Superabsorbent Hydrogels and Their Benefits in Forestry Applications[1]

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Abstract.--Superabsorbent hydrogels applications for forestry use have been developed over the last few years and are now being used as soil additives in growing containerized seedlings and as "ROOT-DIP" prior to packaging and storage.

INTRODUCTION

AGLUKON AGRI-PRODUCTS is part of the worldwide group of Schering Agrochemical Companies.

In Europe, it is estimated that 60% of pine trees are affected by acid rain. Schering (AGLUKON S.D.) is the founding researcher company that in 1984 started and successfully developed products to prevent damage of acid rain in young and established pines.

In the U.S., Schering (AGLUKON) has been marketing agricultural superabsorbents since 1979. In 1982, we built the first U.S. synthetic hydrogel facility for agricultural applications. AGLUKON is the manufacturer of ROOT-DIP superabsorbents.

In 1987, AGLUKON will introduce, for trials, a specialty foliar potassium compound for hardening of seedlings. This could allow nurserymen to lift seedlings even if weather remains warm.

1. WHAT ARE SUPERABSORBENTS?

Crosslinked polymers that absorb and retain fluids hundreds of times their own weight, are call superabsorbents.

The ability to absorb and retain water and other fluids, has encouraged many a company to seek a variety of applications:

Health Care--Diapers, sanitary napkins

Industrial Use--Municipal water treatment, wipers, oil mudding

Agriculture--?

2. ADVENT OF SUPERABSORBENTS IN AGRICULTURE

It is difficult to believe that we are in the third decade of some form of superabsorbent usage. (See Table 1.)

3. TYPES OF SUPERABSORBENTS

The 1960's

In the early sixties, the Agricultural Research Group of Union Carbide already had developed a hydrogel that absorbed up to 40 times its own weight in water... this was a polyethylene polymer combined with sawdust... a soft gel designed to be mixed with soil, to improve water capacity and aeration of soil mixes. This was the first gel developed specifically for horticultural practices.

The USDA in Illinois then discovered that crosslinked acrylonitrile with corn starch could also absorb over 100 times its own weight in water. The USDA licensed several companies to produce such a superabsorbent gel. Most of these designed uses for health care, and some agricultural segments.

Several companies also produced cellulose gels, and research for synthetic hydrogels had begun.

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TABLE 1.--TYPES OF SUPERABSORBENTS

Chemical Name or Ingredient	Market Application	Period
Polyethylene Oxide/sawdust	soil amendment	1965-1978
Polyvinyl Alcohol	diapers	1975-present
Acrylonitrile/starch	tampons, napkins	1979-present
	soil amendment	1966-1983
	planting seedlings	1978-present
Potassium Propenoate/Propenamide copolymer	soil amendment	1978-present
	gel seeding	
(Potassium Polyacrylamide/Poly Acrylate Copolymer)	plug-mix planting	1982-present
	root-dip	
Acrylic Acid (polyacrylates)	diapers	1981-present
	sanitary napkins	1982-present
	water treatment	1983-present
	soil amendment	1984-present
Acrylamide (polyacrylamide)	diapers	1983-present
	sanitary napkins	1984-present
	soil amendment	1983-present
Acrylic Acid/Acrylamide (combinations)	diapers	1985-present
	soil amendment	1985-present

the 1970's

The early products that combined a synthetic polymer with natural polymers penetrated on a small scale, several areas of horticulture and many trials were conducted in agricultural applications, including planting of bare-root seedlings.

In the late seventies, however, researchers in the U.S., Japan and England announced the discovery of different types of synthetic superabsorbents, which sought to eliminate the problems associated with natural polymers.

Most of these newly discovered superabsorbents found a home in the diaper industry, and only one in the U.S. built a facility and began application and product development solely for agricultural uses.

the 1980's

Several of the manufacturers of superabsorbents for diapers and municipal water treatments are now seeking to expand their market into all segments of agriculture.

Many of these products are not fit for our industry. Therefore, it is our responsibility to know why.

It is also our responsibility to recognize which of the superabsorbents are good for agricultural applications.

Proven technology has now been developed and is in place for specific segments of agriculture, horticulture, forestry. This technology application is based on the choice of a correct product for a specific application.

4. APPLICATIONS PRACTICED IN HORTICULTURE AND AGRICULTURE

Propenoate propenamide copolymers are successfully used as follows:

Soil Additive

-to increase water holding capacity
-to improve aeration and drainage of soil mix
-reduce irrigation frequency
-increase shelf life
-maintain moisture equilibrium

The superabsorbent must be able to release water when the moisture equilibrium of the soil changes, or as the roots need it.

Major uses are in container growing and tree and shrub planting.

Growing Of Transplant Plugs In The Greenhouse

The advantage is that the "chunks" of gel are carried from the greenhouse to the field in each plug, thus...

-not only has the grower received the benefit while growing the plug, but
-he can also eliminate transplant shock during transplanting operations

Fluid Drilling Or Gel Seeding Of Pregerminated Seeds

In this case, the superabsorbent gel must make a perfect suspension, soft, but consistent, to protect the delicate 2 mm seedlings while they are extruded to the soil.

Root Dipping Applications

It is now well proven that a major factor in field survival of bare-root seedlings is the proper treatment and handling of seedling roots prior to planting them. Root dipping with the correct gel will fulfill that need.

5. USE OF THE CORRECT SUPERABSORBENT IN FORESTRY APPLICATIONS

Soil additive for growing containerized seedlings.

