SUPERABSORBENTS, A NEW "TOOL" FOR MINE RECLAMATION

An Introduction to a Valuable Technology

James F. Pritchard

Vice President
Industrial Services International, Inc.
4301 32nd St. West
Bradenton, Florida 33505

Proceedings America Society of Mining and Reclamation, 1984 pp 345-368
DOI http://doi.org/10.21000/JASMR84010345

ABSTRACT

Superabsorbents are materials which aid in reclaiming land by promoting the rapid establishment and growth of plants. These amazing substances absorb and store water from which the plant roots can draw water over extended periods, minimizing the likelihood of moisture stress.

In addition, the use of superabsorbents; increases germination and plant survival, conserves water, reduces labor costs and provides other benefits because of their ability to store plant-available water.

These materials have proven highly effective in such reclamation related activities as:

- o Seeding
- o Hydromulching
- o Sodding
- o Transplanting trees and shrubs.

Because of the fundamental way that superabsorbents work and the many benefits they provide, these amazing materials will have an ever increasing role in activities associated with land reclamation.

SUPERABSORBENTS, A NEW "TOOL" FOR LAND RECLAMATION

The rapid establishment of vegetation is a key factor in restoring land. Superabsorbents are materials which will significantly enhance the rapid and vigorous establishment of such vegetation. These materials do this by providing plants with a readily available source of moisture...over an extended period. In addition to promoting rapid plant establishment, superabsorbents can increase survival, improve germination, reduce transplant shock, and permit more efficient use of precious water resources.

This paper will introduce superabsorbent technology and highlight what we at Industrial Services International have learned about these products in field applications. Reference will be made to TERRA-SORB since it is a product we have worked with for years and which has proven highly effective in the laboratory and the field.

Superabsorbents have proven to be of major benefit to:

- o Soil conservationists.
- o Land reclamation contractors.
- o Foresters.
- o Landscape architects.
- o Landscapers.
- o Farmers.
- o Horticulturists.
- o Groundskeepers.
- o Land developers.
- o Interiorscapers.
- o Others associated with the "growing" industries.

WHAT IS A SUPERABSORBENT?

As described in World Crops Magazine (1), a superabsorbent is a material capable of absorbing hundreds or even thousands of times its weight in liquid, usually water. Superabsorbents are sometimes referred to as hydrogels since, upon absorbing water they form a gel-like material.

Water is fundamental to all plants. Certain superabsorbents absorb and store water in a plant available form, providing the plant with a "drink", whenever needed. These materials are water management tools. In addition to their amazing moisture retention capabilities, some superabsorbents act to promote aeration and provide additional benefits because of their ability to retain water and nutrients. For example, studies have also shown that superabsorbents can be used to increase the effectiveness of spray applied chemicals such as herbicides and insecticides. Chemical application rates may be reduced by a factor of two or more by adding a superabsorbent to the solution.

Each superabsorbent particle acts like an amazingly effective sponge. When water comes into contact with a superabsorbent particle, it swells, absorbing the moisture. Depending on the superabsorbent's moisture holding gel characteristics, the water may be held in a form that is almost totally plant available. Certain superabsorbents, however, contain chemicals which are injurious to plants or they may hold water with such tenacity that the water is not plant available.

Therefore, only those superabsorbents which have proven effective in use with plants should be used.

HOW SUPERABSORBENTS WORK:

To gain an understanding of how these particles act to absorb moisture so efficiently, consider a simplified molecule or particle 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 like the rungs of a ladder (Figure A).

When water comes into contact with a superabsorbent an electrical repulsion takes place causing the main branches of the molecule to repel each other as 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 typically expand to over thirty times its original volume. When water evaporates or is extracted, the material shrinks, returning to the unswollen state. When water is again added, the material will re-swell absorbing the water as described previously.

FACTORS AFFECTING ABSORBENCY:

The absorption capacity of superabsorbents is affected by acidity and alkalinity (pH), conductivity, and other variables that inhibit expansion. Superabsorbents having a very high absorption capacity (eg. over 800 times their dry weight in water) are typically sensitive to fertilizers 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.

