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Up | Articles

Calculating Salt Index

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Title
Calculating Salt Inde

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Synopsis
Instructions for calc
index of fertilizers c
a liquid row starter
placement.

Keywords
fertilizer
placement
pop-up
row starter
salt
salt index
seed

Salt content is one of the most critical characteristics of fertilizers that should be considered when fertilizers are applied, especially with seed-row or "in furrow" placement.

Summary: Salt index (SI) of a fertilizer is a measure of the salt concentration that fertilizer induces in the soil solution. SI does not predict the exact amount of a fertilizer material or formulation that could produce crop injury on a particular soil, but it does allow comparisons of fluid formulations regarding their potential salt effects. As we all know, placement of some formulations in or near the seed may decrease seed germination or result in seedling injury.

Fluid fertilizers containing potas□sium phosphate as the source of K have lower SI values than those containing KCI. When applied near the seed, fertilizers with lower SI values generally cause fewer prob□lems in seed germination or seedling injury. SI of any fluid formulation can be calculated using the SI values of the most common fertilizer sources. Dealers or growers then can select those formulations with lower SI values that best fit their needs.

Banding of nutrients has received much attention over the years. Usually, the fertilizer is placed at than that of the seed to allow root interception of the fertilizer band as roots grow outward and dov soil.

Band vs. broadcast

Regions showing the greatest improvement in efficiency from banding over broadcasting lie in the Canada, where colder soil conditions are experienced during spring seeding of row crops and small rates are generally recommended if growers broadcast instead of band their fertilizers.

Banded P tends to be more efficient on very acid soils, highly calcareous soils, and those soils with available soil P. Band applications also are usually more efficient when low P application rates are u

Early planting dates, large amounts of crop residues on the soil surface, and soil compaction may s more stress. Banded nutrients are usually more effective for crops under these stress conditions. V respond well to banded fertilizers because they require a relatively large percentage of their total n their growth period, and their rooting volume in the soil usually is restricted.

As extra equipment has been installed on planters over the years, it has become more difficult to h to include the coulters required to open the soil for fertilizer placement below and to the side of the growers have quit applying starters because of this limitation and also because of the weight of ope large planters. Others have applied starters directly to the seed furrow, which does not require extr

Other considerations. Banding away from the seed row is recommended over seed-row application u conditions when applying higher nutrient rates, especially N, K, and S. Plants can efficiently use nu away from the seed row without adversely affecting seed germination or seedling emergence.

Recommendations for fertilizer place□ment in direct seed contact vary with crop. For many years n
recom□mendations ranged from 10-20 lbs/A of N + K_2O in direct seed contact with corn and sorgh
applied to formula□tions using KCI as the K source and would not be accurate if potassium phosph
the source of K instead of KCI. This is because of the lower SI value of potassium phosphate compa
(Table 1).

Crop tolerance to increased osmotic pressures (salt content) of the soil solution in the vicinity of th
considerably. For example, wheat is more tolerant of high salt conditions than is grain sorghum, wh
intermediate. Tolerance of most oil-seed crops (soy□beans and cotton) to seed-row applica□tion of
low, and seed □row application of fertilizer for these crops should be viewed with caution.

Fluid fertilizers may produce a lower osmotic pressure in the soil solution than granular products of
Fewer problems generally are encountered using fluids as seed-row fertilizers when com□pared to
less soil water is required and salts are mainly dissolved in fluid formulations.

Seed-row application

This method refers to placement of relatively lower rates of nutrients in direct seed contact, usually
also has been called "pop-up" or "in□ furrow" application, but "seed-row" is more descriptive. Seed
increases the possibility of early root interception by nutrients.

Problems. Major concern of this practice is decreased seed germination or seedling injury caused by
concentrations in the soil solutions around germinating seeds.

Also, some starter components such as urea, UAN, or ammonium thiosulfate can produce free amn
certain soil conditions. Direct seed contact by NH_3 could result in poor germination or seedling deat
the proper starter fertilizer is the way to minimize this occurrence.

Fertilizers best suited for seed-row application have 1) low salt index, 2) high water solubility, 3) co
S, with relatively high P content, 4) contain both urea and ammonium-nitrogen, 5) minimize conter
that liberate NH_3, and 6) use potassium phosphate instead of KCl as the K source.

Salt index

Salt content is one of the most critical characteristics of fertilizers used for row-seed placement. Th
of the salt concentration that fertilizer induces in the soil solution.

The SI of a material is expressed as the ratio of the increase in osmotic pressure of the salt solutio
specific fertilizer to the osmotic pressure of the same weight of $NaNO_3$, which is based on a relative
Sodium nitrate was chosen as the standard because it was 100 percent water soluble and it was a
nitrogen fertilizer when the SI concept was first proposed in 1943. Higher analysis fertilizers usually
because fewer ions of salts are placed in the soil solution per unit of plant nutrient when they disso

Note that the N and K materials of commonly used fertilizers (Table 1) have higher SI values than
materi□als. The SI of a mixed formulation containing N, P, and/or K is the sum of the SI values of
Al□though the total SI for a high-analysis NPK mixture may be greater than that for a low-analysis
SI per unit of plant nutrients may be lower in the high-analyses product. Therefore, the lower fertil
to supply the same amount of plant nutrients subjects the germinating seeds to less potentially adv

Table 1: Salt index values of fertilizer materials.

