Assessing the management potential of black polyethylene mulch in short-rotation, woody biomass plantations

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Short-rotation, poplar plantations often require high inputs of pesticides, fertilizers and the extensive use of mechanical cultivation for several years (1, 2, 3), and mulching may provide an effective management tool to reduce both costs and environmental inputs in specific conditions (4, 5, 6). However, few studies have attempted to assess the benefits of mulching as a management tool in such biomass production systems across a range of conditions and genotypes. Consequently, the objective of this study was to gauge the effect of black polyethylene mulch under different site conditions and cultivation treatments in a short-rotation, poplar plantation, using two dissimilar genotypes, to describe the circumstances that maximize the degree and longevity of mulching-related enhancements. At the University of Wisconsin Arlington Research Farms, poplar plantations composed of one native clone (*Populus deltoides* Bartr. [D105]) and one interspecific clone (*P. nigra* L. x *P. maximowiczii* A. Henry [NM6]) were planted in May of 1999 under intensive [conventional till/herbicide] and minimal weed control strategies at two sites of different soil quality. Nested within each weed-control treatment was an assessment of tree performance using black polyethylene ("poly") mulch vs. no mulch. Precipitation during the period of greatest growth (June 1 through August 31) was above the 30-year average (7) in both 1999 and 2000 (281.9 mm vs. 330.5 mm and 416.5 mm, respectively).

Stem volume increments of woody biomass (SVI, dm^3) were measured on trees in all conditions during the 1999 and 2000 growing seasons. Growth benefits of poly mulch varied among years. During establishment, poly mulch enhanced SVI through the reduction of vegetative competition and improvement of the edaphic environment, and we found a significant mulching effect in all treatment combinations (Table 1). While in the second year, the benefit of mulching was largely limited to the reduction of vegetative competition (except under poor site conditions), and its effect was restricted to conditions of higher vegetative competition and lower site quality. Notably, the relative benefit of poly mulch increased in year two in conditions of high vegetative competition at both sites (data not shown), while it decreased in the intensively-managed plots at both sites. Survival was high (> 90%) for both clones in all treatment combinations, except under the most severe vegetative competition (i.e., high-quality site with minimal weed control). In this case, survival for D105 fell below 40% in both mulched and non-mulched conditions. NM6 fared much better here, and survival remained above 80% in both mulched and non-mulched conditions

While poly mulch may improve early growth in short-rotation, poplar plantations under a wide range of conditions, its economic utility may be restricted to specific applications. At the high-quality site in this study, mulching showed little potential as an economically-feasible tool in stands of either intensive (due to the rapid attrition of mulching benefits) or minimal weed management (due to low survival and slow growth). Conversely, on marginal sites the potential utility of poly mulch appears more promising in both intensive and minimal management applications, particularly for certain clones. The persistent mulching effect seen under intensive weed management at the low-quality site suggests a benefit of edaphic improvement extending beyond establishment. Indeed, on well-drained, marginal sites, intensively-managed plantings using genotypes with poor early rooting may not be possible without a mulching aid. And, there may be occasions where genotypes that are inherently less suited to lower site-quality may be

desirable because of other traits that may enhance long-term success (e.g., resistance to indigenous pathogens and browsers, superior stem form and strength).

The use of poly mulch in minimal weed management applications on marginal sites may also provide an attractive option. The impressive increase in the relative benefit of mulching observed in the second growing season suggests the possibility of a longer-term value. At the low-quality site, closed canopies will form early in the 2001 growing season (with and without poly mulch) in the intensively-managed plots, and self-shading will become a limiting factor in stem volume production. On the other hand, tree crowns in plots with minimal weed control will remain open throughout the growing season. And, it is possible that SVI could begin to converge between groundcover treatments if mulching continues to provide a strong relative benefit in the low-intensity management condition.

Table 1: Means for stem volume increment (SVI, dm^3) in 1999 and 2000. In 1999, the effect of poly mulch was highly significant in all cases ($P < 0.0001$). P-values indicate the significance of poly mulch effects in each condition in 2000.

			1999 SVI		2000 SVI		
Site Quality	**Weed Control**	**Clone**	**Mulch**	**No Mulch**	**Mulch**	**No Mulch**	**P**
High	Intensive	D105	0.22 ?0.015	0.14 ?0.008	6.18 ?0.175	6.03 ?0.139	0.90
		NM6	0.36 ?0.016	0.19 ?0.010	4.48 ?0.147	4.24 ?0.125	0.48
	Minimal	D105	0.04 ?0.005	0.01 ?0.002	0.16 ?0.039	0.05 ?0.020	<0.0001
		NM6	0.07 ?0.006	0.03 ?0.003	0.31 ?0.043	0.15 ?0.016	0.0003
Low	Intensive	D105	0.12 ?0.010	0.02 ?0.003	4.42 ?0.153	3.58 ?0.140	0.01
		NM6	0.26 ?0.017	0.11 ?0.010	5.63 ?0.234	4.88 ?0.160	0.03
	Minimal	D105	0.08 ?0.005	0.04 ?0.004	0.89 ?0.071	0.24 ?0.042	< 0.0001
		NM6	0.13 ?0.007	0.08 ?0.006	1.21 ?0.120	0.42 ?0.099	< 0.0001

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