Terra-Sorb has a greater affinity for cations (positively charged particles) such as potassium and calcium than it does for the dipolar water molecule. Consequently, cations can reduce absorbency. Anions (negatively charged particles) do not seem to affect absorbency. Because of the effect cations can have on absorbency it may be necessary to use higher superabsorbent concentrations when fertilizers or other additives which may produce cations are employed. Simple absorbency tests can be performed locally to determine the proper application rate by comparing the absorbency under local conditions to baseline absorption data.

The pH of the absorbed fluid should not present a problem in most plant related applications since the pH of the growing environment is normally within the ideal range (6-9) for optimum absorption. Even though the pH of many reclamed lands may be below 6 this should not present a serious concern.

EFFECTIVE LIFE:

Generally superabsorbents remain effective through many shrink-swell cycles. Our experience and research by others have demonstrated that the life of starch-based superabsorbents in the growing environment is typically six months to a year, although reports of effectiveness

after several years have been noted. The effective life depends primarily on the microorganisms present in the soil which eventually cause complete biodegradation. Starch, one of the major components of several superabsorbents is a food source for these organisms. Even after biodegrading, the material that remains functions as soil amendment to improve aeration and other soil characteristics. In fact, biodegradation converts some superabsorbents to virtually the same material as a soil amendment produced by Monsanto in the 50's called Krilium.

Certain other superabsorbents comprised of synthetic materials such as Terra-Sorb AG do not contain starch and therefore offer an extended life. These synthetic superabsorbents would be most beneficial for use in arid regions where enhanced moisture holding capacity in the soil is necessary over an extended period. It should be noted, however, that starch base superabsorbents have an effective life that is more than adequate for most applications since, by the time the superabsorbent has biodegraded the plant would have adapted to its new environment.

BENEFITS FROM USE OF SUPERABSORBENTS

PROVIDES PLANTS WITH A MORE RELIABLE WATER SUPPLY:

Most plants are watered on a schedule or when signs of wilting appear. Such methods do not ensure that the plant has adequate water for optimum growth. In fact, by the time a plant shows that it needs water, it has long since stopped growing. Using a superabsorbent

allows the plant to obtain water as needed for optimum, uniform growth (Figure B). There is no slow down due to water stress.

Even when a superabsorbent is used water will still have to be applied to the soil. However, over the long term, the severity and frequency of moisture induced stress will be significantly reduced through the proper use of superabsorbents.

IMPROVES AERATION AND DRAINAGE, DOES NOT PROMOTE ROOT ROT:

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 (Figure C). This expansion loosens the growing media by forcing soil particles apart, increasing aeration and improving drainage in the treated zone. Once these particles reach their maximum absorption, excess water flows freely over and around the superabsorbent particles as it would flow over a saturated sponge. "Plugging" of the soil in the treated area is therefore lessened by the use of superabsorbents. The combination of ideal water availability combined with good aeration promotes faster growth and minimizes the danger of root rot.

MAKES MORE EFFICIENT USE OF WATER:

A major advantage of superabsorbents is their ability to make use of gravitational water. Soil moisture is held in three basic forms:

1. Gravitational Water moves through the soil due to the forces of

gravity. This water cannot usually be used by the plant since it moves into and through the soil so rapidly.

2. Capillary Water is held very loosely around the soil particles. It is held by cohesion (attraction between like molecules). Most of this water is plant available. Capillary water is like 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 exceeds the attractive forces of the roots (permanent wilting point).

3. Hygroscopic Water is water held in the form of a very thin film around soil particles. It is not usually available to plants.

When superabsorbents are mixed into the growing medium, they absorb gravitational and capillary water. The plant can use this water as necessary.

Studies by the California Polytechnic State University (2) have shown an almost perfect positive association between the amount of plant available water held in soil amended with Terra-Sorb and the amount of Terra-Sorb applied (Figure D). Because of this relationship it is a simple matter to determine the amount of superabsorbent to be applied to achieve a specific increase in soil moisture retention.

IMPROVES NUTRIENT AVAILABILITY:

Studies by Dr. Frederick B. Perry of Auburn University (3) have demonstrated that the use of Terra-Sorb results in a reduction in water stress and an increase in nutrient retention of a pine bark growing medium. Because superabsorbents make more effective use of water there is less leaching, and consequently an increase in the effectiveness of soluble nutrients. It also appears that the use of superabsorbents may enhance ion exchange capability, contributing to increased fertilizer effectiveness.

