Copper-Coated Containers and Their Impact on the Environment

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Abstract

The following statements and information address public concerns about copper in the environment. They are based on many years of research on the use of copper in agriculture and aquatic weed management and its impact on the environment.

Key Words

Spin-Out®, fixed copper, elemental copper, copper toxicity

What Is Copper?

Copper (Cu) is a pliable, malleable metal having a bright reddish metallic luster. It is an excellent conductor of electricity and heat. Copper occurs naturally in a wide range of mineral deposits and is present in many forms in our daily lives. Copper is an essential micronutrient required for growth in both plants and animals. In humans, it helps in the production of blood hemoglobin. Unlike copper, heavy metals like lead, cadmium, arsenic, and mercury are not involved in biological systems and can be very toxic to plants and animals.

Copper In Our Lives…

Copper is present in many forms in our everyday lives including money in our pocket, kitchen cookware, water pipes, jewelry, electrical wiring, decorative arts, and construction materials. What separates these things from what is used in agriculture to control plant disease, aquatic weeds, root development, wood preservatives, and antifouling marine paints is the form of copper and its biological activity. Copper fungicides and paints only contain a small portion of biologically active copper and the remainder is referred to as "fixed copper". The "fixed copper" particles provide a reservoir of copper ions for residual disease and pest control. The first copper fungicide was Bordeaux mixture, developed in France in the 1880s to control grape diseases.

Copper Is Elemental

Copper is an element and does not break down. When elemental copper is present in the environment it is not biologically active. The only form that is active is ionic Cu^{+2}. Copper in the ionic form quickly complexes with organic matter in the soil and container substrates, rendering it biologically inactive. Fixed copper salts used for root control, like copper hydroxide, release active copper ions over a long period of time. These are quickly made biologically inactive upon contact with soil or container substrates.

Copper Is Toxic To Plants

Copper can be toxic to roots when readily available for uptake. The mode of action for copper treated containers is the controlled-release of copper ions along the container-substrate interface, where Cu ions inhibit root elongation at the root tip. The root inhibition is localized to the root tip, and very little to no excess copper is translocated to other plant parts. Copper treated pots do not affect rhizomes; the effect is very specific to root tips.

Copper Leaches

Statements like "Huge quantities of copper leach from treated containers into surrounding soil…" are not true. This is definitely not true for Spin Out®-coated plastic pots and has not been shown to be an issue for pots and trays made using other technologies or coated with other forms of copper.

Copper hydroxide in the Spin Out® coating is encapsulated in a latex matrix and is very resistant to leaching and dislodging by rain and irrigation.

Copper In the Soil

Copper is present in most soils at levels less than 100 ppm. However, this is total copper. Biologically active copper is in the ppb range at pH 7. For all this copper to be available, the soil pH would need to be below 3.0, which does not favor plant growth. In the pH range of 5.5 to 8.0, 99.99% of the total copper is not available to plants for uptake by the roots. Nurseries concerned about runoff, such as those that grow forest seedlings in treated containers, can prevent any potential movement of copper from the production area by applying agricultural lime to the soil under benches. Raising the soil pH to 6.5 to 7.0 will tie up any soluble copper. This is a common practice where copper fungicides are routinely used on perennial crops, like citrus, grapes, and walnuts. Very high levels of copper (>450 lb/ac [>500 kg/hectare]) can be tolerated by most plants as long as soils are not in the acid range. Soils with high cation exchange capacity are able to bind much more copper than sandy soils with a low CEC.

Copper Can Restrict Growth

Yes, excess available copper can restrict plant growth. However, the copper used to control root growth is limited to the container-substrate interface. Copper ions do not leach throughout the soil media. Free copper ions are either absorbed by root tips or bound by the media. Research has shown that elevated copper levels are confined to the root tip and are not translocated to stems, leaves, and fruit of most species. Residue studies on fruit crops have also shown no change in copper between plants grown in copper-coated and nontreated pots. Certain plant species have been identified as able to absorb and accumulate excess copper. However, these are an exception.

