CROSSROADS ASIA PACIFIC
PRODUCTION & INTERNATIONAL TRADE
SINGAPORE
25-27 OCTOBER 2016

ifa INTERNATIONAL FERTILIZER ASSOCIATION

Slow and Controlled Release and Stabilized Fertilizers for Climate Smart Agriculture

Li Xinzhu & Kevin Moran
Kingenta International, China

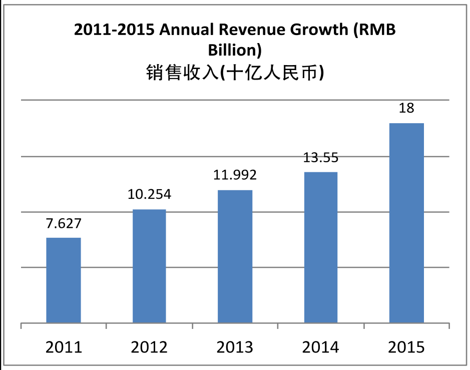
Kingenta International 金正大国际

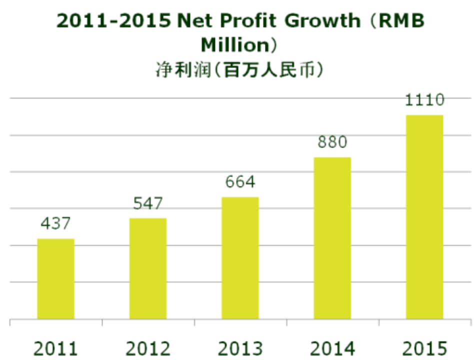
Kingenta's Vision

To be the world's leading expert in plant nutrition and a provider of crop solutions

Kingenta International 金正大国际

Key Data About Kingenta

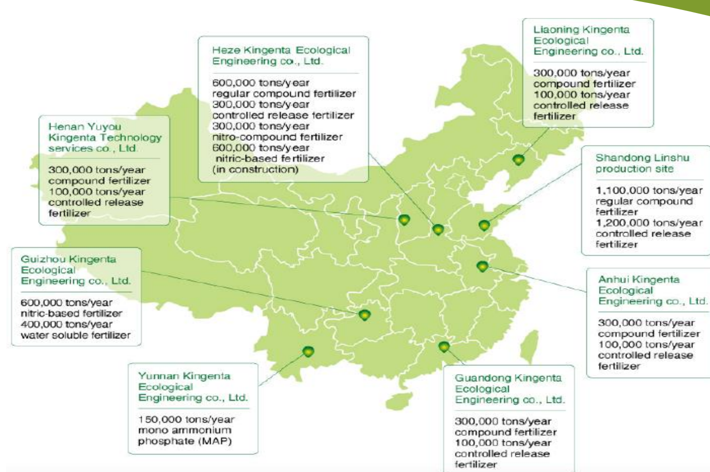




IFA Asia-Pacific Crossroads Meeting 2016, Singapore, 25-27 October

Kingenta 金正大国际

China production site map



Total production capacity of SCRF's = 1.8 million mt
(does not include Compo or Ekompany production in Europe)

IFA Asia-Pacific Crossroads Meeting 2016, Singapore, 25-27 October

Kingenta 金正大国际

Topics

1. Introduction to the principles of Climate Smart Agriculture
2. Role of SCRF's in Climate Smart Agriculture
3. Role of Stabilized Fertilizers in Climate Smart Agriculture

IFA Asia-Pacific Crossroads Meeting 2016, Singapore, 25-27 October

Kingenta International 金正大国际

Topics

1. Introduction to the principles of Climate Smart Agriculture
2. Role of SCRF's in Climate Smart Agriculture
3. Role of stabilized Fertilizers in Climate Smart Agriculture

IFA Asia-Pacific Crossroads Meeting 2016, Singapore, 25-27 October

Kingenta International 金正大国际

Increasing agricultural productivity to minimize climate change (adapted from IFA Message Map, 2009)

- **Agricultural productivity must increase by between 40 and 70% up to 2050 to ensure Food Security for a growing global population.**
- **However this must be done in a sustainable manner which has minimum environmental and climatic impact.**
- **A significant driver of this increased productivity will be N-based fertilizers.**
- **Improving their 'upstream' production efficiencies as well as then optimizing 'downstream' applications has a 'double benefit' in reducing their impact.**

What is Climate Smart Agriculture?

