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Relative performance of neem coated urea (NCU) on nutrient content, uptake and nitrogen use efficiency of rice (*Oryza sativa* L.)

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Abstract
A field experiment was conducted during *Kharif* season of 2016 at Crop Research Centre of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (U.P.) to evaluate the nitrogen release pattern and use efficiency of neem coated urea under different application schedule in rice (*Oryza sativa* L). The soil of the experimental field was well drained, sandy loam in texture, alkaline in reaction (pH 8.03), low in available nitrogen, medium in available phosphorus and available potassium with an electrical conductivity of 0.21dS m^{-1}. Eleven treatments comprising control (No N), 50:25:25 N, 33:33:33 N, 25:25:50 N, 25:50:25 N, 00:50:50 N, 00:75:25 N, 00:25:75 N, 50:50:00 N, 50:00:50 N through neem coated urea as basal, at maximum tillering and panicle initiation stage and LCC based (≤ 4 critical value) replicated thrice estimated in a randomized block design. The results obtained in this study showed that the (T_5) 25:50:25 N through neem coated urea as basal, at maximum tillering and panicle initiation stage performed significantly better than the other treatments in nutrient uptake (128.68 kg ha-1N, 19.58 kg ha-1 P, 131.59 kg ha-1K), agronomic use efficiency (13.08 kg ha^{-1}) and apparent recovery efficiency (54.75 %) of rice.

Keywords: Rice, nitrogen, neem coated urea, nutrient content, nutrient uptake, nitrogen use efficiency

Introduction
Nitrogen (N) is generally required by them in the largest amounts. Urea is one of the most widely used sources of fertilizer N in the world. It also has high nitrogen content (46%), in comparison to many other popular nitrogen sources. When applied to soil, urea is first transformed into ammonical (NH_4^+) form after its hydrolysis and then to nitrite (NO_2^-), followed by to nitrate (NO_3^-) forms by the process of nitrification. Most of the crop plants use nitrate as a source of nitrogen except rice which prefers ammonical form. Though nitrification is a necessary phenomenon for making nitrogen available to crop plants, but the rapid nitrification one of the key processes that encourages nitrogen losses from the soil. This leads to reduced recovery of urea-N by crop plants. The per cent recovery of fertilizer N, say urea-N for example, generally called as nitrogen use efficiency (NUE). The recovery of fertilizer N by a crop, especially through chemical fertilizer such as urea, in India ranges from 30 to 50% for rice. One scientific study has estimated nitrogen use efficiency (NUE) below 33% for cereal production at the global scale. The unaccounted 67% fertilizer N escapes through different routes, such as nitrate leaching, ammonia volatilization and denitrification etc., Various approaches have been adopted inhibit the urease activity and to delay the hydrolysis process of urea. "On an average, 20 per cent less neem-coated urea is required as compared to ordinary urea. It is also helpful in preventing insect attacks (Kumar *et al*., 2015) [2]. Use of slow release sources of nitrogen and/or coinciding the supplies of N at critical stages of crop growth through split application reduce these losses to some extent. The indigenous materials like neem reported to reduce the losses of nitrogen from the soil and increase its efficiency (Sagar and Reddy, 1992) [6]. But the extent of losses and efficiency of applied N varied under different soil systems. (Singh *et al*., 2003) [9]. Reported that basal application of whole motmot of neem extract coated urea was beneficial for growth and yield of rice. On the other hand, (Singh *et al*., 2003) [9] observed that neem extracts coated urea applied in split produced significantly higher grain yield than its whole amount was given as basal. Therefore, present study intended to find out the relative performance of neem coated urea (NCU) on Nutrient uptake and Nitrogen use efficiency of rice (*Oryza sativa* L.).

Methods and Materials
A field experiment was carried out during the *Kharif* season of 2016 at the crop research centre

Chirauri of Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut (U.P.), India to study the relative performance of neem coated urea (NCU) on Nutrient content, Nutrient uptake and Nitrogen use efficiency of rice (*Oryza sativa* L.). Which is located at latitude of 29^0 40′ North and longitude of 77^0 42′ east and at an altitude of 237 metre above mean sea level (MSL). Meerut lies in the heart of Western Uttar Pradesh and has semi-arid to sub-tropical climate.

