# Soil salinity and salt tolerance of vegetable crops

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## 1. What is soil salinity?

Soil salinity is the amount of soluble salts in a soil and measured as electrical conductivity (EC) with unit of deciSiemens per meter (dS/m), milliSimens per centimeter (mS/cm), or millimho per centimeter (mmho/cm). You may also see other units such as µS/cm, µmho/cm. The units of EC were mmhos/cm until changed to dS/m. 1 mmho/cm = 1 dS/m = 1 mS/cm. Soils with high concentrations of salts will have high readings of EC because they have high capacity to pass electrical flow.

## 2. How to collect soil samples for measuring soil salinity?

1) Collect a composite samples (mixing ~10 individual samples) throughout the field to get a representative sample of the field (~5 acres).
2) Collect separate composite samples separately if there are trouble spots that you suspect may have high salt contents.
3) Collect two depths (0-6" and 6-12')
4) Prepare a clean shovel, a clean bucket or bowl, clean Ziploc bags or paper bags.
5) Pick a location. If possible, record GPS location.
6) Excavate to 6" (Fig 1)
7) After shaping face, cut 1" slab from the face (Fig 2).
8) Cut the soil on both sides of a 1-inch section (Fig 3).
9) Discard the left and right sections into the hole.
10) Discard any plant materials, large organic matter, large rocks, or other debris.
11) Place soil Place soil sample in the plastic bucket (Fig 4).
12) After all samples are collected, mix the soil and transfer ~0.5-1 lb soil to a plastic or paper container.
13) Fill in the hole and smooth the surface before taking another sample or moving to another sample location.
14) Label soil sample bags with sample number or name, sample depth, date, name of the grower.
15) Clean all equipment and containers after each sample has been collected. This step avoids soil from one sample from contaminating the next soil sample

Fig. 1

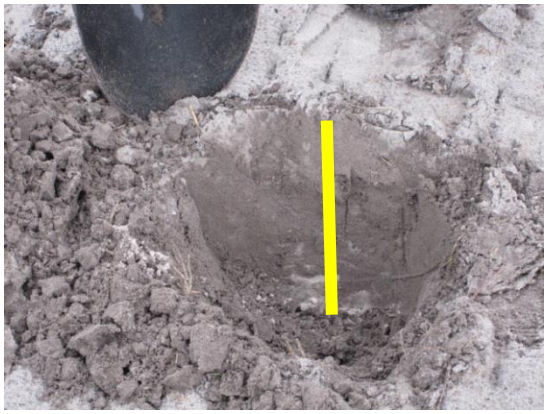

Fig 2

Fig 3

Fig 4

**3. How to measure soil salinity?**

We will follow the procedure described in the UF/IFAS Extension Soil Testing Laboratory (ESTL) Analytical Procedures and Training Manual.
http://edis.ifas.ufl.edu/pdffiles/SS/SS31200.pdf

You can use a potable EC meter or a standard desk pH/EC meter.

**4. Can we measure chloride in soil samples?**

Yes. But we do not have soil chloride standard for interpreting soil testing results.

**5. Classification of salt-affected soils (USDA/NRCS)**

| Class | EC (dS/m) | Sodium Adsorption Ratio (SAR) | Exchangeable Sodium Percentage (ESP) |
|---|---|---|---|
| Non-saline | 0-2 | <13 | <15 |
| Very slightly saline | 2-4 | <13 | <15 |
| Saline | >4 | <13 | <15 |
| Sodic | <4 | >13 | >15 |
| Saline-sodic | >4 | >13 | >15 |

**6. Guidelines in interpreting EC data from soil extracts (1:2 soil-to-water ratio) (Adapted from University of Georgia).**

| EC (dS/m) | Rating | Interpretation |
|---|---|---|
| 0-0.15 | Very low | Plants may be starved of nutrients. |
| 0.16-0.5 | Low | If soil lacks organic matter. Satisfactory if soil is high in organic matter. |
| 0.51-1.25 | Medium | Okay range for established plants. |
| 1.26-1.75 | High | Okay for most established plants. Too high for seedlings or cuttings. |
| 1.76-2 | Very high | Plants usually stunted or chlorotic. |
| >2 | Excessively high | Plants severely dwarfed; seedlings and rooted cuttings frequently killed. |

