TRANSPLANTING LARGE PIÑON AND JUNIPER TREES ON RECLAIMED COAL MINE SPOIL IN NORTHERN NEW MEXICO[1]

by

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Abstract. Establishment of conifers on reclaimed minespoils often is accomplished with seedlings less than 3 years old. However, in the semi-arid Southwest, it may require decades before these trees are large enough to provide habitat for wildlife. The objective of this study was to determine the effect of tree size on the establishment success of piñon (Pinus edulis) and juniper (Juniperus osteosperma). Trees were separated into 3 sizes and balled and burlaped in the spring of 1990. The ball sizes conformed to Colorado Nursery Association standards for native stock. The median age of the trees was 45 yr (range = 25-97 yr) with height ranging from 0.5 m to 2.7 m. Survival across all treatments averaged 42% and appeared to be unrelated to species and tree size. Rather, survival was correlated with ball size, handling, and time between digging and transplanting. Trees with rootballs that did not meet the minimum size standards did not survive as well as those with larger rootballs. Likewise, trees that were heeled in for 4-6 weeks prior to planting or lifted after budbreak in May had lower survival than other trees. The best digging and handling conditions resulted in a 68% survival rate for both piñon and juniper.

Additional Key Words: reforestation, ball and burlap.

[1] Paper presented at the 1991 National Meeting of the American Society for Surface Mining and Reclamation, Durango, CO, May 14-17, 1991.

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Proceedings America Society of Mining and Reclamation, 1991 pp 603-610
DOI: 10.21000/JASMR91020603
https://doi.org/10.21000/JASMR91010603

Introduction

Wildlife habitat is an important end use for reclaimed mine sites in the Southwest. An important prerequisite for wildlife use is the availability of cover. Hiding cover consists of shrubs and trees at least 0.6 m tall, while thermal cover consists of trees and shrubs at least 1.2 m tall. In the arid and semiarid Southwest, it could take years following seeding before reclaimed sites provide hiding cover and perhaps decades before thermal cover is provided. An alternative that could provide cover immediately is to transplant large trees and shrubs onto the reclaimed site.

Transplanting large trees and shrubs is a common practice in the ornamental landscape trade. In fact, both national and state standards exist for the size of planting stock, size of the rootball or container, and for plant vigor. However, these standards are designed for plants that will be planted into soil that has suffered minimal disturbance and supports at least some living organisms. Furthermore, these plants typically will be irrigated and maintained on a regular basis by the homeowner or landscape contractor. Thus, success of these plants is generally high.

Conversely, transplanting such plants into reconstructed mine soils presents very different problems. Reconstructed soils have low microbial populations (Fresquez et al. 1987) which can hamper nutrient availability and subsequent plant establishment. Also, mine sites are not intensively managed and may not be irrigated beyond the establishment phase. Plants transplanted onto mine sites must become established soon after planting and must adapt to nutrient-poor and microbe-deficient disturbed soils. Transplanting of small, containerized stock has been successful (Oaks, unpublished), as has moving large trees with either a tree spade or front-end loader. However, these studies have involved relatively small numbers of trees (generally less than 100 trees per study) and there have been few large-scale, operational trials.

The objectives of this study were to characterize the native piñon and juniper planting stock on the La Plata Mine and to evaluate the ability of native piñon and juniper to survive transplantation into mineland reclamation on an operational scale.

Materials and Methods

Piñon and juniper trees were dug by a commercial nurseryman in an area that had been chained about 35 years previously. The trees were dug according the Colorado nursery standards (Anon. 1988), balled, and burlaped. Digging began in mid-April 1990 and concluded the first week in June 1990. After digging, trees were moved to the planting site and mulched with straw until planted. Rootballs were watered every 1-2 days after digging. The trees were separated into 3 size categories and 50 trees of each species-size group were dug.

The size categories were small (0.3-0.9 m), medium (1.0-1.8 m) and large (1.8 -3.0 m). Three hundred trees were dug in all. Prior to planting, the height, stem diameter, and rootball diameter were measured for each tree.

