RESEARCH WITH CONTAINERIZED SHRUBS AND FORBS IN SOUTHERN IDAHO[1]

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Abstract.--Research on ways to revegetate deer winter range in Idaho has included several trials with containerized seedlings. Problems with potting mixtures, seed treatment, plant density, disease, age and size at planting time, and cold-hardening are briefly discussed. First-year survival for a number of shrub and forb species is also given.

INTRODUCTION

Both human activities and natural events result in land areas deficient in desirable amounts and kinds of vegetation. Fires, floods, landslides, overgrazing, mining, and numerous earth-moving projects partially remove or completely eliminate desirable plant cover.

Man has attempted to revegetate disturbed areas primarily in three ways: letting nature run its course, and managing, with varying degrees of success, the resulting natural vegetation; sowing the seed of desirable plant species; or transplanting young plants grown in nurseries or greenhouses.

In many instances, transplanting has been the only practical method, although it is usually the most costly and time consuming. Growing and transplanting in small containers may become a more successful and more economical method of establishing plants for some purposes than using bare-root stock grown in nursery beds.

Several advantages have been attributed to containerized seedlings: a shorter growing period, less transplanting shock to the root system, a possible extension of the planting season, and--in some cases--decreased production costs. Also, the potential exists for growing planting stock more uniform in size as a result of carefully controlled moisture, temperature, and nutrient conditions.

Seed of useful shrub and forb species is often scarce and expensive. Growing seedlings in small containers offers a way to make efficient use of valuable seed. Also, containerized planting stock may be developed that can be handled more quickly and easily than bare-root stock, and is adaptable to new methods of mechanized planting.

There is little likelihood that any system devised for growing and planting a wide variety of species in wildland areas can overcome the physical and biological obstacles to revegetation encountered in all instances.

Containerized seedlings cannot overcome extremely adverse climatic or soil factors. Choosing species adapted to each particular site, adequate site preparation, and use of healthy planting stock during the proper season will remain factors vital to successful seedling establishment. In many instances, the use of containerized seedlings will not extend the length of the planting season. In semiarid regions, early spring planting will continue to be necessary to permit rapid development of a deep root system.

Perhaps the most difficult problem to solve in the successful establishment of container-grown seedlings is the proper degree of cold-hardening before planting. We are trying to achieve rapid, vigorous growth during the first several weeks after germination, yet we usually need seedlings tough enough to withstand wide extremes of temperature at the planting site. A great many shrub and forb species may be useful in revegetation efforts. Much research and empirical testing are needed to determine the best techniques to obtain cold-hardy seedlings.

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This paper summarizes recent research experience with containerized shrubs and forbs in southern Idaho studies aimed at finding optimal methods of revegetating areas deficient in desirable plant cover, particularly game range.

TYPES OF CONTAINERS

All of the numerous types of containers have been developed with the objective of growing a satisfactory, plantable seedling, while decreasing costs and time required and increasing planting success.

Federal and State range managers we have consulted have hesitated to enter large-scale revegetation programs with shrubs because of the costs involved and the lack of a nearly foolproof planting technique. They want a method that will show results nearly as predictable as planting corn in the black, prairie soils of Illinois, and be at least as inexpensive. Today, the primary factor in most revegetation projects is the cost of labor. Therefore, in game range revegetation research, we have sought planting methods that would keep cost per acre as low as possible.

Low costs apparently are directly related to using the smallest plants that will survive when transplanted. Thus, in the early work with containerized planting, small containers such as the Ontario plastic tube and the Walters bullet were used.

Some types of containers--the paperpot, Conwed tube, and polyloam block--could possibly be planted from a tree planter pulled by a tractor. To date, we have not heard of this being done in the Western United States.

