Seed Handling and Large Scale Production of New Mexico Native Junipers[1]

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The wide distribution of native junipers on coal bearing land in the West necessitates large scale production of seedlings for reclaimation of mine spoils. Discussed are methods of reducing seedling production problems presently caused by improper harvesting and poor seed germination.

INTRODUCTION

Before the year 2000, coal-strip mining will alter more than 200,000 acres of the United States west of the 100th meridian (National Academy of Sciences 1974). New Mexico and Colorado will collectively contribute almost one-fourth of this total which excludes disturbance from road and building construction associated with the extraction process. Because soil physical and biological properties of vast areas will be drastically altered, there has been a steady improvement of technology to facilitate reclaimation of these areas to a semi-native condition. Presently limiting revegetation efforts is the lack of large quantities of planting stock of several native tree and shrub genera, commonly associated with coal reserves due to their general occurrence throughout the west. Among the factors determining availability are ease of seed collection and nursery production. Nowhere is this more evident than in the case of Juniperus, with eastern species being generally available while western species such as J. monosperma and J. osteosperma are in short supply due to propagation difficulties. Improvement of seed germination is the most formidable barrier and is the focus of this paper.

State and federal laws presently require surface reclaimation plans to be developed and approved prior to the initiation of coal extraction. Plans generally propose methods for the disposal of phytotoxic overburden materials, reshaping for soil stability, erosion and temperature control, precipitation containment, and reduction of near-ground wind velocity. Topsoiling, fertilization and irrigation may also be required to promote establishment and growth of desired vegetation.

Aridity makes revegetation of mined areas difficult and expensive. In both semi-arid and warm humid regions of the United States, it has been concluded that revegetation with native plants results in earlier plant establishment and more rapid growth than achieved with introduced species (Monsen and Christensen 1975). Native species are better able to survive long term conditions of adverse climate, soil, disease and inso<ts.

In New Mexico, **revegetation** of disturbed land has involved several species of native grasses, forbes, and major shrub species. In marked contrast to the East, trees have received minor attention and little is known about the large scale production of species not commonly grown for reforestation, windbreaks, or ornamentals. The excellent survival of pinyon on test sites in the northwest corner of New Mexico (Aldon 1978) indicates the need to make juniper seedlings available for planting as well. In cooperation with the U.S. Forest Service, New Mexico State University is conducting work on seed germination of native junipers and will supply experimental seedlings for revegetation of disturbed land previously occupied by juniper woodland.

Characteristics and Importance of Juniper Woodlands

The genus Juniperus grows on about 30 million acres in Arizona and New Mexico (Springfield 1976) in various woodland and shrub

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communities. Junipers are found from 3,000 to 8,000 (915-2439 m) feet on various types of soil with climax stands predominately on rocky ridges and shallow soil and with seral stands frequenting deeper valley slopes (Burkhardt and Tisdale 1976). Characterized by heat and drought resistance, junipers are tolerant of extremely poor, dry soil (Parker 1969). Pinyon-juniper woodlands provide erosion protection, shelter for wildlife and domestic stock, and wood for furniture, fence posts, fuel, and charcoal.

In the last hundred years much effort has been directed towards the control and eradication of pinyon-juniper woodlands due to their alleged encroachment upon range and pasture lands. Often blamed for this spread are overgrazing and lack of range fires (Johnson 1962). Indiscriminate eradication should be avoided since in addition to the uses mentioned junipers have been shown to aid soil fertility and to provide habitat for the growth of early spring grasses (Burkhardt and Tisdale 1969, Clary 1973). Control in areas of poor, shallow or stoney soils, or on slopes greater than 15 percent have resulted in only limited improvement of herbage production and an increase in erosion (Short and McCulloch 1977). Where chemical inhibition of grasses by juniper litter is of concern, tree density should be considered before control since the inhibitory effect is only concentrated on litter covered areas (Jameson 1966).

In northwestern New Mexico, J. monosperma and J. osteosperma occur from approximately 5,500 to 7,000 feet (1677-2143 m). From the southern Colorado and New Mexico border, J. osteosperma extends approximately 38 miles into San Juan and Rio Arriba counties. It is also found at several points along the Arizona and New Mexico border. Distributed throughout New Mexico, J. monosperma occurs 16 miles south of Bloomfield in the northwest corner of the state.

J. osteosperma and J. monosperma are morphologically similar evergreen arborescent shrubs or small trees usually less than 25 feet (7.6 m) tall with gray fiberous and shreddy bark. These species identified in the field by several characteristics: J. osteosperma is usually monoecious, has a leathery berry 1/4 to 1/3 inch (0.6-0.8 cm) in diameter and most often has a single trunk. J. monosperma is dioecious, has a succulent berry with a 1/8 to 1/4 inch (0.3-0.6 cm) diameter and commonly has a multiple trunk.

Juniper Seed Production and Germination

Juniper seed production begins when trees are 10 to 20 years old. Flowering occurs from January to June and fruit are formed by the fusion of the fleshy female flower into an indehiscent strobilus commonly called a "berry" (Johnsen and Alexander 1974). Depending upon location and climate, J. monosperma fruit generally mature in August of their first year and change from green to dark blue or purple as ripening occurs. Fruit of J. osteosperma mature in September of their second year changing from green to brown or copper (Johnsen and Alexander 1974). Ripening of juniper berries in New Mexico coincides with the arrival of several species of migratory birds and other forms of wildlife which consume and disperse the seeds (Salomonson 1978).