The planting site was a west-southwest facing slope. Fifteen trenches (0.9 m x 0.9 m x 43 m) were excavated in mine spoil and backfilled with topdressing. The planting hole was amended with aged sawdust/bark and trees were planted on about 2 m spacing. Each trench was planted with 3 replicates of each species-size (18 total) in a randomized block design. Following planting, trees were hand-watered weekly for 1 month. Vigor and survival were monitored throughout the first growing season.

In addition to the planting study, the stocking, height, and age of piñon and juniper trees on the chained areas of the mine were assessed. Stocking and height were determined from annual vegetation surveys conducted by the mine. Age was determined by a subsample of the trees dug for the study.

Results

La Plata Mine has conducted vegetation surveys annually since 1982 (except 1987). Part of the mine is on native stands of piñon and juniper, which were chained to remove mature trees about 1955. Consequently, shrubs and seedling piñon and juniper are the only woody plants remaining. Inventories of these chained areas indicate that most of the trees are juniper (Fig. 1). Juniper stocking, averaged over the 8 inventories conducted since 1982, is 500 stems/ha, while piñon stocking averages only 30 stems/ha. Areas on the mine that were not chained contain fewer, but larger trees. More importantly, in the unchained areas, piñons constitute about 40% of the total tree population. In the chained areas, piñons comprise less than 10% of the inventory.

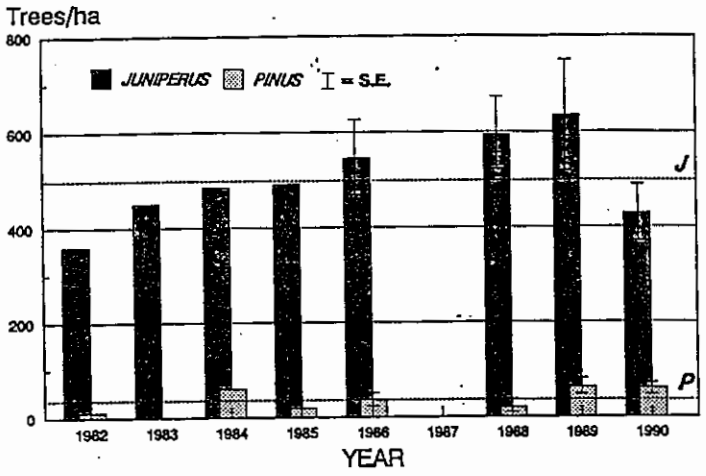

Figure 1. Inventory surveys of piñon and juniper in chained areas of the La Plata Mine. Inventories were conducted annually since 1982 with the exception of 1987.

Most of the trees in the chained areas were apparently seedlings in 1955 and survived the chaining operation. The average age of the junipers sampled was 44 yr (range = 23-97), and the piñons averaged 63 yrs old (range 27-80). Only 1/11 piñons and 5/19 junipers became established after the chaining, as they were younger than 35 yrs. Apparently, natural regeneration of piñon and juniper is slow at this site.

Growth, like natural regeneration, is also slow following chaining in this site. Most of the trees in the chained areas are less than 3 m in height (Fig. 2). Only 10% of the piñon and 15% of the juniper are greater than 3 m. Most of the piñon (70%) are in the 2-3 m height class, and no piñon found were less than 1 m in height. Junipers were found in each height class; however, most (45%) were in the 1-2 m height class.