The development of the plastic bullet and planting gun by Dr. John Walters of the University of British Columbia over a decade ago (Walters 1961), has been the biggest advance in time-saving for wildland transplanting. All other types of containers require digging or drilling a planting hole, inserting the container, and repacking the soil around it. In our experience with the Walters bullet, the chief drawback to its use is the tendency to frost heave during the first winter following planting. Unless the seedling's roots secure a strong "grip" on the soil, the alternate freezing and thawing of the soil during the following winter "heaves" the bullet up out of the ground. The degree of frost heaving will vary greatly depending on soil and climatic conditions and on the extent of root growth made by the plant during the first growing season. We also found that forcing the bullet into the soil became much more difficult as soil moisture decreased.

The 11.5 cm- and 14 cm-size bullets have sufficient volume for suitable growth of some shrub species but have seemed somewhat small for others, such as curlleaf mountain-mahogany.

The rigidity of the plastic bullet may impede rapid root growth of some species, an important factor in seedling establishment on hot, semiarid sites. Figure 1 shows root growth from bitterbrush, penstemon, and wedgeleaf ceanothus plantings.

Figure 1.--Bitterbrush, penstemon, and wedgeleaf ceanothus (left to right, 16 months, 3 years, and 2 years, respectively, from date of transplanting in bullet container). Bitterbrush roots split the bullet in one growing season. Penstemon roots failed to break the bullet apart, but successfully penetrated the surrounding soil. Ceanothus has spread, but not broken, the bullet; roots have successfully penetrated the soil (plant tipped to one side to expose roots).

Further research is needed to determine whether modification of the shape, size, and composition of the Walters bullet could increase its usefulness and still retain the advantage of rapid plantability.

Any container with impermeable sides tends to deform the root system of the seedling. The amount of root deformity probably increases the longer the plant is grown in the container before being transplanted to the field. Modification of the root system may be of greater harm to trees than to shrubs and forbs; however, this has not yet been studied. The inner walls of several types of containers have recently been redesigned with vertical ridges that tend to prevent roots from spiraling.

Such wall-less containers as the polyloam block, BR-8 block, and extruded or compressed forms allow a more natural branching of the root system. The problem with these containers is the need to find some way to keep the units separate before planting, so that the roots of adjacent plants do not become entwined.

We can expect additional new ideas for container types and the mechanics of handling them during both the growing period and the transplanting job.

POTTING MEDIA

Almost everyone who enjoys raising plants, for fun, profit, or because it is his job, has his own ideas on the best growing media. The University of California (Baker 1957), Cornell University (Boodley and Sheldrake 1967), and other universities have accumulated considerable knowledge on potting mixtures for growing plants in containers.

Potting mixtures suitable for commercial production of plants in greenhouses or nurseries may need to be modified to grow containerized seedlings destined for planting in the often severe microclimates of wildland sites. Lightweight potting mixtures are needed to permit easy and inexpensive transportation to the planting site. Suitable mixtures must have high moisture-holding capacity so that when the container or plug is planted the root system will have sufficient moisture to sustain it while new roots are penetrating the surrounding soil; e.g., Owston (1972) reported that a fine ground peat moss and vermiculite mixture retained about 2-2/3 times as much available water as did a sandy soil. The ingredients of the potting mixture must be convenient to obtain and easily mixed. Also, the mixture must be suitable for growing a variety of plant species to the desired size and vigor for field planting.

A peat moss-vermiculite potting mixture meets these criteria reasonably well. In 1971, we seeded 3,000 Walters bullet containers (11.5-cm size) to curlleaf mountain-mahogany (Cercocarpus ledifolius Nutt.). Six different potting mixtures were used, each in 500 bullets (table 1).

Our objective was to see if one of the potting mixtures would yield better mountain-mahogany seedlings than the others. Since the plants were to be studied after field planting, no quantitative data were taken except for information on the number of bullets with emergent seedlings. However, it was obvious that the largest seedlings with the best coloration were grown in the only medium not containing sand (fig. 2). These results indicated that a peat moss-vermiculite mixture could produce excellent seedlings.

