# FACT SHEET:

# Salt Index & Fertilizer Burn


SUL4R-PLUS®
Boron & Zinc Solutions

**March 26, 2019** **Complied by: Greg Parris**

**"Virtually all fertilizer materials are salts. When they dissolve in the soil they increase the salt concentration of the soil solution. An increase in salt concentration increases the osmotic potential of the soil solution. The higher the osmotic potential of a solution, the more difficult it is for seeds or plants to extract soil water they need for normal growth.**

The salt index does not predict the amount of material that will produce injury to crops in a particular soil. It classifies fertilizer material relative to each other and shows which is most likely to cause injury. It is possible to formulate similar grades of mixed fertilizers from different materials that have significantly different salt indices**."** [1]

**Understanding Salt Index**

"Origin Salt Index (SI) is a numerical comparison between fertilizer materials in use since 1943. Sodium nitrate (NaNO3) was used as the standard since it was a commonly used, 100% water soluble source of nitrogen at the time. Its SI was set at 100 and other fertilizers are then expressed as a percent of the standard." [2]

(Osmotic Pressure $_{\text{Fertilizer Material}}$ / Osmotic Pressure $_{NaNO3}$) x 100 = SI

"SI measures the electrical conductivity of a 1% fertilizer solution. Solutions with a high SI have a higher conductivity, an indication of the amount of salt in the solution. Impact of Salt Content on Plant Cells." [2]

"When a solution with a high salt content is separated from a solution with a low salt content by a semi-permeable membrane, such as a cell wall, water will move thru the membrane from the low concentration to the high concentration, seeking a balance. If this water movement is out of the cell, plant injury may occur***. Traditionally, SI has been utilized as an indication of seedling safety for furrow applied starter fertilizers***. Cells in plant seedlings have higher water content than mature plant tissue, therefore they are more vulnerable to movement of water out of the cell." [3]

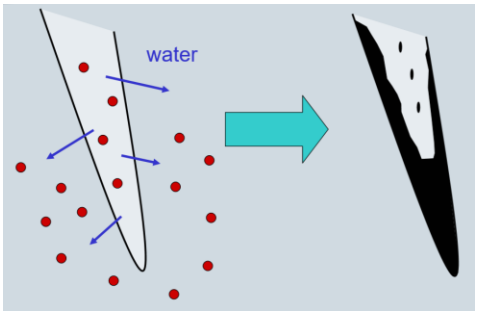


Fig 1: Understanding Salt impact on Root Burn [3]


Fig 2: Healthy Root [4]

"Factors influencing plant injury:

1. Excessively high fertilizer rates.
2. Low spray water volumes.
3. High ambient temperatures.
4. High relative humidity.

These conditions will increase the potential that plant injury may occur when foliar applying a fertilizer solution with a high SI."[2] Both dry and foliar applications can cause issues.

**Factors affections Fertilizer Burn:**

**CROP Sensitivity**

"Crop tolerances vary widely to increased osmotic potential from fertilizer near the seed. Wheat is moderately tolerant of high-salt conditions while soybeans are very sensitive. Corn is intermediate in tolerance." [1]

| 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)

Fig 3: Crop Sensitivity [3]

"Dry soil conditions as well as fertilizers that produce free ammonia (urea, UAN, DAP) will significantly increase seed and seedling stress leading to injury or possible death. Be aware of the salt index of your starter fertilizer and don't overstress your young crop." [1]


Fig 4: Wheat Trials Root damage by Urea (loss of root hairs/ destruction of root cells) [4]

**Soil conditions** [3]

- 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

**Concentration of fertilizer salts**

- Broadcast
  - Fertilizer is dispersed; rarely cause injury
- Banded (2" x 2")
  - Fertilizer is more concentrated closer to seed

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- At typical application rates injury unlikely

❖ In furrow/seed placed/pop-up
- Extremely close proximity to seed
- Reduced rates, but can still cause problems

**Why are fertilizer salts a problem for Nitrogen containing fertilizers?** [3]

❖ 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

Salt index – N fertilizers

| Material and Analysis ($N$-$P_2O_5$-$K_2O$-$S$) | Salt Index per equal weights of materials | Salt Index per 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)

Table 1: SI for N Fertilizers [3]

**How does Ammonia harm the seed?**

"It was concluded that the brown root tips, short root growth, and stunting were due to free ammonia in the soil air. The rapid germination inhibition must have also been caused by free ammonia.

The free ammonia concentration in the soil air was reduced by lowering the soil pH or lowering the concentration of ammoniacal-nitrogen." [5]

**Water Movement Influenced by Salt Content**

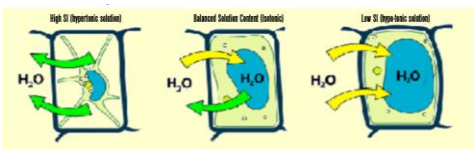


Fig 5: Water will exit across the cell membrane when a solution placed on it has a higher salt concentration than that within the cell. The resulting shrinkage may damage the cell. [6]

Fig 6: When in equilibrium, water will move in both directions across the cell membrane. [6]

Fig 7: Water will enter across the cell membrane when a solution placed on it has a lower salt concentration than that within the cell. The resulting swelling may damage the cell. [6]

**How does SUL4R-PLUS® fertilizer interact with Canola Roots?**

With a salt index of 5 to 8, the direct root contact with calcium sulfate is safe and makes the plant thrive. There is no root burn as indicated in the picture below:


Fig 8: SUL4R-PLUS® fertilizer with Wheat 7 days[4]

"**Salinity is of greatest concern in soils that are**:

Irrigated with water high in salts; Poorly drained, allowing for too much evaporation from the soil surface; Naturally high in salts because very little salt leaches out; In areas where the water table (the level or depth to free-flowable water in the soil) is shallow; or In seepage zones, which are areas where water from other locations (normally up slope) seep out." [7]

"**Toxic Effect of Salts: The Plant Guy**

For the answer, we have to go back to osmosis. The key to osmosis is the presence of a semipermeable membrane, which allows water to pass through it, but NOT dissolved solutes, especially salts. All living cells, including plant cells, are surrounded by semipermeable membranes. So, water can easily flow in and out of the cells osmotically, but not dissolved salts. Indeed, to move dissolved solutes across the membranes, cells typically have to make little pores or transporters in the membrane in order to do so.

In addition to the osmotic effects on plants, the **second problem** when most plants are exposed to high salinity conditions (e.g., saline soils) is that sodium, and certain other ions, are **toxic to plants** when their concentrations are relatively high.

Despite the semipermeable membranes, under high salinity conditions, sodium chloride and other dissolved salts can leak into the cells.

Under normal conditions, the cytoplasm of plant cells typically contains a lot more (10x to 50x) potassium ions (K+) than sodium ions.

Abnormally high amounts of Na+ and high concentrations of total **salts can inactivate some enzymes and inhibit protein synthesis**.

At a high concentration, Na+ may displace calcium ions (Ca++) from the cell membranes, causing them to become "leaky", that is, to lose their semipermeable nature. This can have disastrous, even lethal, effects on plant cells. **Photosynthesis is also inhibited** when high concentrations of Na+ and/or Cl– accumulate in chloroplasts." [8]

Stress from salts can impact yield as early as the seedling stage. Did you know that SUL4R-PLUS® sulfated sulfurs, put down early and available through the growing season, can help supply the plant with sulfur for production of amino acids, and many sulfur containing molecules like glutathione, that will aid in reducing these early drought stresses and allow the crop to reach its best potential?

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## Sources and Excerpts


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