

The Use of Styroblock 1 & 2 Containers for P+1 Transplant Stock Production¹

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Abstract.--The well known Plug+1 and the recently developed Miniplug+1 seedlings begin their life as typical plugs in a container nursery. Each is grown on a slightly different schedule but at the end of their container growing phase both are transplanted in a bareroot nursery. In the bareroot nursery they continue their development for another growing season or until they are outplanted to a reforestation site. Both of these stock types develop bushy tops and fibrous root masses. Such attributes are needed for high survival and good growth on typical Northwest reforestation sites.

INTRODUCTION

The Plug+1 and Miniplug+1 seedling types are the newest among a variety of seedling types used for reforestation. They are hybrids derived from merging recently developed containerized seedling production methods with age-old bareroot methods. Due to this, it utilizes two different nurseries (greenhouse and open field) and two distinctly different growing schedules and growing regimes. Good coordination between the two nursery types is essential to harmonize the two production phases.

Plug+1 seedlings have been produced in large scale quantities for over a decade. Georgia-Pacific Corporation (container nursery), with the cooperation of Tye Tree Nursery (bareroot), was instrumental in developing this seedling type. The process is described by Philip Hahn in 1984.³ Therefore, this report will concentrate mostly on the development of the Miniplug+1 seedling type as carried out by Georgia-Pacific Corporation and cooperating bareroot nurseries, primarily the International Paper Company nursery at Kellogg, Oregon.

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³Hahn, Philip F. Forest Nursery Manual, 1984 (Edited by Duryea, Landis), pp 165.

A BRIEF DESCRIPTION OF THE MINIPLUG+1 SEEDLING TYPE

The "Miniplug+1" is an outgrowth of the "Plug+1" production. Both spend their first growing phase in a container nursery as a Miniplug or Plug and the second growing phase in a bareroot nursery as a Miniplug+1 or Plug+1. While they are similar, they are also different.

The major differences between the two are the following:

1. The container size for the Miniplug is 1 cu. inch (Styro-1) and for the Plug 2.5 cu. inches (Styro-2).
2. The seedling density in the greenhouse for the Miniplug is 210 seedlings/sq. ft. and for the Plug 100.
3. The greenhouse space utilization is further increased by the Miniplugs because two crops/year are raised instead of only one Plug crop on the same greenhouse space.
4. The Miniplugs also utilize the bareroot space better because they are transplanted in a closer spacing than the Plugs.

Miniplug production has a short history. Therefore, it is still in its development stage. In spite of this, the production of the seedling type *is showing good success*. Just like in all containerized production, there are also several approaches used for producing Miniplugs.

To satisfy the tree seedlings unique root requirement, Georgia-Pacific Corporation stuck to the proven container configuration and developed a container type highly suitable for tree seedling production. The container block size is 4"x14"x20". Each block has 408 one cubic inch size cavities. The slightly tapered container cavities have root guiding ribs. There are holes among the cavities to help air circulation among the densely grown seedlings. Each block consists of four segments to aid seedling extraction. This container is commonly known as the Styro-1 (1 cu. inch cavity size) block (fig. 1) or HAHN 408.



Figure 1.--Hahn 408 container with fall sown Mini-plugs.

The HAHN 408 container produces seedlings with good roots and stems suitable for transplanting with a slightly modified conventional transplant machine (see fig. 1).

CONTAINERIZED GROWING PHASE

Growing Facility

Georgia Pacific Corporation uses a shelterhouse type growing facility (fig. 2). These houses have permanent roof covers with double full length roof vents. They have heaters and wall vents, removable sidewall covers, photo period extension lights, ceiling fans. All environment control equipment is motorized and thermostatically controlled. Since the houses provide good natural ventilation through wall and roof vent openings, there is no need for cooling pads and large air moving fans to cool the houses. The seedlings are grown in these houses as close to natural growing conditions as possible. This



Figure 2--Georgia-Pacific's Shelterhouse growing facility.

provides less troublesome growing and helps in developing the required morphological and physiological traits for good transplant quality.