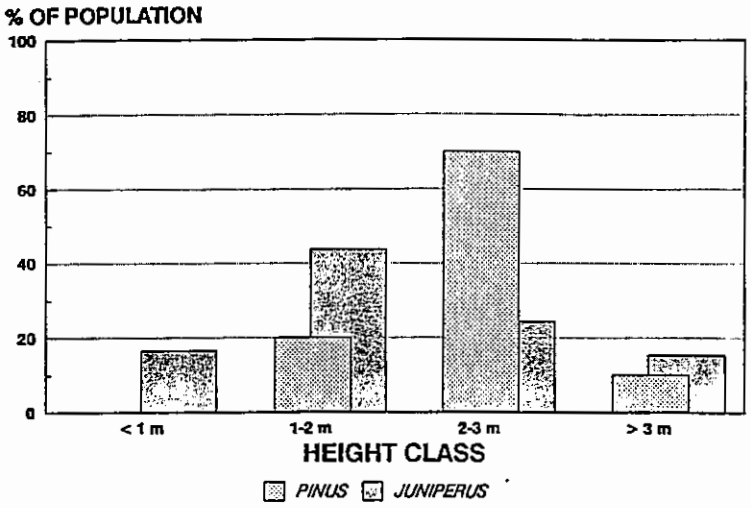

Figure 2. Height distribution of piñon and juniper in chained areas of the La Plata Mine. Measurements conducted during the 1990 vegetation survey.

Trees used in this study were dug over a 6 week period. Generally, the height of the small trees was slightly greater than planned (74 cm vs. 60 cm planned), while the height of the large trees was smaller than anticipated (200 cm vs. 240 cm planned) (See Table 1). The differences in height and stem diameter for all size classes were significant for both species. Also, the differences in ball diameter of juniper were significant for all size classes. However, for piñon, the medium-size ball was not significantly different from the small or the large rootballs, although the small and large rootballs were significantly different from each other.

While the differences among size classes were significant, the range among sizes overlapped and there was a strong correlation between the parameters measured. Stem diameter at ground line was highly correlated with plant height (Fig. 3). Diameter accounted for 63% of the variability in height of

Table 1. Size of piñon and juniper by height class. Within a species, parameters followed by the same lower case letter are not significantly different (p> .05).

Parameter	Juniper			Piñon		
	Small	Medium	Large	Small	Medium	Large
Height (cm)	72.9a	136.1b	209.0c	75.8a	135.7b	191.9c
Stem Diameter (mm)	24.6a	46.9b	77.8c	32.0a	55.9b	77.2c
Ball Diameter (mm)	30.2a	46.9b	53.6c	29.7a	38.0ab	47.3b
Survival (%)	36	24	49	36	58	51

juniper (Fig. 3A) and 82% of the variability in height of piñon (Fig. 3B). Diameters ranged from 9 - 150 mm, while height ranged from 25 - 300 cm.

Stem diameter also was highly correlated with ball diameter (Fig. 4). Diameter accounted for 71% of the variability in ball diameter of juniper (Fig. 4A), and 73% of the variability of piñon (Fig. 4B). Generally, the relationship between diameter and ball size followed the guidelines of the Colorado Nursery Association. The equation defining the relationship between ball size and diameter as specified by Colorado is:

$$\text{Ball} = 0.16 + 0.0057\ (\text{Diameter}) \quad (1)$$

where Ball is ball diameter (m), and Diameter is stem diameter (cm). In this study, the relationships were:

$$B_{juniper} = 0.22 + 0.0045\ (\text{Diameter}), \quad (2)$$

$$B_{piñon} = 0.25 + 0.0050\ (\text{Diameter}). \quad (3)$$

Generally, the rootball sizes conformed to the nursery standard. Piñon rootballs were slightly larger than recommended, while juniper rootballs were slightly larger for small trees and slightly smaller for trees with stem diameter larger than 60 mm.