The mean maximum temperature was noticed in June, which is the hottest month of the year, ranges from 40º to 45ºC while very low temperature (4°C) accompanied by frost may be experienced in Dec.-Jan. The winters are cool; frost generally occurs towards the end of December and may continue till the end of January. The mean annual rainfall of the Meerut is about 840 mm, of which nearly 80 per cent is received in the monsoon period from June to September. The soil of experimental plot was loam in texture. Soil samples from a depth of 0-15 cm were collected from each plot of the experimental field prior to transplanting and a composite sample was drawn for determining its physical and chemical properties. The characteristics of top-soil (0–15 cm layer) at the start of experiment was neutral in reaction (pH 8.03), electrical conductivity 0.21 dSm^{-1}, soil organic carbon 0.44 %, available N 205.37 kg/ha (Subbiah and Asija 1956) [24], available P 10.87 kg/ha (Olsen *et al.* 1954) [14] and available K 231.43 kg/ha (1 N NH4OAc-extractable K). Eleven treatments comprising control (No N), 50:25:25 N, 33:33:33 N, 25:25:50 N, 25:50:25 N, 00:50:50 N, 00:75:25 N, 00:25:75 N, 50:50:00 N, 50:00:50 N through neem coated urea as basal, at maximum tillering and panicle initiation stage and LCC based (≤ 4 critical value) replicated thrice estimated in a randomized block design. The treatment means were compared using least significant differences at 5% level of significance (Gomez and Gomez 1984) [1].

Results and Discussion

Effect of neem coated urea on nutrient content of rice

Nitrogen content of rice

Data pertaining to nitrogen content of rice in per cent are presented in Table 1. The nitrogen content in plant was highest at tillering stage in all the treatments and after that it showed a gradual reduction up to harvesting stage. At harvest stage nitrogen content in grain was higher than straw. At tillering stage, the maximum nitrogen content (2.23%) statistically *at par* to T_2, T_3, T_4, and T_{11} and significantly higher than the remaining treatments was found in T_5 (25:50:25 N through neem coated urea as basal, at maximum tellering and panicle initiation, respectively). The minimum nitrogen content (1.99 %) found under control was statistically *at par* to T_8 but significantly lower than all the remaining treatments. Nitrogen content in plant N as higher with the application of 25% N as basal, 50% at maximum tellering and 25% panicle initiation, through NCU urea (T_5) or 50% N as basal and rest through LCC ≤4 (T_{11}). The application of 75% N at maximum tillering and 25% panicle initiation. or 25% N at maximum tillering and 75% panicle initiation, through neem coated urea did not resulted any significant variation in nitrogen content of plant. At panicle initiation stage, the maximum nitrogen content (1.85 %) statistically *at par* to T_2, T_3, and T_{11} and significantly higher than the remaining treatments was found in T_5 where 25% N was applied as basal, 50% at maximum tillering and 25% at panicle initiation. The minimum nitrogen content (1.48 %) significantly lower than all the remaining treatments was found under control. Nitrogen content in plant was found similar in the plots receiving nitrogen in three equal split as basal, maximum tillering and panicle initiation and 50% N as basal and rest through LCC (≤4) value. Grain and straw N content also varied significantly with the application different treatments. Maximum N content in grain and straw (1.92 and 0.76%) respectively was recorded under T_5. While minimum 1.65 and 0.41% in control. The use of 50% N as basal and rest through LCC (4≤) and existing schedule of N application resulted in similar plant N content. Higher nitrogen content at maximum tillering, panicle initiation and harvesting stage (grains and straw) recorded under the treatment which received 25% N through neem coated urea as basal, 50% maximum tillering and 25% at panicle initiation, respectively. The increased N content in this treatment might be due to better utilization of nitrogen from soil with well-developed root system owing to steady N supply throughout the crop growth stages, which might have resulted in adequate availability of nitrogen causing higher N content in plant at all the stages of crop growth. Minimum nitrogen content at maximum tillering was recorded in a plot which did not received any nutrients. Same trend was also noticed in N uptake. The uptake of N is the product of N content and dry matter yield. It was mainly due to higher N content. Similar opinion was also put forward by Dwivedi *et al.* (2015) [2], Kumar *et al.* (2015) [2] and Shahi *et al*. (2016) [7]. Sharma *et al.* (2012) [8].

