and uptake by coated urea was higher then prilled urea along with high uptake for 180 kg N/ha, further the AE and higher PE of baby corn cob was found highest in variety PHM-1 although for fodder, the higher AE was recorded in HM-4, whereas ANR was higher in PHM-1.

Key words: Coated urea, Growth indices, Nitrogen levels, Nitrogen use efficiencies

Since last one and a half decade baby corn has received the worldwide recognition of being the high value crop in lieu of its high nutritive value and delicious taste. Baby corn is an exhaustive crop and requires high quantities of nitrogen during the period of efficient utilization leading to higher productivity. The development of N efficient genotypes and improvement of N management strategies is an exigency. Fertilizer nitrogen (N) is the main input in augmenting cereal production in the world. The recovery of applied nitrogen is only 30–50% and a significant amount of it is lost from agricultural fields. These circumstances not only add unnecessary input costs to the farmers, but also lead to pollution of the environment (Arregui and Quemada 2008). Subsequently, improvement in nitrogen use efficiency (NUE) has become a desirable goal in crop production enabling efficient N utilization, maximum energy conservation and profitability (Chen *et al.* 2013). There are many advances in enhancing use efficiency of applied fertilizer and one of them is coating of urea granules with suitable materials that promote gradual release of nitrogen fertilizer thus leading to several benefits that are of great agricultural significance.

Keeping all these points in mind, present study was carried out with an objective of understanding the relationship of efficient genotypes and different N management strategies with their physiological processes and biomass/yield formation of crop under different sources of urea and varying N application conditions.

MATERIALS AND METHODS

The field experiments were conducted during *kharif* 2016–17 and 2017–18 at the Research Farm of National Dairy Research Institute, Karnal, Haryana situated at 29°- 43′ N latitude and 76°-58′ E longitude with an altitude of 245 m amsl. The soil texture was sandy clay loam, neutral in reaction (7.3), medium in organic carbon (0.65) and available phosphorus (25.6 N/ha), low in available nitrogen (189.6 N/ha) and high in potassium (269.4 N/ha). The experiment was carried out in split-split plot design with three replications comprising two varieties of baby corn (PHM-1 and HM-4 sown in 60 cm apart line), four-coated urea - Neem coated urea (NCU), zinc coated urea (ZCU), sulphur coated urea (SCU) and prilled urea and four nitrogen levels (180, 150,

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120 kg N/ha and control). Split application of N was done at 20 and 40 DAS according to the treatments assigned. Crop was grown with assured irrigated facilities and other management practices, including P and K application, insect-pests and weed control, were followed according to local agronomic practices.

The crop was harvested at the stage of physiological maturity with in 2–3 days of silk emergence, whereas fodder was harvested within 10–15 days of silk emergence. In both years, the data on cob and fodder yield was recorded from penultimate rows of each sub plot and for laboratory analysis on dry weight basis- five representative plants were randomly selected and expressed subsequently on an individual plant basis. After calculating the yield, the samples were dried to a constant weight and grounded to determine NPK uptake by crop. The samples were oven dried, then finely ground with electric grinder and analyzed for nitrogen, phosphorus and potassium concentration. The nitrogen in plant was analysed by Modified Kjeldhal's method, phosphorus through Vanadomolybdo phosphoric acid yellow colour and potassium through Ammonium acetate method (Jackson 1973).

Nutrient uptake and Nitrogen use efficiency (NUE): Nutrient uptake and NUE (Agronomic Efficiency, Apparent Nutrient Recovery and Production efficiency) was advantageously analyzed through some of the commonly used indices that are frequently used in agronomic research to assess the efficiency of applied fertilizer (Novoa and Loomis 1981).

Statistical analyses: The data obtained from two consecutive years were pooled together and analyzed statistically using Analysis of variance method for drawing conclusions. The significance of various sources of variation was tested by error mean square by Fisher-Snedecorst "F" Test at probability levels 0.05 (Cochran and Cox 1955, Panse and Sukhatme 1967). The results presented in tables are on two-year mean data pooled analysis based.