Table 1.--Potting mixtures used in bullet containers for growing curlleaf mountain-mahogany

Supplemental nutrients	Basic ingredients by volume: Fine sand	Canadian peat moss	Horticultural vermiculite
	----------*Percent*----------		
None	60	40	--
	33.3	33.3	33.3
Cornell Peat-lite Mix[1/]	--	33.3	66.7
	33.3	33.3	33.3
California Mix 1(C)[2/]	50	50	--
	33.3	33.3	33.3

[1/] Adapted from Sheldrake (1970):

	g/0.028 m^3
Calcium carbonate	200
Gypsum	84
Calcium nitrate	25
Treble phosphate (0-45-0)	19
Osmocote (18-6-12)	34
Chelated iron (Sequestrene)	1
Fritted trace elements(FTE#503)	3

[2/] Adapted from Baker (1957):

	g/0.028 m^3
Calcium carbonate	34
Dolomitic lime	101
Treble phosphate (0-45-0)	19
Gypsum	8
Potassium sulfate	4
Potassium nitrate	4

Figure 2.--Curlleaf mountain-mahogany seedlings grown in three different potting mixtures for

Slow-Release Fertilizer

Since the Cornell Peat-Lite mixture gave good results with Cercocarpus seedlings, we decided to continue its use as a basic potting mix.

One of the ingredients in the Peat-Lite mixture is Osmocote (18-6-12), a type of slow-release fertilizer. In 1971, we tested the effect of varying the amount of Osmocote in a modified Peat-Lite mixture. Bitterbrush (Purshia tridentata (Pursh) DC.) was the test plant.

The potting mixture consisted of equal parts (by volume) of shredded peat moss and horticultural vermiculite and these supplements:

Supplement	*g/0.028 m^3*
Ground limestone	200
Treble phosphate (0-45-0)	19
Calcium sulfate	84
Iron (chelated)	1
Fritted trace elements	3
Osmocote (18-6-12)	varied by treatment

Osmocote was added in amounts of 0, 34, 68, or 102 g/0.028 m^3 of mix. Four different mixtures were used, each in 500 bullet containers. Four seeds were sown in each bullet, and all containers were placed in a growth chamber in which the temperature was held at 4 degrees C for 11 weeks. The bullets were then placed in a greenhouse where temperature was maintained at 18° to 22° C during the day and 13 degrees to 18 degrees C at night.

Seedling emergence began within 48 h and appeared to be quite uniform within treatments. However, an analysis of variance indicated a significant difference among treatments ($P = <0.01$). Application of either Tukey's or Keul's test to treatment means indicated that seedling emergence was significantly lower in the control treatment (no Osmocote added) than in the other three treatments ($P = <0.01$), and that there was no significant difference in emergence among the three treatments receiving the Osmocote.

Height measurements, taken when seedlings were 1 month old, showed that the Osmocote-fertilized seedlings were similar in size and about 25 percent larger than the unfertilized (control) seedlings. Additional height measurements taken at 2 months (just before transplanting to the field) and at 8-1/2 months are shown in table 2.

The addition of slow-release fertilizer to the potting mixture increased the rate of seedling growth before field planting. Fertilized seedlings were still 35 to 50 percent larger near the end of one growing season, but the growth of fertilized and unfertilized seedlings during the growing season was nearly equal. Thus, the benefits of fertilizing seemed to be reflected primarily in the availability of larger, more robust seedlings at planting time. The advantage of larger seedlings was shown when statistical analyses of survival data indicated that survival was significantly lower ($P = <0.05$) among control seedlings (x = 9 percent) than among fertilized seedlings. There was no significant difference in survival among seedlings of the three fertilized mixtures (means: 35, 39, and 48 percent). The smaller control seedlings were much more susceptible to destruction by grasshoppers than the larger seedlings.