Containers

The shape and size of the HAHN 408 container were described earlier. Other

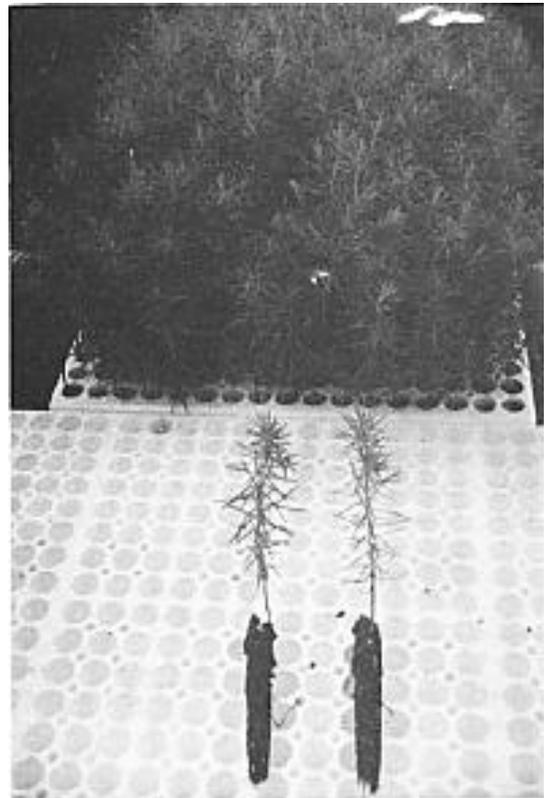


Figure 3--Fall sown Mini-plugs raised in Hahn 408 container ready for spring transplanting.

container types may also be used for such seedling production but we found the KAHN 408 to be the most desirable when used in a shelterhouse system (fig. 3). Beside the container's attributes to produce the desired root configuration, it also aids in producing a hardy seedling when used in a shelterhouse facility.

Crop Growing Schedule

Before starting the Miniplugins, their production is timed so that they reach optimum size and condition on the desired spring or fall target transplant dates. Pre-established sowing dates, target height, and diameter charts aid in this process (figs. 4 & 5).

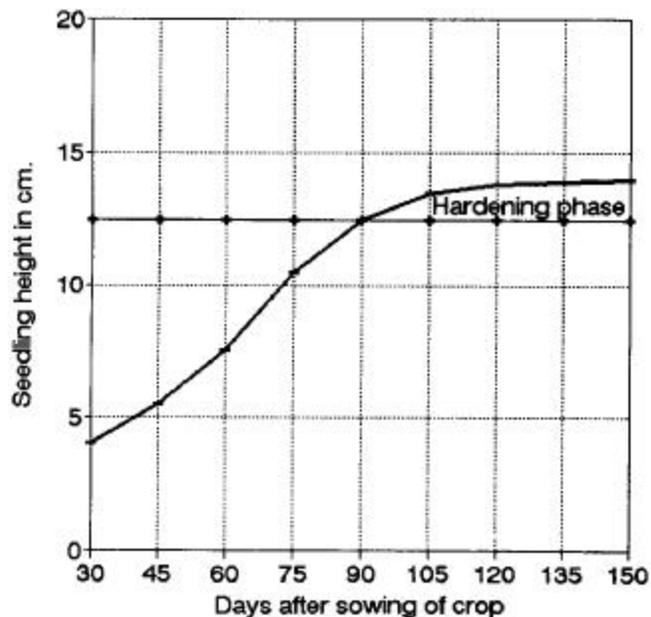


Figure 4--Target height for fall sown Miniplugins.

Miniplug Production for Spring Transplanting

Sowing for the spring transplant growing schedule takes place in August or early September. Warm weather conditions during this time of year aids rapid germination. Soon after germination the activated photoperiod extension lights help prevent premature budsetting, thus promoting continuous seedling growth. During growing, height and diameter growth

are closely monitored and matched to the predesignated growing charts shown in Figures 4 and 5.