MAY INCREASE EFFECTIVENESS OF HERBICIDES, PESTICIDES AND OTHER CHEMICALS.

Terra-Sorb may increase the effectiveness of spray applied chemicals according to Dr. Roy Larson of North Carolina State University. If a small amount of Terra-Sorb is mixed with a growth regulator, herbicide, pesticide or other chemical it will thicken the liquid, improving the ability of the chemical to adhere to the foliage. Most gels can be applied with a pressure sprayer.

Field tests by Philip G. Gibson, a graduate of Oklahoma State University (4) demonstrated that the application rate of Round-Up herbicide can be reduced by a factor of two if a small amount of Terra-Sorb is added to the Roundup solution. A complete kill resulted from both the normal application rate (1 1/2%) and an application of one half of the normal rate (0.75%). Three tablespoons of Terra-Sorb were added to 11/2 gallons (5.7 liters) of the 0.75% solution.

Although this was a preliminary, study, the fundamental way that superabsorbents act to thicken spray applied chemicals, to increase their effectiveness, certainly justifies further consideration for the use of superabsorbents in such applications. Additional research is of course needed.

ACT AS ANTITRANSPIRANTS OR ANTIDESICCANTS:

Dipping plants in a Terra-Sorb gel reduces stress during transplanting and minimizes root desiccation and subsequent loss of roots according to Dr. Hugh Pool (5). In addition, gels applied to the leaves generally act as antitranspirants or antidesiccants. Surinam cherry trees which were treated with Terra-Sorb prior to the Florida Christmas freeze in 1983 suffered much less damage than the untreated trees.

HOW TO USE SUPERABSORBENTS

There are several basic ways to use superabsorbents, these include:

1. Adding to growing media in the dry form.
2. Broadcasting in the dry form prior to seeding.
3. Applying as a gel dip when combined with water.
4. Using as a seed coating.
5. Using as a gel slurry for applications such as hydroseeding.

TRANSPLANTING:

For transplanting larger plants the superabsorbent is sprinkled evenly into the hole prior to setting the plant or mixed into the backfill. Application rate will depend on factors such as soil condition and anticipated amount of moisture stress. Once the superabsorbent has been added the hole is filled and watered as usual.

Smaller plants may be transplanted and shipped using a gel slurry around the roots. The gel is made by combining a small amount of superabsorbent with water. For example, 5 grams per liter (one pound per 25 gallons). Superabsorbents can be applied by dipping the roots in the gel. The material can also be applied by spraying the mixture onto the roots. The mixture should resemble applesauce, it should cling to the roots without totally covering them.

In 1980 David Hensley (6) of the University of Kentucky conducted a study with sugar maple on surface mined land. Three replicates consisting of ten sugar maple trees were evaluated.

The percent survival were as follows: control 6.7%; Terra-Sorb root dip (7.5 grams per liter or 1 ounce per gallon) 20%. These figures represent an average of the three replications.

According to Dr. Hensley, "the results of the test were not 'earth shattering' but the test was conducted during the worst possible conditions. The plants were set very late (May 27th); the nursery

stock was in rather poor condition; and the site was a slope with a fairly heavy cover. The area received approximately 7.62 mm (0.3 inches) of rain from May 20 to July 1."

AMENDING MEDIA, REPLACES PEAT MOSS:

Backfill for plants can be amended with a superabsorbent by simply mixing in the prescribed amount. Mixing is easier with dry media. It is possible to replace peat moss with a less expensive media such as pine bark according to Dr. Carl Whitcomb (7), junipers grown in a bark, sand, Terra-Sorb mix grew at least as well as plants grown in a peat sand mix.

HYDRO-MULCHING:

According to Grounds Maintenance Magazine (8) Terra-Sorb is well suited to many activities associated with protecting disturbed land. In hydro-mulching and hydro-seeding applications Terra-Sorb is mixed with the mulch, water, seed and other additives to promote and speed germination. In addition, the use of superabsorbents can improve fluid flow since the mixture acts as a lubricant.

When used at rates above 80 kilograms per hectare (70 pounds per acre) per acre a superabsorbent may act as a tacker and binder, helping to hold soil particles in place by forming a thin crust over the soil surface. The superabsorbent is simply added to the hydromulch tank at a specified rate for the area to be covered.