Table 2.--Mean height of bitterbrush seedlings receiving different amounts of Osmocote (18-6-12) slow-release fertilizer in the potting mixture

Osmocote added	Height at			
Treatment	2 months		8½ months	
g/0.028 m^3	*mm*	*in*	*mm*	*in*
0	23	0.9	106	4.2
34	61	2.4	138	5.4
68	70	2.8	134	5.3
102	68	2.7	149	5.9

Current Potting Mixture

During the past 2 years, we have used a uniform potting mixture for a variety of shrub and forb species grown in several types of small containers. The mixture is a slight modification of that recommended by Sheldrake (1970) for the ring and trough culture of tomatoes in greenhouses. The following components are added to each 0.028 m^3 of a basic mixture of equal parts by volume of finely shredded Canadian peat moss and horticultural vermiculite:

Component	*Grams*
Treble phosphate (0-45-0)	21
Gypsum	84
Dolomite (finely ground)	187
Agricultural lime	27
Calcium nitrate	27
Osmocote (18-6-12)	36
Fritted trace elements (#503)	3.2
Chelated iron (Sequestrene)	0.8
Surfactant (Biofilm)	2

The amounts of Sequestrene and Biofilm shown are mixed in 2 liters of water and gradually mixed with the peat moss and vermiculite. The remaining components are then thoroughly mixed together and sprinkled in gradually.

This mixture undoubtedly can be improved. The combination of peat moss and vermiculite will not always result in a firm plug when taken from a container, such as the Spencer-Lemaire bookplanter, especially if the mixture is a bit dry when extracted or if the seedlings roots are not fine and well branched. Some shrub species require a longer period of time than others to produce a sufficient root mass to hold the potting mixture together. The addition of an ingredient that will serve as a binder may be very helpful when the seedling is to be removed from its container for transplanting.

Obviously, many variations of nutrient ingredients are possible. Ingredient research may be most efficiently done by those responsible for the mass production of containerized planting stock.

The following tabulation gives plant species grown in our potting mixture, in Spencer-Lemaire bookplanters, at the Forest Service greenhouse in Boise during the winter and spring of 1974. Also shown is the percentage of units with seedlings after 25 days of germination. More than one value indicates tests of seeds from different sources.

Species	Units with Seedlings *Percent*
Amelanchier alnifolia	0
Amorpha fruticosa	90, 97
Artemisia tridentata	40, 8
Arctostaphylos uva-ursi	0
Atriplex canescens	33
Balsamorhiza sagittata	96, 59
Berberis repens	8
Caragana arborescens	96
Ceanothus cuneatus	34, 44
Ceanothus integerrimus	47
Ceanothus lemmonii	86
Ceanothus martinii	55
Ceanothus prostratus	8
Ceanothus sanguineus	79
Ceanothus velutinus	92
Cercocarpus montanus	100, 12
Cercocarpus ledifolius	86, 90, 97, 6, 29, 84, 85
Cercocarpus ledifolius intricatus	67
Chrysothamnus nauseosus	33
Clematis ligusticifolia	88
Cornus stolonifera	100
Cotoneaster acutifolia	0
Cowania mexicana stansburiana	100, 100
Cupressus arizonica	46, 68
Ephedra viridis	81, 96
Eriogonum umbellatum	26, 27
Fallugia paradoxa	70
Fraxinus anomala	0
Grayia spinosa	83
Holodiscus discolor	2
Penstemon fruticosus	32
Penstemon fruticosus scouleri	30
Purshia glandulosa	99
Purshia tridentata	10, 100, 100, 100, 98, 99, 100, 56
Rhus glabra cismontana	10
Rhus trilobata	71
Rosa woodsii	14
Sambucus racemosa	42
Shepherdia argentea	0
Shepherdia rotundifolia	63
Sorbus scopulina	0
Symphoricarpos albus	10

SEED TREATMENT AND GERMINATION

Only 17 of the 43 plant species exhibited sufficient germination to yield seedlings in 70 percent or more of the container units, even though each unit received several seeds.

These results indicate that anyone attempting to grow seedlings of a large number of species is faced with a formidable task; preconditioning requirements for different kinds of seeds and conditions for optimum seed germination can vary greatly. With limited facilities for germinating and raising containerized planting stock, the grower will likely have to choose shrub and forb species that have similar requirements if he is to grow satisfactory plants simultaneously. An alternative would be to work with only a few species.

