THE USE OF SUPERABSORBENTS

IN THE FORESTRY INDUSTRY

A Speech By

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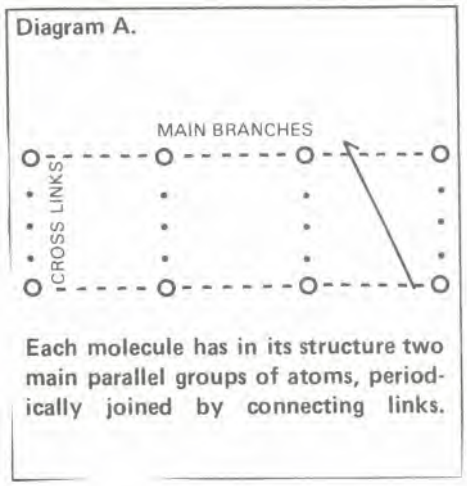
Timber production throughout the United States must increase to meet the demands projected for the 90's. This increased demand will place additional burdens on foresters and people in related industries. Meeting this demand, and remaining competetive will require employing technological advances to improve production efficiency.

Superabsorbents represent one such advance. An advance that can be readily applied to increase survival, improve seedling handling, conserve water and promote growth.

Superabsorbents are substances capable of absorbing hundreds, and even thousands of times, their own weight of fluids. Each superabsorbent particle acts like an amazingly effective sponge, one which is insoluble and does not change the nature of the moisture that it absorbs.

To gain an understanding of how these particles act to absorb moisture so efficiently, we can look at a simplified molecule of the material. Each particle or molecule can be considered as having two main "parallel" groups of atoms. These groups are periodically joined by connecting cross-links (as shown in diagram A).



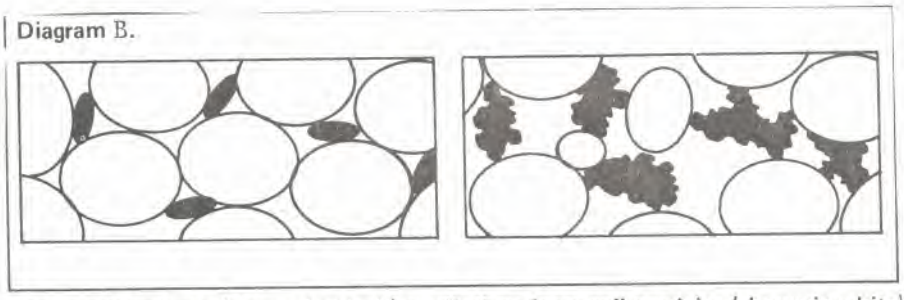
When water is added an electrical repulsion takes place causing the main branches of the molecule to repel each other, as the like poles of a magnet. When this happens, water is drawn between the branches resulting in a rapid swelling of each particle. At maximum capacity each particle will expand to over thirty times its original volume. When water evaporates or is extracted, the material shrinks, returning to the unswollen state.

The absorption capacity of superabsorbents is affected by acidity and alkalinity (pH), conductivity, and other variables that inhibit superabsorbent expansion. Superabsorbents having a very high absorption capacity (eg. over 800 times their weight in water) are typically sensitive to nutrients and other ionic substances, rapidly losing much of their water absorption capability. It is not uncommon for a superabsorbent having an absorption capacity of 800 times its weight in pure water to absorb two or three hundred times its weight in actual use, because of such variables. The pH of the absorbed fluid should not present a problem in most plant related

applications since the pH in the growing enviroment is normally within the ideal range (6-9) for optimum absorption.

Oxygen depletion or carbon dioxide buildup in the plant root zone is harmful or fatal to a plant. When superabsorbent particles are present in the growing media, they will, upon absorbing water, expand to many times their original volume. As the particles expand, they open the soil media by forcing the particles apart, increasing aeration and improving drainage. This combination, high moisture along with high aeration, promotes faster growth as illustrated in Diagram C and minimizes the danger of root rot.