Phosphorus content of rice

The data pertaining to phosphorus content in rice plant as influenced by different treatments at different stages of crop are presented in Table 1. It is legible from the table that phosphorus content reduced with advancement of crop growth in all the treatments. At harvest stage phosphorus content in grain was higher than straw. At tillering stage of rice crop, phosphorus content of rice ranged from 0.181 to 0.200 %. The maximum phosphorus content (0.200 %), statistically *at par* to T_2, T_3, T_4, and T_{11} and significantly higher than the remaining treatments was found in T_5 (25:50:25 N through neem coated urea as basal, at maximum tillering and panicle initiation, respectively). The minimum phosphorus content (0.181 %) found in T_1 was significantly lower than all the remaining treatments. Application effect of 75% N at maximum tillering and 25% at panicle initiation, or 50% N as basal and 50% panicle initiation, was similar plant P content. At panicle initiation stage, the phosphorus content of rice plant ranged from 0.152 to 0.178 %. The maximum phosphorus content (0.178 %), statistically *at par* to T_3 and T_4 significantly higher than the remaining treatments was found in T_5 where 25% N was applied as basal, 50% at maximum tillering and 25% at panicle initiation. The minimum phosphorus content (0.152 %), found in T_1 was significantly lower than all the remaining treatments. Phosphorus content in plant was found statistically similar in the plots receiving 75% N at maximum tillering and 25% at panicle initiation, or 50% N as basal and 50% panicle initiation, through NCU. In grain phosphorus content of rice crop ranged from 0.234 to 0.283 %. The maximum phosphorus content in grain (0.283 %) with the application of nitrogen as 25:50:25 basal, at maximum tillering and panicle initiation, respectively (T_5) was statistically *at par* to P content recorded in T_3 and T_{11} and significantly higher than all remaining treatments. The minimum phosphorus content in grain found under control was significantly lower than all remaining treatments. Phosphorus content in grain was found similar with the application of 25:50:25 N through neem coated urea as basal, at maximum tellering and panicle initiation, (T_5) and 33:33:33 N through neem coated urea as basal, at maximum tellering and panicle initiation, (T_3). The maximum phosphorus content (0.120 %) of rice straw statistically *at par* to T_3 and significantly higher than the remaining treatments was found in T_5 (25:50:25 N through neem coated urea as basal, at maximum tellering and panicle initiation, respectively). The minimum phosphorus content (0.070 %) found in T_1 was significantly lower than all the remaining treatments. The application of 50% N as basal and 50% at maximum tillering respectively (T_9) and 50% N as basal and 50% panicle initiation, stage (T_{10}) did not resulted any significant variation in phosphorus content of plant. Application of 25% N through neem coated urea as basal, 50% maximum tillering and 25% at panicle initiation stage caused an improvement in P content at all the stages, which may be due to the fact that higher organic matter content in soil by the higher application of priled urea or NCU favor the high availability of nutrient to the crop, besides good activity of microbial biomass and hence P contribution to the available pool. The results are corroborated with the findings of Maheswarapa *et al*. (1999) [3] and Kumar *et al.* (2015) [2].

Potassium content of rice

Data pertaining to potassium content of rice plant are presented in Table 1. The potassium content in plant was highest at tillering stage in all the treatments and after that it showed a gradual decrease up to harvesting stage. At harvest stage potassium content in straw was higher than that in grain. At tillering stage, the maximum potassium content of 2.40% in T_5 (25:50:25 N through neem coated urea as basal, at maximum tillering and panicle initiation, was statistically *at par* to K content recorded in all the treatments with exception of content. Potassium content did not differ significantly among the treatment consisting application of 75% N at maximum tillering and 25% panicle initiation, and 25% N at maximum tillering and 75% N panicle initiation. The minimum potassium content (1.86 %) found in T_1 significantly lower than all the treatments. At panicle initiation, the highest potassium content (2.11 %) recorded in T_5 was statistically at par with the treatments T_2, T_3 and T_{11} and significantly higher than the remaining treatments. Minimum potassium content 1.54 % recorded in T_1 (control) was significantly lower than all the treatments. The use of 50 % N as basal and rest through LCC (≤ 4) as compared to recommendation T_2 maximum potassium content of plant. At harvest stage of rice the potassium content in grain ranged from 0.21 to 0.33 % percent. The highest grain potassium content (0.33 %) recorded in T_5 25:50:25 N through neem coated urea as basal, at maximum tellering and panicle initiation, respectively, was statistically at par to T_3 and T_{11} and significantly superior than rest of the treatments. Minimum potassium content 0.21 % recorded in T_1 (control) was significantly lower than the remaining treatments. Potassium content in rice straw ranged from 1.26 to 1.56 percent under different treatments. The highest potassium content 1.56% in straw recorded in (T_{11}) 50% N as basal and rest through LCC (≤ 4), was statistically *at par* to T_3, T_5, T_{10} and significantly superior than the rest of the treatments. Minimum potassium content 1.26 % recorded in T_1 (control) was significantly lower than remaining treatments. The application of 50 % N at maximum tillering and 50% panicle initiation, and 75 % N at maximum tillering and 25 % panicle initiation, through neem coated urea resulted in similar potassium content of plant. All the treatments received similar dose of potassium but still significantly higher K content in T_5 than some treatment could not be fustily at present. Application of 25% N as basal, 50% at maximum tillering and 25% at panicle initiation, respectively resulted in higher K content in grain and straw. The results are consonance with the findings of Naidu *et al.* (2009) and Kumar *et al.* (2015) [2].