- **Climate Smart Agriculture (CSA) is an integrated approach to address the interlinked challenges of addressing food security and climate change with the following objectives:**
  - **Sustainably increasing agricultural productivity;**
  - **Adapting agricultural systems to climate change at multiple levels;**
  - **Reducing Green House Gas (GHG) and other harmful emissions and pollutants from agricultural systems;**
  - **Minimizing impact on natural resources.**
- **This presentation will focus on the third of these with emphasis on application of advanced formulation fertilizers to enable improvements in Nitrogen Use Efficiency (NUE) by crops.**

Routes of nitrogen losses

- Less than 3% of total global Green House Gas (GHG) emissions are directly related to fertilizer production and use.
- However most of these are emitted as Nitrous Oxide (N_2O) gas, half of which arises from application of N fertilizers to soils.
- These losses arise mostly from low N use efficiency (NUE) of applied fertilizers by crops which can also result in:
  - Leaching of N (as nitrates) as a pollutant into ground waters, rivers and lakes;
  - Loss of N (as ammonia gas) by volatilization into the atmosphere.

Benefits of improving Nitrogen Use Efficiency (adapted from Yara, 2010)

All contribute to reducing GHG emissions and N loss for CSA

© Yara 2010

Increasing Nitrogen Use Efficiency (NUE)

Increases Resource & Energy Use Efficiencies

Reduces Nitrogen Loss into Environment

Increases Food & Biomass Production and Soil Carbon Capture

Topics

1. Definition and objectives of Climate Smart Agriculture
2. Role of SCRF's in Climate Smart Agriculture
3. Role of Stabilized Fertilizers in Climate Smart Agriculture

Definitions of Slow and Controlled Release Fertilizers

Slow Release Fertilizers (SRF's) involve
the release of N at a slower rate
than is usual for uncoated fertilizer
but the release patterns are not well controlled,
for example: Sulphur Coated Urea (SCU)

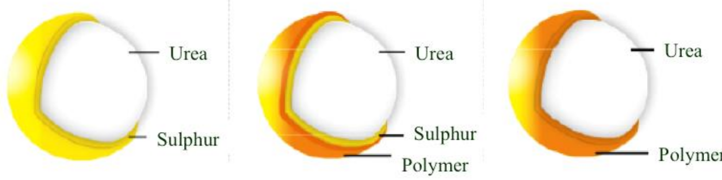
Controlled Release Fertilizers (CRF's) are more advanced
in that the factors dominating the rate, pattern and duration
of release are well known and controllable,
for example: Polymer Coated Urea (PCU)

Coatings used for SCRF's

Sulfur Coated Urea (SCU):
Urea granules are repeatedly coated with a suspension of liquid sulfur to ensure the coating uniformity of each granule.

Polymer and Sulfur Coated Urea (PSCU):
Urea granules are coated with 1% polymer after which they are coated with sulfur. Polymer coating makes the SCU coat more flexible and durable.

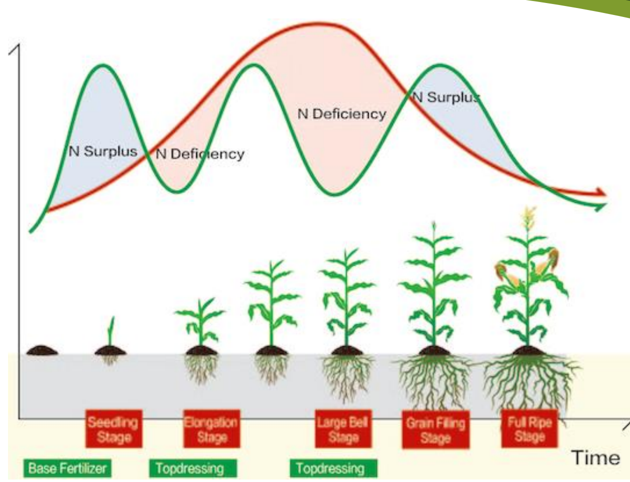
Polymer Coated Urea (PCU):
Urea granules are coated with a biodegradable polymer using advanced membrane coating technology which makes the release as required thus increasing fertilizer utilization rate.