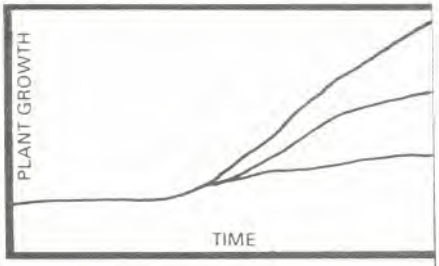
Diagram B.



As superabsorbents (shown in black) swell, they force soil particles (shown in white) apart, opening passsages for air and at the same time improving moisture availability.

Once these particles have reached their maximum absorption, excess water will flow freely over and around the particles as it would flow over a saturated sponge. "Plugging" of the soil is not, therefore, a problem.

Diagram C.



Top line: Treated with superabsorbents
Middle line: Growth with some stress
Bottom line: With continuous stress

Several other firms are producing superabsorbents, however, I am not able, with confidence, to cite specific application rates, results and other details concerning these products. I will, therefore, discuss one product, TERRA-SORB, that we have been working with since 1976 and which has proven effective in the laboratory and most importantly in the growing environment.

TERRA-SORB is relatively new to the forestry industry, but much of what has been learned in landscaping, the nursery and greenhouse markets is directly applicable to forestry.

Leading nurseries are adding TERRA-SORB to their growing media to improve moisture retention and promote aeration and drainage. Some of the benefits are a reduction in growing time (up to 25%), reduced irrigation frequency (up to 50%), increased shelf life and increased nutrient retention, due to reduced leaching of nutrients.

Mr. Fred Haupt, President of Sunshine Plants, Inc., Zellwood, Florida, wrote to us in July, 1980, explaining his experiences with the material. Because so much of what Mr. Haupt states is appropriate, I would like to share this document with you:

"I am writing to report on our experiences of the past 18 months with TERRA-SORB. We have examined the product closely in two applications related to our fern operation. In one application the material was utilized as a soil amendment in stock beds for the production of fern runners. In a second use, we tested TERRA-SORB in the production of 10" fern baskets. In the stock beds TERRA-SORB was incorporated into domestic peat at the rate of 2 pounds per cubic yard. We ran control beds adjacent to the two test beds and grew ferns under identical conditions of light and nutrient levels. After harvesting two crops in eight months we concluded that there was not a significant difference in the production of ferns in the two areas. This is not surprising since ground beds are very easy to keep moist.

We ran similar tests with 10 inch fern baskets. TERRA-SORB was used at the 2 pound rate and controls containing no TERRA-SORB were grown under identical conditions. The differences were dramatic. The TERRA-SORB treated baskets exhibited no transplant shock (transplant shock is very common with bare root ferns). Watering requirements were substantially reduced (I estimate approximately 50%). Of primary importance to us was the sharply reduced crop time. Normally we expect to finish a fern basket in about 20 weeks. We found that with TERRA-SORB in the potting medium we reduced the time to finish the crop to 15 weeks,asavings of 25%. We attribute this difference to the water-holding capacity of TERRA-SORB.

Further, we have considerable feedback from our customers concerning the performance of our product on their shelves. They tell us consistently that our ferns are easier to maintain and require less watering in the stores than our competitors' products...

In summary, our assessment of your product TERRA-SORB is very favorable. In some later tests we have determined that levels of TERRA-SORB as low as 1/2 pound per yard are effective, especially in smaller containers...."

As Mr. Haupt explained, there are conditions where the applications of superabsorbents is not warranted. When ideal moisture conditions are maintained in the growing medium superabsorbents are of little value. However, the cost of maintaining the ideal moisture conditions should be examined and compared to the potential savings that could result if superabsorbents were applied.

In addition to incorporating TERRA-SORB in the growing media, landscapers and nurserymen.. are improving survival and minimizing transplant shock by applying a gel slurry to the transplant roots. About one pound of material is combined with 20 - 30 gallons of water, to form a free-flowing gel that will adhere to the root structure. Because of the immediate availability of water, transplant shock is reduced and survival increases.

