Efficacy of Urease and Nitrification Inhibitors in reducing Ammonia Volatilization from Urea and UAN in high-pH soils

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Source: https://www.farmersedge.ca/effectively-apply-fertilizer-spring/

Introduction

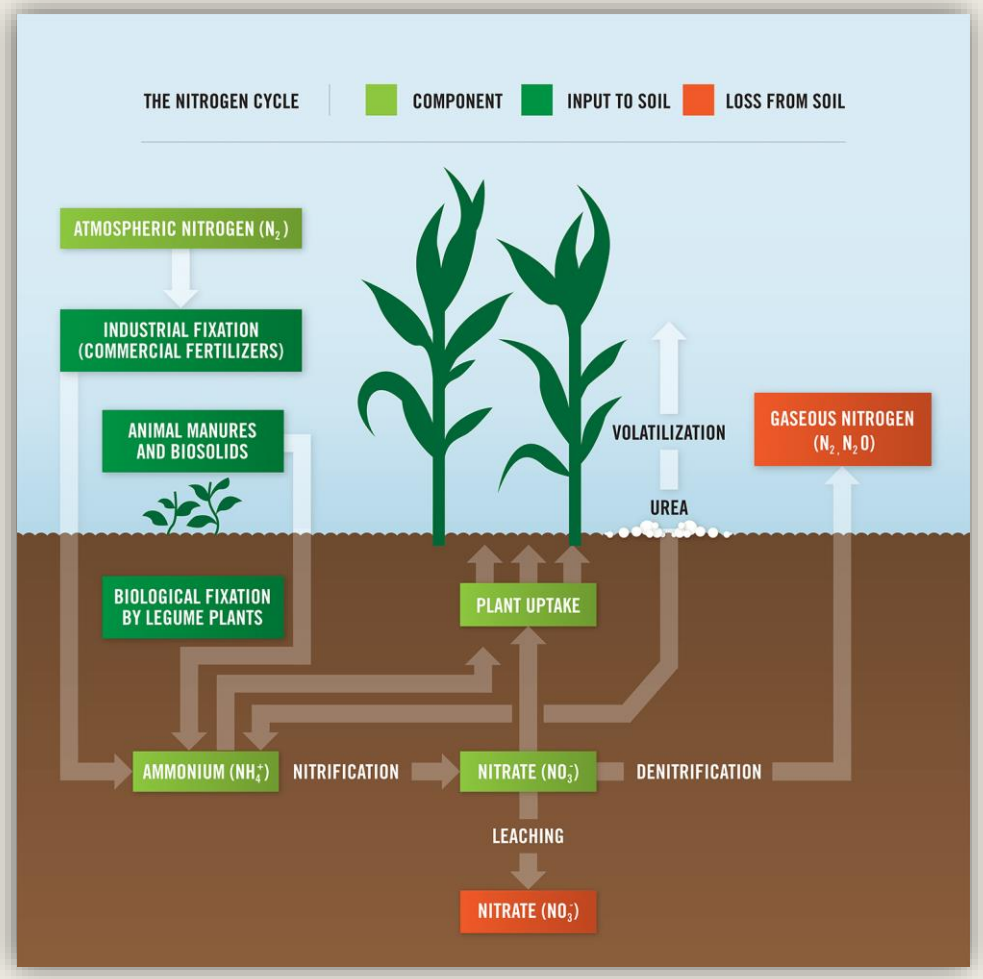
Source: https://www.canolacouncil.org/canola-watch/2018/05/29/equipment-for-top-dressing-fertilizer/

- Ammonia volatilization can reduce the efficiency of urea-based nitrogen fertilizers

- ≥20% of ammonia volatilization losses are from surface applied urea-based fertilizers (Cantarella et al., 2018)

