Understanding Salt Index of Fertilizers

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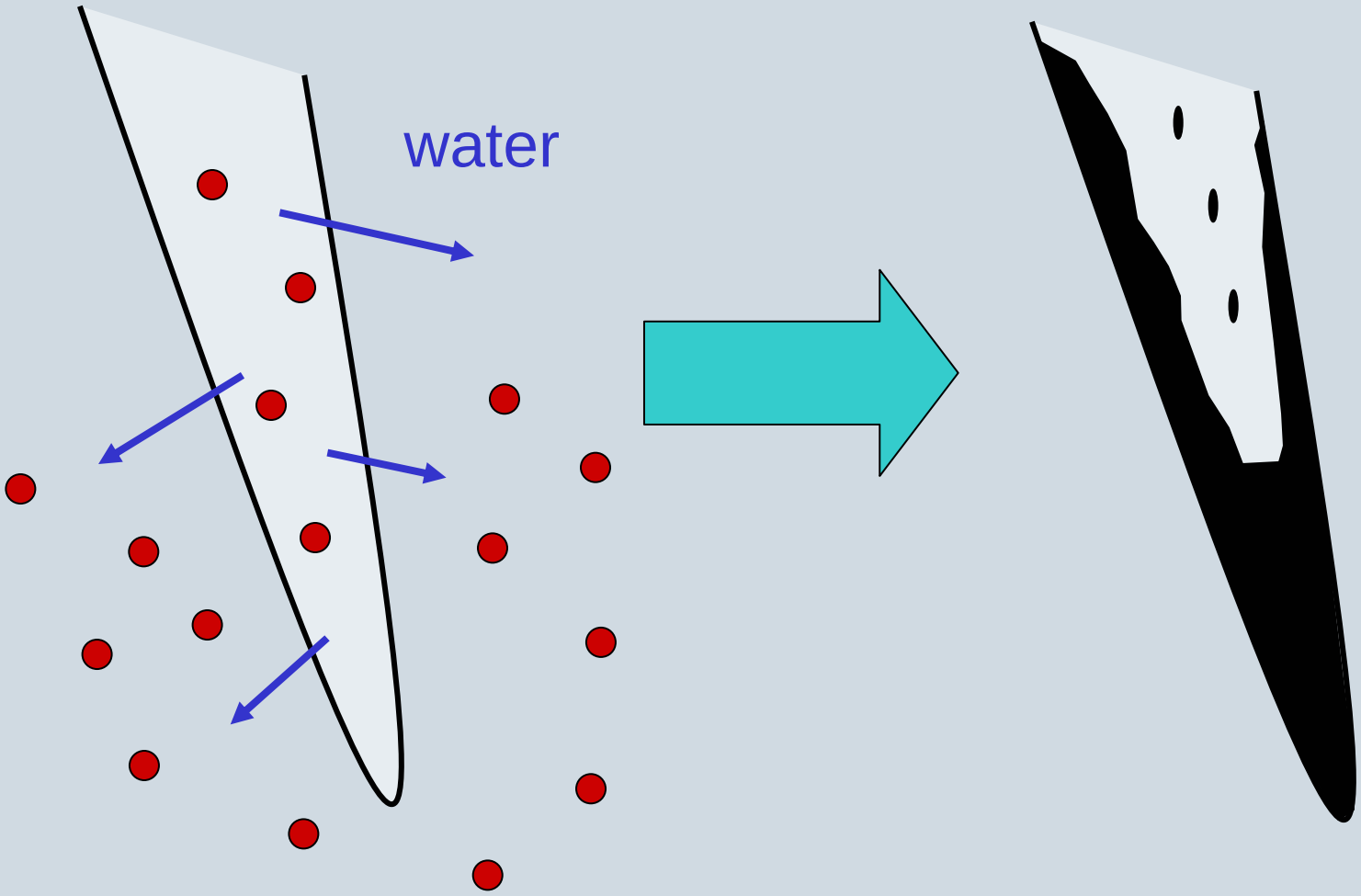
Why are fertilizer salts a problem?