Effect of neem coated urea on nutrient uptake of rice

Nitrogen uptake (kg ha^{-1})

The data related to nitrogen uptake by rice plant as influenced by different treatments at different stage of crop are presented in Table 2. It is legible from Table 2 that nitrogen uptake by rice increase with crop growth of rice in all treatments. The nitrogen uptake by rice at all the growth stages was influenced by different N schedules. At tillering stage, the maximum nitrogen uptake (32.33 kg ha^{-1}) found in T_2 with the application of 50:25:25 N through neem coated urea as basal, at maximum tellering and panicle initiation, respectively was statistically *at par* to T_3 and higher than remaining treatments. The minimum nitrogen uptake 17.71 kg ha^{-1} found in T_1 (control) was *at par* to T_6 T_7 and T_8 and significantly lower than all the remaining treatments. The application of 33:33:33 N through neem coated urea as basal, at maximum tillering and panicle initiation, respectively accumulated 40.80 % more nitrogen uptake as compared to control. At P.I. stage, the maximum nitrogen uptake (80.29 kg ha^{-1}) statistically *at par* to T_2, T_3, T_{11} and significantly higher than the remaining treatments was found in T_5 (25:50:25 N through neem coated urea as basal, at maximum tillering and panicle initiation, respectively). The minimum nitrogen uptake (45.14 kg ha^{-1}) found in T_1 was significantly lower than all the remaining treatments. The nitrogen uptake by rice grain ranged from 33.95 to 69.65 kg ha^{-1}. The maximum nitrogen uptake in grain (69.65 kg ha^{-1}) in 25:50:25 N through neem coated urea as basal, at maximum tellering and panicle initiation, respectively (T_5) was statistically *at par* to N uptake recorded in T_2, T_3, T_4, T_{11} and significantly higher over all other treatments. Uptake of nitrogen did not differ significantly due to addition of 50 % N at maximum tillering and 50 % panicle initiation and 25 % N at maximum tellering and 75 % panicle initiation, stage. The maximum (59.04 kg ha^{-1}) and minimum (20.31 kg ha^{-1}) nitrogen uptake in straw was found in T_5 and control respectively. Almost similar trend of treatment effect as was found for grain N uptake was noticed in case of straw. Total nitrogen uptake by plant differs significantly under different treatments. The maximum total nitrogen uptake with 25:50:25 N through neem coated urea as basal, at maximum tellering and panicle initiation, respectively (T_5) was statistically similar to T_2, T_3, T_4, T_{11} and significantly higher over the rest of the treatments. The minimum nitrogen uptake found under control was significantly lower than all the remaining treatment. The uptake of N is the product of N content and dry matter yield. It was mainly due to higher N content. Similar opinion was also put forward by Dwivedi *et al*. (2015) [2], Kumar *et al.* (2015) [2] and Shahi *et al*. (2016) [7]. Sharma *et al.* (2012) [8] carried out an experiment at research farm of Chaudhary Charan Singh Haryana Agricultural University, Hisar during *kharif* season of 2010 on clay loam alkaline soil, low in organic carbon and available nitrogen, medium in phosphorus and high in potassium. They noticed that the application of N_{90}, P_{45} kg ha^{-1} in three splits ($\frac{1}{4}$ basal + $\frac{1}{2}$ active tillering $+\frac{1}{4}$ panicle initiation) showed highest nitrogen uptake in rice.

