POLYLOAM: A SELF-CONTAINED MEDIUM FOR TREE PROPAGATION 1/

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Abstract.--Polyloam is a synthetic, low-density medium fully endowed with plant nutrients and a favorable water-air regime. As a self-contained block, root emergence is unimpeded and size (seedling spacing) is correlated with production and handling costs. Ground Polyloam can be used in potting mix for walled-containers.

INTRODUCTION

There are two basic concepts for containerization: (1) the pot, or walled boundary to hold filler; and (2) the self-contained, wall-less, shaped medium. The pot concept is as old as horticultural practice and is still the tool of nurserymen selling ornamental shrubs and trees. The self-contained medium concept is relatively new, although pressed peat and pressed manure cubes have been used for a number of years in Europe. In normal use, the self-contained medium, with the rooted plant, is transplanted upon root emergence. This means that pot-binding of roots is not possible as is the case with walled containers. It also means that propagation periods are timed to biology--not a calendar--although, plants can be held longer than is desirable if there is no objection to air-pruning of roots.

Most potting mixes are composed of two or more unconsolidated materials such as peat, exfoliated mica, calcined clay, sand, bark, or "garden" soil. Unless one allows sufficient time to pot-bind these mixes, the materials fall off the roots when the core is removed from the pot. Otherwise, it is possible to plant with the roots enveloped in the pot. In recent forestry history, pot-bound plugs and various tubed seedlings and bullets have been introduced as container techniques. The tendency for root-girdling and self-strangulation of perennial plants appears a real possibility with these techniques.

Self-contained media require a different degree and form of management than is usually practiced with pot systems. However, there are definite adjustments required among potting media. I wish to describe the characteristics and management of Polylloam, a truly synthetic, unique self-contained medium.

POLYLOAM PROPERTIES

Physical

Polyloam has a low, uniform bulk density of 3 pounds per cubic foot, when in block form. Ground Polyloam varies from 2.5 to 4 pounds per cubic foot, depending on packing. Such variation is common in all unconsolidated media. The blocks have a total drainable pore content of 45% by volume and retain water (field capacity) in slightly over 2/3 of this space. This means that it is virtually impossible to cause oxygen starvation in the roots by overwatering; yet, there is a water supply in up to 1/3 the block volume.

Polyloam is black in color, which maximizes capture of sun energy for root warmth. It is dimensionally stable, wet or dry, and lends itself to mechanized handling, in block form, due to uniformity of the "root package" and resiliency of texture.

Chemical

Polyloam is fully supplied with all essential plant nutrients incorporated in multiple forms and availabilities. Without additional fertilizer, plants have been green from seed to fruit by using suitable volumes of this medium. Total plant available nitrogen is 2.5% and there is another 2.5% in the polyurethane matrix which will become available

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upon biodegradation. Available P205 and K_2O are 1% each. Mechanisms for the re ention and release of nutrients include: cation exchange capacity (30me./100 g.), anion exchange capacity (1.5me./100 g.), membrane diffusible ions, enzyme-sensitive resins, chelated ions, and soluble and slowly soluble salts. The electrokinetics of the nutrients have been adjusted to obtain ion specific activities which result in the most desirable nutrient ratio for normal plants; including the import- ,nt N:S, P:S, Ca:Mg, and Mg:Fe ratios, which are only rarely considered in potting-mix formulations. Further, Polyloam tree blocks are made to function in the pH range 5.8 to 6.3 due to buffering. The buffer system is especially effective against alkaline water, a common source of propagation problems.

Biological

Because it is a completely synthetic, manufactured medium, Polyloam harbors no microbial organisms, pathogenic or non-pathogenic. However, as with any nutrient-containing substrate, it will support growth of such organisms, if inoculated. A clean growing area is a must for seedling production. With a clean area, clean seed, and Polyloam, the incidence of damping-off should be at a minimum. In the event of disease, it is recommended that an effective fungicide be applied at normal dosages.

Root permeation and egress from the blocks are enhanced by the porous, resilient nature of the matrix. The emergence of roots is easily seen and dictates the time for outplanting. The advantage of seeing the roots is translatable into efficiency of cycling expensive propagation space with no guesswork.