	Salt Index	
Material and analysis	**Per equal wts. of materials**	**Per unit of nutrients***
Nitrogen/Sulfur		
Ammonia, 82% N	47.1	0.572
Ammonium nitrate, 34% N	104.0	3.059

Ammonium sulfate; 21% N, 24% S	68.3	3.252
Ammonium thiosulfate, 12% N, 26% S	90.4	7.533
Urea, 46% N	74.4	1.618
UAN, 28% N (39% am. nitrate, 31% urea)	63.0	2.250
32% N (44% am. nitrate, 35% urea)	71.1	2.221
Phosphorus		
APP, 10% N, 34% P_2O_5	20.0	0.455
DAP 18% N, 46% P_2O_5	29.2	0.456
MAP 11% N, 52% P_2O_5	26.7	0.405
Phosphoric acid, 54% P_2O_5		1.613**
72% P_2O_5		1.754**
Potassium		
Monopotassium phosphate, 52% P_2O_5, 35% K_2O	8.4	0.097
Potassium chloride, 62% K_2O	120.1	1.936
Potassium sulfate, 50% K_2O, 18% S	42.6	0.852
Pot. thiosulfate, 25% K_2O, 17% S	68.0	2.720
** Salt index per 100 lbs of H_3PO_4	* One unit equals 20 lb.	

It should be noted that the SI *does not* predict the exact amount of fertilizer material or a fertilizer could produce crop injury on a particular soil. However, it does compare one fertilizer formulation v regarding the osmotic (salt) effects. It also shows which fertilizers (those with a higher SI) will be r cause injury to germinating seeds or seedlings if placed close to or in the seed row.

Calculating salt index

The SI of a mixed fertilizer (NPKS) is the sum of the SI of each component per unit of plant nutrier number of units in that component. See Table 2 for SI calculations of 7-21-7.

To calculate SI of any formulation:

1. List the material, grade, and weight for each component in columns 1-3.
2. Determine nutrient units in columns 4-6 by multiplying the weight of each component by its nu dividing each result by 20.
3. List SI per plant nutrient unit in each component in column 7.
4. Determine the SI due each component by multiplying the sum of the nutrient units in columr corresponding SI value in column 7.
5. Total individual SI values of all components in column 8.

Table 2. Calculating salt Index of 7-21-7

						Salt inde	
			Nutrient units				
Material	**% Nutrient**	**Lbs/ton**	**N**	**P_2O_5**	**K_2O**	**Per unit (20 lb)[a]**	**I**
(1)	(2)	(3)	(4)	(5)	(6)	(7)	
10-34-0	10%N, 34% P_2O_5	1235	6.2	21.0	-	0.455	
UAN	28% N	57	0.8	-	-	2.250	
KCl	62% K_2O	226	-	-	7.0	1.936	
Water	-	482	-	-	-	-	

Total	2,000	7.0	21.0	7.0		

[a] Salt index per unit (20 lb) of plant food nutrients, listed Table 1, also called the partial salt inde
[b] 0.79 SI/unit plant nutrient

SI values for a 6-24-6 formulation containing potassium phosphate are shown in Table 3. Phosphor ammoniated to a 1-3-0 ratio, which results in an approximate 50-50 mixture of MAP and DAP at ab Potassium phosphate is then added to provide all of the K and remainder of the P Resulting SI of th per unit of plant nutrients are much lower than those for 7-□21-7, which contained KCI.

Table 3. Calculating salt Index of 6-24-6

						Salt in	
			Nutrient units			Per unit (20 lb)[a]	
Material	**% Nutrient**	**Lbs/ton**	**N**	**P_2O_5**	**K_2O**		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	
NH_3	82% N	146	6.0	-	-	-[b]	
H_3PO_4	54% P_2O_5	666	-	18.0	-	1.613	
Potassium phosphate	22% K_2O, 22% P_2O_5	546	-	6.0	6.0	0.097	
Water	-	642	-	-	-	-	
Total		2,000	6.0	24.0	6.0		

[a] Salt index per unit (20 lb) of plant food nutrients, listed Table 1, also called the partial salt inde
[b]Ammoniation of phosphoric acid to a 1-3-0 ratio forms a mixture of MAP and DAP.
[c] 0.32 SI/unit plant nutrient.

Other points to consider are:

When K_2SO_4 is used instead of KCI, the SI is somewhat lower. However, the solubility of K_2SO_4 is l KCI, so this must be considered in producing formulations relatively high in K_2O.

SI values of acids are given as values per 100 lbs of acid rather than a unit of 20 lbs. Also, the SI c with P concentration of the acid.

SI values calculated differ for formula□tions when ammoniated phosphate solutions are prepared. S due to the ammoniating solution is not included because its contribution has already been accounte per 100 lbs of H_3PO_4, since it has been converted to ammonium phosphate. The same method is us the SI of ammoniated H_2S0_4 formulations.

SI values and SI per plant nutrient of some commonly used liquid formulations are listed in Table 4 formulations containing potassium phosphate have relatively low SI values. The two formulations c □21-7 and 4-10-4) have much higher SI values and are not suggested for use in seed-row placeme show that SI of fluid fertilizers varies signifi□cantly, depending on the grade and components in the

Table 4. Salt index of some common liquid formulations

Formulation	Salt index	Salt index per unit of plant nutrient (20 lb)
2-20-20[a]	7.2	0.17
3-18-18[a]	8.5	0.22
6-24-6[a]	11.5	0.32

6-30-10[a]	13.8	0.30
9-18-9[a]	16.7	0.48
10-34-0[b]	20.0	0.45
7-21-7[c]	27.8	0.79
4-10-10[c]	27.5	1.18
28% UAN[c]	63.0	2.25

[a] These grades are formulated using potassium phosphate as the K source.
[b] Use in seed-row with caution.
[c]Not suggested for use in seed-row placement.

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