For optimum growth, the climate in the greenhouse is maintained at 70-75°F during daytime and 60-65°F during the night. For nurturing the seedlings, an appropriate

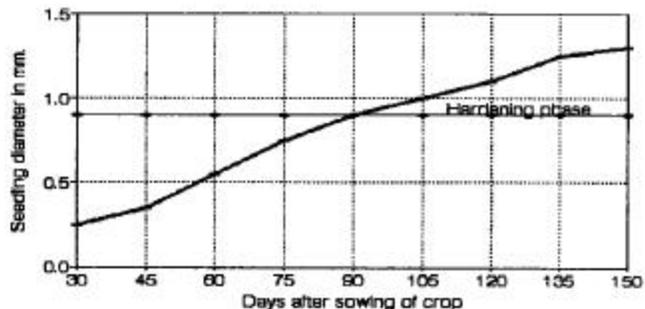


Figure 5--Target diameter for fall sown Miniplugins.

irrigation and fertilization schedule is followed.

Table 1 shows a typical nutrient requirement for liquid feed application. The recommended rates are only suggested guidelines. They are altered to accommodate specific nursery conditions and nutrient requirements of the seedlings. Periodic testing of soil and foliar nutrient contents aid in balancing the nutrient needs of the crop. Tables 2 and 3 show the foliar nutrient indicators for optimum seedling growth.

When growing is done by following the growing schedule and the predesignated growth charts, the seedlings generally reach the proper size for hardening around late November. For hardening, the greenhouse temperature is maintained around 65°F, the lights are turned off, and the seedlings are exposed to several nutrient and water stresses to initiate budsetting. After budset initiation, normal irrigation and fertilization resumes as needed. The fertilizer applications favor high K and low N mixes to promote stem lignification and strong bud development. When budsetting is taking place the greenhouse temperature is allowed to cool to 26-28°F. Seedlings exposed to short and light freezes helps the hardening process. Avoid freezing the root plugs. The insulating capacity of the styroblock container will aid in this effort. During the entire growing season,

TABLE 1 - General nutrient requirements for a liquid feed application to grow Douglas-fir containerized seedlings

Nutrients	Macronutrients (ppm)						Micronutrients (ppm)						
	N	P	K	Ca	Mf	S	Cu	Zn	Mn	Fe	B	Mo	Cl
Establishment Phase	70	100	90	30	10	10	0.20	0.20	0.10	7.00	0.20	0.05	0.50
Rapid Growth Phase	160	90	100	50	15	15	0.50	0.50	0.30	12.00	0.30	0.06	0.60
Hardening Phase	50	60	140	20	5	7	0.30	0.40	0.20	5.00	0.15	0.03	0.50

TABLE 2 - Desirable Soil Fertility levels for Containerized Seedling Production
The rates are based on Soil and Plant Laboratory, Inc.'s testing method.

	Half Sat. %	pH	ECe	Macronutrients (ppm)						Micronutrients (ppm)				Saturated Extract	
				No3* N	NHA N	PO4-	K	Ca	Mg	Cu	Zn	Mn	Fe	B ppm	SO4 Me/L
DESIRABLE LEVEL	200-280	4.5-5.5	0.5-1.0	Total of 100-300		50-175	600-1000	6000-8000	800-1000	4-8	18-25	30-70	350-550	.1-.5	0.3-2.0

*Ratio of NO3:NH4 should be 2:1 or better

TABLE 3 - Desirable foliar mineral content rates.
The rates are based on Soil and Plant Lab., Inc. tests

Nutrients	Percent						Parts Per Million				
	N	P	K	Mg	Na	S	Cu	Zn	Mn	Fe	B
DESIRABLE LEVEL	1.5-2.5	.4-.8	1.0-2.0	.10-.20	.01-.03	.2-.4	4-20	15-40	100-300	50-80	25-50

disease and insect control is maintained as needed.