The species grown at Boise in 1974 were all sown directly into bookplanters in late November 1973. Of the species listed, only seed of the seven Ceanothus species received any pretreatment. All Ceanothus seeds were poured into water heated to, or just below, the boiling point. The mixture was allowed to cool from 8 to 16 h. Seeds were then spread to dry before being planted in our potting mixture. Following a thorough watering, all containers were exposed to natural winter conditions for the next 10 to 11 weeks. After being returned to the greenhouse in February, all species were subjected to the same temperature conditions, a constant 22 degrees to 27 degrees C. Considering differences in stratification and germination requirements, it is a bit surprising that we obtained as many seedlings of the various species as we did.

The grower of shrub seedlings can refer to several publications for aid in selecting methods useful in the treatment of seeds to obtain satisfactory germination. Helpful information has been published by Nichols (1934), Griswold (1936), McKeever,[3] Glazebrook,[4] USDA For. Serv. (1948), Stone and Juhren (1951), Hubbard (1958), Adams and others (1961), Quick and Quick (1961), Yelenosky (1961), Corns and Schraa (1962), Emery (1964), Springfield (1970a, 1970b, 1973), Wright (1967), Heit (1968), Plummer and others (1968), Aldon (1970), Hogue and LaCroix (1970), McDonough (1970), Chan and others (1971), Frolich and others (1971), Conrad and McDonough (1972), and Sorensen and Holden (1974).

PLANT DENSITY

Plant density is one matter that needs careful study in the growing of containerized seedlings. The degree of crowding of closely spaced plants in containers will affect not only growth rate and form, but the cost of pro duction as it affects space requirements. Also, density could affect the incidence and spread of plant disease, and the efficacy of disease control.

Growers, who raise trees in containers, usually desire a single plant per container. However, one of the things that needs further study is the effect on survival and growth of planting more than one shrub seedling in a spot. There is little doubt that growing more than one plant per small container will result in great variation in plant size and will decrease the overall rate of growth prior to transplanting. Whether or not this is of critical importance in growing shrubs remains to be determined.

For the grower, the inefficiency resulting if more than 5 percent of his containers fail to yield plants is obvious. He has several choices. He can sow a single seed in each container, in which case only an exceptionally clean lot of seed of high viability will yield seedlings in nearly all containers--providing germination conditions are optimal. He can sow several seeds in each container (as we have at Boise) and pay the cost of subsequent thinning. Or, he can bring his seeds to the point of germination in a germinator and then sow a single seed per container, thereby increasing his chances of obtaining a high percentage of containerized planting stock. However, many shrubs and forts have very small seeds, which makes it difficult to sow one seed at a time. With these species, thinning may be the only practical method of obtaining the density desired.

DISEASE PROBLEMS

The literature abounds with references on means of combating plant diseases in the nursery and greenhouse. Usually, each grower chooses methods that are practical and successful for his particular situation.

Once found, normally successful methods must be religiously followed, because the moist, nutrient-rich environment required for the rapid growth of containerized seedlings is often tailormade for rapid infection by and spread of lethal disease organisms.

Even if the grower sterilizes his potting mixture before seeding, the seed used may be infested with one or more disease organisms. Some seeds can be safely and successfully treated to eliminate pathological organisms, but other seeds are difficult to treat. It seems only prudent for the grower to continually experiment with new and better chemical means for preventing or controlling outbreaks of disease.

We have had reasonable success in halting or suppressing damping-off diseases by using a mixture of Benlate (methyl 1-(butylcarbamoyl) -2-benzimidazole-carbamate), and Dexon

3/Donald Gibson McKeever. The effect of various methods of treatment on the germination of seeds of some plants valuable for game and erosion purposes. Master Sci. Thesis, Univ. Moscow, Idaho. 1938.

4/Thomas B. Glazebrook. Overcoming delayed germination in the seed of plants valuable for erosion control and wildlife utilization. Master Sci. Thesis, Univ. of Idaho, Moscow, Idaho. 1941.

(p-(dimethylamino) benzenediazo sodium sulfonate). We mix 1.2 g of Benlate 50 and 0.09 g of Dexon 35 per liter of water. This mixture is used liberally as a drench immediately after sowing the seed and again at the beginning of the germination period. To date, we have not detected any phytotoxic effects on any plant species we have grown.