TERRA-SORB is effective for transplanting container grown nursery stock. About one tablespoon of material is evenly sprinkled into the hole and worked lightly into the soil prior to setting the transplant. When watered, the TERRA-SORB particles expand holding 50% or more water than the untreated media.

In 1980 the University of Kentucky, conducted a study to evaluate the effectiveness of TERRA-SORB and other transplant aids. Three replicates consisting of 10 sugar maple trees were evaluated. The test was conducted under the worst possible conditions. The plants were set very late (May 27); the nursery stock was in rather poor condition; the site was a slope with a fairly heavy cover; and the area received approximately 0.3 inches of rain from May 20 to July 1. Treating the transplants by dipping in a gel slurry consisting of one ounce of TERRA-SORB per gallon of water resulted in a 298% increase in survival.

CHAMPION INTERNATIONAL PAPER COMPANY has been using TERRA-SORB for the past year to gel coat seedlings prior to packing. Champion has modified its lifting machines by adding a water tank and pump. The seedlings are coated by pumping the TERRA-SORB gel from the tank directly onto the bare roots as they approach the packing boxes. Prior to using TERRA-SORB a hydromulch was employed which was inadequate and proved to be a production slowdown. In addition to providing moisture, this application of TERRA-SORB improved production because of the improved efficiency of the application method and the subsequent reduction in handling time.

Clay continues to be used as a bare root moisture retention media and is often used in place of the mulch that had been used by Champion. Even though clay holds substantial quantities of water, most of the water is not in a plant available form, as shown on figure D.

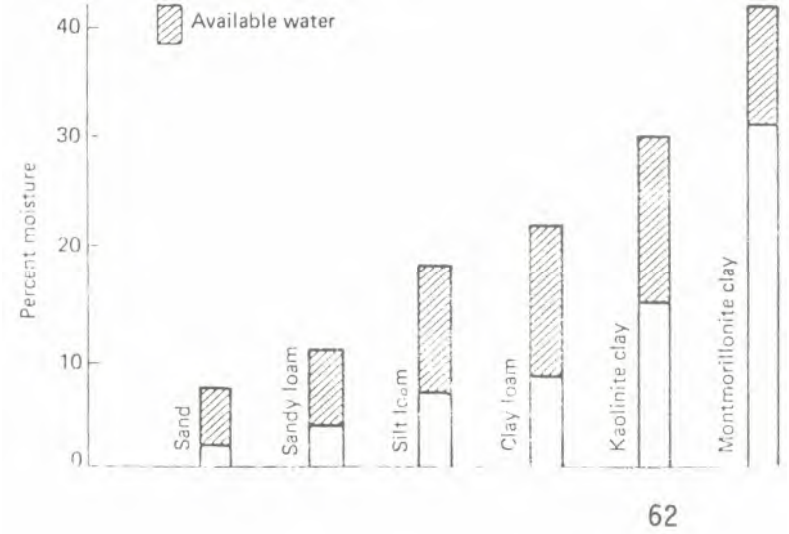


Figure D. Relationship among various soil textures and moisture-holding capacity. Each bar represents the water between oven dryness and field capacity.

Soil moisture is held in three basic forms:

GRAVITATIONAL WATER is water that freely moves through the soil due to the forces of gravity, this water is not usually used by the plant because it rapidly moves out of the soil.

CAPILLARY WATER is water that is held very losely around the soil particles. The water is held by cohesion (attraction) between water molecules. Most of this water is available to plants.

Capillary water can be considered as being in the form of a thick film around the soil particles. The water moves to the point of highest tension (lowest pressure). The root hairs create a low pressure and are capable of drawing moisture until the attraction between the soil and the water molecules is greater than the attractive forces of the roots (permanent wilting point).

