Sodium, a major hydroponics nutrient problem.

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Sodium is an element essential to animals but not required by in all but trace amounts by most plants. It, however, is the sixth most common element on earth. Since New Zealand and many areas where hydroponics crops are growing, are close to or surrounded by the sea, natural waters can contain high levels of sodium as the chloride (common salt), it is not surprising that levels of sodium can rise in circulating solutions to cause serious plant injury and losses of production. The chloride ion is required by plants for photosynthesis, but in very low amounts. Responses to common salt applications can be seen in salt tolerant plants. These plants include barley, wheat, asparagus, beets,and mangolds all of which can take up some sodium but no commonly grown hydroponics crops tolerate sodium at high levels found in many waters. Tolerance to sodium is closely related to the optimum conductivity required by the crop. Crops that require a high conductivity tolerate higher sodium levels.

Excess sodium results in starvation of essential nutrients resulting in slow hard growth, increased tip burn, root diseases and related problems associated with calcium and other nutrient deficiencies. Crops may take on a grayish green appearance. (See illustration on right)

Sodium is present in rain water commonly to 2-4 parts per million (ppm). It occurs in well waters from low levels, similar to rain water, to levels locally in excess of 100ppm. Shallow wells generally have a higher amount of sodium than deep wells unless there is contamination from sea water when levels can almost double this maximum. Sodium chloride is deposited on land in New Zealand commonly at 180 Kg per Ha each year. This arrives in salt laden winds. In storms salt can be blown from one side of New Zealand to the other. It finds its way into wells as the water percolates through the soils or runs into rivers and from there into the aquifers.

One gram of sodium in 1000L of water is 1 ppm. Well waters often have 12ppm. The best level for sodium in water, used for hydroponics nutrient solutions, is to have it as low as possible but levels above 12ppm become increasing difficult to manage. If water being used has 12ppm of sodium present, and plants are using water for evapotranspiration at the rate of 4mm a day (4 litres/sq.m per day) every 1000sq m of crop will use 4000L of water/day containing 48g of sodium. There will be no removal of sodium by the plants. The sodium is left in the catchment tank and its concentration increases day by day.

Slight Tip burn, typical of that resulting from excess sodium.
Note the hardened smaller leafed younger growth. Tip burn may have resulted on a day with high temperatures.

The rate of accumulation of sodium in the circulating solution depends on the total amount of nutrient circulating. The larger the tank, within limits, the easier it is to manage. Tanks are too large when the volumes of nutrients required to provide a suitable pH and conductivity are difficult to maintain and the time required to drain and dump then replenish the tank and system, with new nutrient, may result in crop stress.

For leafy greens and beans, toxic levels of sodium occur at 20ppm for cF 8, 30ppm at cF 12, 45ppm at cF 18. To avoid problems dumping must be done when these levels are reached

The table below shows, with three different waters containing 12, 4 and 1ppm of sodium, how long it takes sodium levels to build up to a point where dumping is needed. Other periods can be determined by proportioning relevant levels. ‘Crop

area' is about 60% of most house floor area. (It is the photosynthetic area of the foliage that is used here represented by the actual crop's shadow at mid day.)

Sodium has several adverse effects when it is present in hydroponics solutions in excessive amounts. The first symptom is seen when the acid use declines while other conditions remain similar. This is followed by a decline in the uptake of nutrients. If these rates of use are graphed each day, along with notes on the weather conditions present, growers can identify the period after dumping when sodium levels increase and are drastically affecting plant nutrition and growth. Symptoms will become noticeable on the plants.

If dumping is not undertaken at the right time plants will take on a grayish colour and lack the vigour associated with well nourished plants. Growth and yields will be depressed. Nutrients in the circulating solution are drastically reduced, being replaced by sodium chloride. The plants become starved of essential nutrients.

Sodium in nutrient solutions, applied to media in run-to-waste systems, accumulates in a similar manner. In this case 10-30% more nutrient solution than required by evapotranspiration is applied in irrigations each day so sodium salts, left by the previous day's nutrient irrigations, are washed out.