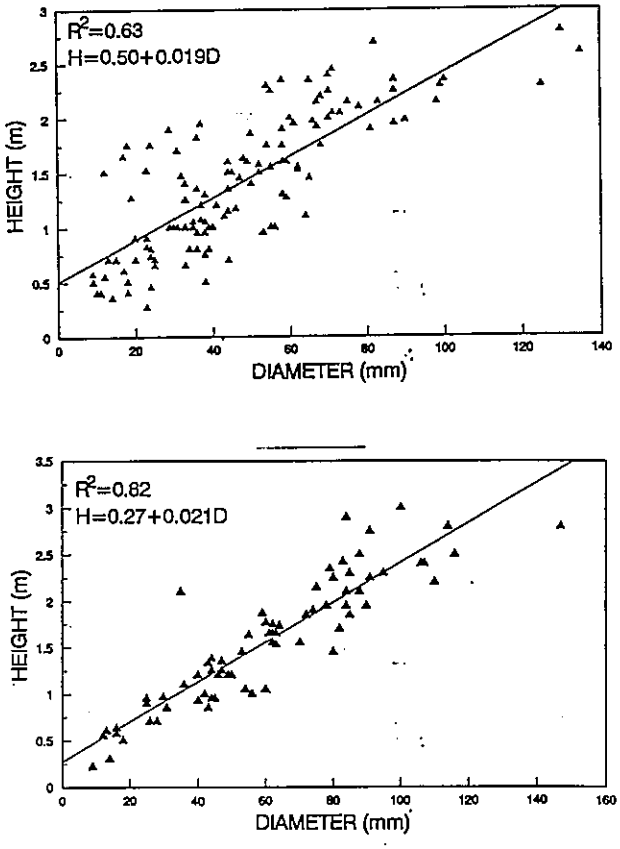

Figure 3. Relationship between tree height and trunk diameter at ground line where A = juniper, and B = piñon.

A

B

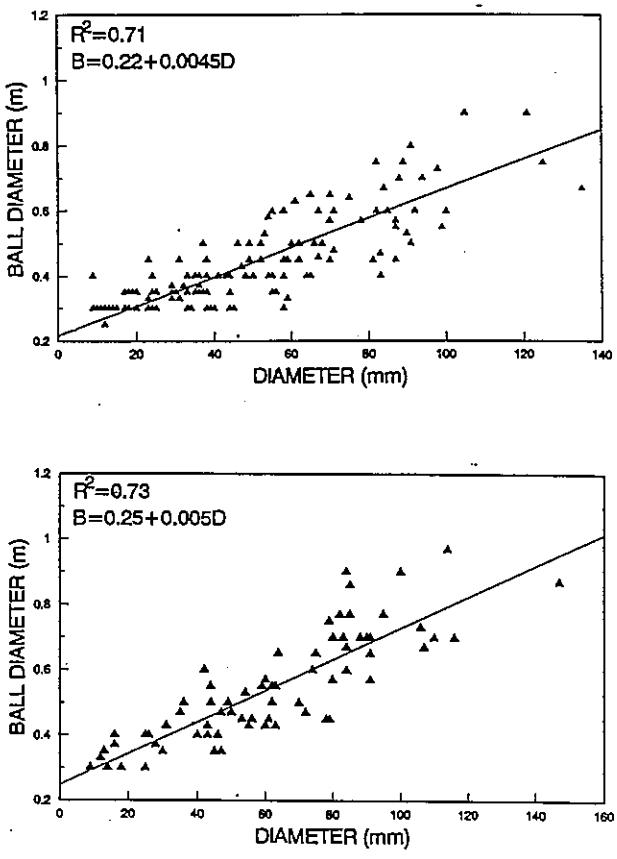

Figure 4. Relationship between rootball diameter and trunk diameter where A = juniper, and B = piñon.

Overall survival at the end of the growing season was 42%. Piñon survival was 48%, while juniper survival was 36% across all size treatments. Survival increased as tree size increased (Fig. 5). Small trees averaged a 36% survival rate, medium trees averaged 41%, and large trees averaged 50%. Highest survival was for the medium-sized piñon trees (58%), while the lowest survival was for the medium junipers (24%). The best survival for juniper was the large category (49%).

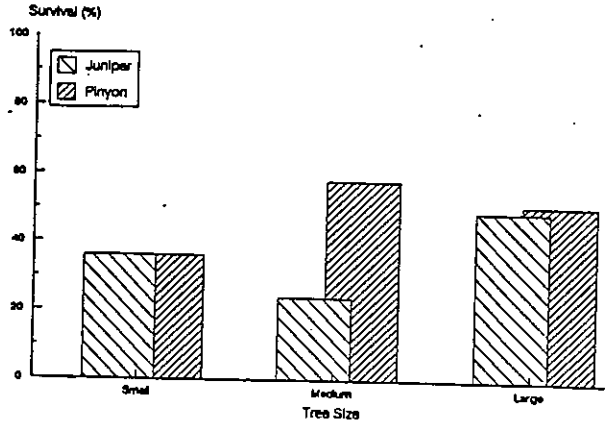

Figure 5. Survival by height class for piñon and juniper after 1 growing season.