- Ammonia volatilization takes place during the hydrolysis of urea to ammonia

- This process is controlled by the urease enzyme



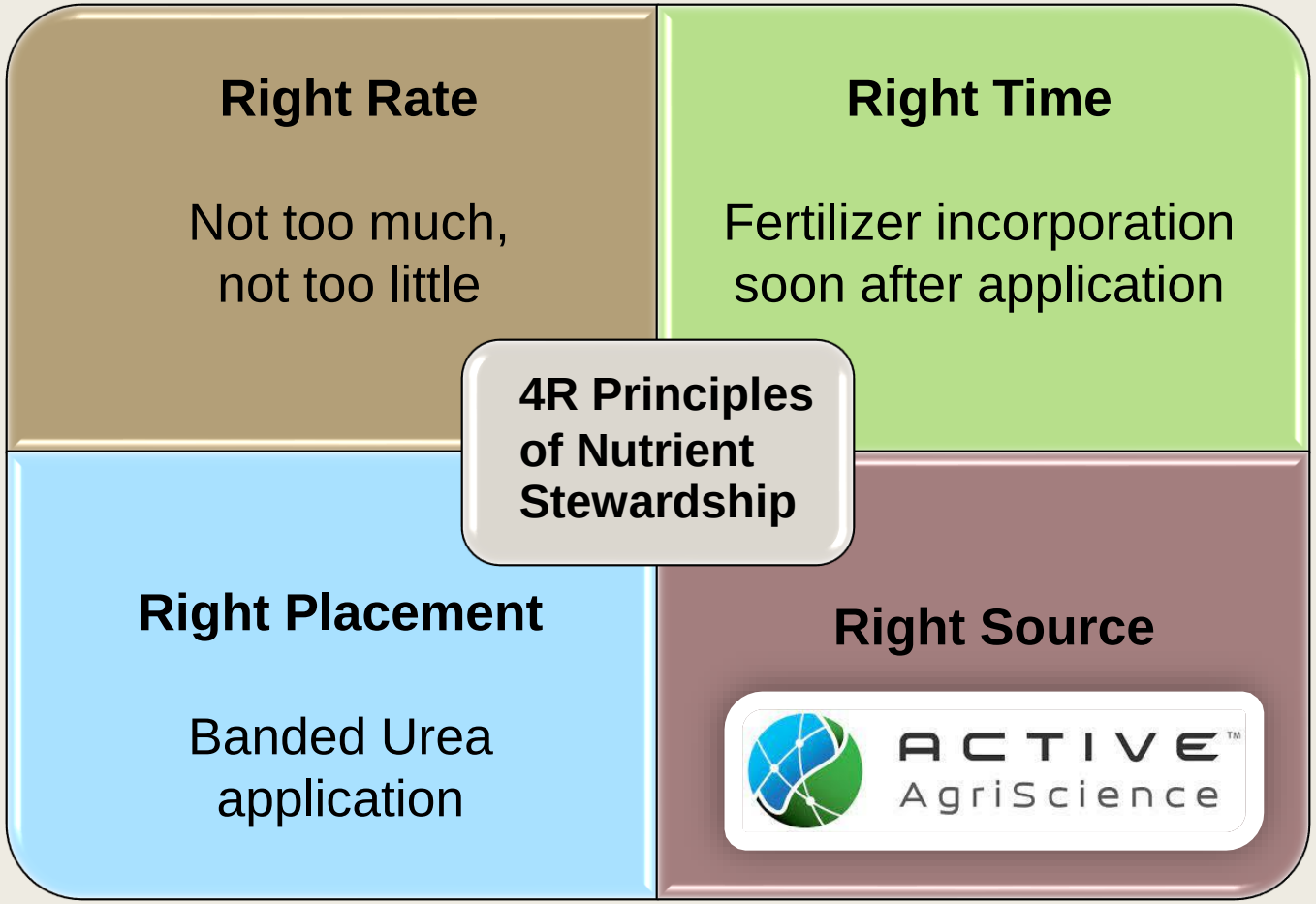
The Nitrogen Cycle

Source: https://kochagronomicservices.com/knowledge-center/what-is-nitrogen-loss_2217.aspx