RESULTS AND DISCUSSION

Growth parameters: The growth parameters have its importance in contributing to biological yield, particularly in fodder crops. The growth parameters (Table 1) avowed that the variety PHM-1 (149.96 cm) recorded significantly higher plant height than HM-4 (142.89 cm), whereas significantly higher LAI and DMA was recorded in variety HM-4 by 11.99 and 5.70%, respectively over PHM-1. It may be due to the genetic makeup and plant type of variety. The three coated urea being statistically at par with each other, remained superior over prilled urea. The NCU spurred into significantly higher plant height (155.54 cm), which was 7.41% higher over SCU and 14.63% over control (prilled urea) but at par with ZCU. These findings relate to the results of Kumar *et al.* (2011). Similarly, NCU accumulated significantly highest DMA (174.1 g/plant). This could be related to the releasing characteristics of the coated urea, which are controlled, by the type and thickness of coating (Hayat and Khan 2013). These results are comparable to the findings of Khan *et al.* (2015). The accretion in N level

Table 1 Effect of varieties, coated urea and N levels on nutrient growth, yield attributes and yield of baby corn

Treatment	Plant height (cm)	LAI	DMA (g/ plant)	No. of cobs	Dehusked cob weight g/cob)	Husked cob yield	Dehusked cob yield (t/ha)	Husk yield (t/ha)	Green fodder yield (t/ha)	Total fodder yield (t/ha)
Varieties										
PHM 1	149.96	6.42	162.37	3.15	6.00	7.63	1.72	5.91	23.73	29.65
HM-4	142.89	7.19	171.63	2.27	5.08	6.22	1.38	4.84	29.00	33.84
SEm±	1.31	0.14	1.31	0.07	0.12	0.11	0.03	0.09	0.59	0.51
CD (P=0.05)	5.63	0.60	5.64	0.30	0.50	0.48	0.12	0.38	2.54	2.18
Coated urea										
NCU	155.54	6.84	174.12	2.79	5.67	7.49	1.67	5.82	28.22	34.04
ZCU	149.68	6.75	169.56	2.72	5.56	6.94	1.55	5.39	27.12	32.51
SCU	144.80	6.77	170.11	2.67	5.55	6.89	1.55	5.34	26.45	31.78
PU	135.68	6.86	154.21	2.64	5.40	6.38	1.43	4.95	23.68	28.63
SEm±	3.32	0.09	4.74	0.05	0.16	0.25	0.06	0.20	1.27	1.29
CD (P=0.05)	7.23	NS	10.32	0.11	NS	0.55	0.14	0.43	2.76	2.81
N levels										
0 kg/ha N	95.62	6.20	89.14	2.22	3.83	2.91	0.64	2.28	13.21	15.49
120 kg/ha N	151.13	6.82	170.25	2.22	6.00	7.83	1.74	6.09	28.83	34.92
150 kg/ha N	165.66	6.94	195.66	2.88	6.15	8.44	1.87	6.56	31.40	37.96
180 kg/ha N	173.28	7.26	212.95	2.98	6.19	8.52	1.94	6.58	32.02	38.59
SEm±	3.68	0.12	4.67	0.07	0.16	0.26	0.06	0.20	1.01	1.03
CD (P=0.05)	7.41	0.24	9.40	0.15	0.32	0.52	0.13	0.40	2.03	2.07

increased plant height, LAI and DMA of baby corn. The application of 180 kg N/ha ensued into significant increase over other three levels. The magnitude of increase of plant height at 180 kg N/ha was 81.2, 14.7 and 4.6% over control, 120 kg N/ha and 150 kg N/ha, respectively. Similarly 180 kg N/ha was highest in LAI (7.26) and DMA (212.95) at 60 DAS. The magnitude of increase in DMA at 180 kg N/ ha over 0, 120 and 150 kg N/ha was 138.9, 25.0 and 8.83%, respectively. These results are akin to that of Bindhani *et al*. (2008).

Yield and yield attributes: Eventual objective of any technological intervention is to get maximum productivity per unit area. The mean data (Table 1) stated that the variety PHM-4 produced significantly higher number of cobs/plant (3.15) and weight of dehusked cob (6.0 g/cob) over HM-4 (2.27 and 5.08 g/cob, respectively). Das *et al.* (2009) showed similar results among the cultivars. The superiority in yield attributes of PHM-1 over HM-4 in growth parameters might be reason that the HM-4 variety expensed more energy in vegetative growth, whereas PHM-1 performed better at reproductive phase. Under different coated urea the NCU spurred into significantly highest number of cobs/plant (2.79) which was statistically at par with ZCU (2.72) but superior over SCU (2.67) and control (2.64). Khan *et al*. (2015) reported similar conclusions. The four-coated urea being non-significant among each other proclaimed highest weight of cob under NCU (5.67).

