Study on the Effect of Herbicides Applied to Oak, Hickory and Walnut Seedlings

National Plant Materials Center, Beltsville, MD September 2008

Introduction

Most tree plantings for riparian buffers, forest regeneration or wildlife habitat are planted as one to two year old bare-root stock seedlings. Direct seeding (planting tree seed rather than seedlings) of hardwood species of trees is not a new idea. Compared to planting one to two year old seedlings direct seeding is easier, one-third to one half less costly, and have superior root development. By avoiding seedling transplant shock, direct seeded plants will typically out-perform transplanted seedlings.

A white oak seedling on the edge of a control plot shown three months after sowing, yellow nutsedge (*Cyperus esculentus*) and smooth pigweed (*Amaranthus hybridus*) are present in this plot.

While this is not a widely accepted practice, in certain situations it may be a cost effective re-vegetation method. The central idea of this study is to assess what herbicides are effective at controlling weeds and yet are not toxic to the seedlings

Procedure

Seed

Local sources of Oak, Hickory and Black Walnut seed were used for this study. We are grateful to the *Growing Native* organization of the Potomac Conservancy for donating all the seed. The husks of the hickory and walnut seed were removed when received. Seed husks contain compounds which inhibit germination. Prior to sowing, all seed was refrigerated and stored in woven plastic bags to limit desiccation.

Field Site Location

The field site was selected for a location such that seed predation from mice, squirrels, chipmunks and other wildlife was minimized. If there is a large amount of habitat (i.e. trees, shrubs and other vegetative cover) in areas around the seeded site, then losses of seed may be high. By making sure that vegetative cover was minimized, predators, such as hawks, owls,

foxes and coyotes are more effective in reducing existing populations and preventing future population increases.

Soil Conditions
The soil classification of the field site is Cedartown-Galestown-Matawan Loamy sand. This loamy sand soil type is very representative of the soils in the mid-Atlantic area. There were no significant nutrient deficiencies for the soil for seedling survival and growth. During the 2005 – 2006 test periods the mid-Atlantic experienced a severe drought, so the amount of available moisture was a concern for plant survival. The plots were irrigated to ensure that moisture was not a limiting factor for seedling survival.

Field Site Preparation
The test site and adjacent areas were mowed and the field was sprayed with 3 applications of 2% glyphosate in June, August and September to kill existing vegetation the season prior to planting. Just before planting, the site was tilled and packed in preparation for seeding. The field did have a fair amount of yellow nutsedge in one area. In those areas lower quantities of seedlings survived.

Plot Layout
Seed was planted in April 2006. A set of discs was used to create a furrow the 200 foot length of the field. The seed was then evenly sown over the whole field length, covered to an approximate depth of 2" and the soil firmed. Herbicide treatments were run perpendicular to the seeded rows. Each plot was 6 feet wide and 20 feet long for a total area of 120 square feet. Due to limitations in the amount of seed available, only 2 replications of each treatment were planted. The rate of seeding varied with the species of seed sown. The rate of seeding varied with the species of seed sown. Approximate quantities per plot are Table 1.

Seed Viability Test
At the same time that the field sowing took place 30 seeds (10 seed x 3 replications) were sown in containers and grown in the greenhouse to determine the seed viability under optimal conditions. This was done in order to compare actual seed viability to seed survival in the field. The bitternut hickory seed was not viable, so that data is not included in the results. Table 1 has baseline germination rates for each tree species.

Table 1: Species Used, Seeding Rate and Baseline Germination

Woody Species	Botanical Name	Total Seeds/plot	Seed/Acre	Baseline Germination Percentage
Pignut Hickory	Carya glabra	3,300	7,500	30%
Hickory species	Carya species	3,700	8,500	65%
Mockernut Hickory	Carya tomentosa	3,300	7,500	55%
Black Walnut	Juglans nigra	5,500	12,500	80%
Sawtooth Oak	Quercus acutissima	8,800	20,000	80%
White Oak	Quercus alba	6,400	14,500	80%

Herbicide Applications

Six different herbicide treatments were applied (Table 2) in bands perpendicular to the row lengths. The herbicides used in the test were selected for their control of annual and perennial grasses and broad leaf weeds which will out complete tree seedlings for water and nutrients. The herbicides Outrider and Plateau are not labeled for use over woody plants and are primarily used for control of specific cool-season grasses in forb and warm-season grass meadows.