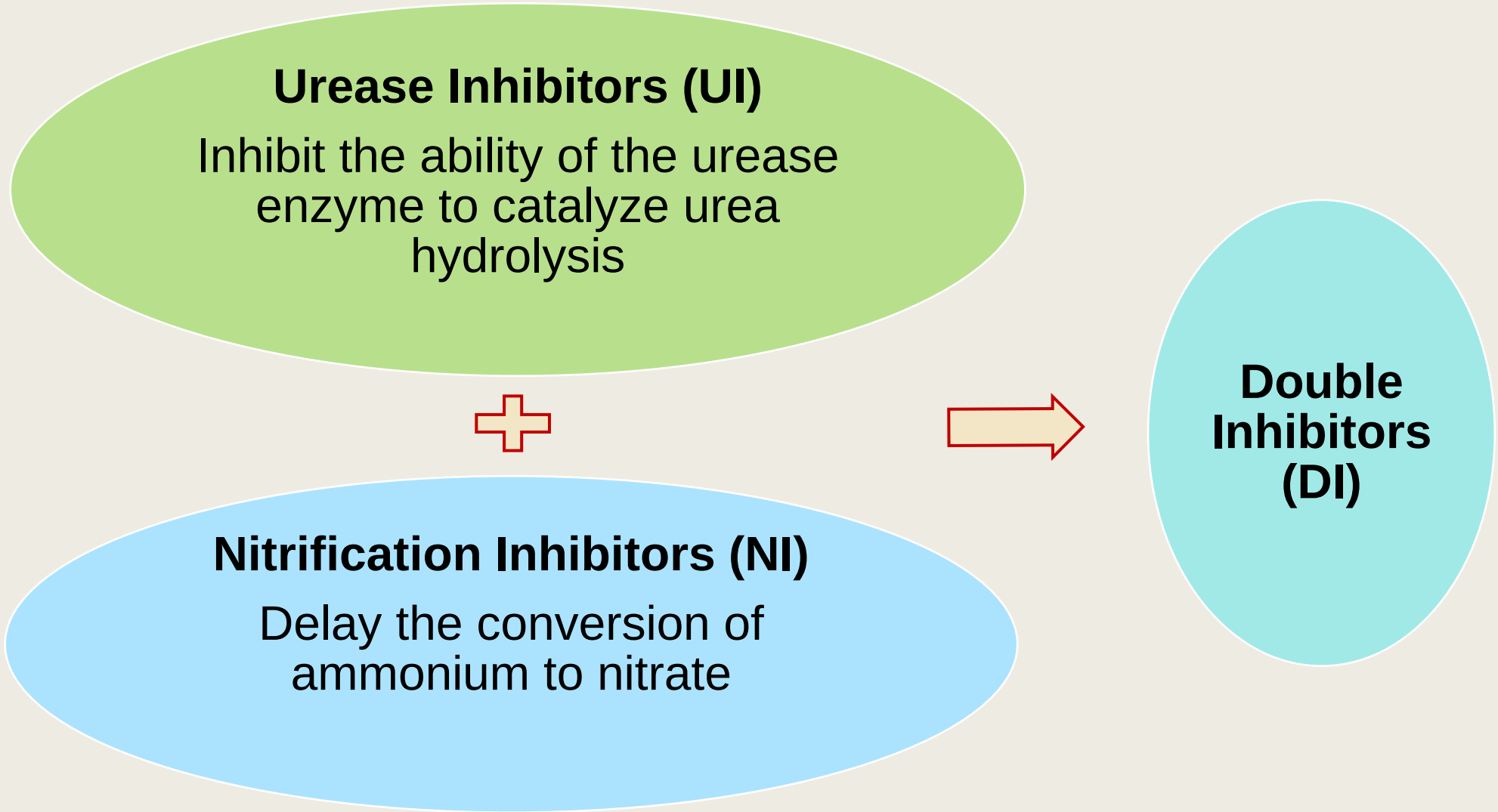
- Adverse effects:
  - Reduced yield and grain N concentration
  - Soil acidification
  - Atmospheric ammonia contamination
  - Respiratory issues caused by reactions between volatilized ammonia and acidic gases in the atmosphere

- Ammonia volatilization is greater with
  - broadcasted urea application compared to banded urea application under no-till soil management (Rochette et al. 2009)
  - Higher soil temperature and pH

- Coating urea with urease inhibitors improves nitrogen use efficiency (Lasisi et al., 2020; Wang et al., 2020)



- Treatment of urea with nitrification inhibitors and urease inhibitors improves nitrogen use efficiency



- Inconsistent results on UIs and DIs in the literature
  - ➢ No difference between UIs and DIs (Lasisi et al., 2019)
  - ➢ DIs increase N volatilization (Zaman et al., 2008; Soares et al., 2012)

Objective of the study

To evaluate the efficacies of a range of products from Active Agriscience containing NBPT only or NBPT plus DMPP (DI) on ammonia volatilization from surface and banded applications of urea and UAN

Methods

- A 14-day growth room study was conducted utilizing soils from a farm in Roseisle, MB

- **Experimental design**: Completely Randomized Design (CRD)
  - 4 replicates
  - 5 sampling times at Day 1, 2, 4, 7 and 14