Experience has shown that the use of superabsorbents may not be

desirable when using stolons in lieu of seed. Superabsorbents have shown a reverse effect, withdrawing moisture from the stolons since they are basically cuttings.

BROADCASTING:

Superabsorbents can be broadcast over an area to be seeded to enhance moisture retention, promote emergence and increase germination by providing the seed with a "moisture reservoir".

In a study conducted by the Florida Department of Transportation (9) the use of Terra-Sorb resulted in a very substantial increase in germination. Dry Terra-Sorb was broadcast over the ground prior to seeding at a rate of about 0.014 kilograms per square meter (one pound per 350 square feet). The area was then seeded (60% bahia, 40% rye) and mulched with straw. Where the superabsorbent was used germination was 75%, the untreated area had a germination of 15%.

SODDING:

Superabsorbents are broadcast over soil prior to sodding to improve moisture retention, minimize shock and promote rapid establishment. The superabsorbent, when watered, forms a moisture reservoir under the sod resulting in minimized transplant shock and improved establishment.

Having the water readily available is especially important for sod. When it is cut, most of the root structure has been removed. Before cutting, sod typically has a root length of over eighteen inches.

Obviously, the roots that remain with the cut sod cannot provide the same ability to draw water and nutrients to the plant as the fully developed root system. Superabsorbents go a long way toward compensating for the loss.

Studies by Virginia Polytechnic Institute (10) demonstrated that the use of Terra-Sorb increased the percentage of green cover and resulted in a 56% increase in the root strength of sod.

FORESTRY:

In forestry, or other tree planting activities, a superabsorbent is an ideal medium for maintaining bare root moisture. Leading timber companies are using superabsorbents to gel treat seedlings prior to packing and planting. More than 750 million forestry seedlings will be treated with TERRA-SORB this year.

Leading timber companies have modified their tree lifting machines by adding a water tank and pump. The seedlings are coated by pumping the superabsorbent gel from the tank directly onto the bare roots as they approach the packing boxes.

The use of Terra-Sorb results in significant reductions in moisture stress according to studies conducted by the U.S.D.A. Forest Service (11). Moisture stress of trees dipped in a Terra-Sorb gel and kept in cold storage was much less than trees dipped in water (Table 1). Using Terra-Sorb as a gel dip prior to planting results in a substantial increase in survival in areas subject to moisture stress.

Obviously, the roots that remain with the cut sod cannot provide the same ability to draw water and nutrients to the plant as the fully developed root system. Superabsorbents go a long way toward compensating for the loss.

Studies by Virginia Polytechnic Institute (10) demonstrated that the use of Terra-Sorb increased the percentage of green cover and resulted in a 56% increase in the root strength of sod.

FORESTRY:

In forestry, or other tree planting activities, a superabsorbent is an ideal medium for maintaining bare root moisture. Leading timber companies are using superabsorbents to gel treat seedlings prior to packing and planting. More than 750 million forestry seedlings will be treated with TERRA-SORB this year.

Leading timber companies have modified their tree lifting machines by adding a water tank and pump. The seedlings are coated by pumping the superabsorbent gel from the tank directly onto the bare roots as they approach the packing boxes.

The use of Terra-Sorb results in significant reductions in moisture stress according to studies conducted by the U.S.D.A. Forest Service (11). Moisture stress of trees dipped in a Terra-Sorb gel and kept in cold storage was much less than trees dipped in water (Table 1). Using Terra-Sorb as a gel dip prior to planting results in a substantial increase in survival in areas subject to moisture stress.

TABLE 1

Effect of Terra-Sorb on Moisture Stress

	Water Dipped packed in moist sphagnum, rolled in nursery paper, 6 wks., in Frig. at 38-42°F.	Terra-Sorb Dipped packed in moist sphagnum, rolled in nursery paper, 6 wks., in Frig. at 38-42°F.	Fresh sample from 20 yr. old Shortleaf near Lab.
Moisture stress of main stems & branches in Bars.	16-22+	5.5-6.5	8.5*

*Mid-day sample expected to be higher than pre-dawn.

A study in 1983 by James Kroll of the Stephen A. Austin State University (12), School of Forestry showed an 81% survival for trees (Loblolly) dipped in a Terra-Sorb gel prior to transplanting. Trees dipped in clay or water had a survival of 49% and 51% respectively (Table 2). The test was conducted over an area of 7000 acres near Nacogdoches, Texas.

