Revegetation of Disturbed Piñon-Juniper Woodlands

James Fisher, Professor
Agronomy and Horticulture, NMSU*

GENERAL REMARKS

Issues such as global warming and deforestation seem to be increasingly addressed by the media and a growing number of citizen advocacy groups. In my view, it is the responsibility of professional foresters to make sure that reliable information reaches the public and to give serious attention to their concerns. We have everything to gain by fostering this interaction because grassroots movements tend to create major and lasting change. I have witnessed this while visiting the deforestation problems of developing countries in Asia and South America. In Bolivia, for example, major revegetation and conservation projects developed by the private sector have succeeded after years of ineffectual government programs. The point is that this meeting affords an opportunity to put new knowledge in the hands of those most likely to effect change. An enlightened public can also have a role in developing research priorities and funding so that new knowledge is available and relevant.

WOODLAND REVEGETATION

This meeting was organized to feed technical information to those with an interest, be it professional or otherwise, in the management of piñon-juniper woodlands. My role is to highlight some of the work we have done on woodland revegetation. This is not a minor issue in view of the state's need for economic development on the one hand and the challenge woodland revegetation poses on the other.

The New Mexico mining industry deals with acute problems in the sense of having to revegetate disturbed land to a cover of vegetation reflecting ecological stability. Much difficulty surrounds the issue of defining what the state is and how to measure it. For woodland areas, it seems reasonable that the presence of established young trees means the site will again provide diverse benefits, including watershed protection, wildlife habitat, and recreation.

Returning disturbed land to a productive state is made difficult by such factors as regional aridity, significant alterations in soil properties, and animal pressure on planted trees. In the late 1970s we began working with Dr. Earl Aldon of the U.S. Forest Service to overcome some of the factors limiting woodland revegetation success. Through cooperative projects, we first focused on problems associated with juniper seed germination. This phase was followed by efforts to develop techniques for producing juniper nursery stock reliably. The final phase was to develop techniques for establishing planting stock on some rather harsh sites.

Our research was done at three experimental sites in northern New Mexico as described in Table 1. Table 2 summarizes the treatments applied in each study to the containerized seedlings planted. Planting dates were tested to determine the effects of environmental stress on establishment. Factors related to time of planting and potentially causing seedling stress include seasonal moisture deficits and low soil temperatures prohibiting transplant root growth. The aim of drip and mulch treatments was to provide or maintain critical moisture. Owing to the generally poor nutrient status of disturbed sites, fertilizer levels and types were compared. The form of slow-release fertilizer (SRF) tested was Osmocote (18-6-12). Triple superphosphate (TSP, 0-46-0) was tested in the absence and presence of SRF, with amounts being varied by study. Our most recent work was to remeasure trees with the hope of detecting long-term effects of treatments and other significant factors affecting growth and survival. The methods applied in these studies and the results obtained from them are found in much greater

*Presented at the 1991 Piñon Conference, April 23, 1991, Santa Fe, NM.

detail in another publication (Fisher et al., 1990).

Table 1. Description of experimental sites.

Site	Nearest NM City	Elev. (m)	Precip. (mm)	Condition
York Canyon Mine	Raton	2,194	360–460	coal/ 20–30 cm topsoil
Zia	Grants	2,194	130–230	uranium spoil
McKinley Mine	Gallup	2,070	280–380	coal/ 20–30 cm topsoil

Table 2. Treatments applied to three northern New Mexico experimental sites.

Site	Treatment			
	Planting date	Protection	Moisture	Fertilization
York Canyon mine	May 1982		Drip. irrig.	-0-
	July 1982		Straw mulch	SRF + TSP
	Aug 1982			
Zia mine Expt. 1	Aug. 1982	Vexar	wood chip	-0-
			mulch	21g TSP
			-0-	SRF + TSP
Zia mine Expt. 2	Sept. 1983	Netting	wood chip	-0-
		-0-	mulch	21 g TSP
				SRF + TSP
Mckinley mine	Aug. 1982	Vexar		-0-
	Sept. 1982			SRF + TSP
	Nov. 1982			

Work at the York Canyon mine compared two types of moisture treatments and two levels of fertilization. We applied a mixture of slow-release fertilizer, Osmocote, and triple superphosphate. We also compared three planting dates.

Survival data obtained from the York Canyon study showed July (73%) to be superior to May (55%) or August (48%) planting dates. Fertilizer reduced survival from 89% to 29% and drip (84%) was better than mulch (64%).