Polymer coatings improve control of N release from urea with typical rates of release from 3 to 12 months

Kingenta 金正大国际

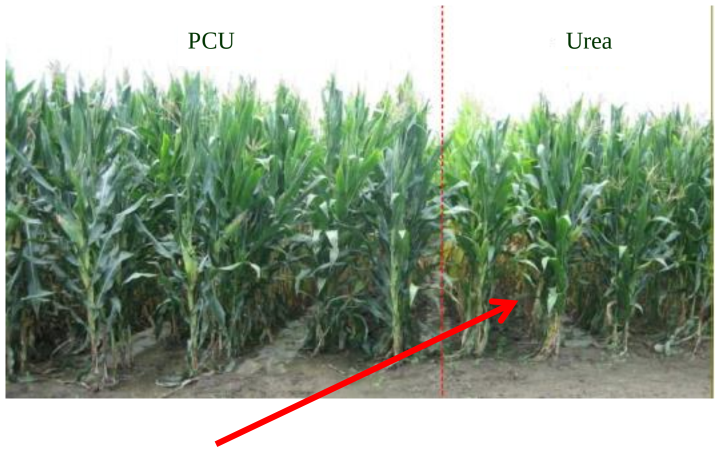
Traditional multiple straight N applications during crop growth (adapted from Kingenta, 2015)



Crop 'feast or famine' with surplus causing GHG emissions and N leakage into environment and N deficiency resulting in yield loss and reduced NUE

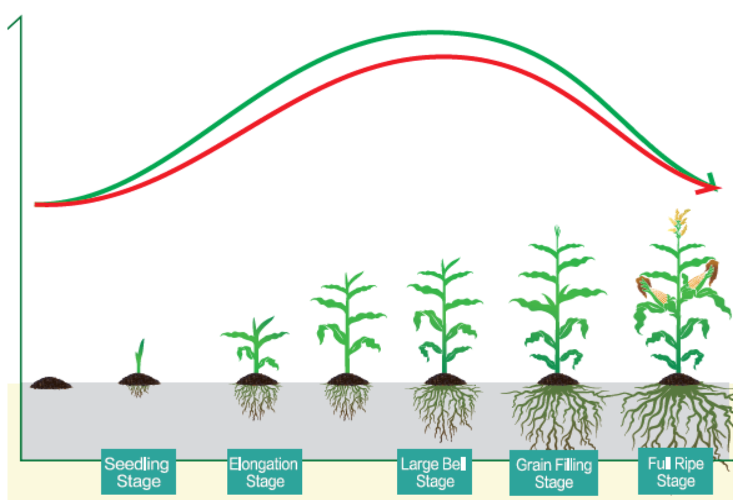
Kingenta 金正大国际

Controlled N release improves corn growth and yield (Chen, 2013)



Symptoms of "firing" (N deficiency) more pronounced in urea treatments

The 'Ideal Fertilizer' – synchronizing N release with crop requirement



Benefits of SCRF over straight urea in rice (Levi, 2003)

Fertilizer applied	Rate (kg/ha)	Cost (RMB)	Cost of application	Yield (kg/ha)	Total Value (RMB)	Profit (RMB/ha)	NUE (kg/kg N)
Straight Urea	225	383	3@50 RMB =150 RMB	6,000	10,200	9,667	26.6
Coated Urea	150	750	1@50 RMB =50 RMB	7,000	11,900	11,100	46.6

Despite doubling of coated fertilizer cost:

- N application rates were 33% less and labour costs reduced by 66%;
- Yield was increased by nearly 17% and NUE was improved by 75%;
- Profit was increased by 1,433 RMB/ha;
- ALL meet criteria for Climate Smart Agriculture.