Soil property	**Values**
Soil pH	**7.9 ± 0.09**
Electrical conductivity (ds m^{-1})	0.28 ± 0.02
Field capacity (g kg^{-1})	260
Organic matter (%)	**2.4 ± 0.1**
CEC (meq/100g)	11.3 ± 0.4
Soil type	Sand
Sand %	89.3 ± 0.9
Silt %	7.3 ± 0.9
Clay %	3.4 ± 0
N (mg kg^{-1})	**15.7 ± 0.5**
P (mg kg^{-1})	23.3 ± 0.5
K (mg kg^{-1})	213.3 ± 18
S (mg kg^{-1})	5 ± 0.8
Ca (mg kg^{-1})	1767 ± 47
Mg (mg kg^{-1})	223 ± 12
Na (mg kg^{-1})	11.3 ± 0.9

- Treatments

Urea	Application Rate (L per 1000 kg Urea)	UAN	Application Rate (L per 1000 kg UAN)
Untreated Urea		Untreated UAN	
Urea + Active Stabilizer (NBPT only)	1.2	UAN + Active Stabilizer (NBPT only)	1
	1.8		1.5
	2.4		2
Urea + Active Stabilizer PLUS (NBPT + DMPP)	1.2	UAN + Active Stabilizer PLUS (NBPT + DMPP)	1
	1.8		1.5
	2.4		2
ARM U (18% NBPT) (18% ARM U)	2	ARM U (18% NBPT) (18% ARM U)	1.2
Arm U Advanced	1.8	Arm U Advanced	1.1
ARM U (30% NBPT) (30% ARM U)	1.5	ARM U (30% NBPT) (30% ARM U)	1
Agrotain	2.1	Agrotain	1.05

Treatment Application

Urea

- Banded

- Broadcast

UAN

- Banded

- Broadcast

Column set-up

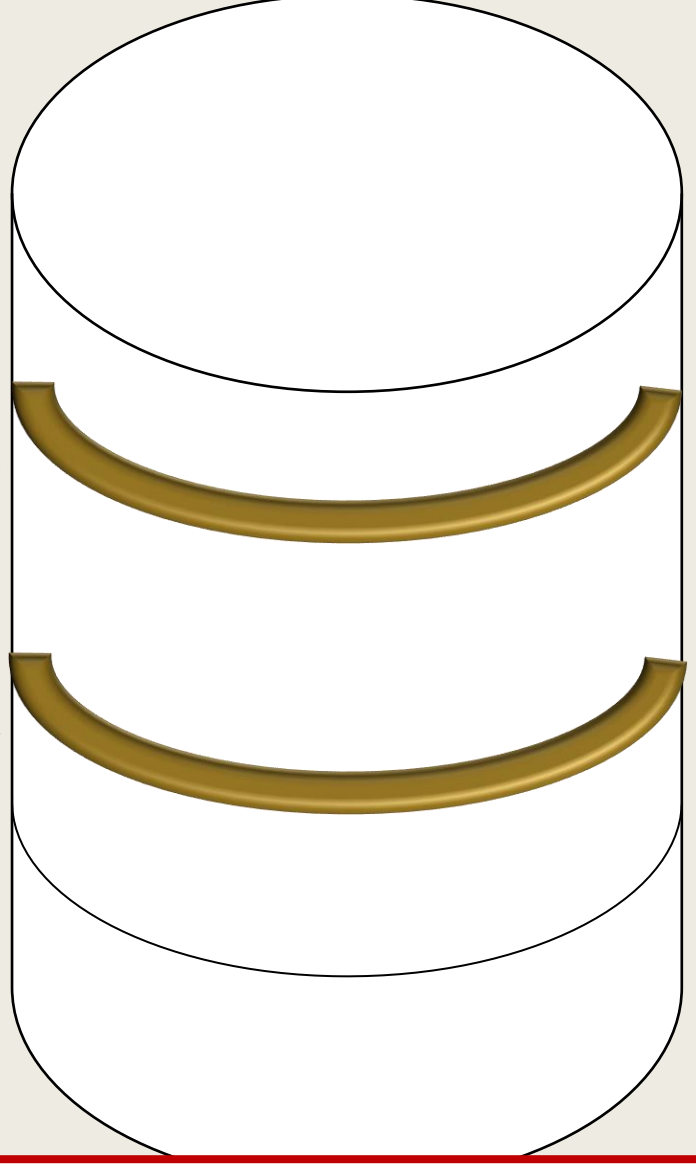
30°C

50%

16-h photoperiod

Controls atmospheric ammonia contamination

Traps volatilized ammonia



5 cm (Top acid charged foam disk :1M phosphoric acid + 4% glycerol)