Table 2

Survival Rates of Pine Seedlings on Camp Tonkawa

Species and Root Treatment	Percentage Survival by Survey Month (+S.E.)*		
	April	June	October
Loblolly - untreated	83.1 ± 2.3^{d}	78.1 ± 2.9^{b}	50.5 ± 3.1^{b}
Loblolly - Terra-Sorb	$95.6 \pm 1.1^{a,b}$	95.6 ± 1.1^{a}	81.3 ± 2.2^{a}
Loblolly - clay	$88.0 \pm 2.8^{c,d}$	79.7 ± 3.0^{b}	$49.2 \pm 4.3^{b,c}$
Slash - untreated	$90.1 \pm 1.8^{b,c}$	69.3 ± 2.7^{c}	$41.1 \pm 2.5^{c,d}$
Slash - Terra-Sorb	$94.3 \pm 1.3^{a,b}$	$72.7 \pm 2.7^{b,c}$	$46.9 \pm 3.3^{b,c}$
Slash - clay	$85.9 \pm 2.7^{c,d}$	62.0 ± 3.0^{d}	35.4 ± 2.8^{d}
Longleaf - container	97.9 ± 0.6^{a}	96.9 ± 0.9^{a}	85.2 ± 2.0^{a}

*Common letters denote homogeneous subsets.

Studies by the Royal Veterinary and Agriculture University, Department of Forestry, Denmark (13) revealed that the use of Terra-Sorb as a gel dip greatly increased the survival of noble fir seedlings. Mortality of the untreated trees was 25%. Mortality of the treated trees was only 0-2%.

BARE ROOT SHIPPING:

For long distance bare root shipping the application of a superabsorbent gel to the roots of seedlings and larger plants not only provides moisture, its use also reduces shipping weight and cost since peat, clay, mulch or other moisture retaining materials is no longer required.

APPLICATION RATES:

The superabsorbent application rate which will provide the best result depends on specific site conditions. Such factors as: degree of slope, type of soil, anticipated degree of moisture stress, availability of irrigation water, type fertilizers used and other factors should be considered when specifying the amount of material to be used in a project.

For gel dipping approximately five grams is used per liter (one pound per 25-30 gallons) of water. For seeding, sodding or hydromulching approximately 10-14 grams are used per square meter (one pound per

350-500 square feet). As a media amendment, 1.2 kilograms are used per cubic meter (2 pounds per cubic yard). A tree with a 0.3 meter (1 foot) diameter root ball can be treated with 28 grams (1 ounce) of material.

COST:

Adding any additional material beyond those substances currently used such as fertilizers, pesticides and herbicides adds to the total project cost. The cost, of using superabsorbents, however, should be viewed in the relation to the benefits which they provide.

The cost of using superabsorbents is very reasonable, especially considering advantages they can provide.

Because superabsorbents are so effective only a small amount is required to treat a plant. Used as a gel dip, up to 22,000 seedlings can be treated with one kilogram of superabsorbent. This equates to a cost of less than 0.04 cents ($0.0004) per tree. A tree with root ball diameter of 0.3 meters (1 foot) can be planted in soil amended with a superabsorbent at a cost of approximately 40 cents. Used in hydromulching, sodding or seeding, the cost is usually less than 10 cents per square meter (9 cents per square yard).

A very important factor to be considered in reaching a decision about whether or not to use superabsorbents is the total cost, including transportation and labor, of replacing plant material which would have survived if a superabsorbent had been applied.

OTHER APPLICATIONS

Superabsorbents, because of their absorption characteristics hold promise to help minimize the adverse environmental impact of many substances generated in mining activities. Such applications include:

1. Adding a superabsorbent to water base, hazardous liquids, converting the liquid to a semi-solid gel to minimize leaching into ground water, minimize runoff and to minimize soil infiltration.

2. Gelling hazardous liquids prior to transporting them, reducing the danger of spills.

3. Immobilizing hazardous liquids, to enhance the effeciency of microbial decompostion. Using a gel could significantly increase the contact time between the microorganisms and the hazardous substance.

4. Superabsorbents will help to minimize dust. Applying a thin gel over surfaces will provide greater moisture retention and could significantly reduce the number of water applications necessary to minimize dust.

