CULTIVATION AND HERBICIDES PROMOTE QUAKING ASPEN SEEDLING ESTABLISHMENT[1]

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ABSTRACT

Containerized aspen seedlings were planted at two high elevation sites in southern (May, 1982) and northern New Mexico (May, 1983). The Sacramento Mountains site is four latitudinal degrees south of the northern site and is drier. Each plantation was designed as a split-block with the main treatments testing time of pre-plant cultivation (fall versus spring). Subtreatments included the herbicides linuron, trifluralin and simazine at two levels each.

Survival for the best treatment was more than 75% at each site. In general, cultivation proved to be an effective weed control practice. Fall cultivation at the drier site increased seedling survival over spring cultivation. Simazine increased seedling mortality and should be avoided. The remaining preemergent herbicides had no apparent effect on seedling survival. Both linuron and trifluralin controlled weeds effectively. Trees grown in fall-cultivated trifluralin-treated plots were 30% to 40% larger (height and caliper) than control trees.

INTRODUCTION

The geographical range of quaking aspen (Populus tremuloides Michaux) in western North America spans over 40 degrees latitude. More than 200,000 hectares are occupied in New Mexico, Arizona and the adjacent San Juan Basin (Jones and Trujillo 1975) where aspen forests provide many human benefits and renewable resources.

An important potential benefit of aspen is the role it can play in redirecting the course of wildfire. In the southern Rockies, aspen has a lower fire potential than conifer types and can provide a critical fuelbreak. Aspen flammability has been estimated to be less than half that of adjacent conifers (Fechner and Barrows 1976). This might explain why wildfires spreading from high elevation conifer forests have been observed to die out in aspen. Healthy aspen stands are regarded by fire managers as relatively fire proof. It follows that maintenance and establishment of aspen are useful fire management practices, particularly in mountain resort areas where ignition is likely and the potential for loss of resource value and life is great.

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At present, land managers in the Southwest do not have a full understanding of the steps necessary to grow aspen seedlings reliably and efficiently, or of those steps leading to fuelbreak establishment. Through a U.S. Forest Service-Eisenhower Consortium cooperative research project begun in 1981, we are developing or refining greenhouse, nursery, site preparation and weed control practices leading to establishment of aspen. This paper addresses the last two elements of the project: site preparation and weed control.

METHODS

Two test sites were established, one in the Sacramento Mountains of south-central New Mexico in 1982; the other, one year later in the Sangre de Cristo Mountains, about 360 kilometers to the north. The southern site is at an elevation of 2,650 m and is the drier site. It receives approximately 700 mm of precipitation annually versus 900 mm for its northern counterpart (elevation 2,870 m). The southern site also has higher annual evapotranspiration, 550 mm versus 400 mm.

The experimental design was a split-block. Main treatments were:

1. Fall cultivation (with an application of dalapon at 5.6 kg a.i./ha)
2. Spring cultivation

Subtreatments were:

1. linuron at 1.1 kg a.i./ha
2. linuron at 2.2 kg a.i./ha
3. trifluralin at 1.1 kg a.i./ha
4. trifluralin at 2.2 kg a.i./ha
5. simazine at 2.7 kg a.i./ha
6. simazine at 4.5 kg a.i./ha
7. cultivation-only
8. cultivation plus dalapon at 5.6 kg a.i./ha (fall only)
9. no cultivation (spring only)

At both sites, dalapon was applied to the fall main plots in September of the year before planting. Plots were cultivated to a depth of approximately 20 cm when the vegetation showed browning. Spring cultivation and application of the preemergent herbicides (linuron, trifluralin and simazine) was completed the following April. All chemicals were applied with a calibrated, hand-held spray boom. Trifluralin was incorporated into the soil according to label directions. Four-month-old containerized seedlings were planted approximately 1 month later. Plots were 40-tree rectangular plots, and treatments were each replicated four times.

Seedling survival was scored at the end of the first growing season. Percent soil moisture was measured throughout 1982 at the "dry" site. Weed cover was measured at both sites with a point sampling method (Grieg-Smith 1957) two months after planting. Percent weed reduction from the control was estimated with the uncultivated, unsprayed plot as the control. In the second growing season, seedling height was measured at both locations, as was seedling basal caliper at the "wet" site.

RESULTS

Survival

The Sacramento Site

Seedling survival after one growing season for fall-cultivated plots averaged 49% versus 40% for plots cultivated in the spring. This significant difference could be attributed to the recharging and storage of additional soil moisture during the winter fallowing of fall-cultivated plots (Figure 1).

Soil moisture at the time of planting (May 15) was significantly higher for the fall plots than for their spring counterparts. There was a heavy spring rain shortly after planting and soil moisture in all plots approached field capacity. As the soil moisture decreased, however, fall plots maintained their superiority until the late summer when the trend reversed. Soil moisture was higher in the fall-cultivated plots at the critical time of planting and early establishment.