5 cm (Bottom acid charged foam disk :1M phosphoric acid + 4% glycerol)

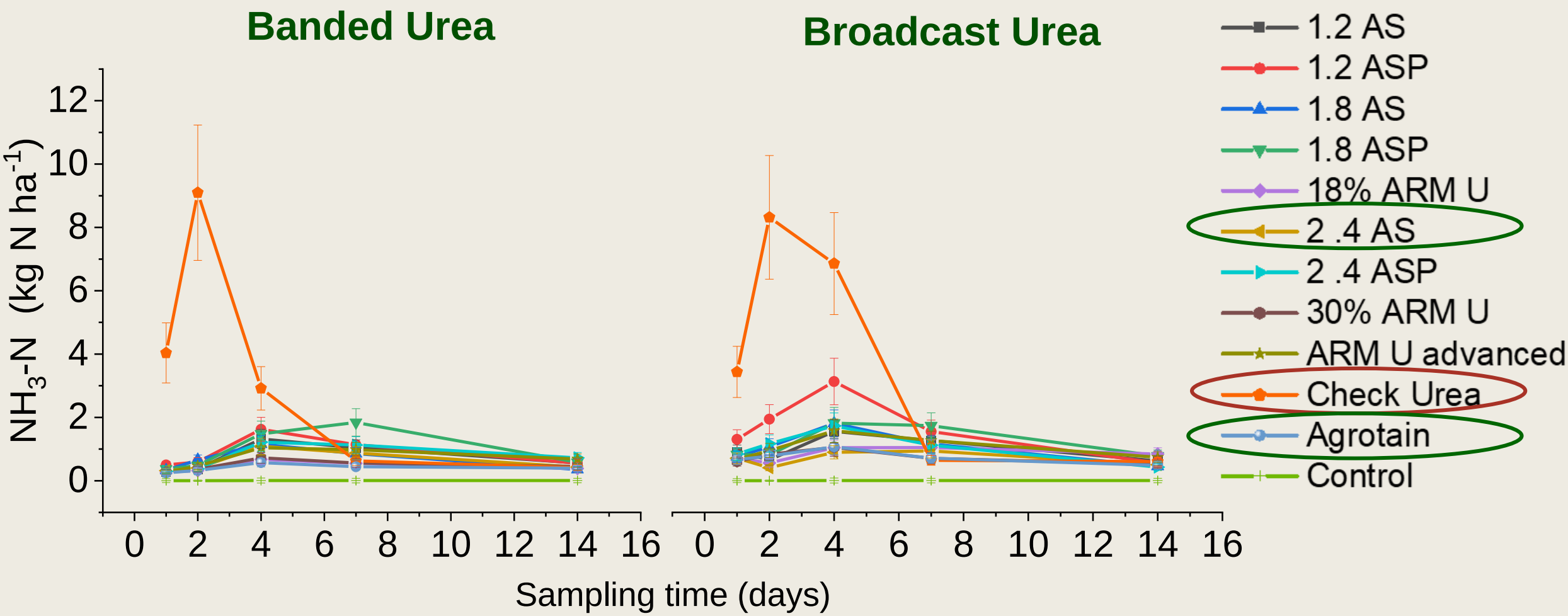
7 cm of soil

- Bulk Density: 1.1 MT m^{-3}

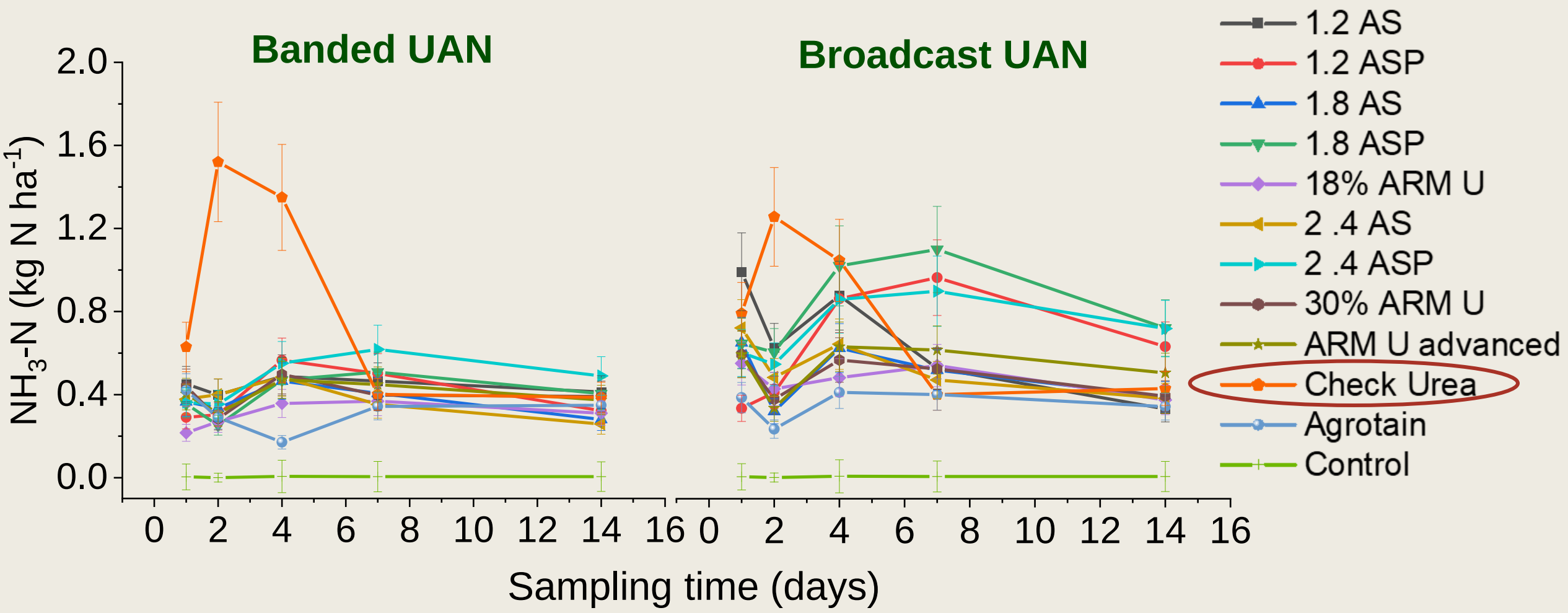
$$NH_3\text{-}N\ (kg\ ha^{-1}) = \left(\frac{Extractant\ (mL) + absorbent\ in\ disc\ (mL) \times NH_3\ (mg\ N\ mL^{-1})}{Area\ of\ chamber\ (ha) \times 10^6}\right)$$

Results

Ammonia volatilization loss (AVL) following banded vs surface application of urea



