THE NATURE AND USES OF POLYLOAM IN FORESTRY

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Polyloam is a truly synthetic growing medium which is suited to both short-term propagation of cuttings and seedlings and to sustaining plant growth for extended periods. It is capable of being the sole support for a plant from seed to fruit by using volumes commensurate with root requirements; demonstrating that all essential nutrients are present and available for use.

The manufacturing process for Polyloam produces a low density matrix which can be formed in molds and cut into various shapes and sizes. In addition, it can be shredded or ground to give a low density, unconsolidated medium which can be used alone or in a mixture as filler for pots. For short-term tree seedling production, major efforts have been directed toward a self-contained block 3/4 x 3/4 x 4 inches in size. This will permit a propagation period of from 8 to 16 weeks for most species of conifers. There are 180 blocks attached to a pad at the bottom to give a compact and easily transported package which occupies approximately 3/4 of a square foot of bench space. Prior to use, this 180-block unit weighs 12 ounces; while, at the time for outplanting it should weight about 6 pounds. Williston and Balmer (1972) pointed out a serious problem incurred in trying to supply tubelings packed in 70 pound boxes to planting machines or hand planters. The particular tubeling was heavy due to the paper thickness and the density of the growing medium when wet. This type of weight-handling problem has been an important consideration in development of the self-contained block. Any unconsolidated material, except coarse sand, will increase in bulk density in a pot or other walled-container, during the propagation cycle, due to watering and handling.

NATURE OF POLYLOAM

There have been very few attempts made to manufacture a truly synthetic growth medium which incorporates the important soil property of cation exchange capacity. This mechanism is second only to photosynthesis in sustaining vegetation on the land. Without it, all plant nutrients would have leached or washed into the oceans as soon as they became soluble. The Polyloam process includes interaction between organic and inorganic compounds which provides both cation and anion exchange sites. In addition, nutrients are incorporated as chelated ions, enzyme-sensitive resins, membrane encapsulated compounds, and soluble and slowly soluble salts. With such a diversity of nutrient supplies, the importance of ionic activities and ratios is paramount. However, even though it is not a true index of availability, the medium is a 2.5-1-1 fertilizer. This and other properties of Polyloam blocks are summarized in Table 1.

Table 1.--Properties of polyloam self-contained propagation blocks

Chemical	
NUTRITION:	2.5-1-1 ($N-P_2O_5-K_2O$) +3 secondary & 7 minor elements
CATION EXCHANGE CAPACITY:	30 me/100 g
ANION EXCHANGE CAPACITY:	1.5 me/100 g (=210 ppm N as NO_3)
BUFFER CAPACITY:	From exchange sites
pH:	5.8-6.3
Physical	
BULK DENSITY:	0.05 g/cc (approximately 3 lb/cubic foot)
DRAINABLE PORE SPACE:	45%
WATER RETENTION:	1200% saturated; 700% field capacity (0.33 atm)
COLOR:	Black
TEXTURE:	Moderately resilient
Biological	
PATHOGENS:	Free of insects, diseases, and nematodes
PLANTS:	Resists overwatering due to favorable air-water balance
	Easy root penetration of fibrous and tap-rooted species
	Visible root emergence indicates proper outplanting time

Nitrogen is a structural component of the Polyloam matrix and may be of some value upon biodegradation in the soil. This is a bonus and not included in the 2.5% which is supplied as nitrate, ammonium, and amide forms. The nitrate ion is highly mobile and readily leached from normal soils and potting mixes. However, the anion exchange sites are capable of retaining nitrate in Polyloam.

pH of the forestry blocks is buffered in the range 5.8-6.3. This has proved important for the performance of conifer seedlings and appears to be related to the maximized availability of the monovalent phosphate ion (H_2PO_4) in this range.

The low bulk density of the blocks is especially valuable for handling and transportation purposes. It also permits root permeation with relative ease for a formed, bonded medium. It has been possible to incorporate a hydrophilic nature which allows a reasonably good amount of water to be held against gravity. This amounts to 32% of the volume which leaves 13% of the drainable pores for air diffusion; a balance of air to water which virtually rules out the common propagation medium problem of overwatering.

Polyloam blocks are moderately resilient; yet, maintain the same size whether wet or dry. This is an asset for transplanting by forming a dibble hole and for machine handling.

As manufactured, Polyloam is free of pathogens. However, as it supports the growth of higher plants, it will grow microflora, if inoculated. There is no substitute for cleanliness in the propagating area. Because most potting soils are sterilized, the nitrifying bacteria are inactivated which results in little or no conversion of reduced nitrogen to nitrate. Since nitrate is most needed by seedling plants, the nitrate retained on the anion exchange sites in Polyloam assumes unique importance.