Copper Can Hamper Nutrient Uptake

Excess copper can result in a condition known as copper-induced iron chlorosis. This is caused by the competition of iron and copper, which are both absorbed as divalent ions. When using copper coated pots, this condition is most common where there is a high ratio of container surface area to substrate volume, such as containers used to grow forestry seedlings, bedding plants, or plugs. The condition is rare with the use of pretreated containers because the coating has been formulated to minimize this effect. If the condition occurs, it can easily be corrected with an application of a chelated iron fertilizer. Nutrient uptake for some species is related to mycorrhizal colonization of the roots. Copper treated pots do not kill mycorrhizal fungi (fig. 1). Three published studies show enhancement of mycorrhizal colonization of seedlings grown in treated pots due to an increase in the number of fine roots. Studies also show that *Trichoderma*, used to reduce root diseases, is not adversely affected by copper-treated pots.

Copper Stunts Some Species

Of the numerous university and grower trials, there are only a few cases where copper treated pots have caused any significant reduction in plant growth. In general, growers that have used copper treated pots are very satisfied with the performance. Not all plant species react the same to treated pots, which is why extensive research has been conducted in the last 12 years. Even species showing a slight reduction in growth may benefit from an improved root to shoot ratio when transplanted. Applying the copper coating at the correct rate is important to avoid excess root control and nutrient imbalance. Plants can become stunted if left in containers too long before transplanting. Unfavorable results published in the 1970s were most likely due to mixing copper salts in house paint. Today, pots are treated with products specifically formulated and EPA registered for root control.

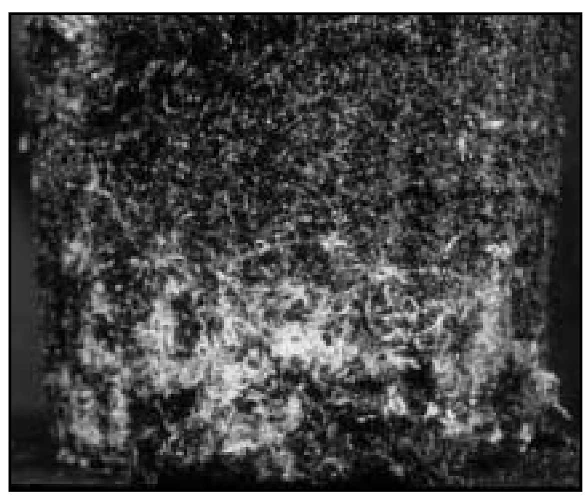

Figure 1. Mycorrhizal growth on oak roots in a copper-treated container.

Copper Coating Works Primarily with Fibrous Root Systems

The benefits of root branching have been demonstrated on numerous tap-rooted species like oaks, bald cypress, and ash. Air root pruning has been practiced on many of these species when grown in containers. However, copper coated containers are equally effective when used in conjunction with timely transplanting. On many species of trees and shrubs, the benefits of using copper coated pots are numerous, including improved root structure, improved utilization of soil media and fertilizer, much easier removal from the pot at transplanting, significantly more root tips for regeneration and a reduction in shock and disease due to mechanical root pruning of root bound trees and shrubs. However, it is important not to substitute the use of treated containers for timely transplanting into larger containers or the field.

The use of copper-coated pots has evolved from hand painting a few pots or trays with copper salts mixed in house paint to pots pretreated with formulated coatings at uniform rates using precision spray equipment to provide better root systems. Years of research in the US, Canada, Europe, Asia, and Australia have demonstrated the benefits on plants grown in treated containers. All this research has demonstrated the benefits to growers and the benign environmental effects to government regulators. There are many ways to improve root growth of container-grown plants and no one way is the magic bullet. Using proven methods of root modification should be encouraged so nursery growers will provide a better product to the professional landscapers, arborists, foresters, and the gardening public.

Copper Hydroxide Ecological Information

Ecotoxicity

Bluegill fish: LC_{50} 180,000 ppb

Fathead minnow: LC_{50} 23 ppb

Rainbow trout: LC_{50} 23 ppb

Bobwhite quail: Acute oral LD_{50} >340 mg/kg

Bobwhite quail: 8 day dietary LD_{50} >10,000 mg/kg

Mallard duck: 8 day dietary LD_{50} >10,000 mg/kg

Honeybee: Non-toxic

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