ENGINEERING THE CONTAINER -- Panel Discussion

Eighth of Nine Papers

ENGINEERING FOR INJECTION PLANTING 1/

John Walters 2/

Abstract.--The mechanization of forest nursery and planting operations involving large quantities of seedlings can be facilitated by growing and planting seedlings in bullet-shaped rigid plant pots formed of separable sections designed to withstand the impact of injection planting and yet permit their radial separation by the force of root growth.

INTRODUCTION

Current interest in ball planting and pot planting receives its impetus from the need to develop systems for the mechanization of forest nursery and planting operations and to provide optimum conditions for seedling survival and growth.

The mechanization of nursery and planting operations involving large quantities of seedlings requires that the dimensions of seedlings be constant. This requirement can be fulfilled within narrow tolerances, by growing seedlings in rigid plant pots of specific dimensions and design.

Logistics involved in packaging, growing, shipping, and planting large numbers of seedlings demand that the container configuration must be precisely modular and must accommodate a sequence of related requirements and constraints. The engineering rationale for this requirement can best be met by injection molding the containers from a versatile and relatively inexpensive thermoplastic.

Injection planting of tree seedlings offers the greatest potential for the mechanization of the planting process. To exploit this potential, the container must be "bullet-shaped" and it must be structurally rigid to withstand the impact of mechanical insertion into the ground.

Seedling morphology and physiology during transfer from nursery to planting site can be given maximum protection by pot planting. The pot must be designed to protect the seedling before planting while permitting unrestricted root egress and soil moisture entrance after planting. Thus, subsequent to planting, the pot must be eliminated as an obstruction to root growth and distribution. This can be accomplished by container design only or a combination of design and material properties.

The purpose of this paper is to describe the design of such a bullet-shaped "plant pot" in which seedlings can be grown, packaged, and subsequently injection planted by manually or mechanically powered planting guns.

THE PLANTING BULLET

In those reforestation systems which rely on tree seedlings, the planting operation is the crucial element. In terms of biological and economical constraints it is the process of planting itself which governs the success and cost of the plantation. Therefore, the system must provide maximum facility for the planting process itself as well as for the nursery and shipping processes. Of course, the elements of the system must also provide for the biological requirements of the seedling.

Because bullet-shaped plant pots as described previously (Walters 1.961; 1963; 1965; 1966; 1967a; 1.967b; 1969; 1970;) can cause root deformation and slow growth on droughty sites, the bullets were re-designed to reduce these problems, to improve handling characteristics, and to increase structural properties. Figure 1 shows the re-designed bullet and the sequence of assembly of the four identical separable sections from which it is comprised. Each wall of the container has an identical arrangement of offset apertures and lugs

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arranged to mate with any wall of another identical container. Each section of the bullet has interconnecting pins and pin receiving apertures for connecting with two other identical sections.

The nose portion of each section comprises complementary interlocking elements- which prevent relative vertical displacement of the sections and also limits horizontal displacement so that the sections do not separate as the bullet is inserted into the soil, and yet allows radial separation of the sections by the force of root growth (Figure 2).

The inside surface of the nose of each section slopes downwardly and outwardly to the bottom of the lowest aperture to allow unimpeded egress of the roots. The apertures in the walls of the four sections comprising the bullet are intersected by the edge of the sections so that the apertures are in the form of notches in order that the roots as they grow are not girdled by the apertures.

In response to compact or stony ground conditions the wall thickness at the corners of the sections can be increased to provide the structural rigidity to withstand the forces of injection planting without inhibiting root egress through the apertures. Similarly, the structural properties required for injection planting, of large bullets can be provided without detriment to root development.

In preparing for planting, selected numbers of bullets are grouped in the desired quantity and configuration and a suitable strap of band is applied to form a unified bundle. Figure 3 shows a bundle of 54 bullets held by a rubber band. The bundles are then filled with soil and seeded. The square shape and interlocking arrangement prevents soil from falling between bullets. This bundle arrangement is readily adapted to manual gun planting as shown in Figures 4 and 5 and to fully automatic machine planting.

The possibility of the tap root growing out from the lower section is minimized by its lowest apertures being, disposed some distance (5/8-inch in the case of the 4-inch bullets shown in Figures 1 and 3) above the tip of the nose which rests on the supporting surface in the nursery.

It is usually inevitable that a fraction of the seeds sown in containers will not yield a seedling and therefore a container configuration may have one or more containers without a seedling. Figure 6 illustrates a rapid method of ensuring that each bullet of a bundle will have a seedling at substantially the same stage of development. Simultaneously to the seeding of the planting bullets, an additional number

Figure 1.-- Four-section bullet showing sequence of assembly.

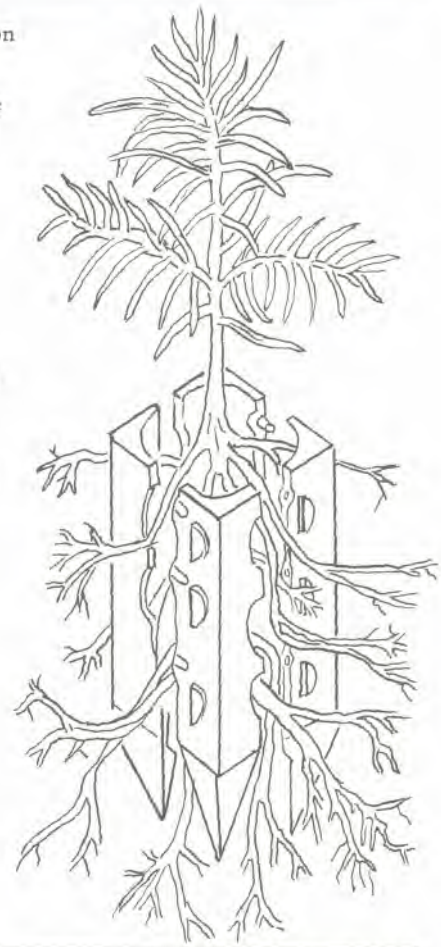

Figure 2.-- Radial separation of bullet sections caused by force of root growth.

Figure 3.-- A bundle of 54 bullets held by a rubber band.

Figure 4.-- Bullet being dropped into "breech" of the planting gun.

Figure 5.-- Fully equipped manual planter.

Figure 6.-- Small bullet containing seedling being planted into large bullet in which germinant has failed.

of relatively small bullets are also seeded, which will develop at the same rate. These small bullets are similar to the other bullets differing only in size. Prior to planting, a small bullet containing a seedling is injection planted by gun into large bullets so that the bundles are fully stocked with seedlings (Figure 6).

Bullets may be molded of any rigid material such as polystyrene or of a biodegradable material such as polycaprolactone (Union Carbide 1973) or thermoplastics with biodegradable fillers such as starch-filled polystyrene or polyethylene (Griffin 1973).

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