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What is the real agronomic benefit of neem-coated urea?

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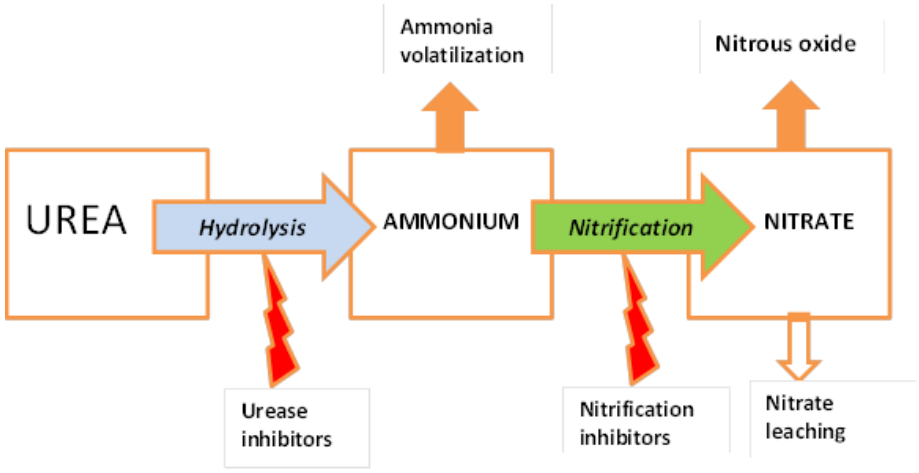
Urea in Indian agriculture

- India consumed 17.44 Mt fertilizer N in 2015-16; second largest consumer in the world
- More than 82% fertilizer N is urea
- Record urea production of 24.5 Mt in 2015-16
- Most N at the low cost, no storage risks, can be used for all types of crops and soils, little or no harm to the soil
- But its N use efficiency is 20 to 50%

Low N use efficiency of urea?



Urease inhibitors

- NBPT or NBTPT
- PPD or PPDA
- Hydroquinone

Nitrification inhibitors

- Nitrapyrin or N-Serve
- DCD
- DMPP
- Neem oil
- Neem cake

Neem, Neem oil and Neem cake

80,000 tons of oil and 330,000 tons of neem cake produced annually from 14 M naturally growing neem trees

Neem oil extraction:

- Pressing
- Steam distillation
- Solvent extraction

Variable quality of neem products

- Triterpenoids in neem oil and cake inhibit nitrification – *Large range in the content*
- Content changes with the region and the season
- Neem trees in moderate climates and in red, lateritic and shallow black soil at lower altitudes are richer in triterpenoids than the ecotypes growing at higher altitudes and on alluvial soils in hot and cold climates
- More the total rainy days during fruiting season, less is the content of triterpenoids

Neem Coated Urea (NCU)

- **Neem cake coated urea (NCCU**)

  200 g kg^{-1} urea; 35 % N; coal tar-kerosene solution as adhesive; 1971 -

- **Nimin/Neemex/Ralli Neem coated urea**

  Containing 2-10 % neem extract and 10-60 % neem oil ; mixed with urea at 0.5 -1.0 % w/w;1990 -

- **Neem oil coated urea (NOCU)**

  0.5 kg t^{-1} urea; prepared in urea plants; 2000 -

NCU versus Urea

- Since 1971, more than 75 studies conducted to evaluate agronomic benefits of NCCU/NOCU vis-à-vis urea
- About 60% of these studies used NCCU and were conducted before 2000
- After 2000, when NOCU became available, only 17 more studies were published
- More than 60% of all the published research papers to evaluate NCCU/NOCU vis-à-vis urea have used rice as the test crop.