HYGROSCOPIC WATER is water held by adhesion in the form of very thin films around the soil particles. It is not usually available to plants.

As soils become finer textured there is increased adhesion between the water and the soil particles. This adhesion binds the water so tightly that it is not plant available. This is the situation with clay.

When superabsorbents are mixed into the growing medium, the material absorbs gravitational and capillary water. This water is held by a mechanism similar to cohesion, providing water that can be readily extracted by the plant root, promoting ideal growing conditions. Recent studies at Auburn University indicate that TERRA-SORB can be effectively added to pine bark media to reduce water stress and increase nutrient retention.

Four rates of TERRA-SORB and a control were used on an all pine bark medium. Four-inch plastic containers were filled with unamended pine bark, or pine bark medium plus 1, 2, 3 or 4 pounds of TERRA-SORB per cubic yard. Pots were fertilized from one to five times using a 200 ppm N, P, K soluble fertilizer from a 20-20-20 source.

The weight of 4-inch containers at field capacity increased the first day of watering by 41, 85, 117 and 131 percent (figures correspond to amount of TERRA-SORB added to the media). A subsequent test showed an increase of 19, 50, 66 and 70 percent. The difference in percentage is attributed to the bark not being at moisture equilibrium during the first test.

The use of TERRA-SORB to enhance the water holding capacity also increased the nutrient holding capacity of the pine bark medium. Soil nitrogen increased 3%, 6%, and 9% as the weight of TERRA-SORB increased from one to three pounds per cubic yard. Generally the nitrogen content increased by 1% with subsequent waterings. Nitrogen concentration increased with increasing amounts of TERRA-SORB, up to three pounds per cubic yard.

TERRA-SORB was evaluated by the University of Georgia for its effectiveness in increasing water holding capacity and for reducing required watering of a soilless growing medium (Metro-Mix 300). In addition, germination percents and rates of Phaseolus volgaris, "Topcrop", bushbean were compared. Water holding capacity increased and required watering decreased with increasing rates of TERRA-SORB in 4-inch containers. There were similar changes in 6-inch containers.

Phaseolus volgaris was chosen as the test plant because it has a large transpiration surface area, and would, therefore, be expected to respond rapidly to changes in soil water content.

The weight of 4-inch containers at field capacity increased by 9, 18, and 36 percent as the amount of TERRA-SORB was increased from 1.2, to 2.2, to 3.3 pounds per cubic yard. Increases of 16, 22, and 38 percent were recorded for the test with 6-inch pots.

The weight at the wilting point was reduced by 8 and 16 percent for the 4-inch pots and 4 and 9 percent for the 6-inch pots at the 2.2 and 3.3 pound per cubic yard rates.

Germination in the 4-inch containers increased from 48 percent (control) to 83 percent (1.3 and 2.2 pound per cubic yard rate) to 90 percent at the 3.3 pound per yard rate.

Germination in the 6-inch pots was not significantly affected by the TERRA-SORB since the germination rate, in the control group, was very high.

Superabsorbents may also be an ideal innoculant carrier for mycorrhizial fungi in addition to use as a seed bed amendment, gel dip and other uses described previously. Superabsorbents are being evaluated as seed coatings to improve germination and promote growth, as a water thickening agent to aid in fighting forest fires, and as a mulch additive to improve moisture retention in seed beds.

Other applications will be recognized as the value of this technology spreads throughout the industry.

Costs are reasonable, especially when viewed in relation to the benefits. Typical cost for applying TERRA-SORB are about $8.50 to treat a yard of media, which equates to about 2 cents to treat a 6-inch standard pot; 5 cents to treat a 72-cell bedding flat, and one cent to gel dip 50 seedlings.

The application of superabsorbent technology will increase survival, reduce transplant shock, reduce watering frequency, promote faster growth, reduce shipping weight, increase germination and in other ways benefit the forester and the entire growing industry. Consider the many, cost effective ways that you can benefit from this important technology.