Other than size category, tree dimensions had no significant relationship to survival. During the first 2 months following transplanting, rootball size appeared related to survival. Rootballs smaller than the nursery standard suffered higher mortality than rootballs larger than the standard. However, at the end of the growing season, other factors overshadowed the effect of ball size.

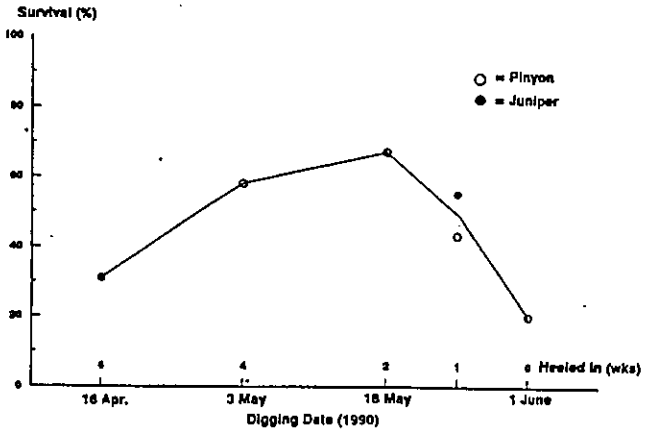

Figure 6. Interaction between digging date (weeks held before planting) and survival of piñon and juniper.

Onve factor which strongly influenced survival was digging date. Digging of the trees for this study began April 16, 1990 and was completed June 1, 1990. Budbreak and shoot elongation began about May 25, 1990. The trees that were dug prior to May 25, 1990 had delayed budbreak due to transplant shock. All trees were transplanted the last week of May 1990. The time between digging and transplanting appeared to have a strong effect on survival (Fig. 6). Trees dug after budbreak had the lowest survival (20%). A few replacement trees were dug and transplanted after June 1, 1990 and all died (data not shown). Trees dug immediately before and during budbreak had reasonable survival rates (50%). The best survival rate (68%) was for trees dug before budbreak, but held for no more than 2 weeks prior to transplanting. Trees held for 6 weeks averaged only a 30% survival rate.

Discussion

The La Plata Mine is located at the edge of the Piñon-Juniper ecosystem. The area is semiarid and tree growth is slow. The trees were much older than anticipated and age may have contributed to mortality. As trees mature, the root systems grow away from the trunk. Consequently, older and larger trees require larger rootballs. While the rootballs of the trees conformed to the standards of both the AAN and Colorado Nursery Association, survival may have improved with larger rootballs. These standards are designed for nursery-grown trees or native trees that are younger and more vigorous.

Survival increased with tree size. This contradicts previous research where larger trees suffer greater transplant shock than smaller trees. However, the smaller trees in this study were treated different from the larger trees. Small trees, in general, were dug earlier than large trees, and the rootballs were not bound as tight and were handled less carefully than the large trees. All these factors would tend to decrease survival. If treated the same, small trees would survive as well or better than large trees.

It is possible to establish large piñon and juniper trees for wildlife habitat at the La Plata Mine. Highest survival rate (68%) in this study was attained by digging trees before budbreak and holding them no more than 2 weeks prior to transplanting. A major problems with this study was that the contractor required 6 weeks to dig 400 trees or about enough trees to plant 2 ha of reclaimed mineland. As this is one of the few contractors in the area, it is unlikely this rate could be improved. Partially as a result of this study, the requirement for large trees was removed from the permit for La Plata Mine. Future revegetation activities will focus on shrub establishment for wildlife cover.

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http://dx.doi.org/10.21000/JASMR87010107