USES OF POLYLOAM

Polyloam blocks have a cavity 3/8 inches in diameter and 3/8 inches deep with a slit in the bottom which extends to a depth of 11/4 inches. This combination aperture is useful for seed or for "sticking" cuttings. Seeding can be readily accomplished by use of a pattern with either a vacuum or gravity flow. Blocks can be seeded dry or wet, depending on the need. Because the blocks are of uniform size, the 180-block packs can be pre-seeded and stored for later use. This technique can include stratification of the seed in moist blocks under refrigeration.

The accepted environment for plant propagation is one of high soil moisture and humidity. The light and temperature requirements vary with genera and species. With most conifers, there is no need to cover the seed in the blocks if overhead mist or fine spray is applied. Because of the air-water balance in the blocks, the high moisture, which conditions the imbibitional power of the seed (Doneen and MacGillvray, 1943), can be maintained with confidence. Best control of the moisture conditions is through use of automatic watering devices actuated by evapotranspiration. By watering the blocks between 500 and 800% (5 to 8 times the dry weight), a good moisture regime is maintained. This can be accomplished with a Chapin balance or by calibrating a Mistamatic or Solatrol device against gravimetric values. Experienced propagators might do an acceptable watering job with a hand sprinkler or time clock, provided they work seven days a week. Following formation of true leaves and root extension to the bottom of the block, the watering should be reduced. It is desirable, at this point, to move the seedlings to an area of reduced light,, moisture, and temperature to effect "hardening" prior to outplanting. With southern species of pine, such as loblolly or slash, the seedlings can be moved to the "hardening" area after 5 or 6 weeks. With other species, such as spruce or some northern pines, a comparable period might be 8 to 10 weeks. The physiological condition of the seedling should determine the propagation program. At different times of the year and with a variety of weather conditions possible, it is difficult to gear growth to the calendar, except by using growth chambers. Root emergence is readily apparent with the blocks and serves to indicate the time for outplanting has arrived.

While there is an optimum time to outplant the Polyloam-contained tree seedling, it is possible to hold the plants for a considerable time. However, there will be air-pruning of roots and the root:top growth becomes a consideration in field survival. Further, as is frequently done with bareroot stock, the blocks can be "heeled-in". As with any transplant, there must be adequate soil moisture at the time of outplanting to allow continued growth. It is unreasonable to expect a containerized seedling to withstand drought and extreme temperatures. To increase survival in the field, the blocks should be inserted about 1/4-inch below ground level and the soil firmed around the root-package by foot pressure or packer wheel. It is desirable to soak the blocks prior to carrying to the field and detach the individual blocks from the 180-pack just before insertion in the soil.

Ground Polyloam can be used alone or mixed with materials such as sand, perlite or "so-called" vermiculite as a pot filler. Chemically, it is the same as the blocks. Physically, it has a variable bulk density which is usually between 2.5 and 4.0 lb/cubic foot. Watering techniques with the ground material will depend on whether it has been mixed or not and the nature and bulk density of the mix. While the moisture retention characteristics of mixes can be evaluated in the laboratory, most commonly water is applied in excess or by visual inspection. Otherwise, handling and outplanting procedures remain consistent with the procedures for the walled-containers being used to hold the medium.

DISCUSSION

The commonly accepted meaning of containerization in forestry is that seedlings are propagated in small volumes of soil for short periods of time to be outplanted with the root system intact and the plant growth uninterrupted. This concept is at variance with the age-old use of large containers and trees, one or more seasons old, still in vogue with nurserymen. The practical reasons for the small size include; container and/or soil cost, transportability (weight), plantability, and propagation costs. The latter can be a bigger factor than one might expect. Professional horticulturalists put a high value on greenhouse space. Thus, size of the container and length of the growing cycle become important to the economics of the project. There is no question that a larger tree can be produced in a larger volume of soil. Likewise, there is no doubt that a plant can be grown longer in a large volume than in a small volume. The choice of the size for the Polyloam forestry block was largely due to the rather extensive work in Canada. Kinghorn (1970) described the Canadian efforts as "(it) relates wholly to economic considerations rather than to biological desirability". Kinghorn also pointed out that "reproducible soil media are desirable".

There are definite advantages for containerization of tree seedlings, such as: space savings, flexibility in production schedules, shortened growing time, possibilities of reduced labor, and few restrictions on location of the growing facility. However, operating a greenhouse is not farming. In fact, about the only common denominator for both operations is that plants are grown. An entirely successful Iowa corn farmer can lose his shirt trying to make a cotton crop in Mississippi. Similarly, a successful geranium propagator might be as inept as a city boy if he attempted to grow tomatoes in the field. The fact is, greenhouse propagation requires either considerable knowledge of soils, fertilizers, plant physiology, diseases, water quality, watering practices, light quality, and temperature effects, or an experienced grower--not too far from home. A number of people who have had some experience with containers in forestry concur with me that a training program in tree propagation in containers is desirable. If one assumes that containerization is a reality in forest regeneration, the time has come to recognize that trained personnel are necessary for success.

LITERATURE CITED

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