Phosphorus uptake (kg ha^{-1})

The data pertaining to phosphorus uptake by rice plant as influenced by different treatments at different stages of crop are presented in Table 2. It is legible from Table 2 that phosphorus uptake by rice increase with crop growth of rice in all the treatment. The phosphorus uptake by rice at all the growth stages was influenced by different treatments. At tillering stage, the maximum phosphorus uptake (2.90 kg ha^{-1}) significantly higher than all the remaining treatments was found in T_2 with the application of 50:25:25 N through neem coated urea as basal, at maximum tillering and panicle initiation, respectively. The minimum phosphorus uptake (1.61 kg ha^{-1}) found under control was significantly lower than all the remaining treatments. Uptake of phosphorus did not differ significantly among the treatments having application of 75 % N through NCU at maximum tillering and 25 % panicle initiation (T_7) and 25 % N through NCU at maximum tillering and 75 % panicle initiation (T_8). At P.I. stage, the maximum phosphorus uptake (7.22 kg ha^{-1}) significantly higher than the other treatments was found in T_5 (25:50:25 N through neem coated urea as basal, at maximum tellering and panicle initiation, respectively). The minimum phosphorus uptake (4.63 kg ha^{-1}) found in T_1 was significantly lower than the remaining treatments. Uptake of phosphorus differ significantly due to addition of 25 % N at maximum tillering and 75 % panicle initiation (T_8) and 50 % N as basal and 50 % maximum tellering (T_9). The phosphorus uptake by rice grain ranged from 4.81 to 10.26 kg ha^{-1}. The maximum phosphorus uptake in grain (10.26 kg ha^{-1}) in 25:50:25 N through neem coated urea as basal, at maximum tillering and panicle initiation, respectively (T_5) was statistically *at par* to P uptake recorded in T_3 and significantly higher than all other treatments. Phosphorus uptake did not differ significantly with the application of 50 % basal and rest through LCC ($\leq$ 4) and recommendation T_2. Minimum phosphorus uptake in grains was found in control followed by T_8 and T_7. The maximum (9.32 kg ha^{-1}) and minimum (3.46 kg ha^{-1}) phosphorus uptake in straw was found in T_5 and T_1 respectively. Uptake of phosphorus by rice straw was lower with the application of 75 % N tillering and 25 % panicle initiation and 25 % N at tillering and 75 % panicle initiation. The use of 50 % N basal and rest through LCC ($\leq$ 4) recorded significantly higher phosphorus uptake as compared to (T_2). The maximum total phosphorus uptake with 25:50:25 N through neem coated urea as basal, at maximum tillering and panicle initiation, respectively (T_5) was statistically similar to T_3 and significantly higher over the rest of the treatments. The minimum phosphorus uptake was recorded under control (8.45 kg ha^{-1}) followed by T_8 and T_7. P uptake at tillering, panicle initiation and in harvesting stage (grains + straw and total biomass) was similar to N uptake. According to Sharma *et al.* (2012) [8], the application of N_{90}, P_{45} kg ha^{-1} in three split ($\frac{1}{4}$ basal + $\frac{1}{2}$ active tillering + $\frac{1}{4}$ panicle initiation) showed highest phosphorus uptake in rice also.

Potassium uptake (kg ha^{-1})

The data pertaining to potassium uptake by rice plant as influenced by different treatments at different stages of crop are presented in Table2. It is legible from Table 2 that potassium uptake by rice increase with crop growth of rice. The potassium uptake by rice at the harvest was influenced by different fertility levels. At harvest stage potassium uptake by rice was higher in straw as compared to grain uptake. At tillering stage, potassium uptake in plant under different treatments varied from 16.55 to 34.41 kg ha^{-1}. The maximum potassium uptake (34.41 kg ha^{-1}), statistically *at par* to T_3 and T_{10} and significantly higher than the remaining treatments was found in T_2 where the 50:25:25 N through neem coated urea was applied as basal, at maximum tillering and panicle initiation, respectively. The minimum potassium uptake (16.55 kg ha^{-1}) found in T_1 was significantly lower than all the treatments. Potassium uptake in plant decline significantly due to skipping of basal N application. At P.I. stage, the maximum potassium uptake (91.57 kg ha^{-1}), statistically *at par* to T_3, and significantly higher than the remaining treatments was found in T_5 where 25:50:25 N through neem coated urea was applied as basal, at maximum tellering and panicle initiation, respectively. The minimum potassium uptake (46.97 kg ha^{-1}) found in T_1 was significantly lower than all the treatments. Potassium uptake under different treatments followed the similar trend as was found during tillering stage. The maximum potassium uptake by rice grain (11.97 kg ha^{-1}) in T_5 (25:50:25 N through neem coated urea as basal, at maximum tillering and panicle initiation, respectively was statistically at par to K uptake recorded in T_3 but significantly higher than all other treatments. Skipping of basal nitrogen application resulted in lower K uptake by rice grain. The minimum potassium uptake in grain found in T_1 was significantly lower than all the treatments. The potassium uptake by rice straw ranged from 62.42 to 119.62 kg ha^{-1}. The highest potassium uptake (119.62 kg ha^{-1}) found in T_5 was statistically *at par* to T_2, T_3 and significantly higher than all the reaming treatments. The minimum potassium uptake (62.42 kg ha^{-1}) was found under control was followed by T_8 and T_7. Uptake of potassium by rice straw under different treatments followed the similar trend as was found in case of grain.