**7. Salt tolerance of vegetable crops (Grieve et al., 2012)**

| Crop | Botanical name | Threshold Soil EC | Reference |
|---|---|---|---|
| | | dS/m | |
| Bean, mung | Vigna radiate (L.) R. Wilcz | 1.8 | Minhas *et al.*, 1990 |
| Broccoli | Brassica oleracea L. | 1.3 | Bernstein & Ayars, 1949a; Bernstein *et al.*, 1974 |
| Cabbage | B. oleracea L. | 1.8 | Bernstein & Ayars, 1949a; Bernstein *et al.*, 1974; Osawa, 1965 |
| Cauliflower | Brassica oleracea L. | 1.5 | |
| Corn, sweet | Zea mays L. | 1.7 | Bernstein & Ayars, 1949b |
| Cowpea | Vigna unguiculata L. | 4.9 | West & Francois, 1982 |

| | | | |
|---|---|---|---|
| Cucumber | Cucumis sativus L. | 2.5 | Osawa, 1965; Ploegman & Bierhuizen, 1970 |
| Eggplant | Solanum melongena L | 1.1 | Heuer *et al.*, 1986 |
| Lettuce | Lactuca sativa L. | 1.3 | Ayars *et al.*, 1951; Bernstein *et al.*, 1974; Osawa, 1965 |
| Okra | Abelmoschus esculentus L. | 1.2 | Rhoades et al., 1992 |
| Onion | Allium cepa L. | 1.2 | Bernstein & Ayars, 1953b; Bernstein *et al.*, 1974; Hoffman & Rawlins, 1971; Osawa, 1965 |
| Pea | Pisum sativum L. | 3.4 | Cerda *et al.*, 1982 |
| Pepper | Capsicum annuum L. | 3.4 | Bernstein, 1954; Osawa, 1965; USSL†† |
| Potato | Solanum tuberosum L. | 1.7 | Bernstein *et al.*, 1951 |
| Squash, zucchini | C. pepo L. var melopepo (L.) Alef. | 4.9 | Francois, 1985; Graifenberg *et al.*, 1996 |
| Strawberry | Fragaria x Ananassa Duch. | 1.0 | Ehlig & Bernstein, 1958; Osawa, 1965 |
| Sweet potato | Ipomoea batatas (L.) Lam. | 1.5 | Greig & Smith, 1962; USSL†† |
| Tomato | Lycopersicon lycopersicum (L.) Karst. ex Farw. | 2.5 | Bierhuizen & Ploeman, 1967; Hayward & Long, 1943; Lyon, 1941; Shalhevet & Yaron, 1973 |
| Tomato, cherry | L. lycopersicum var. Cerasiforme (Dunal) Alef. | 1.7 | Caro et al., 1991 |

**7. Soil salinity (dS/m) for potential yield reduction from saline soil for selected crops (Gardon et al, 2007)**

| Crops | Relative yield decrease % | | | |
|---|---|---|---|---|
| | 0 | 10 | 25 | 50 |
| Squash, zucchin | 4.7 | 5.8 | 7.4 | 10.0 |
| Asparagus | 4.1 | 9.1 | 16.6 | 29.1 |
| Broccoli | 2.8 | 3.9 | 5.5 | 8.2 |
| Tomato | 2.5 | 3.5 | 5.0 | 7.5 |
| Cucumber | 2.5 | 3.3 | 4.4 | 6.3 |
| Cantaloupe | 2.2 | 3.6 | 5.7 | 9.1 |
| Spinach | 2.0 | 3.3 | 5.3 | 8.6 |
| Cabbage | 1.8 | 2.8 | 4.4 | 7.0 |
| Potato | 1.7 | 2.5 | 3.8 | 5.9 |
| Sweet corn | 1.7 | 2.5 | 3.8 | 5.9 |
| Pepper | 1.5 | 2.2 | 3.3 | 5.1 |
| Sweet Potato | 1.5 | 2.4 | 3.8 | 6.0 |
| Lettuce | 1.3 | 2.1 | 3.2 | 5.2 |
| onion | 1.2 | 1.8 | 2.8 | 4.3 |

| | | | | |
|---|---|---|---|---|
| Carrot | 1.0 | 1.7 | 2.8 | 4.6 |
| Bean | 1.0 | 1.5 | 2.3 | 3.6 |
| Strawberry | 1.0 | 1.3 | 1.7 | 2.5 |