Herbicide applications were made in May, June and July 2006 and 2007 as pre and post emergent applications. A non-ionic surfactant (Big Sur 90) was added to Goal, Plateau, Goal, Envoy and Outrider to enhance their performances. Due to hot, droughty summer conditions, irrigation was necessary before the June and July applications of both years.

Oxyfluorofen (Goal 2Xl) test plot in August 2006, horseweed *Conyza canadendsis* shown in the adjacent plot, has been suppressed.

Table 2: Herbicides Tested and Application Rates Used

Trade Name	Active Ingredient	Type	Rate (oz/ac)	Weeds Controlled
Envoy	clethodim	Post	26	annual and perennial grasses
Goal 2XL	oxyfluorfen	Pre/post	80	annual grasses, broadleaf weeds
Outrider	sulfosulfuron	Post	1	annual and perennial grasses, broadleaf weeds
Pendulum + Envoy	pendimethalin+clethodim	Pre/post	49 + 26	annual and perennial grasses
Pendulum + Goal	pendimethalin+oxyfluofen	Pre/post	49 + 80	annual grasses broadleaf weeds
Plateau	dihydro 4 methyl	Pre/post	12	broadleaf weeds

This photo was taken two months after sowing seed; it shows the openness of the field location. This greatly helped in discouraging wildlife which can feed on the seed. The test plot shown here was the most successful, Goal 2XL (oxyflorfen).

Results

In September 2007, in order to accurately count the seedlings which had survived; the test field was mowed to a height of 1 foot. The resulting seedling survival percentage data is shown in Table 3. The seedling height was not measured due to the widely variable seedling size within the test plots.

Table 3: Percentage of Seedling Germination/Survival for Each Treatment*

Herbicide Treatment	Pignut Hickory	Hickory species	Mockernut Hickory	Black Walnut	Sawtooth Oak	White Oak
Seeds per plot	150	170	150	250	400	290
Viable seeds per plot	98	136	83	200	320	87
Goal 2XL	13%	33%	8%	23%	5%	6%
Pendulum + Envoy	3%	31%	10%	16%	7%	1%
Pendulum + Goal	9%	26%	10%	17%	2%	1%
Envoy	15%	24%	4%	13%	7%	0%
Control	10%	15%	7%	10%	7%	6%
Outrider	10%	17%	11%	9%	2%	1%
Plateau	0%	7%	0%	0%	8%	6%

* percentages expressed based on viable seeds per plot

Herbicide effectiveness
The three herbicides which had the greatest percentages of seedling survival were:

1) Goal 2XL
2) Pendulum + Envoy
3) Envoy

Seedling Toxicity
The two herbicides which had the least percentages of seedling survival were:

1) Plateau
2) Outrider

These two herbicide treatments had even a lower survival percentage than the control plot.

Seedling Survival
The three species of plants with the highest percentage of survival were:

1) Hickory species
2) Black walnut
3) Sawtooth Oak

The survival percentages of the oak seedlings might have been higher if the seed had been autumn sown instead of the spring sown. Many species of oak seed do not store well. Tthe moisture content of the white oak acorns must be maintained at 30 – 50% for optimal germination.

References

Herman, R., Schmoker, D., Sloan, R., Ward, T., 2003. *Illinois Direct Seeding Handbook – A Reforestation Guide.* Online publication by the Illinois Environmental Protection Agency.

Clatterbuck, W., 1998. *Direct - Seeding Acorns for Bottomland Oak reforestation: Guidelines for Success*. Society of American Foresters. Convention Proceedings p397 – 398.

Durea, M., 1992, reviewed 2000. *Forest Regeneration Methods: Natural Regeneration, Direst Seeding and Planting.* Online publication by the University of Florida, Cooperative Extension Service, Institute of Food and Agricultural Sciences.

Timmons, R., Smiles, W., Dawson, J., 1993. *Planting Method and Herbicide Treatment Influence Direct Seeding Success of Some Central Hardwood Tree Species*. Illinois Agricultural Experiment Station, Forestry Research Report

93-1. Department of Forestry, University of Illinois, Urbana-Champaign, Illinois. 7 pp.

Hipkins, P., Coartney, J., 1987. *A Case for Direct Seeding of Woody Species on Highway Roadsides*. Journal of Environmental Horticulture. 5(4) p 176 – 179.

Prepared by:

Shawn Belt, Horticulturist, USDA-NRCS National Plant Materials Center, Beltsville, MD