The maximum total potassium uptake (131.59 kg ha^{-1}) with 25:50:25 N through neem coated urea as basal, at maximum tillering and panicle initiation, respectively (T_5) was statistically similar to T_3 and T_{11} and significantly higher over the rest of the treatments. The minimum potassium uptake (67.37 kg ha^{-1}) recorded in T_1 (control) was significantly lower than all the treatments. It was mainly due to the fact that K uptake is governed by nutrient content and their respective yield, combined action of both led to more uptake of K in grain and straw as well as total biomass. Similar opinions were also put forward by Dwivedi *et al.* (2015) [2] and Kumar *et al.* (2015) [2].

Effect of neem coated urea on nitrogen use efficiency

N Agronomic efficiency varied significantly due to different treatments. Maximum Agronomic efficiency 14.55 kg grain / kg applied N recorded with the integration of N as 50 % N as basal and rest through LCC $\leq$ 4 (T_{11}) was significantly similar than T_5, T_3 and statistically *at par* with rest of the treatments. T_5 recorded about 42.58 percent higher agronomic use efficiency than T_9. Among the nitrogen integrated treatments, agronomic efficiency was higher for those treatments where N was supplied through 50 % N as basal and rest through LCC ($\leq$ 4). Apparent N recovery efficiency varied significantly due to different treatments, Maximum apparent recovery 57.31 percent recorded due to application of 50 % N as basal and rest through LCC $\leq$ 4 (T_{11}) was statistically at par with T_2, T_5, and significantly higher than the remaining treatments. Minimum recovery was recorded with control. Recovery of applied N was comparatively higher in 25:50:25 N through NCU as basal, at maximum tillering and panicle initiation, than 25 % N at maximum tillering and 75 % panicle initiation. **s**In general values of nitrogen use efficiency in India are lower as against global. Moreover, values of NUE in the field experiment in western U. P. showed that, N is much more efficiently utilized in world as compared with western U. P. in India. Consequently, in western U. P. there is a considerable scope for increasing the efficiency of nitrogenous fertilizer (Naresh *et al*., 2014) [4]. Maximum agronomic efficiency and apparent N recovery efficiency was recorded with the application of 50% N through neem coated urea as basal and rest through LCC ≤ 4 (T_{11}) which was significantly higher than most of the treatments. Higher nitrogen use efficiency and more recovery of applied nitrogen in T_{11} may be supposed possibly due to reduced N losses through volatilization and denitrification from added NCU which releases nitrogen slowly. Similar opinion was also put forward by Tomar *et al.* (2016) in maize and Naresh *et al.* (2016) [7] in rice. A field experiment was conducted by Tayefe *et al.* (2011) [11] to know the effects of nitrogen fertilizer on nitrogen use efficiency and they reported that agronomic nitrogen use efficiency (ANUE) improved significantly with the incensement of the amount of nitrogen applied with increased split INS.

Table 1: Effect of Neem coated urea on nutrient content (%) at different stage in rice