Root dip spray for bare root seedlings, after lifting, prior to storage.

6. SOIL ADDITIVE FOR GROWING CONTAINERIZED SEEDLINGS

System

The small granules of superabsorbents are thoroughly blended into the peat mix prior to filling the plugs.

"Viterra" absorbs free water that is normally lost to leaching. As the "Viterra" granules expand, the soil volume increases and aeration and drainage improves. Each granule acts as a tiny water reservoir, replenishing moisture as the soil dries out, or absorbing excess moisture. Essentially, "Viterra" acts as a buffer in your soil, stabilizing the moisture levels for optimum root development.

Benefits

The small amount of superabsorbent will create optimum growing medium with consistent moisture equilibrium, resulting in a homogeneous size seedling which can reduce grading activity with less frequent irrigations.

An additional benefit is that the containerized seedlings already have hydrated gel "chunks" to protect against transplant shock, and give the forester a better stand.

Rates

Mix 1.5 lbs. of superabsorbent for each cubic yard of mix OR 1 oz. per cubic foot of mix.

7. ROOT DIP SUPERABSORBENT FOR BARE ROOT SEEDLINGS

A nursery can now choose the easiest, least messy, labor prompt and most effective method from the following:

a. root packing with peat moss
b. dipping in a clay slurry
c. spraying with ROOT-DIP superabsorbent

If we are concerned with field survival of bare-root seedlings, we must give their roots the best care and treatment available. ROOT-DIP will keep the roots in a moist condition, and will prevent root "dry-out" during storage and shipping.

How to use ROOT-DIP

Easy to use. There is no need for special equipment to produce a ROOT-DIP slurry suspension. Just add the correct rate of ROOT-DIP to water. Wait a few minutes to hydrate, and your ROOT-DIP treatment is ready!

Spray the bare-root seedlings with ROOT-DIP slurry.

The tiny water-laden gel particles will cling to the seedling roots, and will replenish moisture to the roots during storage and shippings.

Rates

One pound of ROOT-DIP for 33 gallons of water is sufficient to treat up to 15,000 bare-root seedlings, at an average cost of $.367/1,000 seedlings, or less.

8. BUT...

Let's remember that not all superabsorbents are the same. (See Table 2.)

In fact, ROOT-DIP superabsorbent is good for treatment of bare-root seedlings, but not good for treatment of baby diapers.

9. WHAT TO LOOK FOR IN A ROOT-DIP GEL

-Non-toxic by FHSA standards
-Non phytotoxic, must be inert
-Neutral Ph

Table 2.-- Comparison of "VITERRA"ROOT-DIP versus other super-absorbents.

SYNTHETIC SUPERABSORBENT MEASUREMENT TEST

National Tree Seed Laboratory
September 9, 1986

SCREENING FOR PARTICLE SIZE	ROOT-DIP	COMPETITOR
Sample	50 gr.	50 gr.
Over #20 screen	.19 gr. .3$	8.27 gr. 16.5$
Through #20 screen and over #40 screen	49 gr. 98%	35.75 gr. 71.5$
Through #40 screen (Dust)	.79 gr. 1.6%	5.89 gr. 11.8%
Lost in screening	.02 gr.	.09 gr.
ABSORPTION		
Superabsorbent Sample	.25 gr.	.25 gr.
Water sample	300 ml.	300 ml
Hydrated Gel Particles	86.67 gr.	49.87 gr.
Excess Water Vacuumed off	205 ml	243 ml
Excess Water Lost in Filter	8.58 ml	7.38 ml
Absorption Rate	346:1	198:1
CHARACTERISTICS		
Particle Size	Excellent	Poor
Suspension	Good	Poor
Gel Strength	Soft	Hard
Water Absorption	Good	Poor

Dustless--Superabsorbent dust added to water can become a "coating." If this coating dries out, it can act as a barrier, sealing off oxygen to the roots.

Uniform particle size--In order to obtain (-20+35) a uniform, stable suspension, with sufficient hydrated granules, to adhere to the seedlings ...when the granules are too large, they will fall off roots.

-Propenoate-propenamide copolymers with the correct rate of potassium polyacrylate and polyacrylamide.

-Absorption capacity should be no more than 400 times its own weight, and no less than 300 times.

-The absorption capacity and size of the granule determine the weight of the hydrated gel that clings to the roots.

-ROOT-DIP superabsorbent should be coated with hydrophobic adjuvant to avoid lumping during hydration.

-Should be easy to use.

-The physical-chemical properties of the ROOT-DIP gel should ensure that moisture is released from the gel to the roots when the moisture equilibrium of the roots need it. (diaper gels hold and retain water, but do not release it)

-When dry, the ROOT-DIP gel looks like a white crystal. It is odorless, free flowing.

-When hydrated, the ROOT-DIP gel should not be rubbery or hard. To be sure that moisture can be released, gel should be on the soft side.

-Hard gels will fall off the seedlings during handling.

-The ROOT-DIP gel must be supported by good quality control and a company that is in the agricultural business, knowledgeable and responsive to grower needs.

10. THE FUTURE

The future of superabsorbents in forestry is bright.

The aim will continue to be to encourage governments, industry, and the public in general, to forest the land, to preserve it and enjoy it, and in so doing, to utilize safe proven products at an economical cost.

Our responsibility as nurserymen, is to be there and to utilize the best methods available to grow the best seedlings.