Why are fertilizer salts a problem?

- Nitrogen containing fertilizers
  - Sometimes more injury than estimate based on salt content alone
    - NH_3 – Toxic to plant tissue, moves freely through cell walls
  - Urea, UAN, ammonium thiosulfate and DAP can cause more damage from NH_3 toxicity than MAP, ammonium sulfate, and ammonium nitrate
  - Moderate alkaline soil conditions promote NH_3 production
    - In bulk soil
    - Caused by reaction of the fertilizer

Factors affecting fertilizer burn

- Crops vary in their tolerance to salts

Crop	Relative sensitivity
Wheat	Least sensitive†
Corn	
Forage legumes	
Soybean and Edible bean (dry or snap)	
Vegetables including sweet corn	Most sensitive

* Reproduced from Reid (2006).

† Least sensitive does not mean that the crop is not sensitive to salt.

Don’t place fertilizer with seed of super sweet hybrids of sweet corn, soybean, dry bean, & pea (Reid, 2006)

Factors affecting fertilizer burn

- Soil conditions
  - Soil moisture
    - Moist soils – Fertilizer salts diffuse away from band
    - Dry soils – minimal diffusion
  - Low CEC (sandy, low OM soils)
    - Less reaction of soil & fertilizer
    - Salt concentration remains high
  - Temperature
    - Roots grow slowly in cold soils

Factors affecting fertilizer burn

- Concentration of fertilizer salts
  - Broadcast
    - Fertilizer is dispersed; Rarely cause injury
  - Banded (2” x 2”)
    - Fertilizer is more concentrated closer to seed
    - At typical application rates injury unlikely
  - In furrow/seed placed/pop-up
    - Extremely close proximity to seed
    - Reduced rates, but can still cause problems

Salt index (SI)

- Measure of the salt concentration that fertilizer induces in the soil solution

$$\frac{\text{Osmotic Pressure}_{\text{Fertilizer Material}}}{\text{Osmotic Pressure}_{\text{NaNO3}}} \times 100 = \text{SI}$$

- Used to compare fertilizer materials
- Can not determine the amount of fertilizer that will cause injury

Salt index – N fertilizers

Material and Analysis (N-P_2O_5-K_2O-S)	Salt Index per	
	equal weights of materials	Per unit of nutrients†
Ammonia, 82-0-0-0	47.1	0.572
Ammonium nitrate, 34-0-0-0	104.0	3.059
Ammonium sulfate, 21-0-0-24	68.3	3.252
Ammonium thiosulfate, 12-0-0-26	90.4	7.533
Urea, 46-0-0-0	74.4	1.618
UAN, 28-0-0-0 (39% AN, 31% urea)	63.0	2.250
32-0-0-0 (44% AN, 35% urea)	71.1	2.221

† One unit equals 20 lb.

Reproduced from Mortvedt (2001)

Salt index – P fertilizers

Material and Analysis (N-P_2O_5-K_2O-S)	Salt Index per	
	equal weights of materials	Per unit of nutrients†
APP, 10-34-0-0	20.0	0.455
DAP, 18-46-0-0	29.2	0.456
MAP, 11-52-0-0	26.7	0.405
Phosphoric acid, 0-54-0-0		1.613‡
0-72-0-0		1.754‡

† One unit equals 20 lb.

‡ Salt index per 100 lbs of H_3PO_4.

Reproduced from Mortvedt (2001)

Salt index – K fertilizers

Material and Analysis (N-P_2O_5-K_2O-S)	Salt Index per	
	equal weights of materials	Per unit of nutrients†
Monopotassium phosphate, 0-52-35-0	8.4	0.097
Potassium chloride, 0-0-62-0	120.1	1.936
Potassium sulfate, 0-0-50-18	42.6	0.852
Potassium thiosulfate, 0-0-25-17	68.0	2.720

† One unit equals 20 lb.

