



THE ANDERSONS, INC | TECHNICAL BULLETIN 09

CALCULATING SALT INDEX

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 potassium phosphate as the source of K have lower SI values than those containing potassium chloride (KCl). When applied near the seed, fertilizers with lower SI values generally cause fewer problems in seed germination or seedling injury. SI of any fluid formulations 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 a depth greater than that of the seed to allow root interception of the fertilizer band as roots grow outward and downward in the soil.

BAND VS BROADCAST

Regions showing the greatest improvement in efficiency from banding over broadcasting lie in the northern U.S. and Canada, where colder soil conditions are experienced during spring seeding of row crops and small grains. Higher P 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 very low levels of available soil P. Band applications also are usually more efficient when low P application rates are used.

Early planting dates, large amounts of crop residues on the soil surface, and soil compaction may subject plants to more stress. Banded nutrients are usually more effective for crops under these stress conditions. Vegetables respond well to banded fertilizers because they require a relatively large percentage of their total nutrients early in 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 have enough room to include the coulters required to open the soil for fertilizer placement below and to the side of the seed furrow. Some growers have quit applying starters because of this limitation and also because of the weight of openers for very large planters. Others have applied starters directly to the seed furrow, which does not require extra openers.

Banding away from the seed furrow is recommended over in-furrow application under most conditions when applying higher nutrient rates, especially N, K, and S. Plants can efficiently use nutrients banded away from the seed furrow without adversely affecting seed germination or seedling emergence.

Recommendations for fertilizer placement in direct seed contact vary with crop. For many years maximum recommendations ranged from 10-20 lbs/A of N + K₂O in direct seed contact with corn and sorghum. These recommendations using KCl as the K source would not be accurate if potassium phosphate was used as the source of K. This is because of the lower SI value of potassium phosphate compared with KCl (Table 1).

Crop tolerance to increased osmotic pressures (salt content) of the soil solution in the vicinity of the seed varies considerably. For example, wheat is more tolerant of high salt conditions than is grain sorghum, while corn is intermediate. Tolerance of most oil-seed crops (soybeans and cotton) to in-furrow application of nutrients is very low, and in-furrow 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 a similar grade. Fewer problems generally are encountered using fluids as in-furrow fertilizers when compared to granular, since less soil water is required, and salts are mainly dissolved in fluid formulations.



IN-FURROW APPLICATION

Some starter components such as urea, UAN, or ammonium thiosulfate can produce free ammonia (NH₃) under certain soil conditions. Direct seed contact by NH₃ could result in poor germination or seedling death. Selection of the proper starter fertilizer is the way to minimize this occurrence.

Fertilizers best suited for in-furrow application have 1) low salt index, 2) high water solubility, 3) contain N, P, and K, with relatively high P content, 4) contain both urea and ammonium nitrogen, 5) minimize content of compounds that liberate NH₃, and 6) use potassium phosphate instead of KCl as the K source.

The Andersons PureGrade® fertilizers have these desirable characteristics.

SALT INDEX

Salt content is one of the most critical characteristics of fertilizers used for seed row placement. The SI is a measure 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 solution produced by a specific fertilizer to the osmotic pressure of the same weight of NaNO₃, which is based on a relative value of 100. Sodium nitrate was chosen as the standard because it was 100 percent water soluble and it was a commonly used nitrogen fertilizer when the SI concept was first proposed in 1943. Higher analysis fertilizers usually have a lower SI because fewer ions of salts are placed in the soil solution per unit of plant nutrient when they dissolve.

Note that the N and K materials of commonly used fertilizers (Table 1) have higher SI values than those of P materials. The SI of a mixed formulation containing N, P, and/or K is the sum of the SI values of its components. Although the total SI for a high-analysis NPK mixture may be greater than that for a low-analysis NPK mixture, the SI per unit of plant nutrients may be lower in the high-analysis product. Therefore, the lower fertilizer rate needed to supply the same amount of plant nutrients subjects the germinating seeds to less potentially adverse salt effects.

It should be noted that the SI does not

TABLE 1. SALT INDEX VALUES OF FERTILIZER MATERIALS

Material & Analysis	Salt Index	
	Per equal wts of material	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% a. nitrate, 31% urea)	63.0	2.250
32% N (44% a. nitrate, 35% urea)	71.0	2.221
PHOSPHORUS		
APP, 10% N, 34% P ₂ O ₅	20.0	0.455
DAP, 18% N, 46% P ₂ O ₅	29.2	0.456
MAP, 11% N, 52% P ₂ O ₅	26.7	0.405
Phosphoric acid, 54% P ₂ O ₅	-	1.613 ^a
72% P ₂ O ₅	-	1.754 ^a
POTASSIUM		
Monopotassium phosphate, 52% P ₂ O ₅ , 35% K ₂ O	8.4	0.097
Potassium chloride, 62% K ₂ O	120.1	1.936
Potassium sulfate, 50% K ₂ O, 18% S	42.6	0.852
Potassium thiosulfate, 25% K ₂ O, 17% S	68.0	2.720
	-	
*Salt index per 100 lbs of H ₃ PO ₄ *One unit equals 20 lb.		