By the end of January or early February the crop reaches the proper morphological and physiological condition for packaging and storing. The seedlings are freezer stored (28°F) until transplanting. Transplanting normally takes place from late March to early June. This depends on the work schedule and weather conditions in the bareroot nursery.

Spring Transplanting of Miniplugins

Spring transplanting has a lot of advantages. It is also traditional and well suited for containerized and bareroot crops. The seedlings generally develop their most favorable physiological condition for spring transplanting. With a spring transplant schedule, bareroot nurseries are able to rotate their nursery space better and keep their space occupied for a shorter time period. There is no need to worry about over wintering a freshly transplanted crop. In addition, late hardening and winter frost sensitive species develop better with spring than with fall transplanting. The Miniplug+1 crop production specifically adds two more advantages to the spring transplant schedule. First, the plug growing phase takes place on bonus growing space in the container nursery as a second crop. Second, the fall grown plug doesn't develop a pot-bound root system as the spring sown and held over Styro-2 plug does.

On the flip side of the above, general and specific advantages, one needs to look at some of the disadvantages for spring transplanting, too. Late summer or fall sown seedlings grow under a more artificial environment than the spring sown crop. As the days get shorter and colder during fall, the use of photoperiod extension lights and heaters are required. Using artificial means for growing makes growing cumbersome and increases the cost for the container phase production. However, most of this cost increase is compensated by lower spring transplant production costs in the bareroot operation phase.

It may be more natural to transplant in the spring than fall. However, spring transplanted seedlings will have a shorter time for growing between transplanting and lifting. For this reason, they will develop into smaller trees than the fall transplants (figs. 6 & 7).



Figure 6--Fall sown Miniplugins transplanted in April 1990 (photo: July 5, 1990).

On the other hand, the spring transplanted Miniplug+1 will still have a good mass of fibrous roots because of its many root starts and the absence of pot-boundness.

Miniplug Production for Fall Transplanting

Sowing normally takes place in early to mid-April. Due to the small container



Figure 7--Fall sown Miniplugins transplanted in April 1990 show good height and root development by early July.

cavity size and dense spacing, the seedlings are produced in short growing periods (4-5 months) (fig. 8).

The spring sown seed germinates rapidly and the seedlings also develop rapidly at near natural growing conditions. Growing during the summer, under near natural growing conditions, is less cumbersome and less expensive when compared to fall growing.

The nutrient requirement and growing schedule for this crop is similar to the fall sown crop (see Tables 1, 2 & 3 and Figs. 9 & 10).

Hardening of the seedlings for transplanting is also important. The seedlings need to have the proper morphological and

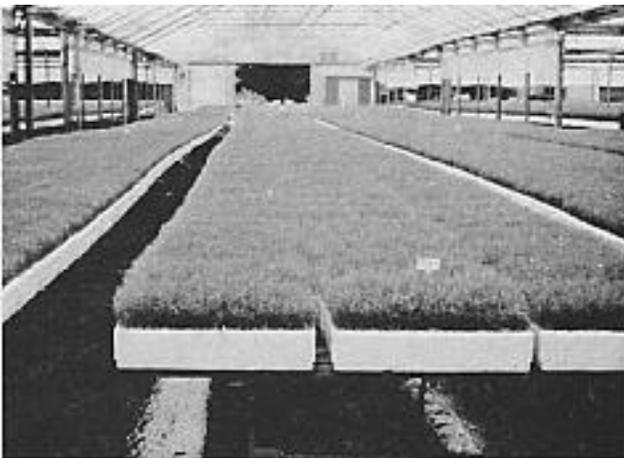


Figure 8--Spring sown Mini-plugs raised in shelterhouse for fall transplanting.