SUMMARY

Superabsorbents are new products, representing an important advancement in reclamation technology. Much of what has been learned about these materials in related applications such as landscaping, forestry and horticulture is directly transferrable to reclamation activities. These products will be of tremendous benefit in mine reclamation, land stabilization, reforestation and related uses throughout the world.

There is an urgent need for additional research to help identify the true potential applications for superabsorbents in mine reclamation and other industries. While the true potential remains to be discovered, these are substances which have proven effective in many ways. Consideration should be given to using these new water management 'tools' in future reclamation endeavors.

For Additional Information Please Contact

INDUSTRIAL SERVICES INTERNATIONAL, INC.

4301 32nd St. West A-11

Bradenton, Florida 33507

813/792-7778 Telex 808779 (TERRASORB)

REFERENCES

1. Barcroft, Alasdair, 'Superabsorbents improve plant survival'. World Crops, January/February, 1984. 6-9.

2. Gaardner, Jeffrey D. 1983. 'The effect of Terra-Sorb on water retention and hydrophobicity in the Pismo loamy sand'. Thesis. California Polytechnic State University, Soil Sciences Dept., San Louis Obispo.

3. Perry, Fred B. 1981. 'Effects of Terra-Sorb on water retention, pH, and nitrogen retention of an all pine bark medium'. Report, Experimental Station, Auburn University, Alabama.

4. Gibson, Philip. 1983. Study evaluating effect of using Terra-Sorb in combination with Round-Up herbicide. Correspondence.

5. Poole, Hugh A., PhD. 1984. Report concerning evaluation of plant material treated with Terra-Sorb. A & L Agricultural Lab, Ft. Lauderdale, Florida.

6. Hensley, David L., PhD. 1980. Report. Effects from the use of Terra-Sorb on tree survival. University of Kentucky, College of Agriculture.

7. Whitcomb, Carl PhD. and Gibson, Philip. 1981. Substituting starch based absorbents for peat. Proc. Southern Nurserymen's Association Research Conf. 27:23-25.

8. Buckingham, Frank. 'Products for protecting disturbed land', Grounds Maintenance, January, 1982. 87.

9. Higgins, Carl. 1984. Correspondence concerning Terra-Sorb in grassing. Florida Department of Transportation.

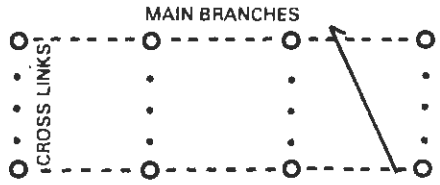
10. Anon. 1981. Effects of Terra-Sorb on the growth of sod. Virginia Polytechnic Institute, Extension Division. Proceedings of the Virginia Tech Turfgrass Field Days.

11. Melick, Ross A. 1983. Evaluation of Terra-Sorb as a packing medium. Correspondence, U.S. Department of Agriculture, Forest Service.

12. Kroll, James. 1984. Evaluation of Terra-Sorb as a gel-dip for forestry seedlings. Correspondence. Stephen A. Austin State University, School of Forestry. In press as part of annual report.

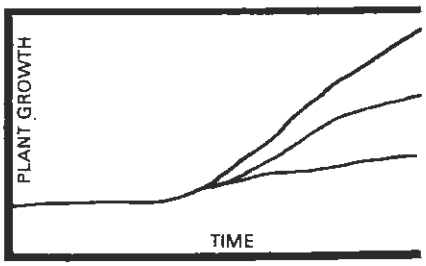
13. Dr. Hendriksen, H.A. & Sanojca, K. 1983. 'Et forsog med rod-coating' (Danish). Translated by Agri Contact, Hundested, Denmark.

Figure A



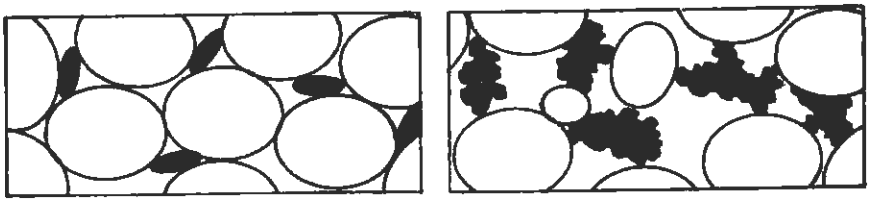
Each superabsorbent molecule can be considered as having in its structure two main groups of atoms, periodically joined by connecting links. When water is added an electrical repulsion develops between the main branches causing the superabsorbent particles to swell.