NCU versus Urea: Rice

Per cent increase in yield of rice by applying NCU over that obtained with urea at same N level

- Prasad et al. (1993): **Mean 9.6**; range -26.30 to 54.2 with 3 negative values in 29 comparisons
- Prasad et al. (2007): **Mean 8.5**
- 55 comparisons from 50 studies : no increase in yield in 18 (> 30%) comparisons ; **Mean 8.9**
- **Mean 6.3** after excluding 5 abnormally high values more than 24.7; range 0 to 18.4

NCU versus Urea: Wheat

Per cent increase in yield of wheat by applying NCU over that obtained with urea at same N level

- Prasad et al. (1993): **Mean 6.9**; 4 comparisons; range 4.3-12.7
- 7 comparisons from 6 studies : no increase in yield in 2 comparisons ; **Mean 5.3**

NCU versus Urea: Rice-Wheat system

- Only 5 reports published in 1999 and later do not reveal a consistent effect
- Only Chauhan (1999) could obtain significant yield increases in both rice and wheat over uncoated urea in two consecutive years
- Out of the remaining 7 comparisons, in the 4 there was no increase in yield of both rice and wheat
- In three instances, a yield benefit only in rice was observed, possibly because NCU/NOCU was applied to rice and residual effect was tested in wheat

NCU versus Urea: other crops

Mean per cent increase in economic yield of different crops by applying NCU over that obtained with urea at same N level

Crop	Number of comparisons	Mean increase (%)
Potato	3	10.5
Sugarcane	4 (1)*	8.7
Cotton	4 (1)	4.3
Maize	1 (1)	0
Finger millet	2	5.4

*Figures in parenthesis indicate the number of comparisons showing no increase

Agronomic benefits of NCU over urea on researcher's plots

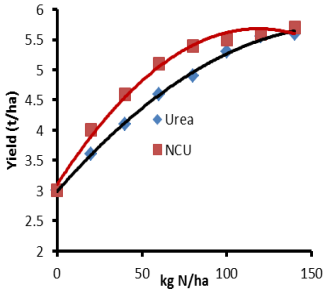
- On an overall basis, increase in yield of rice and wheat, in particular and other crops by applying NCU was in the range of ***5 to 6 %*** over that obtained by applying urea.
- On-farm assessments of fertilizer N use efficiency in rice fields in Asia were ***smaller by 25%*** than the average reported values determined in researcher-managed plots

Translating into realistic agronomic benefits on national scale

- Irrigated systems show a significantly higher response than rainfed systems to the application of nitrification inhibitors
- 32.8% of all urea consumed was applied to rainfed crops grown on 53.6% of the gross cropped area
- Thus one third of neem coated urea supplied to farmers in India is likely to show very little agronomic benefits

Even at high N application rates NCU will not outperform urea

- Mean N use level was 128.9 kg N ha^{-1} in irrigated crops against 76.4 kg N ha^{-1} in rainfed crops
- More than 50% urea used in irrigated rice and wheat is used at high per hectare N rates
- NCU and urea do not differ significantly at high levels of N application rates



NCU is not going to work better than urea in alkaline and fine textured soils

- NCUs perform better in acidic soils than in neutral and alkaline and sodic soils
  - Acidic soils constitute about 30% of the cultivable soils but extent of fertilizer use is very small
  - Most urea is applied to alkaline soils where NIs lead to enhanced ammonia volatilization losses
- NCUs generally do not perform better than urea in fine textured soils
  - Typical rice soils and black cotton soils are generally fine textured soils

Yield benefits due to replacing urea with NCU likely to be very small

- About one third studies show no benefit
- Extent of benefit to be reduced at farmers' fields
- About third of NCU used on rainfed crops will exhibit little benefit
- More than 50% NCU applied to irrigated rice and wheat at high N levels to result in small benefits
- In about 70% alkaline soils NIs are not very effective
- In fine textured soils too, NIs show very small positive effect

Demand for NCU is not likely to be reduced than urea because

- NCU specific recommendations for different crops and regions are yet to be formulated
- Farmers will think in terms of applying less NCU only when there is substantial increase in yields which is not very likely
- Farmers who are accustomed to apply high doses of N are not likely to reduce the dose of NCU to avoid any risk of reduction in yield

NCU need to be managed following SSNM

- Managing NOCU in food crops like rice, wheat and maize following principles of site-specific nutrient management is possibly the only way that can lead to increased production and/or reduced demand for NCU as compared to urea.
- SSNM will be able to take into account the effects of factors like soil texture, pH and irrigation in determining the amount of NCU to be applied in a given field.

Conclusions

- There is likely hood of a very little increase in the agricultural production due to replacing of urea with NCU in India
- In the near future, demand for NCU should not decrease as compared to urea
- Possibly NCU managed following SSNM principles can lead to both higher or similar yields levels as observed with urea but with lower rates of application