All growers of containerized planting stock would be aided immensely if new disease prevention and control methods were reported soon after their discovery.

AGE AND SIZE AT PLANTING TIME

Since it is hoped that containerized planting stock can be produced in a shorter time than is required to grow bare-root stock, determination of the optimum seedling size for transplanting is an immediate consideration. The grower and user must ask, "What size and age of seedling is most practical to raise and handle to attain maximum survival after transplanting."

The rapid growth rate of some shrub species --fourwing saltbush (Atriplex canescens (Pursh) Nutt.) and deerbrush ceanothus (Ceanothus integerrimus H. & A.)--often makes it difficult to grow 1-0 nursery stock that is not too large for efficient handling. The range of differences in rate of seedling growth among shrub species results in some species in containers reaching planting size in 6 weeks, and other species in 10 to 12 weeks. Growers specializing in particular species will most likely be able to modify growing conditions to such an extent that nearly all shrub and forb species can be large enough and hardy enough for field planting at 12 weeks of age.

Figure 3 illustrates the variation in rate of growth among shrub species grown under the same environmental conditions.

HARDENING-OFF BEFORE PLANTING

Container-grown seedlings, started during January or February and intended for planting in March or April, will be exposed to the same danger of cold damage as newly emerged seedlings. We are faced with the probability that some species are more cold tolerant than others. Nevertheless, when we have invested in growing and planting a large number of seedlings, we should seek ways to precondition young plants so as to maximize their tolerance of normal frost occurrences.

Spring frosts and subfreezing air temperatures are responsible for mortality among natural seedling populations. We have little assurance that we can completely coldproof container-grown seedlings by any method; however, some steps can be taken.

Seedlings could be started a month earlier to permit a longer hardening-off period. Also, nutrients and moisture supplied the seedlings could be drastically reduced during the final 2 to 3 weeks before planting.

Very likely, successful cold hardening will require storage in greenhouses or other holding facilities in which temperature (and possibly day length) can be closely controlled. Much additional research is needed to find out how much cold hardening is possible and how the grower can treat large numbers of plants economically.

SHRUB AND FORB SURVIVAL IN IDAHO

Our first trial planting of container-grown shrub seedlings was in the spring of 1969. Four hundred and fifty-three Walters bullets (6.4- to 14-cm size) containing bitterbrush

Figure 3.--Indigobush, big sagebrush, and curlleaf mountain-mahogany seedlings (left to right) 7-1/2 weeks old, grown at constant greenhouse temperatures (mid-seventies) for 5 weeks and at fluctuating temperatures thereafter.

seedlings were planted in well-drained, granitic soil. Most seedlings were only 5 weeks old, though about 60 were nearly 13 weeks old. Establishment and growth during the first 2 months following planting was excellent. However, during late June, July, and August grasshoppers girdled and defoliated many seedlings; virtually all mortality resulted from grasshopper destruction. Final survival was 59 percent. Many bitterbrush seedlings attained a height of 18 cm by October. There seemed to be no relation between bullet length and percentage survival. Figure 4 shows this planting 5 years later.

In 1970, a small trial of 247 Walters bullets, containing a variety of 12 species, was a failure (table 3). Several factors contributed to seedling mortality: seedlings were only 6 to 7 weeks old when transplanted on a dry south slope late April, and little rain fell during the following 2 weeks; mice and ants cut off numerous seedlings; and frost heaving took a heavy toll the first winter.

Figure 4.--Five-year-old bitterbrush plants established by transplanting in Walters bullet containers. (Ada County, Idaho.)