TABLE 2. CALCULATING SALT INDEX OF 7-21-7

						Salt Index	
Material	% Nutrients	lbs/ton	Nutrient Units			per unit (20 lb) ^a	in formulation
			N	P ₂ O ₅	K ₂ O		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
10-34-0	10% N, 34% P ₂ O ₅	1,235	6.2	21.0	—	0.455	12.4
UAN	28% N	57	0.8	—	—	2.250	1.8
KCl	62% K ₂ O	226	—	—	7.0	1.936	13.6
Water		482	—	—	—	—	—
		2,000	7.0	21.0	7.0	—	27.8 ^b
a. Salt index per unit (20 lb) of plant nutrients, listed Table 1, also called the partial salt index. b. 0.79 SI/unit plant nutrient							

predict the exact amount of fertilizer material or a fertilizer formulation that could produce crop injury on a particular soil. However, it does compare one fertilizer formulation with others regarding the osmotic (salt) effects.

It also shows which fertilizers (those with

a higher SI) will be most likely to cause injury to germinating seeds or seedlings if placed close to or in the seed furrow.



FOR MORE INFORMATION

The Andersons, Inc.
800-831-4815
www.AndersonsPlantNutrient.com

Download all technical bulletins at
AndersonsPlantNutrient.com



CALCULATING SALT INDEX

The SI of a mixed fertilizer (N-P-K+S) is the sum of the SI of each component per unit of plant nutrient times the 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 nutrient content and 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 columns 4-6 times the corresponding SI value in column 7.
5. Total individual SI values of all components in column 8.

SI values for a 6-24-6 formulation containing potassium phosphate are shown in Table 3. Phosphoric acid is first ammoniated to a 1-3-0 ratio, which results in an approximate 50-50 mixture of MAP and DAP at about pH 6.8. Potassium phosphate is then added to provide the remainder of the P and all of the K. Resulting SI of this grade and SI per unit of plant nutrients are much lower than those for 7-21-7, which contained KCl.

Other points to consider are: When K_2SO_4 is used instead of KCl, the SI is somewhat lower. However, the solubility of K_2SO_4 is lower than that of KCl, 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 of H_3PO_4 varies with P concentration of the acid.

SI values calculated differ for formulations when ammoniated phosphate solutions are prepared. SI per

TABLE 3. CALCULATING SALT INDEX OF 6-24-6

						Salt Index	
Material	% Nutrients	lbs/ton	Nutrient Units			per unit (20 lb) ^a	in formulation
			N	P ₂ O ₅	K ₂ O		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
NH ₃	82% N	146	6.0	—	—	— ^b	—
H ₃ PO ₄	54% P ₂ O ₅	666	—	18.0	—	1.613	—
Potassium Phosphate	22% K ₂ O	—	—	—	—	—	10.7
Water	22% P ₂ O ₅	546	—	6.0	6.0	0.097	1.2
		642	—	—	—	—	
		2,000	7.0	24.0	6.0	—	11.9 ^c

a. Salt index per unit (20 lb) of plant nutrients, listed in Table 1, also called the partial salt index.
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.

TABLE 4. SALT INDEX OF SOME COMMON LIQUID FORMULATIONS

Formulation	Salt Index	Salt Index per unit of plant nutrient (20 lb)
3-18-18 ^a	8.5	0.22
6-24-6 ^a	11.5	0.32
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
8-20-5-5S-5Zn ^c	39.4	1.17
28% UAN ^c	63.0	2.25

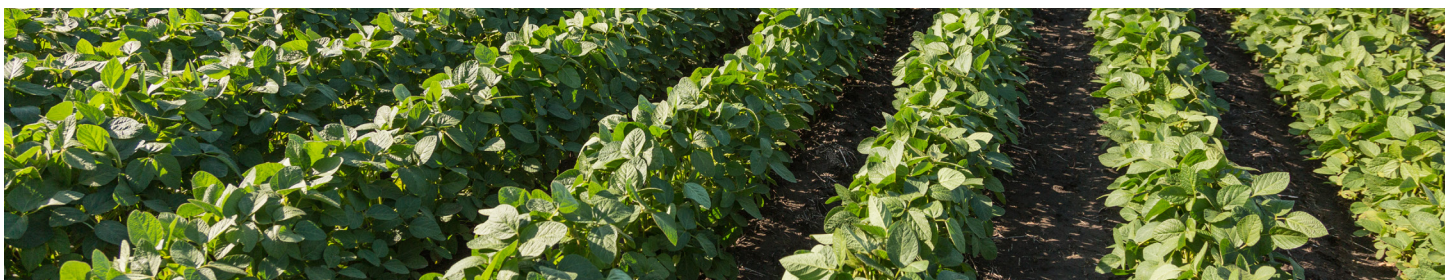
a. These grades are formulated using potassium phosphate as the K source.
b. Use in in-furrow placement with caution.
c. Not suggested for use in in-furrow placement.

unit of N due to the ammoniating solution is not included because its contribution has already been accounted for in the SI per 100 lbs of H_3PO_4 , since it has been converted to ammonium phosphate. The same method is used for calculating the SI of ammoniated H_2SO_4 formulations.

SI values and SI per plant nutrient of some commonly used liquid formulations are listed in Table 4. Note that all formulations containing potassium phosphate have relatively low SI values. The two formulations containing KCl

(7-21-7 and 4-10-10) have much higher SI values and are not suggested for seed row placement. These results show that SI of fluid fertilizers varies significantly, depending on the grade and components in the formulation.

Dr. Mortvedt, previously with the National Fertilizer and Environmental Research Center, TVA, Muscle Shoals, AL, and Colorado State University, is a consultant with U.S. Borax.



FOR MORE INFORMATION

The Andersons, Inc.
800-831-4815
www.AndersonsPlantNutrient.com

Download all technical bulletins at
AndersonsPlantNutrient.com