At an abandoned uranium spoil near Grants, New Mexico, we conducted two experiments. The first study examined the effectiveness of wood chip mulch and level of fertilizer (10 g SRF or 21 g TSP). Compared to unprotected trees, those provided Vexar tubes showed greater survival (58% vs 14.3%) and height growth (43.7 cm vs 19.2 cm). The unprotected trees were gnawed back to ground level year after year. Apparently they can exist almost indefinitely as a ground level hedge protected at times from rodents by shifting sand. Neither seedling survival nor height was influenced by wood chip mulch or fertilizer. When the analysis was restricted to only protected seedlings, survival and growth did not differ between fertilized and nonfertilized plots. Mulch increased the height growth of protected seedlings 12% but did not influence their survival. Also, seedling height was not affected by a mulch-by-fertilizer interaction.

In the second study (Expt. 2), we substituted netting for the Vexar tube, which proved to be difficult to install and maintain in the preceding study. By placing a nylon net over containerized seedlings in the greenhouse, we greatly reduced the cost of labor and materials. The material degrades after a year or two giving way as the growing juniper requires more above-ground space.

The netting was highly effective in protecting the transplants, while costing only a few cents to apply to each. Essentially, one year after planting survival exceeded 92% among protected seedlings. Protection increased height, crown spread, and stem diameter but had no effect on survival.

Overall seedling survival decreased from 91.5% one year after planting to 71.3% after four years. Survival was greater in mulched plots (96%) than in nonmulched (62.2 %) plots after four years.

Fertilizer treatments had no effect on survival or growth. Seedling growth was similar after fertilization with either TSP (0:46:0) alone, or a formulation including both TSP (21 g) and SRF applied at one of two rates (10.1 or 20.2 g). Seedling growth was not affected by mulch-fertilizer interaction.

The decline in survival from two to four years after planting appears related to site invasion by perennial weeds. Broom snakeweed (*Gutierrezia sarothrae*) accounted for 13.0% of the weed cover with primarily three perennial grasses accounting for 8%, and miscellaneous species comprising the rest. As determined by correlation analyses, survival, and several measures of juniper growth were inversely related to weed cover.

At the McKinley Mines, we also tested Vexar while again comparing planting dates and fertilizer level. Protection increased five-year survival from 13.9% to 27.5%, but did not influence seedling growth. Although fertilization did not affect growth (Table 3), mean survival in fertilized plots was about 40% less than in non-fertilized plots.

Table 3. *Juniperus monosperma* survival and growth response to planting date and fertilization.(data from McKinley mine research).

Planting Date	Treatment Response			
	Survival (%)	Height (cm)	Crown width (cm)	Stem basal dia. (mm)
Aug.	36.7	28.0	16.9	9.1
Sept.	14.4	19.0	12.4	6.5
Nov.	10.4	23.8	15.7	7.7
Fertilizer				
SRF + TSP	15.5	25.1	15.0	7.9
None	26.1	25.3	16.1	8.4
Significant at 0.05 level				

Planting date affected seedling survival and growth (Table 3), with August having the highest mean values for each response variable. Among protected plots, 5-year survival was 45% for August, 22.5% for September, and 15% for November.

Survival was found to be related to grass and combined cover (Table 4), reflecting both shrub and grass vegetation. Combined cover was also inversely related to height and stem diameter. A negative correlation was also found between grass and shrub cover.

Table 4. Correlation matrix between *Juniperus monosperma* growth parameters and ground area occupied by grass, shrub, and combined grass and shrub cover (data from McKinley site).

	Survival (%)	Height (cm)	Crown width (cm)	Stem basal dia. (mm)	
Combined cover	(-)	(-)	NS	(-)	
Grass cover	(-) NS	NS	NS		
Shrub cover	NS	(-)	(-)	(-)	(-)

The severity of competition from grassland combined cover was affected by treatments. Fertilized plots had 126% more grass cover than unfertilized plots. A notable feature was the absence of fertilizer in the August planting, resulting in the least grass cover.

In summary, our studies evaluated effects of establishment methods and postplanting site conditions on seedling survival and growth. Wood chip mulch and animal protection provided by rigid plastic mesh tubes or netting improved juniper survival, growth, or both, depending on the study. The forms and rates of fertilizers tested provided no benefits and sometimes decreased survival. Juniper fertilization at planting stimulated the growth of reseeded grasses and resulted in greater competition. Perennial weeds that invaded a mechanically cleared planting site also reduced juniper growth and survival. Overall, our work points to the need to consider the adverse effects associated with fertilization, time of planting, and order of grass and juniper revegetation.