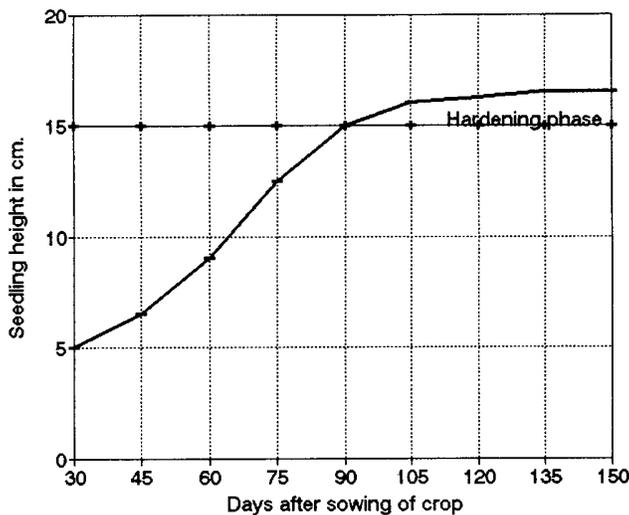


Figure 9--Target heights for spring sown Mini-plugs.

physiological condition for successful transplant development. Transplanting normally takes place during September.

Fall Transplanting of Mini-plugs

Fall transplanting works well when the seedling's are conditioned for the open field over wintering requirements. Most species are suitable for this. However,

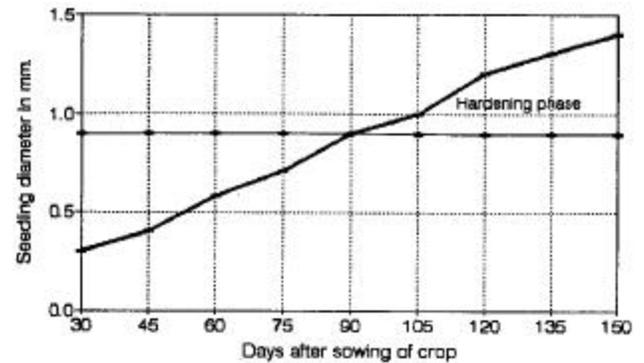


Figure 10--Target diameter for spring sown Mini-plugs.

there are some species like Western Hemlock and true firs that set bud late. Therefore, they don't do well when fall transplanted.

There are several good reasons for fall transplanting Mini-plugs. These are the following:

- Seedlings removed from greenhouses late August or early September provide space for a second crop.
- Fall transplanted plugs continue bud development, lignification and maintain active root and diameter growth in the bareroot nursery bed. This primes the seedlings for early budburst and more rapid growth during the following growing season (figs. 11 & 12).
- They develop into larger seedlings than the spring transplants and have a heavier and more fibrous root system.
- The husky transplants are produced at a lot lower cost than the similar size Styro-2 transplants.

While there are some highly desirable advantages in fall transplanting there are some disadvantages, also. These include:

- The problem of over wintering a freshly transplanted crop under potential adverse weather conditions in the bareroot nursery. With good species selection and hardened crops this, however, is seldom a problem.
- The bareroot nursery space cycling is more difficult.
- The seedlings occupy the bareroot nursery space longer than the spring transplants do. Due to this the bareroot production phase for fall transplanting is higher. This higher cost is somewhat compensated by the lower container or first phase production costs.

Packaging, Handling and Shipping

The crop is ready for transplanting when the seedlings are in the proper physiological and morphological stage. At this stage, the stems are lignified enough to allow extraction of seedlings from their containers without injury. The root plugs are firm enough to hold together during shipping and transplanting.

All plugs are packaged in a pre-extracted form. Such a packaging method is a routine operation in container nurseries. Most nurseries have an assembly-line type packaging operation. This makes the process quick and cost effective. About 100 seedlings are removed from 1/4 of the HAHN 408 styroblock to form a seedling package. The root plugs of these seedlings are placed into a plastic bag to protect the roots. About 30 of these bags fill a 14"x20"x16" shipping box. The stacked boxes on pallets are easily moved into cold storage or loaded onto refer vans for shipment. One 40 foot van has the capacity to transport about 1.8 million seedlings in one shipment.

Shipping and storing large quantities of Miniplugs are convenient and inexpensive. This makes it easy to keep up with a rapid transplant operation.