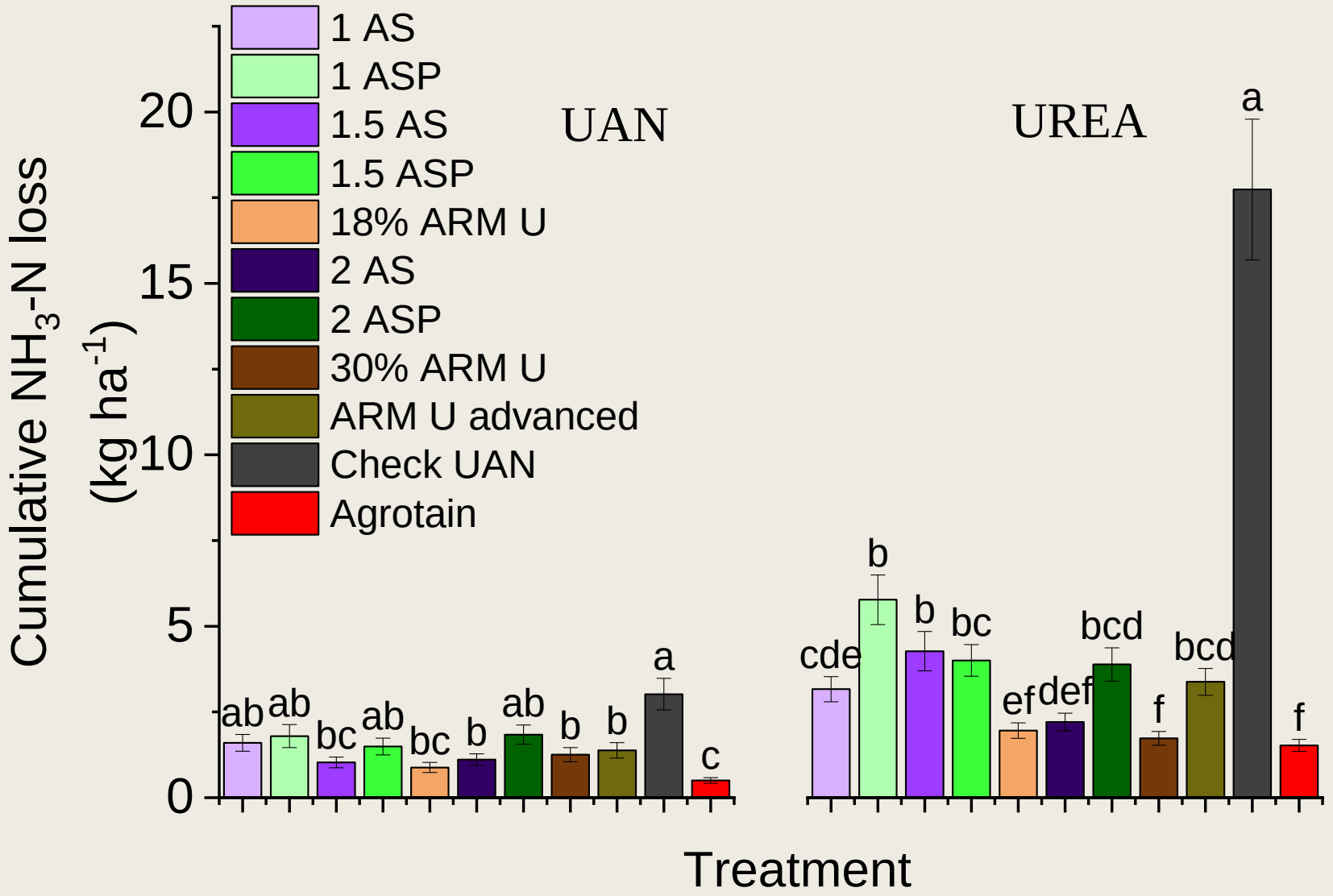
Ammonia volatilization loss following banded vs surface application of UAN