Within the fall treatments, dalapon alone resulted in 76% survival (Table 1). This is an acceptable rate in the Southwest. The Dalapon treatment was superior to all others, except trifluralin (2.2) and linuron (1.1).

In both fall- and spring-cultivated plots, preemergent chemical treatments were largely equivalent, and cultivation-only was statistically as good as any preemergent herbicide treatment. That is, the use of a preemergent herbicide provided no additional benefit in terms of seedling survival. Simazine, particularly at the higher rate, increased mortality and was inferior to the other treatments, except spring/no cultivation where nearly all seedlings died.

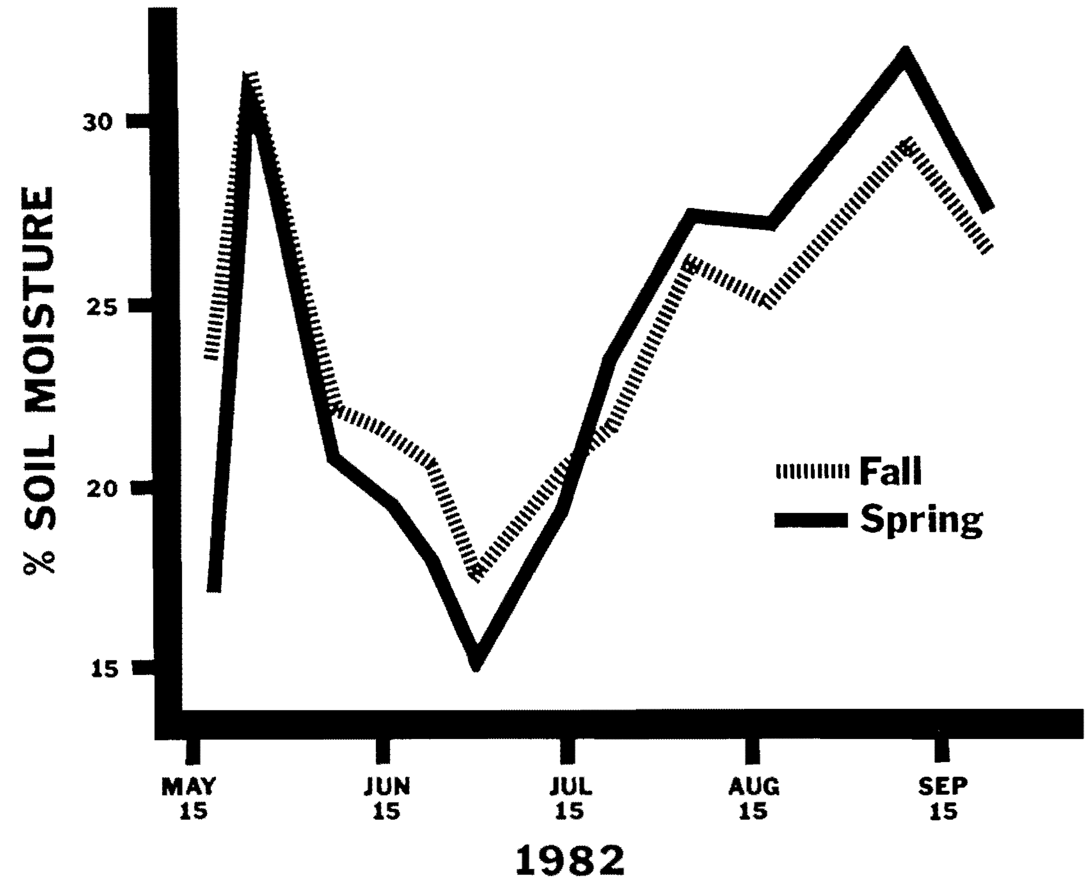

Figure 1. Percent soil moisture in the top 15 cm of soil for fall- versus spring-cultivated plots at the Sacramento Mountains site (1982).

Table 1. Seedling survival within fall- and spring-cultivated plots at the Sacramento Mountains site (1982).

Treatment	Rate (kg a.i./ha)	Percent Survival Fall	Percent Survival Spring
dalapon alone	5.6	76 a	---
trifluralin	2.2	64 ab	38 a
linuron	1.1	61 ab	42 a
trifluralin	1.1	56 b	44 a
linuron	2.2	52 b	46 a
cultivation-only	---	45 b	44 a
simazine	2.7	45 b	40 a
simazine	4.5	22 c	29 a
no cultivation	---	---	1 b

Subtreatments were analyzed within each main treatment as if in a randomized complete block design. Values with the same letter are not significantly different. Overall alpha equals .05, but the pairwise alpha was adjusted with the Bonferroni technique to reduce the chance of detecting spurious differences.

The Sangre de Cristo Site

Although not statistically different, survival for the main treatments at the site was 71% for fall plots and 67% for spring. Apparently precipitation and soil moisture were already sufficient and the winter fallowing period provided no additional benefit.