Treatment	Nitrogen				Phosphorus				Potassium			
	Tillering Stage	P.I Stage	At harvest Grain	At harvest Straw	Tillering Stage	P.I Stage	At harvest Grain	At harvest Straw	Tillering Stage	P.I Stage	At harvest Grain	At harvest Straw
T_1 Control (No N)	1.99	1.48	1.65	0.41	0.181	0.152	0.234	0.070	1.86	1.54	0.21	1.26
T_2 50:25:25 N	2.17	1.82	1.90	0.74	0.195	0.172	0.276	0.098	2.31	2.05	0.27	1.45
T_3 33:33:33 N	2.20	1.83	1.91	0.75	0.198	0.174	0.280	0.117	2.32	2.06	0.32	1.50
T_4 25:25:50 N	2.16	1.80	1.89	0.72	0.195	0.173	0.266	0.097	2.22	2.04	0.29	1.44
T_5 25:50:25 N	2.23	1.85	1.92	0.76	0.200	0.178	0.283	0.120	2.40	2.11	0.33	1.54
T_6 00:50:50 N	2.02	1.68	1.75	0.58	0.193	0.167	0.262	0.093	2.27	2.04	0.27	1.47
T_7 00:75:25 N	2.00	1.69	1.73	0.57	0.194	0.168	0.264	0.092	2.26	2.02	0.26	1.45
T_8 00:25:75 N	2.01	1.59	1.71	0.56	0.193	0.164	0.256	0.088	2.25	1.99	0.26	1.41
T_9 50:50:00 N	2.12	1.75	1.81	0.68	0.196	0.169	0.269	0.096	2.24	2.04	0.28	1.47
T_{10} 50:00:50 N	2.11	1.70	1.83	0.69	0.194	0.168	0.268	0.095	2.26	2.05	0.30	1.49
T_{11} LCC Based (4 ≤ Critical value)	2.18	1.83	1.88	0.74	0.198	0.171	0.278	0.105	2.29	2.04	0.31	1.56
SEm±	0.03	0.01	0.01	0.01	0.002	0.002	0.002	0.002	0.06	0.02	0.01	0.03
CD at 5 %	0.08	0.04	0.04	0.02	0.005	0.005	0.006	0.004	0.18	0.06	0.03	0.08

N = Nitrogen through neem coated urea at basal, at maximum tillering and panicle initiation, respectively

Table 2: Effect of Neem coated urea on nutrient uptake (kg ha^{-1}) at different stage in rice

Treatment	Nitrogen				Phosphorus				Potassium			
	Tillering Stage	P.I Stage	Grain	Straw	Tillering Stage	P.I Stage	Grain	Straw	Tillering Stage	P.I Stage	Grain	Straw
T_1 Control (No N)	17.71	45.14	33.95	20.31	1.61	4.63	4.81	3.64	16.55	46.97	4.95	62.42
T_2 50:25:25 N	32.33	73.16	65.15	55.67	2.90	6.91	9.46	7.37	34.41	82.41	9.25	109.08
T_3 33:33:33 N	29.92	75.94	68.64	56.98	2.69	7.22	10.06	8.88	31.55	85.49	11.50	113.97
T_4 25:25:50 N	23.54	71.82	63.78	53.80	2.12	6.90	8.97	7.24	24.19	81.39	9.78	107.61
T_5 25:50:25 N	26.98	80.29	69.65	59.04	2.42	7.72	10.26	9.32	29.04	91.57	11.97	119.62
T_6 00:50:50 N	19.59	59.30	48.82	40.41	1.87	5.89	7.30	6.48	22.01	72.01	7.53	102.42
T_7 00:75:25 N	19.20	58.98	47.88	40.31	1.86	5.86	7.30	6.50	21.69	70.49	7.19	102.54
T_8 00:25:75 N	19.99	53.42	46.73	39.00	1.91	5.51	6.99	6.12	22.27	66.86	7.10	100.29
T_9 50:50:00 N	28.19	68.07	53.57	48.69	2.60	6.57	7.96	6.87	29.79	79.35	8.28	105.26
T_{10} 50:00:50 N	28.90	66.64	55.90	50.45	2.65	6.85	8.18	6.94	30.96	80.36	8.56	108.94
T_{11} LCC Based (4 ≤ Critical value)	27.46	73.74	64.57	55.94	2.49	6.89	9.54	7.93	28.85	82.21	10.64	117.93
SEm±	1.05	2.54	2.09	5.88	0.06	0.11	0.15	0.18	1.23	3.04	0.27	3.56
CD at 5 %	3.15	7.73	6.23	1.71	0.18	0.33	0.44	0.55	3.56	9.12	0.81	10.58

Table 3: Effect of Neem coated urea on total nutrient uptake in rice

Treatment	Total nutrient uptake (kg ha^{-1})		
	Nitrogen	Phosphorus	Potassium
T_1 Control (No N)	54.26	8.45	67.37
T_2 50:25:25 N	120.82	16.83	118.33
T_3 33:33:33 N	125.62	18.94	125.47
T_4 25:25:50 N	117.58	16.21	107.61
T_5 25:50:25 N	128.68	19.58	131.59
T_6 00:50:50 N	89.23	13.78	109.95
T_7 00:75:25 N	88.19	13.80	109.73
T_8 00:25:75 N	85.73	13.11	107.39
T_9 50:50:00 N	102.26	14.83	113.64
T_{10} 50:00:50 N	106.35	15.21	117.94
T_{11} LCC Based (4 ≤ Critical value)	120.51	17.47	128.57
SEm±	3.79	0.33	3.81
CD at 5 %	11.28	0.98	11.33