J. osteosperma and J. monosperma seeds require stratification treatments before germination will occur. In the case of J. monosperma, cold stratification is required for necessary physiological changes of the embryo to occur, possibly in association with the respiratory enzyme system or the formation of a germination promoter. (Pollock and Olney 1959, Johnsen and Alexander 1974). J. osteosperma seeds must undergo both physiological and morphological changes before germination. Warm stratification must therefore precede cold treatments to complete maturity and initiate microbial decomposition of the seedcoat (Krugman et al. 1974).

Time required for stratification and germination of juniper seeds is from 1 to 8 months, depending on species and physical or physiological changes required. Seed stratification requires careful preparation and maintenance of the seed to avoid mold and overheating and, finally, separation of seed and medium. In spite of these efforts poor germination energy and capacity are commonly observed by nurserymen.

Seedling production may be more feasible if the time required for seed stratification is reduced and germination improved. This may be possible through the use of hydrogen peroxide and various exogenous hormones. Hydrogen peroxide (H202) has been shown to improve germination of Douglas fir and loblolly pine seeds (Stein 1965, Mexal 1975). Decomposition of hydrogen peroxide has been shown to be involved in respiratory oxidation and stimulates germination of dormant seeds lessening stratification requirements (Hendricks and Taylorson 1975). It is well documented that gibberellic acid (CA), applied exogenously, acts as a primary stimulus for germination and induces some of the same physiological responses initiated b' stratification (McDonough 1976). Kinetin overrides abscisic acid inhibition, and in combination with GA, may partially substitute for stratification requirements and increase germination.

Recommendations for Seed Harvest, Germination and Seedling Production

Juniper nursery beds are often plowed under following poor and sporadic seed germination. The ornamental industry relies heavily on the rooting of cuttings to avoid the expense of such failures. It is highly probable that seed germination can be greatly improved by developing optimum stratification treatments and seed harvest schedules. Our research will focus on these areas in addition to prestratification hormonal applications of GA, kinetin and H_2O_2. Based on observations and research completed thus far several recommendations can be made:

Juniper seeds were collected in September and November of 1978 and January 1979 from seed zones 510, 520, and 610 (Schubert and Pitcher 1973). Observations of seed loss in late fall from animals and insects indicate a need for early harvest.

Large seed crops of J. osteosperma are produced every two years and mature in the fall of their second year. To avoid collection of immature seed, harvest should be delayed until years when the majority of seeds are mature. Purple berries of this species should be avoided as they have been observed to contain necrotic embryos.

Recommended methods of seed harvest include flailing, stripping and rubbing. Rolling the berries back and forth between gloved hands appears to be the most effective method for removing them from branches. The berries are allowed to fall into a box hanging from the waist and are separated from coarse debris by shaking the box to bring debris to the top. Berries are then placed in plastic bags and labeled according to species, tree, location, date, slope, and aspect and are stored in Styrofoam coolers for several days following harvest before cleaning.

Seed cleaning is accomplished through maceration of the fruit in a blender controlled at low speed with a rheostat using a method similar to that described by Van Haverbeke and Banhart (1978). The rheostat obviates the need for replacement of blender blades with rubber strips and permits better control. J. osteosperma berries are macerated for approximately 4 to 5 minutes whereas the more succulent J. monosperma berries require less than three minutes. Seed coats are extremely hard but may be damaged if the blender is operated at high speed. Water floatation removes berry pulp, leaf debris, and the lighter empty seeds. Seeds are stored at 3°C in polyethylene bags following air drying at room temperature for 48 hours. Other cleaning methods which have been recommended involve soaking the seeds in lye, the use of a Dybvig separator, and separation by screening (Stein et al. 1974).

Six and one-half pounds of J. monosperma berries yield one pound of cleaned seed, at an average of 18,300 seeds per pound. Four pounds of J. osteosperma berries will yield one pound of seed at 5,000 seed per pound.

Before stratification, seeds should be soaked in water 48 hours or until fully imbibed (Johnsen 1962). Seeds may be placed in either a slightly moist medium or in plastic bags without medium provided they are kept moist. Treatments in plastic bags should be opened and turned occasionally to permit air exchange and to check heat and moisture content. Although some germination will occur without treatment, J. monosperma seeds require stratification at 3°C for 30 to 90 days. J. osteosperma seeds require 90 to 120 days of stratification diurnally alternating at 20° and 30°C followed by the same time at 3°C. Seeds should be sown immediately after stratification (Johnsen and Alexander 1974).

J. monosperma seeds stratified three months and germinated at 20° -30°C alternating resulted in 29 percent germination after 50 days. Temperatures of 15° and 10°C during germination resulted in an average of 30 and 18 percent and required 62 days to achieve this capacity. Expected germination capacity of J. osteosperma seed stratified 7 months is 8 to 49 percent after 70 days at 20° -30°C (Johnsen and Alexander 1974).

An alternative to stratification is to sow seed directly in the ground after cleaning with germination expected one to two springs after planting. Seeds should be mulched and kept moist until germination.

At present, seedlings of J. monosperma and J. osteosperma are being grown at the Mora Research Center in 9-cu.-in. RL tubes. A 2:1 (V/V) peat-vermiculite mixture is used with complete N, P, K and micronutrient fertilizer. Temperatures in the greenhouse range from 24° to 27°C during the day and 16°C at night. Photoperiod is artificially extended by incandescent lights, switched on for one minute of each 15minute period. Growth is greatly accelerated under these greenhouse conditions and is expected to be 3 to 4 times faster than observed outdoors.

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