The number of cobs/plant was found to be statistically cogent at level 180 kg N/ha (2.98) that was statistically at par with 150 kg N/ha but significantly higher over 120 kg N/ha and control. Bindhani *et al*. (2008) also observed comparable results. Albeit the weight of dehusked cob at the three levels 180, 150 and 120 kg N/ha were found to be statistically at par with each other but significant over control (3.83 g/cob). The highest weight of dehusked cob (6.19 g/cob) was obtained in level 180 kg N/ha.

Baby corn yields: The variety PHM-1 recorded significantly higher baby corn husked cob yield (7.63 t/ha) and dehusked cob yield (1.72 t/ha) with percent increase of 22.7 and 24.6, respectively over variety HM-4 (Table 1). The green fodder and total fodder yield were recited significantly higher in variety HM-4. The total fodder yield of HM-4 was 14.1% higher over PHM-1. The number of cobs/plant and weight of dehusked cob may have increased the yield, as these are vital yield contributing characters, which could be attributed to genetic character of the cultivars making differences in the partitioning of photosynthates between them. The results corroborate the findings of Kasikranan *et al*. (2001).

Amid coated urea being statistically at par with each other, the NCU produced highest yield. The magnitude of increase of baby corn husked and dehusked yield under NCU over prilled urea was 17.4 and 16.8%, respectively. Likewise, the total fodder yield (34.0 t/ha) in neem coated urea was also found to be statistically at par with ZCU (32.5 t/ha), SCU (31.9 t/ha) but significantly higher over prilled urea (28.6 t/ha). The husked and dehusked yield of baby corn was observed to be highest in N level 180 kg/ ha was observed to be statistically at par with 150 kg N/ha in terms of baby corn yield. The magnitude of difference in highest N level and control was 74.71 and 65.84% for dehusked and husked baby corn yield, respectively.

The baby corn fodder yield at 180 kg/ha N level had shown significant increases over 120 kg N/ha (34.9 t/ha) and control (15.4 t/ha). The yield at N level 180 kg/ha (38.6 t/ ha) was observed to be statistically at par with 150 kg N/ha (37.9 t/ha), which may be due to favorable effect of nitrogen supply on the growth characters which formed the buildup blocks for the yield attributes and which in turn resulted in the higher baby corn yield. The vigorous and luxuriant growth of crop as noticed from improved growth characters, viz. plant height, dry matter accumulation and leaf area index at higher nitrogen levels might have contributed to the higher green fodder yield. Thakur and Sharma (1997) also made similar findings.

Nutrient uptake: The statistical analysis of nutrient uptake data revealed that the variety HM-4 reported significantly highest N uptake (93.1 kg/ha), which was 12.68% higher over PHM-1. Total N uptake conglomerate significantly under different coated urea. The total uptake of N (94.13 kg/ha) by baby corn was found to be significantly highest in NCU over prilled urea (77.65 kg/ha). The total N uptake in two levels 180 kg N/ha and 150 kg N/ha were found to be statistically at par but superior over 120 kg N/ ha and control (Table 2).

The neem coated urea recorded highest total P uptake (13.28 kg/ha and the prilled urea reported significantly lowest P uptake (11.16 kg/ha). Among nitrogen levels, the total P uptake also increased with increase in dose of nitrogen. The level 180 kg N/ha recorded highest phosphorus uptake (15.0 kg/ha). The two levels 180 kg N/ha and 150 kg N/ha being at par with each other reported significantly higher phosphorus uptake then 120 kg N $ha^{-1}$and control.

The variety HM-4 (122.56 kg/ha) recorded significantly higher potassium uptake over PHM-1 (104.28 kg/ha). Among different coated urea, the NCU had taken up highest total potassium (123.13). The three-coated urea being at par with each other produced significant results over prilled urea. The nitrogen level 180 kg/ha reported highest total uptake of potassium (133.36 kg/ha) which was 53.5% higher over control.

The statistical analysis of nutrient uptake data (Table 2) revealed that out of two cultivars the total uptake of N, P and K was in the order of HM-4> PHM-1. The varietal differences in uptake pattern may be ascribed to their differential root geometry and concomitant nutrient mobilization capacity by root exudates. Pratyusha *et al.* (2014) also reported similar outcomes. Similarly the total nutrient uptake conglomerate significantly, under treatment with different coated urea. The total uptake of N, P and K by baby corn was found to be significantly highest in NCU over prilled urea. This may be attributed to faster dissolution rate of prilled urea thus leading to various losses and comparatively reduced uptake by baby corn. The higher P

Table 2 Effect of varieties, coated urea and N levels on nutrient (NPK) uptake and NUE