Comparison of N loss potential for urea and 'Meister' polymer coated urea on rice in Japan (Shoji, 2005)

Treatment	N rate kg N/ha	N rate reduction	N uptake kg N/ha	NUE %	N loss potential kg N/ha
Straight urea	100	0	30	30	70
Polymer coated urea	40	60	32	80	8

Lower rates of N using controlled release urea result in improved crop uptake and NUE and reduced N loss potential as emissions and leakage – both contributing to CSA.

^{15}N tracer SCRF comparison field research (Kingenta, 2014)

^{15}N loss comparison of PCU with conventional urea (Kingenta, 2014)

Treatment	Nitrogen Applied	N losses in runoff	The leaching loss of N
	kgN/ha	(N%)	(N%)
PCU	240	9.22	8.55
Urea	240	12.6	10.2
PCU vs Urea	--	-3.38 (-27%)	-1.65 (-16%)

When comparing PCU with conventional urea, N-runoff was 27% less and N-leaching was 16% less. Also reduction in volatile ammonia by 68% and nitrous oxide losses by 34%.

Topics

1 Introduction to the principles of Climate Smart Agriculture

2 Role of SCRF's in Climate Smart Agriculture

3 Role of Stabilized Fertilizers in Climate Smart Agriculture

Kingenta 金正大国际

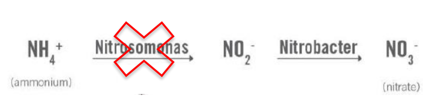
Stabilized Fertilizers (SF's)

Fertilizers which are treated to stabilize applied N-based fertilizers in soils for a longer period of time and protect against N-losses into the environment.

These can be either:

- **Urease inhibitors which slow the hydrolysis of urea into ammonia by the soil urease enzyme;**

- **Nitrification Inhibitors which slow the soil-bacterial oxidation of ammonium-N into nitrate-N.**

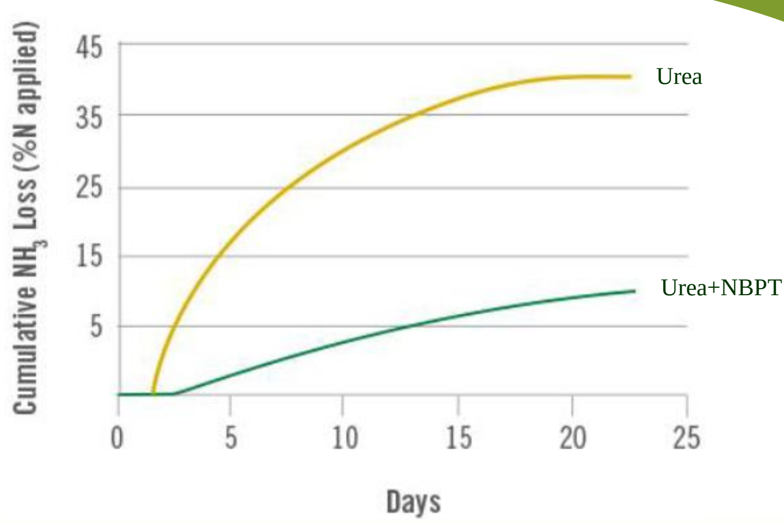


Kingenta 金正大国际

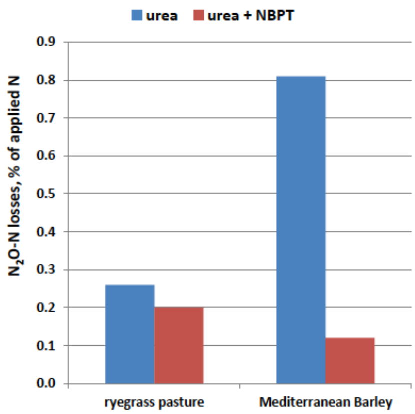
Main types of urease inhibitors
(Fertecon SCR&SF Report, 2016)

Acronym	Chemical formula	Supplier/Brand
NBPT	N-(n-butyl) thiophosphoric triamide	Koch Agronomic Services/Agrotain® Eurochem/UTEC® BASF/Limus® (+NPPT) Solvay/Agrho® N-Protect Weyerhaueaser Co/Arborite®
NPT	N-phenylphosphoric triamide	SKW Piesteritz
NPPT	N-(n-propyl) thiophosphoric triamide	BASF/Limus® (+NBPT)