Sources of Na are mainly from water but may also arise from the use of low quality nutrients. An investigation of a hydroponics system, where there was serious Pythium and tip burn on a leafy green crop,. revealed that sodium levels in a new nutrient solution were in excess of 30ppm at cF12. Toxic levels of sodium were being added from the nutrients in use. Certainly the price of the mix was low but, with the sodium levels present, growing any quality horticultural crop would be impossible. It is important to use high grade nutrients without sodium contamination.

Normal use of disinfecting materials, such as Oxine®, have an insignificant effect on sodium levels adding under 1-2ppm to the total solution.

Excessive sodium levels are avoided by dumping the solutions at frequent intervals, determined by the sodium levels in the water, the size of the catchment tank related to cropped area and evapotranspiration rates. The larger the amount of circulating solution the longer it takes for the sodium to reach a toxic level. As a guide with present common tank sizes and systems tank nutrients may need to be dumped every 1-3 weeks in summer but up to 9-12 weeks in winter with the low water sodium levels used in the Table below.

Water Treatment?

If water levels are above 12ppm there are two satisfactory methods to, avoid excess sodium in nutrient solutions. One is to use a reverse osmosis water purifier. The other is to save and use rain water. Both are in common use.

The most important aspect here is to know how much sodium, and other elements, are present in the water in use and to use nutrients that do not add to the sodium

High sodium levels on Callas.

Towards the end of the previous growing season a single irrigation of water containing 110ppm of sodium was made, in error, to this bed of Callas. The plants leaves rolled up and the crop stopped growing. In the next flowering period these tubers produced compact small plants and the flower stems failed to elongate to produce marketable stems. Callas have a similar sensitivity to sodium as leafy green crops, such as lettuce. They are also said to have a memory, the previous seasons nutrient status being evident in the performance of the tubers in relation to growth, flowering and flower quality, as can be seen in these plants with short stems.

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problems. Because animals require sodium, and excess levels for animals are seldom encountered in ground water, many water tests applied to new wells do not include a test for sodium. Similarly, water tests designed to provide information for suitability of water for drinking and house hold use may be unsuitable for indicating suitability for hydroponics. Many reports on water quality have been used to indicate that a water is suitable for horticulture and hydroponics, but are based on tests for domestic use, where clearly the sodium levels are unacceptably high for hydroponics. Most nutrients (fertilisers) sold for farm use are not suitable for hydroponics use.

To avoid problems, ensure that the correct laboratory tests of the water to be used, or which is in use, are undertaken and nutrients are of the quality required by hydroponics crops. Test nutrient solutions prior to dumping to confirm sodium levels.

Crop Susceptibility to Sodium

Very susceptible (Greater than 30ppm Na at a cF of 12 will cause problems)
Beans, leafy greens, leafy herbs, Callas.

Intermediate(Greater than 45ppm Na at a cF of 18 will cause problems)
Cucumbers and Carnations, woody herbs.

Most resistant (Greater than 60-90ppm at a cF of 28-30 will cause problems)
Peppers and Tomatoes

Days to Reach the Period when the NFT Nutrient Tank Dump, and Replacement with a new mix, is required.

Area of actual crop used=**1000 sq m** Av Evapotranspiration used=**4mm/day**

Size of Tank relative to crop area (use shadow of crop)	**Crop area ratio, (sq.m:L) 1000:4000 (1:4)**			**Crop area ratio, (sq.m:L) 1000:6000 (1:6)**		
ppm Na in water used >	12 ppm	4 ppm	1 ppm	12 ppm	4ppm	1ppm
Crop and ppm when to dump V	days	days	days	days	days	days
Dump at 30 ppm, e.g. Lettuce	3	8	30	4	12	46
Dump at 45 ppm, e.g. Cucumbers	4	11	45	5	17	68
Dump at 60 ppm, e.g. Tomatoes	5	15	60	8	23	90

Example: For a 1667 sq metre green house the photosynthetic area occupied by the crop (as indicated by the crop's shadow at midday) is approximately 60% of the total green house area. (Estimate and use actual areas and values here)

1667sq m x 60% shadow = 1000sq m of crop area as shown in the table.

If the crop area in sq m to total litres circulating is 1:4 and the level of sodium in the water is 4ppm, the maximum level for lettuce etc (30ppm) will be reached in 8 days when a dump is required.

If the tank is larger, say with a 1:6 crop area in sq m to total litres circulating, a dump would not be required until the 12th day.