Dalapon alone did not control weeds as effectively as it did at the southern site (Table 2). Within both fall and spring plots, preemergent herbicide treatments showed largely equivalent results and were not better than cultivation-only. Simazine was phytotoxic, especially at the high rate.

Table 2. Seedling survival within fall-cultivated plots at the Sangre de Cristo Mountains site (1983).

Treatment	Rate (kg a.i./ha)	Percent Survival Fall	Spring
linuron	2.2	78 a	78 a
trifluralin	2.2	73 a	71 abc
cultivation-only	---	70 ab	73 ab
linuron	1.1	69 ab	73 ab
trifluralin	1.1	69 ab	78 a
simazine	2.7	66 ab	67 abc
dalapon alone	5.6	50 bc	---
simazine	4.5	44 c	56 bc
no cultivation	---	---	54 c

Statistical differences are denoted as in Table 1.

Weed Control

At both sites, grasses occupy nearly twice as much area as the forbes. The drier site is covered primarily with western wheat grass and Kentucky bluegrass with a less frequent occurence of western yarrow, dandelion, vetch and other forbes. The wetter site includes Kentucky bluegrass, Timothy, western yarrow, dandelion, iris and others.

Weed scientists commonly consider 70% reduction in weed cover as commercially acceptable. When main treatments are compared, only the spring plots at the northern site gave acceptable control. Fall plots at that site reduced cover by 62%. At the southern site, percent weed reduction was 52% and 38% for fall- and spring-cultivated plots, respectively. We intrepret these results to mean that time of cultivation does not have as great an impact on weed control as does the site and the composition of the invading species.

Only the fall/simazine (2.7 kg a.i./ha) combination effectively controlled weeds on the drier site (77%). Simazine, however, increased seedling mortality. In contrast, several treatments at the wetter site, especially those in association with the spring cultivation, produced acceptable results (Table 3).

Table 3. Treatments producing at least 70% reduction in weed cover at the Sangre de Cristo Mountains site (1983).

Treatment	Rate (kg a.i./ha)	Percent Reduction
fall/trifluralin	1.1	88
fall/trifluralin	2.2	84
fall/linuron	2.2	76
spring/linuron	1.1	100
spring/linuron	2.2	100
spring/trifluralin	1.1	100
spring/trifluralin	2.2	100
spring/cultivation-only	---	100
spring/simazine	4.5	97
spring/simazine	2.7	95

Seedling Growth

Height

Seedling height was measured 14 months after planting the southern site and 16 months after planting the northern site. Trees in the fall plots were 27% taller than those in the spring plots at the southern site. In the north, spring plot trees were 8% taller than those in the fall plots. These differences are significant at the .01 level.

Chemical treatments were compared to the cultivation-only treatment to see if the addition of the herbicides generated a benefit in terms of seedling growth. Ignoring the effects of time of cultivation, seedling height was greatest in the trifluralin-treated plots at both sites. At the southern site, trifluralin at 2.2 kg a.i./ha produced trees that were significantly taller (.01 level) than all other treatments and 36% taller than the cultivation-only control. At the northern site, trifluralin at both 2.2 and 1.1 kg a.i./ha had trees that were significantly taller than the other treatments and were 26% and 25% taller than the control, respectively. Individual main/subtreatment combinations that produced significantly taller seedlings than those in control plots are listed in Table 4.

Basal Caliper

Basal stem caliper was measured only at the Sangre de Cristo site at 16 months after planting. Seedlings in the spring-cultivated plots were 5% larger (significant at .01) than those in the fall plots. Overall, the two rates of trifluralin produced seedlings with equivalent calipers that were significantly larger than all other treatments and 21% greater than the control. The only main/subtreatment combinations that were significantly better than the control were fall/trifluralin (1.1 kg a.i./ha), fall/trifluralin (2.2 kg a.i./ha) and fall/linuron (2.2 kg a.i./ha) which were 31%, 29% and 17% larger, respectively.

Table 4. Treatments that produced seedlings significantly taller (.01 level) than the cultivation-only control.

Site	Treatment	Rate (kg a.i./ha)	% Height Increase
Sacramento	fall/trifluralin	2.2	40
Sangre de Cristo	fall/trifluralin	1.1	38
	fall/trifluralin	2.2	34
	fall/linuron	2.2	20
	fall/simazine	4.5	19
	fall/linuron	1.1	18
	spring/trifluralin	2.2	17

RECOMMENDATIONS

Cultivation is an effective site preparation practice that enhances seedling survival and growth, as well as weed control. At a relatively dry site, fall cultivation with a winter fallow is superior to a spring cultivation before spring planting. The additional soil moisture captured has a significant positive impact on seedling survival. Even on a moist site, winter fallowing cannot hurt. Further, it appears the impact of herbicides on seedling growth is less detrimental when the site is cultivated in the fall. Based on survival at the Sacramento site, the use of dalapon before fall cultivation can provide a benefit.

Simazine has phytotoxic effects on aspen seedlings and should be avoided. Trifluralin performs as well or better than linuron regarding weed control and aspen seedling survival and growth.

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