Figure B



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

Figure C



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

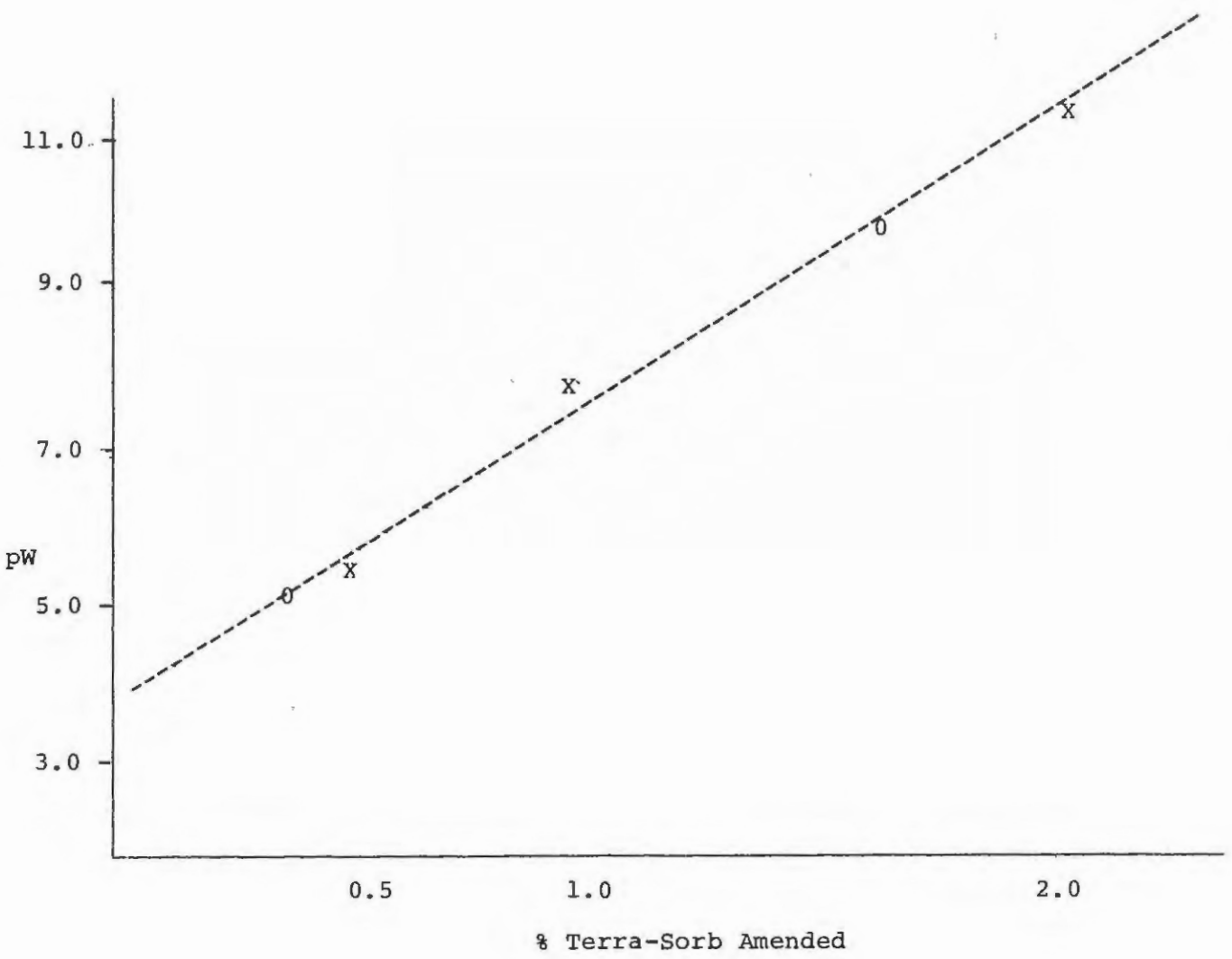


Figure D

The relationship of applied Terra-Sorb on plant available water.

Figure E

Superabsorbents are used in hydromulching to improve moisture availability, promoting emergence and growth.