MANAGEMENT CONSIDERATIONS

Container Size

The present, generally accepted, concept of containerized tree seedlings stems from the work of McLean (1958). He proposed the tubed seedling method in Ontario "as a compromise between inexpensive seeding operations and the use of conventional nursery stock." The original container was 1/2 x 2 3/4 inches and, while it has been shown that a larger soil volume is beneficial, there are practical reasons for using the smallest container that gives acceptable performance. While initial cost of the container and/or medium is important, the more serious economic factors are container size and overhead. The following figures show there are rapid increases in costs as the container (seedling) spacing widens.

SPACING IN INCHES	SEEDLINGS PER SQUARE FOOT	ESTIMATED COST OF 1000 SEEDLINGS FOR 3 MONTH RESIDENCE 1/
0.75	256	$ 6.00
1.00	144	10.50
1.25	90	16.50
1.50	64	24.00
2.00	36	42.00

1/ Based on space and labor at $0.50/Mo./Ft^2

Whether the figure of $0.50 per month per square foot of propagation space is correct or not, there is some such figure and, generally, a commercial grower places a much higher price on his space. The fact is that long-term residence in a greenhouse and large containers lead to expensive plants. Colby and Lewis (1973) have used data, based on a particular case, that is in accord with the point being stressed. The present economic status of bare-root seedlings is such that it is unrealistic to compare it with "containerized" production figures. Nevertheless, most foresters involved in regeneration make this comparison. Therefore, it will continue to be vital that the "containerized" stock be produced and delivered to the planting site as cheaply as possible. Container size affects both propagation and handling costs. The latter is also influenced by weight, convenience of multiple units versus singles, amenability to shipping, and susceptibility to spill of the root package.

Polyloam blocks for tree seedlings are 3/4 x 3/4 x 4 inches with 180 of them attached by a pad at the base. As shown in the figures on spacing, this allows the propagation of 256 seedlings per square foot.

Seed and Seeding

Polyloam blocks are furnished with a seed cavity which has a slit in the bottom to help the radicle penetrate the medium. Because the holes are uniformly spaced, the 180 block package is conveniently seeded by using a pre-spaced pattern with a vacuum lift or gravity flow. After seeding, the seed should be pressed into the hole to insure good contact. This can be accomplished with a board containing short dowels that fit into the holes or with the pressure of a smooth board, due to block resiliency. In some instances, with certain species, the seed may be covered by sprinkling with peat, sand, or ground Polyloam. Depending on watering techniques, it may be efficacious to cover the blocks with plastic or cloth until germination is complete.

Most seed are variable in size and there appears to be an improvement in uniformity of germination when the seed used are of the same size. Too, we have found that the seed can be a source of disease and that a wash in 10% Clorox or 3% hydrogen peroxide is a good practice. In some cases, this treatment can be applied at initiation of stratification.

Watering

Both germination and growth of conifers in Polyloam blocks have been best under a mist or semi-mist watering system. The amount of water can be adjusted to the desired level by a variety of means. With a device such as the Chapin balance, a Polyloam package can be watered to between 5 and 8 times the dry weight with good results. However, it is equally possible to calibrate a Mistamatic or Solatrol device to actuate the solenoid and dispense the needed amount of water according to environmental conditions. These automatic watering devices are at work, weekends and holidays, in cloudy or sunny weather. They require maintainence and understanding, but eliminate the hazards of hand-watering and time clocks. The latter fail to detect weather changes.

Normally, with conifers, watering can be reduced following formation of true leaves. With Polyloam, an excellent system utilizes a second area having reduced light, water, and temperature to which, at certain times of the year, seedlings can be moved following true leaf formation and extension of the primary root to the length of the block. In the case of loblolly pine, time in the greenhouse may be 5 or 6 weeks followed by an additional 2 to 4 weeks in the "hardening" area. With spruce, fir, and northern pines, these time periods may be more like 8 to 10 weeks followed by 2 to 6 weeks.

