WEED BARRIERS FOR TREE SEEDLING ESTABLISHMENT IN THE CENTRAL GREAT PLAINS

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ABSTRACT.—Horticultural-type mulches were tested on alluvial sites in two studies to examine survival and growth of black walnut, Scotch pine, and cottonwood seedlings. In one study, black walnut and Scotch pine were established with three weed control treatments using either an annual herbicide or two types of landscape polypropylene fabric barriers. After three years, walnut seedlings had 15 percent greater survival and were 60 percent taller when established with woven landscape fabrics than with Surflan herbicide. Scotch pine seedlings had 25 percent greater mortality with herbicides but no differences in height among treatments. In a second study, cottonwood seedlings were established with a tall fescue sod, a polypropylene weed barrier, black or gray plastic films, cultivation, or herbicide weed control treatment. After 5 years, cottonwood saplings mortality was highest in a grass sod, slightly lower with herbicides, and lowest for the three landscape fabrics and cultivation treatments. Sapling growth was best with cultivation, slightly less for the landscape fabrics and films, and least using herbicides or grass sod for weed control. Mulches appear to be practical for use in tree establishment under environmental conditions of the Great Plains.

Tree seedling establishment typically requires suppression of competitive weeds to achieve high survival and rapid growth. Weed control strategies include cultivation, application of herbicides, ground covers, or weed barrier mulches including plastic or polyethylene sheets and woven landscape fabrics or geotextiles (Appleton and others 1990, Stevenson 1994, Van Sambeek and others 1995). Mulches have several advantages over herbicides and cultivation. Mulches are generally less toxic than herbicides and may not require repeated application. Other benefits can include conserving soil moisture and reducing soil erosion and nutrient leaching (Truax and Gagnon 1993). Although there is scant use of plastic mulches in traditional forestry, landscape mulches are used widely in horticulture. Various new types of plastics and fibers appear frequently on the market and are continually being evaluated (Windell and Haywood 1996).

The early studies with weed barrier materials were done with 1.5 to 6 mil black polyethylene films that were impermeable to water unless mechanically punctured. Woven polypropylene weed barrier fabrics are now being marketed including Sunbelt and Earthmat manufactured by the DeWitt Company in Sikeston, MO. Sunbelt was one of the first permeable weed barrier fabrics marketed. Compared to Earthmat, Sunbelt is slightly thicker (18 and 17 mil, respectively), slightly heavier (110.2 and 101.7 g m^{-2}, respectively), and has a higher infiltration rate (491 and 402 L m^{-2} min^{-1}, respectively). Both are long-lasting and contain carbon black as a UV light stabilizer. Earthmat is about 15 percent lower in price than Sunbelt. The objective of my study was to compare the effectiveness of weed barrier fabrics and plastic mulches to conventional herbicides for controlling competing vegetation in a mixed black walnut and Scotch pine planting and in a cottonwood planting.

MATERIALS AND METHODS

Two studies were conducted in the central Great Plains near Manhattan, Kansas. Precipitation averages about 30 inches per year, with 75 percent coming during the growing season. The planting site was on flat, alluvial, fine sandy loam and silty clay loam.

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In one study, 1-0 (1-year-old) seedlings of black walnut (*Juglans nigra* L.) and Scotch pine (*Pinus sylvestris* L.) were hand planted. Tree seedlings of each species were alternately planted 8 feet apart within ten 300-foot long rows spaced 40 feet apart for a total of 380 trees. The alleyways were planted with various agricultural crops for another study. Each row was divided into three treatment plots 6 feet wide by 100 feet long with 12 or 13 trees per plot.

Weed control treatments were annual application of Surflan herbicide or strips of either Sunbelt or Earthmat woven polypropylene fabric supplied by the DeWitt Company, Sikeston, MO. The area was cultivated before the weed barriers were laid. Seedlings were planted through small X-shaped slits cut in the fabrics. Surflan at commercial label rates was applied each spring over the top of dormant seedlings during the first and second year and along the side in the third year. A randomized complete block design was used with weed barriers and herbicide treatments replicated once in each of the 10 rows or blocks.

In the second study 1-0 seedlings of cottonwood (*Populus deltoides* Bartr. Ex Marsh.) were hand planted 4 feet apart in four 400-foot long rows spaced 12 feet apart for a total of 394 trees. Each row was divided into eight 6 feet wide by 50-foot long plots with 12 trees each. A randomized complete block planting design was used with each row considered a block.

Weed control treatments consisted of plots with solid and punctured 3 mil black plastic mulch, plots with solid and punctured 3 mil gray/black plastic mulch, Sunbelt woven polypropylene fabric, tall fescue sod, annual cultivation, and application of a herbicide using 2 percent Roundup to deaden the sod and post planting application of Gallery (2 lb a.i. per acre) and Surflan (0.75 lb a.i. per acre).

Survival in percent, height in feet, and stem diameter at the ground line in inches of the walnut and pine saplings were recorded at the end of the third growing season and the cottonwood saplings at the end of the fifth growing season. Biomass index is the average oven dried weight for each surviving tree. Plot means were calculated and subject to ANOVA using Duncan's new multiple range test to separate treatment means when significantly different at the p = 0.05 level. The two plots of black plastic and the two of gray/black were combined, as there was no statistical difference between the punctured and unpunctuated forms of either plastic film.

