**BORON**

**GOOD-BAD-REMOVAL**

1. **WHAT IS BORON?**

It is a naturally occurring element with the chemical symbol B. The Periodic Table of the Elements refers to it as element number 5 which is its atomic number or AN. This tells us that there are 5 positively charged protons with an assigned weight of 1 each in the core of a Boron atom surrounded by 5 negatively charged, weightless electrons in orbit around the core. The like number of positively and negatively charged particles cancel one another so the boron atom, as all atoms in the table, have a zero electrical charge. Joining the protons in the core are 6 neutrally charged particles aptly called neutrons. They have an assigned weight of 1 each or 6 total which when added to the 5 of protons gives a total weight of 11 for boron. This is referred to its molecular weight or MW.

Boron is a very sparse element in the earths crust and is found primarily as boric acid {B(OH)3}or borate {B(OH)4-} compounds and never in its elemental form. Once laboratory isolated into elemental form, boron is an extremely hard, black material not totally unlike its chemical cousin carbon with its AW of 6 and MW of 12. Major accumulations of boron mineral compounds are found in Turkey, Russia and Northern California. Boron compounds are very soluble in water so after eons of time, sea water now contains an average of 4.5 mg/l (4-1/2 pounds in 110,000 gallons). As a result of seawater evaporation and intrusion into ground water over the ages, boron can be found in trace amounts virtually everywhere with typical values in water of 0.5 mg/l or less. Higher values are seen in areas with high ground mineral deposits.

1. **WHAT IS BORON USED FOR?**

* Making high temperature, dimensionally stable glass
* Making extremely strong rare earth magnets
* Making high power density, rechargeable batteries
* Strengthening metal alloys
* Making certain cleaning and bleaching compounds
* As a soil additive for certain crops
* As dietary supplement

1. **HOW DOES BORON IN WATER REACT WITH HUMANS?**

Boron is an essential micronutrient necessary in our systems as it works in concert with vitamin D to increases our bodies ability to assimilate calcium for bone, tooth and brain tissue health. The best natural sources are dark green leafy vegetables, non-citrus fruits, dried fruits and tree nuts. There is also a correlation between boron levels in the body and the levels hormones especially of estrogen and testosterone which ultimately slows bone deterioration due to osteoporosis. Currently, the NIH is studying links between boron and effective cancer treatment by certain protocols.

Most information on the topic suggests a maximum intake of 3 milligrams daily. The USEPA does not have a mandated maximum level in drinking water, but has a suggested maximum level of 3 PPM for healthy adults and 2 PPM for children. The World Health Organization (WHO) has an established maximum of 2.4 PPM. California has a state mandated limit of 1 PPM (expressed as 1,000 ug/l) and a number of other state drinking water regulations call for limits from 0.6 to 1.0 PPM.

Excess boron will affect people differently, but common reactions include nausea, indigestion, vomiting, headache and diarrhea. High levels over a long time can lead to rashes, hair loss and kidney damage. Fatal doses occur at 15-20 grams (15,000 to 20,000 mg)

1. **HOW DOES BORON REACT WITH PLANTS?**

Apparently, there is carryover of boron (as boric acid) in air over oceans and seas and this

becomes the Jonny Appleseed propagation of boron in soil at a rate estimated in millions of tons annually. Typical soil levels of boron in soil vary from 5 to 80 PPM and are location and sea proximity dependent.

The extremely low level of boron required for optimum plant vitality is a classic example of Liebig’s Law of Minimums which in plant applications states that unless a minimum level of a key micronutrient is provided, growth is compromised regardless of feeding excess amounts of other nutrients. With adequate boron levels in the soil combining with microorganisms, calcium and phosphorus in particular are more effectively used by plants. Boron in the irrigation water is additive to the boron in the soil. Overall, proper boron levels combined with other minerals, nutrients and adequate water will produce plants with healthier cell walls, non-browning leaves, more rapid growth, better water transport throughout the plant and more productive seed and flower growth.

In some cases, higher levels of boron in the soil and/or irrigation water becomes too much of a good thing. The plants exposed to excess levels of boron for their species exhibit slower, stunted growth, browning of leaves and flowers and poor-quality fruit. It’s known that photosynthesis is inhibited by excess boron, but beyond that, the precise reason for plant damage by excess boron remains elusive in 2021.

1. **IF BORON LEVELS ARE TOO HIGH FOR PLANTS, WHAT CAN BE DONE?**

If it is a soil contamination issue, leach with low/no boron water from a river or lake repeatedly until soil samples from beneath the crop root level tests low enough to be satisfactory.

If boron is in the water above a safe level for the intended species of plant, Dime Water, Inc.

can be of help. Boron has a very low surface energy which makes it virtually impossible to remove with standard reverse osmosis, so variants of seawater (desal) R.O. units must be employed with varying levels of success. The water waste, high energy use, high CAPEX and OPEX makes this a less than acceptable method in most cases. We therefore have developed a unique, regenerable filter with a medium that is selective to boron, is 90% plus water efficient and has a fraction of CAPEX and OPEX.