Reproduced from Mortvedt (2001)

Salt index

- Higher analysis fertilizers have lower SI
  - Fewer salt ions go into the soil solution per unit of plant nutrient
  - SI of high analysis can be > SI of low analysis
    - Use of the high analysis may not be more risky than the low analysis
      - Higher rates of the low analysis are needed & may result in similar amounts of salt being added to the soil
- N and K fertilizers generally have higher SI values than P fertilizers

Calculating salt index of 7-21-7

		lbs of material per ton of formulation	Nutrient units			Salt index	
Material	% Nutrient		N	P_2O_5	K_2O	Per unit (20 lb)†	in formulation
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
			(Col 3 x Col 2)/20				(Col 4 + Col 5 + Col 6) x Col 7
10-34-0	10% N 34% P_2O_5	1,235					
UAN	28% N	57					
KCl	62% K_2O	226					
water		482					
Formulation		**2,000**					

† SI per unit (20 lb) of plant nutrients listed in previous tables, also called partial SI

Calculating salt index of 7-21-7

(1,235 x 0.10) / 20 = 6.2

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Material	% Nutrient		N	P_2O_5	K_2O	Per unit (20 lb)†	in formulation
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
			(Col 3 x Col 2)/20				(Col 4 + Col 5 + Col 6) x Col 7
10-34-0	10% N 34% P_2O_5	1,235	6.2	21.0	-		
UAN	28% N	57	0.8	-	-		
KCl	62% K_2O	226	-	-	7.0		
water		482	-	-	-		
Formulation		**2,000**	**7.0**	**21.0**	**7.0**		

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UAN	28% N	57	0.8	-	-	2.250	
KCl	62% K_2O	226	-	-	7.0	1.936	
water		482	-	-	-	-	
Formulation		**2,000**	**7.0**	**21.0**	**7.0**		

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Calculating salt index of 7-21-7

(1,235 x 0.10) / 20 = 6.2

(6.2 + 21.0) x 0.455 = 12.4

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Material	% Nutrient		N	P_2O_5	K_2O	Per unit (20 lb)†	in formulation
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
			(Col 3 x Col 2)/20				(Col 4 + Col 5 + Col 6) x Col 7
10-34-0	10% N 34% P_2O_5	1,235	6.2	21.0	-	0.455	12.4
UAN	28% N	57	0.8	-	-	2.250	1.8
KCl	62% K_2O	226	-	-	7.0	1.936	13.6
water		482	-	-	-	-	-
Formulation		**2,000**	**7.0**	**21.0**	**7.0**		**SI = 27.8**

† SI per unit (20 lb) of plant nutrients listed in previous tables, also called partial SI

Salt index of common liquid fertilizer formulations

Formulation	Salt index	Salt index per unit of plant nutrient (20 lb)
2-20-20*	7.2	0.17
3-18-18*	8.5	0.22
6-24-6*	11.5	0.32
6-30-10*	13.8	0.30
9-18-9*	16.7	0.48
10-34-0**	20.0	0.45
7-21-7***	27.8	0.79
4-10-10***	27.5	1.18
28% UAN***	63.0	2.25

Formulated with potassium phosphate as K source

Use caution in-furrow

Not suggested for use in-furrow

Tips for safely using liquid fertilizers with/near the seed

- Do not use fertilizer with a SI greater than 20.0
- Avoid using fertilizers containing ammonium thiosulfate as the SI may be high
- Apply no more than 10 lb/a of N + K_2O in-furrow
- Minimize compounds that liberate NH_3

Tips for safely using liquid fertilizers with/near the seed

- If the soil is dry at planting
  - Consider placing the fertilizer away from the seed
- If dribbling the fertilizer on the soil surface, be sure
  - Seed is planted deep enough
  - There is adequate soil moisture for the fertilizer to diffuse

Questions