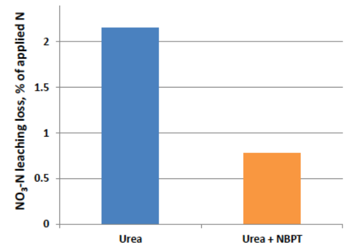
Reduction in ammonia emissions with 'Agrotain' NBPT urease inhibitor (Wade, 2015)



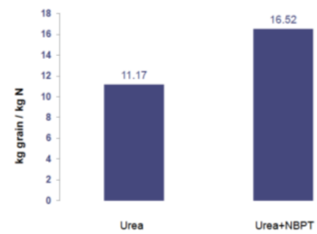
Triple Benefits for CSA using 'UTEC' NBPT Urease Inhibitor (Berger, 2015)



Lower Nitrous Oxide Emissions

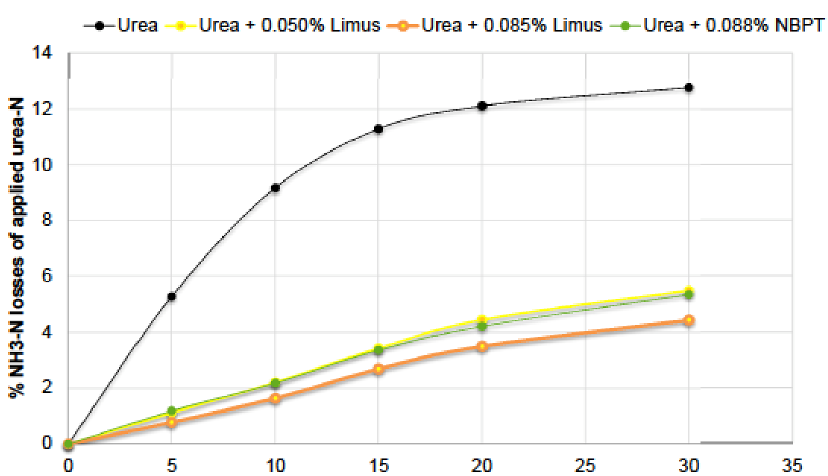


Reduced Nitrate Leaching

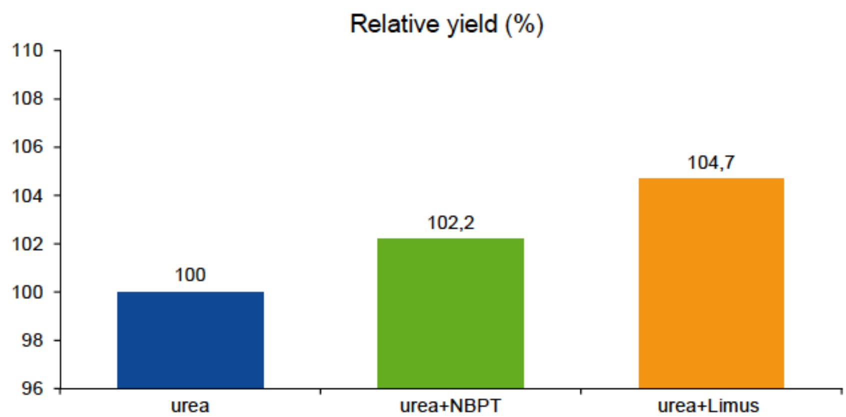


Improved Nitrogen Use Efficiency

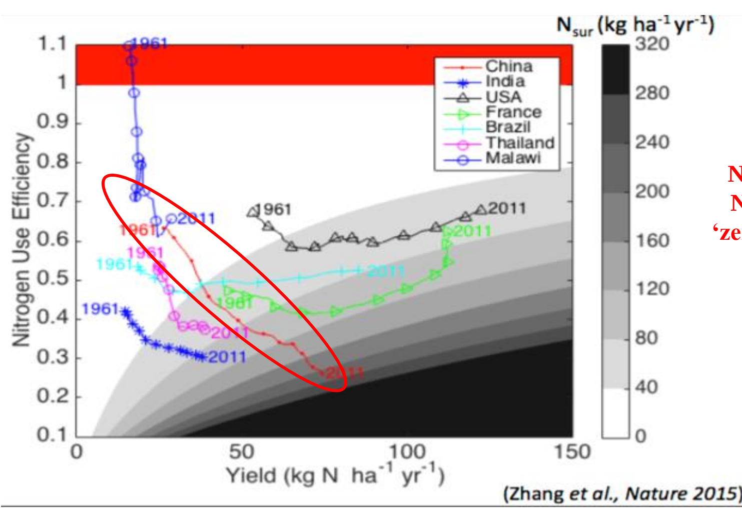
Reduction in Nitrous Oxide Emissions using new Limus® NBPT+NPPT Urease Inhibitor (BASF, 2016)