Table 3.--Survival of tree, shrub, and forb species transplanted in bullet-type containers

Species	Year of Planting					
	1970		1971		1972	
	Number planted	Percent survival	Number planted	Percent survival	Number planted	Percent survival
Amelanchier alnifolia	2	0				
Amorpha fruticosa	14	0				
Artemisia tridentata					9	66
Atriplex canescens			85	7	33	79
Balsamorhiza sagittata			20	0	46	0
Ceanothus cuneatus	2	0	10	0	97	26
Ceanothus integerrimus	10	0			96	12
Ceanothus lemmonii					39	3
Ceanothus martinii			3	0	12	8
Ceanothus prostratus					44	43
Cercocarpus ledifolius	68	0	1,880	37	48	4
Cercocarpus montanus	4	0	13	0		
Cowania mexicana	6	0	21	0	47	0
Cupressus arizonica					14	1
Cupressus sempervirons			25	0	22	14
Ephedra viridis			5	0	15	0
Grayia spinosa	42	0	20	0		
Lupinus latifolia			11	0		
Penstemon acuminatus			30	10		
Penstemon deustus					48	70
Pinus brutia			21	0	13	0
Pinus halepensis			25	0	21	0
Purshia glandulosa					121	12
Purshia tridentata	75	9	1,700	35	314	17
Rhagodia baccata	17	0	32	0		
Rhus trilobata	2	0				
Sophora arizonica	3	0	4	0		
Thuja orientalis			21	0	10	0

In the 1971 test involving four levels of slow-release fertilizer in the potting mixture, 33 percent of 1,200 seedlings survived the first growing season. These bitterbrush seedlings were planted March 30 at 9 weeks of age after a 2-week hardening period before planting. A minimum of 50 percent of the mortality was caused by grasshoppers and 10 percent by browsing deer.

That same year, 500 bitterbrush, 1,800 curlleaf mountain-mahogany, and 300 assorted plants of other species were also planted in bullet containers (table 3). Only bitterbrush and curlleaf mountain-mahogany exhibited moderate success. Extremely heavy or complete mortality among other species was not necessarily a result of the planting method. All these species were exotic. Also, a severe grasshopper infestation in southern Idaho was an important decimating factor.

In 1972, approximately 1,000 seedlings, comprised of 17 different shrubs and two forbs, were planted in Walters bullets. Again, survival of most species was low (table 3). However, the fact that 79 percent of the fourwing saltbush seedlings and 70 percent of the penstemon became established indicates that this type of small container can be used successfully.

In the spring of 1973, 320 curlleaf mountain-mahogany in 3- by 15-cm paperpots were planted on an extremely dry winter-range site near Challis, Idaho. At the time of planting, seedlings were 9 weeks old, about 2.5 cm tall, and had not received any cold-hardening Despite their small initial size, 55 percent of the plants were still alive in late September.

On the same site and date, 150 curlleaf mountain-mahogany seedlings were transplanted from BC/CFS styroblock containers. These seedlings were the same age and approximately the same size as those in the paperpots. However, it was difficult to extract them from the styroblock units without damaging the root system. Only 6 percent survived the summer.

We have discussed recent work with containerized shrubs and forbs in southern Idaho directed at finding the best means of revegetating areas deficient in desirable plant cover, particularly game range. We have made no detailed comparison of results obtained from planting containerized seedlings on the same sites and at the same time as nursery-grown bare-root transplants. However, the primary advantage held by bare-root stock is the inherent hardiness of plants that have survived an entire growing season and dormancy before being lifted and transplanted. We can raise containerized seedlings that are equal in size to bare-root stock, but it is difficult to achieve hardiness in plants only 6 to 12 weeks old. As a result, spring frosts and all forms of insect and animal damage are usually more destructive to containerized seedlings than to bare-root stock.

Although it is perhaps too early to predict the ultimate usefulness of containerized shrubs and forbs in revegetation efforts, growing and transplanting plants in small containers may become a more successful and more economical method of establishing seedlings for some purposes than using bare-root stock grown in nursery beds. The speed of production and availability on short notice that allow the user of containerized stock to take advantage of special planting opportunities are important factors in any comparison with bare-root transplants. It may also be found that some plant species can be transplanted more successfully as container-grown seedlings than as bare-root stock.

In the long run, the user will decide what kind of planting stock best suits his particular needs, but research can play an important part in examining the alternatives.

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