Outplanting

The proper time to outplant the Polyloam seedling is determined by root emergence from at least two sides and the bottom of the block. Little harm is done by waiting a few days for favorable weather, manpower, or whatever, but it is best to time the operations to allow a new cycle of propagation to commence. Outplanting is expedited by the size and lightness of the blocks. The uniform size of the root package is adaptable to a custom-made dibble or mechanical planter. Blocks should be inserted to about 1/4 inch below ground level and firmed in by foot pressure or packer wheel. In dry periods, the blocks should be soaked prior to outplanting. However, it is unreasonable to expect a plant to survive transplanting during hot weather without some probability of showers. This is a reality which applies to any containerized or bareroot plant.

Comparisons Among Media

In both horticultural and forestry efforts to "pick-the-winner", it appears to be common practice to mix media and subject the contestants to some arbitrary watering regime; frequently confounded further by addition of nutrients. This is contrary to established principles of soil science and common sense. A given medium used in plant propagation has definite, identifiable characteristics, especially as to water retention and release and to nutrient status. The normal technique for evaluating nutrition among a group of diverse soils in a common climate, such as a greenhouse, is to adjust the supply of all nutrients not being evaluated to some common level and water to definite tension ranges of each soil. Thus, a sandy loam may hold 10% water by weight at field capacity and 4% at the wilting point (0.33 and 15 atmospheres, respectively), while a clay loam may hold 30% water by weight at field capacity and 15% at the wilting point. Obviously, by watering both to an arbitrary 10%, the plant thrives in the sandy loam but soon dies in the clay loam. The particular investigator may declare the clay loam worthless; yet, there must be some logical purpose for so much clay loam on the planet. The many mechanical potting mixes in use today greatly magnify the water and nutrient combinations possible. But, to make matters more difficult, it is possible to get considerably different results using a "uniform" mix simply by varying the bulk density, or degree of packing. This being true, it points up another strong reason why a uniform bulk density, such as is possible with Polyloam blocks, should be desirable. Obviously, one must establish a definite water regime for the block and it is most unlikely that it is the same as one worked out for a peat-perlite mix. There are good reasons why a son will stick to the potting mix his father used and, generally, the main one is that it works and he is too busy to experiment. This is not the case in forestry, yet. There is time to inject a little science into the art of propagating tree seedlings.

SUMMARY

1. There are two fundamental forms of containers used for tree seedling propagation. The pot or walled boundary to hold filler and the self-contained, wall-less medium. The chief function of the pot is to hold unconsolidated soil which is ultimately bound together by roots. Tree seedlings propagated in pots are either outplanted with the pot or the core "plug" is extracted prior to insertion in the ground. In either case there must be pot-binding which means there is strong liklihood of root girdling and possible self-strangulation

in a perennial plant such as a tree. In contrast, the self-contained medium allows free root egress which dictates the time to outplant.

2. Polyloam blocks provide a self-contained medium of low bulk density which is dimensionally stable, wet or dry, resulting in a lightweight, uniform seedling package. Black color maximizes the effect of the sun's energy in warming the roots. It holds one-third of the volume in water after drainage yet permits adequate gas exchange. Certain adaptions of water management practices are possible and should be advantageous with Polyloam.

3. Polyloam is supplied with all essential plant nutrients in multiple forms and availabilities resulting in both quick and sustained release for plant growth. The mechanisms for nutrient retention and release include a unique anion exchange system, cation exchange sites, membrane diffusible ions, chelated ions, enzyme-sensitive resins, and soluble and slowly soluble salts. The amounts and activities of nutrients are designed to result in optimum balances in normal plants. The pH is buffered in the range 5.8-6.3.

4. Polyloam is synthetic and thus, is sterile as packaged. When any plant organism is introduced into this medium, growth will be enhanced. Because this includes many microflora, simply starting with sterile media does not rule out normal grower cleanliness. Due to the matrix properties, plants are ready for outplanting when roots emerge from the block. Plants can be held beyond this point but, such holding operations will result in some economic and biological losses. Propagation with Polyloam is geared to physiological timing.

5. Container size and resulting seedling spacing during propagation have a profound influence on production costs. It is important that the container be as small as possible to do the job required because size affects both propagation and handling costs.

6. Each potting mix, soil type, or self-contained medium has identifiable water constants which are affected by particle size and distribution and bulk density. Comparisons among diverse media should be made using proper water and nutrient regimes for each medium.

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