Improved yield and NUE using 'Limus' NBPT+NPT Urease Inhibitor (BASF, 2016)



Decline in NUE in China between 1961 and 2011 (Zhang et al, 2015)



Need to increase NUE with 2020 'zero growth' limits in China

A step in the right direction for CSA!

"Optimal plant nutrition using more N efficient fertilizers: Kingenta and BASF to jointly address a tough agricultural challenge in China."

"Limus®, a novel urease inhibitor, addresses the serious problem of N-loss in urea-based fertilizers".

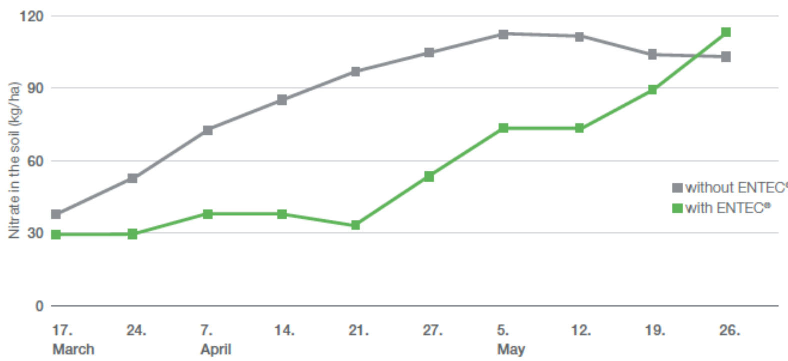
"BASF and Chinese fertilizer supplier Kingenta recently announced their partnership to bring farmers in China novel fertilizers coated with BASF's new Limus® technology, available from July 2016".

Main types of nitrification inhibitors (Fertecon SCR&SF Report, 2016)

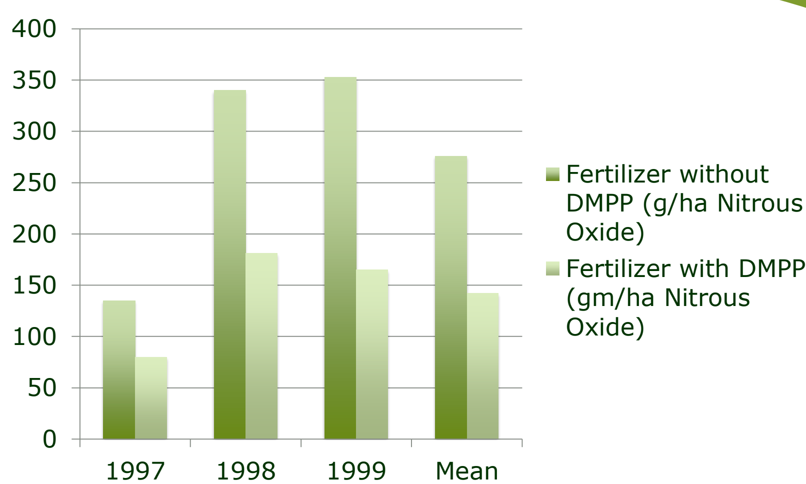
Acronym	Chemical formula	Supplier/Brand
DCD	Dicyandiamide	Conklin Co/Guardian® JCAM-Agri Co/Yodel® SKW Piesteritz/Alzon® Solvay/Agrho® N-Protect
DMPP	3-4 dimethylpyrazole phosphate	Compo Expert/Novatec® Eurochem/Entec®
Nitrapyrin	2-chloro-6-trichloromethyl pyridine	Dow Agrosciences/N-Serve®
ATS	Ammonium thiosulphate	Tessenderlo Kerley