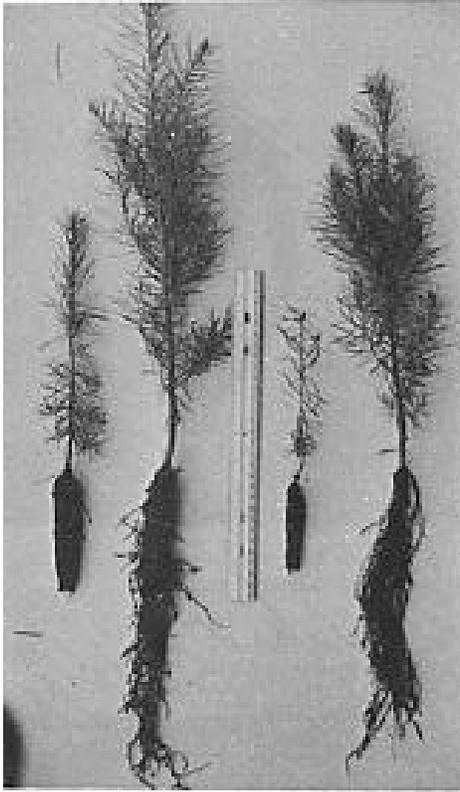


Figure 11--Fall transplanted plug comparisons. From left to right: (Plug (Styro=2), Plug+1, Miniplug (Styro-1) and Miniplug+1 (photo: June 6, 1990).



Figure 12--Fall transplanted Miniplugs almost ready for hardening (Photo July 5, 1990).

BAREROOT GROWING PHASE

As soon as the Miniplug seedlings arrive at the transplant nurseries, the second or bareroot growing phase for Miniplug+1 production begins. Naturally, by this time, the bareroot nursery must be ready to schedule and carry out the transplanting.

The bareroot nursery operation to produce Miniplug+1 is similar to Plug+1 production. However, some adjustments are needed in the equipment used and in cultural practices.

Bed Preparation

Timing transplant bed preparation is relatively easy for fall transplanting because of good climatic conditions during late summer. Fall transplanting also helps in shifting some of the workload from the heavy spring transplanting load.

Both fall and spring planting bed preparation requires similar plowing, discing, rototilling, soil-loosening and bed shaping procedures. Precise bed shaping is more important for Miniplugs, because of their smaller size, than for larger seedling types.

Planting and Handling

Mechanized transplanters with some modifications are highly suitable for Miniplug transplanting. Due to the smaller seedling size, the transplanter is equipped with smaller plating shoes. The smaller shoes are put closer on the row. This way the 6-8 row planters are converted to 9-12 row planters (fig. 13). Nine row planters are successfully used and a pilot model 12 row planter is being considered for future development.

Closer seedling spacing increases the efficiency of the expensive bed space utilization. This lowers the bedspace associated cultivation and growing cost, too. When these savings are added to the savings from the Miniplug production the overall seedling cost becomes one of the lowest among transplant seedling types. Besides its low cost, it has all the good qualities (bushy top, strong stem, fibrous roots, etc.) the Plug+1 transplants demonstrated in the past.



Figure 13--Nine row transplanter. Suitable to transplant Miniplugs.

Rearing of the Transplanted Crop

The bareroot rearing practices for Miniplug+1 production is similar to those used for Plug+1 production. The only exception might be the lack of need for top mowing. However, at the rate the fall transplanted Miniplug are growing, this may not be an exception either (see fig. 12).

Due to the detailed discussion of Plug+1 transplant production in the Forest Nursery Manual (see Chapter 16), the discussion of this is omitted in this paper.

CONCLUSION

Miniplug+1 transplant seedlings are the newest and just one more seedling type among the many available for reforestation. There is no doubt that they will fill a special purpose but will not cure all re-forestation problems. They show special qualities and abilities to perform well if produced and used properly. They are produced in the shortest time out of all transplants and they are the most economical.

LITERATURE CITED

Hahn, Philip F. Forest Nursery Manual, 1984. (Edited by Duryea, Landis), pp 165.