Table 4: Effect of neem coated urea on agronomic use efficiency and apparent recovery efficiency

Treatment	Agronomic use efficiency (kg ha^{-1})	Apparent Recovery efficiency (%)
T_1 Control (No N)	0.00	0.00
T_2 50:25:25 N	11.42	55.40
T_3 33:33:33 N	12.80	46.45
T_4 25:25:50 N	10.97	39.73
T_5 25:50:25 N	13.08	54.75
T_6 00:50:50 N	6.10	32.57
T_7 00:75:25 N	5.91	30.15
T_8 00:25:75 N	5.62	13.17
T_9 50:50:00 N	7.51	20.70
T_{10} 50:00:50 N	8.30	26.65
T_{11} LCC Based (4 ≤ Critical value)	14.55	57.31
SEm±	0.25	1.39
CD at 5 %	0.74	4.15

Conclusion

The application of neem coated urea significantly increased the grain yield of rice as compared to control (no nitrogen). Nutrient content and uptake of Nitrogen, Phosphorus and Potassium by plant was maximum in (T_5), 25:50:25 N through neem coated urea as basal, at maximum tillering and panicle initiation stage, followed by (T_3), 33:33:33 N through neem coated urea as basal, at maximum tillering and panicle initiation stage and minimum was noticed under T_1 control. Similarly recorded in Nitrogen agronomic efficiency and Apparent N recovery efficiency was found higher under T_5 and T_{11} LCC Based (4 ≤ Critical value), respectively. Agronomic use efficiency and apparent recovery efficiency was found in maximum in treatment (T_5), 13.08 kg ha^{-1} and 54.75 % of rice.

Reference

1. Gomez KA, Gomez AA. Statistical Procedures for Agricultural Research, 2nd Ed. John Wiley and Sons. New York, 1984, 639.
2. Kumar A, Kumar A, Dwivedi A, Dhyani BP, Shahi UP, Sengar RS. Production potential, nutrient uptake and factor productivity of scented rice in rice-wheat cropping system along with physicochemical and microbiological properties under site specific integrated plant nutrient management. Journal of Pure and Applied Microbiology. 2015; 9(2):1487-1497.
3. Maheswarappa HP, Nanajppa HV, Hegde MR. Influence of organic manures on yield of arrowroot, soil physicochemical and biological properties when grownas intercrop in coconut garden. Annals of Agricultural Research. 1999; 20(3):318-323.
4. Naresh S, R Swarna P. Studies on the bio-efficacy of neem coated urea on rice. An Asian Journal of Soil Science, The Asian J of Hort. 2014; 3(1):333-335.
5. Olsens SR, Cole EV, Watanable FS, Dean LA. Estimation of available phosphorus in soil by extraction with $NaHCO_3$. Cri. U.S. Dep. Agric, 1954, 939.
6. Sagar GK, Reddy. OtyZa. 1992; 29:376-387.
7. Shahi UP, Mamta Naresh RK, Dwivedi Ashish Kumar A, Dhyani BP. Assessment of Bio compost for Chemical Fertilizers Substitution by Monitoring Soil Fertility and Crop Productivity of Potato (*Solanum tuberosum* L.) in Sandy Loam Soil. Nature Environment and Pollution Technology. 2016; 15(2):465-470.
8. Sharma D, Singh I, Sagwal PK. Influence of different nitrogen and phosphorus levels on profitability, plant nutrient content, yield and quality in Basmati cultivars. Trends in Biosciences. 2012; 5(4):289-293.
9. Singh B, Singh Y. Efficient nitrogen management in rice-wheat system in the Indo-Gangetic plains. National Agricultural Technology Project, Indian Council of Agricultural Research, 2003, 99-114.
10. Subbaiah BV, Asija. A rapid procedure for the estimation of available nitrogen in soils. Curr. Science. 1956; 25:259-260.
11. Tayefe M, Gerayzade A, Amiri E, Zade AN. Effect of nitrogen fertilizer on nitrogen uptake, nitrogen use efficiency of rice. International Conference on Biology, Environment and chemistry IPCBEE, 2011, 2.
12. Tomer M, Dongara P, Singh D. Improvement in properties of urea by phosphogypsum coating. International journal of Chem tech research, 2016, 0974-4290.