RESULTS AND DISCUSSION

In the mixed walnut-pine planting, seedling mortality after 3 years was greater for both species in plots treated with Surflan herbicide than with either Sunbelt or Earthmat weed barrier fabric (table 1). Both species achieved similar survival and heights with either weed barrier material. Unlike pine that had no differences, herbicide decreased walnut seedling height by 40 percent compared to weed barrier fabrics. Although the fabric barriers prevented growth of most weeds, some weeds did grow in the X-shaped slits where trees were planted. Some weeds also grew in soil clods used to hold down the fabric at installation. Limited handwork was done around the trees in the herbicide plots.

Weed barrier fabrics have been shown to improve the soil environment in several similar studies. Polyethylene weed barriers have been shown to increase soil temperatures during the growing season and preserved soil moisture at depths of 6 and 10 inches (Appleton and others 1990, Ham and others 1993, Truax and Gagnon 1993, USDA-Agriculture Research Service 1993). Ham and Kluintenberg (1994) have developed mathematical models relating optical properties and soil contact resistance of plastic mulches to soil heating. The models suggest plastic mulches improve early spring soil temperature. Presumably warmer soil temperatures when soil moisture is still near field capacity leads to improved tree growth.

In the cottonwood study significant differences existed after five growing seasons among weed control treatments for survival, height, stem

Table 1.—*Third-year survival and growth in a walnut/pine planting using three weed control methods*

Species	Treatment	Survival	Height
		— % —	— ft –
Walnut	Surflan	81 b	3.4 b
	Sunbelt	95 a	5.5 a
	Earthmat	92 a	5.3 a
Pine	Surflan	62 b	1.7 a
	Sunbelt	87 a	1.8 a
	Earthmat	83 a	1.7 a

Values followed by same letters within column and species are not significantly different at the p = 0.05 level.

diameter, and biomass (table 2). Survival of cottonwood seedlings was very poor in the sod (33 percent) confirming previous observations that weed control is usually required for successful establishment (Boysen and Strobl 1991). Seedling survival was less with the use of herbicides (52 percent) than with weed barrier treatments or cultivation (67 to 89 percent).

Overall, cottonwood saplings had the best growth using cultivation within the tree row to control herbaceous competition (table 2). Although not significantly different, the average height for saplings with the three polyethylene or polypropylene mulches was about 90 percent of the height of the saplings in the cultivated treatment. No differences existed between use of solid and punctured black or gray-on-black plastic film. Sapling height was the shortest using either tall fescue sod or herbicides for weed control.

Cottonwood stem diameter followed a similar pattern to height (table 2); however, diameter for saplings grown with the three polyethylene or polypropylene mulches were 75 to 90 percent of the diameter of the saplings in the cultivated treatment. Using oven-dried weight as a biomass index, cottonwood grown with plastic mulches had about 80 percent of the biomass of the saplings in the cultivated treatment. In contrast, the cottonwood saplings in the tall fescue sod and herbicide weed control treatments had only 50 to 60 percent of the biomass compared to those under the cultivated treatment.

Table 2.—*Fifth-year survival and growth in a cottonwood planting using six weed control methods*

Treatment	Survival	Height	Stem diameter	Biomass index
	— % —	— ft —	— in —	—lbs—
Tall fescue Sod	33 c	15.2 b	2.0 c	6.8 cd
Gallery and Surflan	52 b	15.4 b	2.2 c	5.7 d
Sunbelt Fabric	81 a	21.4 a	3.2 b	15.4 bc
Gray/black Plastic	67 b	22.1 a	3.3 b	14.8 bcd
Black Plastic	89 a	23.7 a	3.8 ab	19.3 b
Annual Cultivation	77 a	24.7 a	4.2 a	29.8 a

Values followed by the same letter are not significantly different at the p = 0.05 level.

Use of herbicides to control herbaceous competition was less effective than expected. As is often the case in field application, the herbicides were applied later in the spring than desired. Late spring application to dry soils in the Great Plains resulted in heavy weed competition and reduced height of both the walnut and cottonwood seedlings. Fabric weed barriers yielded better results than herbicides for several reasons. They can be installed over weeds that may have already germinated and the opaque fabrics will exclude light killing existing vegetation and minimizing germination of weed seeds. With the use of weed barrier fabrics, some weeding may be necessary within the planting hole.

Durability of the plastic mulch in the cottonwood study exceeded life expectancy normally expected under full sunlight because tree leaf litter and grassy vegetation at the barrier edge covered them. Rodents did not appear to damage the tree trunk nor did the plastic girdle the base of the tree.

SUMMARY AND CONCLUSIONS

Weed barrier fabrics have many positive attributes including increasing soil temperatures in the spring, reducing evaporative soil moisture loss during dry periods, and controlling herbaceous competition. Although these UV-resistant fabrics initially may be more expensive to establish, they are practical to use under special conditions such as when planting a limited number of trees, where wind and snow barriers are needed for landscape plantings, or within tree rows that are widely spaced for production of agriculture crops as part of an alley cropping agroforestry practice.

The use of weed barrier fabrics also may be desirable and practical for general forestry. Survival and growth of both walnut and cottonwood were better with weed barrier fabrics than less effective weed control treatments such as herbicides and grass sods. Weed barrier fabrics also may be economically sound, because they require less maintenance in the years following establishment.

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