Treatment	Total nutrient uptake kg/ha			Nutrient use efficiency: Dehusked cob			Nutrient use efficiency: Green fodder		
	N	P	K	AE	PE	APN	AE	PE	APN
Varieties									
PHM 1	81.37	11.62	104.28	6.83	9.13	0.60	85.91	2.49	28.30
HM-4	93.19	13.46	122.56	5.51	9.52	0.44	92.01	2.59	28.26
SEm±	1.45	0.492	2.85	-	-	-	-	-	-
CD (P=0.05)	6.25	NS	12.26	-	-	-	-	-	-
Coated urea									
NCU	94.13	13.28	123.13	6.50	10.05	0.57	92.08	2.67	28.58
ZCU	88.47	12.85	114.23	6.12	9.52	0.51	93.06	2.62	28.70
SCU	88.89	12.87	113.71	6.70	9.07	0.56	92.23	2.46	30.21
PU	77.65	11.16	102.62	5.36	8.66	0.44	78.48	2.41	25.61
SEm±	5.02	0.653	5.64	-	-	-	-	-	-
CD (P=0.05)	10.94	1.423	12.30	-	-	-	-	-	-
N levels									
0 kg/ha N	40.78	6.50	61.95	-	-	-	-	-	-
120 kg/ha N	93.56	13.97	126.95	9.20	14.17	0.75	130.16	3.48	39.66
150 kg/ha N	106.07	14.70	131..34	8.24	12.26	0.69	121.22	3.43	39.31
180 kg/ha N	108.72	15.00	133.36	7.24	10.87	0.64	104.47	3.25	34.14
SEm±	4.12	0.668	4.87	-	-	-	-	-	-
CD (P=0.05)	8.29	1.343	9.80	-	-	-	-	-	-

*AE= agronomic efficiency, (kg yield/kg N); *PE= production efficiency, (kg yield/kg N); *APN= apparent nutrient recovery, (%)

and K uptake can be attributed to higher total yield obtained in coated urea in contrast to prilled urea. Khandey *et al.* (2017) reported corresponding results.

The total NPK uptake was recorded highest in nitrogen level 180 kg/ha. Significant enhancement in uptake of nitrogen, phosphorus and potash with the increase in fertility levels was due to higher biological yield as well as content of nutrients observed with higher dose of nitrogen. These results corroborate the findings of Paramasivan *et al.* (2010).

Nitrogen use efficiencies: The agronomic efficiency (AE) of dehusked cob (6.83) was found highest in variety PHM-1 although agronomic efficiency of green fodder was recorded highest in HM-4. The variety HM-4 realized higher production efficiency (PE- kg yield kg/N) of both green fodder (2.59) and baby corn cob (9.52). Whereas, the apparent nutrient recovery (APN) was recorded 2.5% higher in PHM-1 than HM-4 (30.91%). The varietal differences in efficiency and nitrogen recovery might be due to difference in uptake pattern that may be ascribed to their differential root geometry and concomitant nutrient mobilization capacity by root exudates. Among different coated urea, the SCU (6.70) observed highest AE followed by NCU, ZCU and prilled urea in dehusked cob. Whereas, in case of green fodder AE was highest in ZCU (93.06). The production efficiency (PE) was highest in NCU followed by ZCU, SCU and prilled urea (Table 2). SCU recorded highest APN (33.35%). Pooniya *et al*. (2017) also worked out nitrogen use efficiency of different coated urea and found conforming results. This improvement in use efficiency of nitrogen in coated urea is ascribed to its slow release and comparatively less nitrogen losses than prilled urea that favoured higher nitrogen uptake throughout the crop period, thus amplified yields. The increment in nitrogen level decreased the AE of dehusked cob and green fodder. The level 120 kg N/ha recorded highest efficiency. Similarly, PE and APN too followed same trend as of AE. The increment in nitrogen level decreased the NUE of dehusked and green fodder. The negative effect caused by losses at large nitrogen concentration was larger than the positive effect of dry matter production and N redistribution at high N rate, so NUE decreased with increasing N rates. Mae *et al*. (2006) reported comparable results.

The two years of experimentation blazed into realizing genetic potential of the PHM-1 yielding into higher baby corn yield while HM-4 in green fodder yield. The higher nutrient uptake, yield and nitrogen use efficiency of neem-coated urea proved its superiority. Among different levels of nitrogen, significant increase in final outcome that is yield of baby corn and green fodder was realized up to 150 kg/ha. The results in form of growth indices, yield, NPK uptake and N use efficiency will assist in taking up management decisions considering the profitability and environmental impact.

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