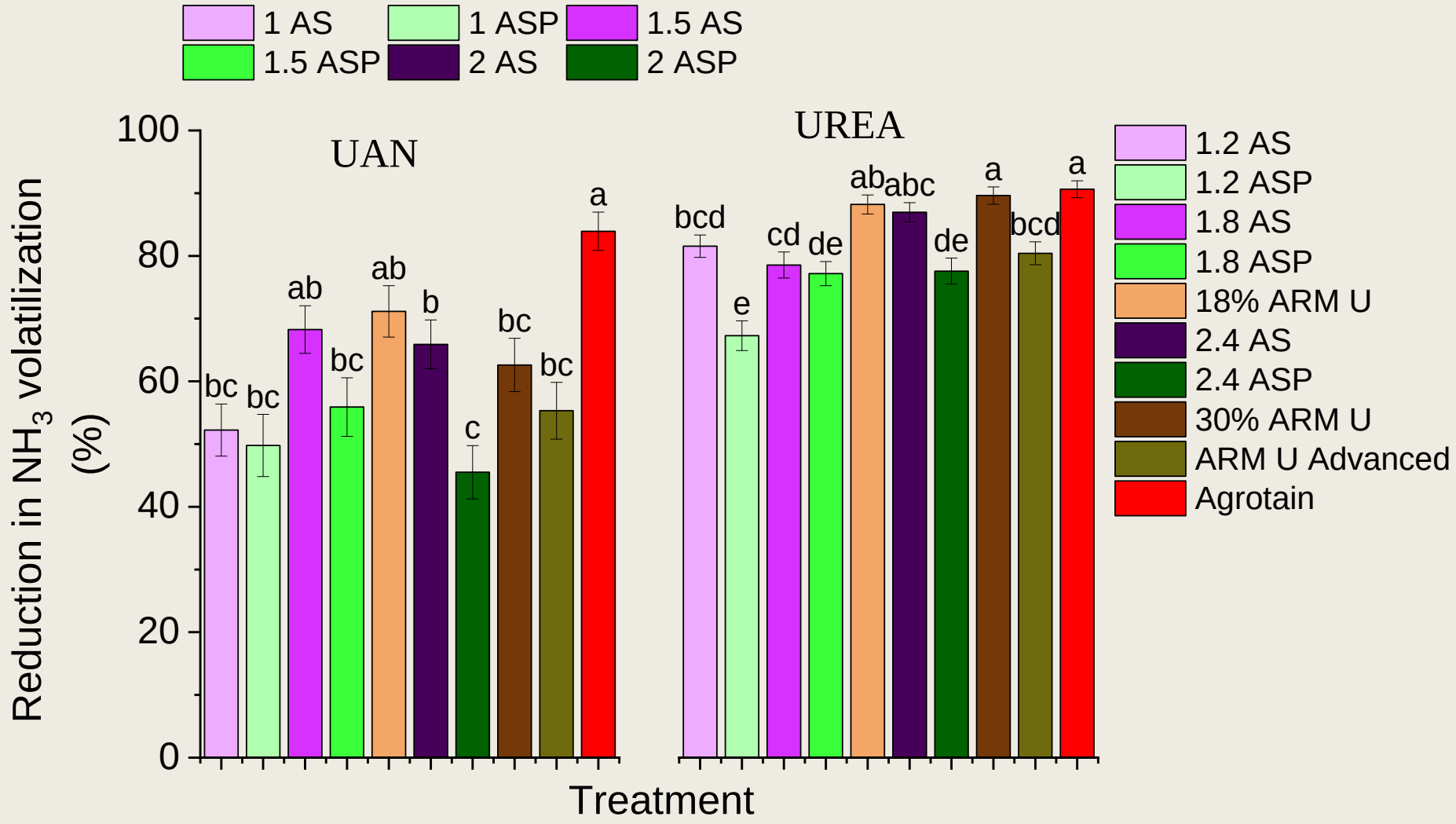
Cumulative ammonia volatilization

Treatment	Cumulative ammonia volatilization (kg ha^{-1})		Reduction in volatilization (%)	
	UAN	Urea	UAN	Urea
Placement				
Banded	0.95b	2.57b	72.71a	86.58a
Broadcast	1.78a	4.59a	49.73b	78.21b
	P value			
Inhibitor	<0.0001	<0.0001	<0.0001	<0.0001
Placement	<0.0001	<0.0001	<0.0001	<0.0001
Inhibitor × placement	0.15	0.06	0.10	0.08

Cumulative ammonia volatilization losses



Percent reduction in ammonia volatilization from inhibitor-treated UAN and urea



Residual soil N concentration

	Ammonium N (mg kg^{-1})		Nitrate- N (mg kg^{-1})	
Treatment	UAN	Urea	UAN	Urea
Control	4.2	4.2	31.4	31.4c
1 AS	10.36	13.30	144.5	155.38 ab
1 ASP	15.88	9.67	164.25	154.25 ab
1.5 AS	10.55	9.81	152.25	178.5 a
1.5 ASP	15.33	12.27	150.62	172.75 a
18% ARM U	8.81	9.77	147.75	133.25 ab
2 AS	9.59	10.06	151	146.5 ab
2 ASP	16.11	11.91	141.5	135.6 ab
30% ARM U	12.89	10.43	**180.25**	**176.5a**
ARM U Advanced	**16.88**	12.51	153.37	143.5ab
Check-untreated	13.04	**14.47**	137.62	109.69b
Agrotain	16.23	8.37	146.25	163.5a

Residual soil N concentration

	Ammonium N (mg kg^{-1})		**Nitrate- N (mg kg^{-1})**	
Treatment	UAN	Urea	UAN	Urea
Application				
Banded	13.90	13.39a	155.36	154.8
Broadcast	12.58	8.89b	148.16	148.7
	P value			
Inhibitor	0.10	0.89	0.05	**0.0001**
Application	0.64	**0.03**	0.37	0.61
Inhibitor × application	0.8629	0.61	0.61	0.13

Conclusion

- Shallow banding of urea and UAN in combination with urease and nitrification inhibitors significantly reduced ammonia volatilization
- Active Stabilizer treatments with NBPT only (AS) were more effective than the double inhibitors (ASP)
- For urea, the performance of 18% ARM U, 30% ARM U and 2.4 AS was comparable to Agrotain despite their lower concentration of NBPT per kg of fertilizer
- For UAN, the performances of 18% ARM U and 1.5 AS were similar to Agrotain

Active AgriScience products reduce ammonia emission from applied urea,
thus limiting N loss and potentially increasing fertilizer N use efficiency

The use of lower dosage rates of Active AgriScience suggests they are more economical


Thank you