Delayed Nitrate-N Soil Supply using 'Entec' DMPP Nitrification Inhibitor (Eurochem, 2014)

(Tests by BASF, Limburgerhof agricultural research centre, 120 kg N/ha)



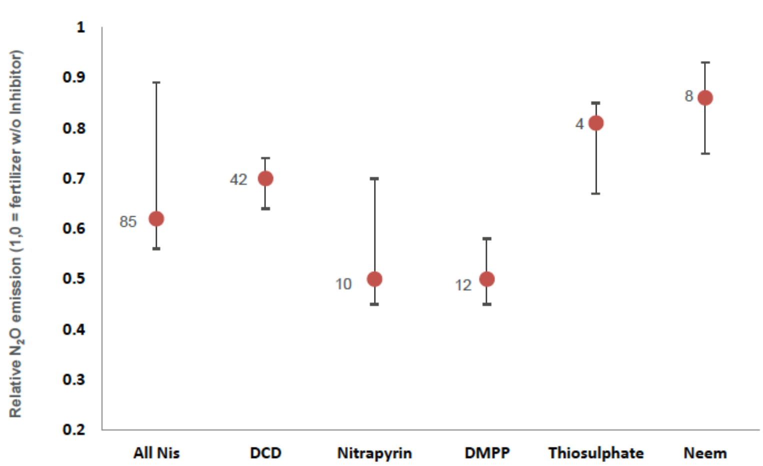
Effect of DMPP on Annual Nitrous Oxide Emissions (Trenckel, 2010)



CSA Benefits from Nitrification Inhibitors

- **In 24 winter wheat trials, one application of N-based fertilizer+DMPP increased yields by 7% compared with (European standard practice) of three applications of untreated fertilizer (Huther et al, 2000).**
- **For winter rapeseed, the conventional two N applications could be replaced by one when using N-based fertilizer+DMPP early in the spring (Huther et al, 2000).**
- **Cabbage yields were increased by 2.0 t/ha and 5.5 t/ha at two locations (Jinhua and Xinch), and quality including vitamin C, soluble sugars and micronutrient content, using DMPP in China (Xu et al, 2004).**
- **Trials in Europe on various field grown vegetables and fruit crops showed DMPP-containing fertilizers reduced N-leaching losses and increased yields at lower applied N-rates (Hahndel and Zerulla, 1999-2001)**

Relative influence of main Nitrification Inhibitors on Nitrous Oxide Emissions (adapted from Berger, 2015)



IFA Asia-Pacific Crossroads Meeting 2016, Singapore, 25-27 October

Conclusions

- **Slow and Controlled Release and Stabilized Fertilizers offer many benefits which contribute to the principles of Climate Smart Agriculture, including:**
  - Increasing agricultural production by matching N supply more closely to crop growth demands therefore improving Nitrogen Use Efficiency (NUE);
  - This reduces the potential for GHG and other emissions, particularly of the very potent Nitrous Oxide (N_2O) gas and the harmful volatilization of Ammonia (NH_3).
  - Furthermore, leaching of excess soil nitrate-N into water resources is significantly reduced;
  - Improved NUE results in the direct benefit of increased profit/ha for farmers and indirectly through improvements in soil quality, environmental and human health;
  - Improvements in ‘downstream’ NUE will amplify the increases in ‘upstream’ efficiencies and use of GHG mitigation technologies currently underway in international fertilizer production industry;
  - Altogether, these represent powerful resources to support the objectives of Climate Smart Agriculture.

IFA Asia-Pacific Crossroads Meeting 2016, Singapore, 25-27 October

New Report from Fertecon

Fertecon
Agribusiness intelligence | informa

Innovations for Slow,
Controlled Release &
Stabilized Fertilizers

Implications for Climate Smart Agriculture

IFA Asia-Pacific Crossroads Meeting 2016, Singapore, 25-27 October

Thank you for your attention！

We welcome cooperation at Kingenta

Kevin Moran
kevin.moran@kingenta.com

Li Xinzhu
lixinzhu@kingenta.com