Tillage Superior to No-till for Establishing Hybrid Poplar Plantations'

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In this study on the effects of till and no-till on early survival and growth of hybrid poplar, till was always superior to no-till regardless of site, clone, or planting material. Over the three sites, tillage produced the greatest tree growth on the loam soil, the wettest and most fertile of the sites. In contrast, no-till showed its best performance on the dryer (and therefore probably warmer) sandy loam site. (Tree Planters' Notes 37(1):6-10; 1986)

Hybrid poplar (*Populus* spp.) plantations are typically established on old field sites that are heavily infested with weeds. For successful establishment of poplars, these weeds must be controlled. Site preparation and weed control are most commonly accomplished by a combination of herbicides and tillage (3,6). However, mechanical tillage is energy-expensive (8). No-till site preparation methods using herbicides alone are alternatives for possible reductions in site preparation costs. Also, no-till has the advantage of improving trafficability on wet sites. However, two plantation establishment studies using unrooted hybrid poplar cuttings as planting material have shown no-till to be inferior to tillage on imperfectly drained clay loam soils in Ontario (9) and on silt loam soils in Wisconsin (4). Both of these studies compared a range of site preparation intensities and in both cases no-till was the poorest in terms of tree growth. The no-till treatment in Ontario also resulted in poorer tree survival.

During the period these studies were in progress, the point was frequently discussed that 1 +0 rooted hybrid poplar stock may grow as well under a no-till system as under a till system or better. No-till with 1 +0 rooted stock is the system used by Packaging Corporation of America (PCA) for planting several thousand hectares in northern Lower Michigan. Because of the potential economic savings and increased versatility of no-till, a broader data base for comparing no-till with the more common tillage systems would be useful. So a study was begun in 1981 on PCA land near Manistee, MI, to compare the effects of till with those of no-till on early survival and growth of hybrid poplar. The study included two clones and two types of planting stock, and was installed on three different sites to check the consistency of results across soil types.

Methods

The experimental design was a split-split plot with 2 replications. Clones were the main plots, tillages the subplots, and planting stock the sub-subplots. Trees were machine planted at a 2.4- by 3.0meter spacing with 2 rows in each sub-subplot. Rows were a minimum of 50 meters long.

The soil types consisted of a poorly drained Bergland loam developed under mixed lowland hardwoods and swamp conifers (loam). The area had been previously used as pasture and wild carrot (*Daucus carota* L.) predominated. A fine-clay subsoil contributed to poor drainage and formed an impermeable barrier to rooting 48 to 50 centimeters below the soil surface. (The water table was at 0.50 meter on October 28, 1981.) A second site was a well-drained Emmet sandy loam formed under sugar maple, beech, and hemlock (sandy loam). There were no impediments to rooting (plow pans or fine-textured layers), and the soil structure was fine granular. (The water table was at 1.7 meters on November 3, 1981 .) Emmet is considered one of the best soils in the area for fruit, potatoes, and alfalfa. The site had been in pasture for several years and plant cover consisted of crownvetch (*Coronilla varia* L.) and alfalfa (Medicago sativa L.) The third site was an excessively drained Kalkaska sand that had not been farmed for at least 3 years before this study (sand). Moisture-holding capacity of this soil is poor because of its coarse texture and loose consistency throughout the deep soil profile. Sludge was applied 10 to 15 centimeters below the surface in 1978 on this latter site. Although sludge application may have raised the

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surface soil pH, it did not affect moisture-holding capacity and soil fertility.

All three sites were sprayed with glyphosate (Roundup) at 2.2 kilograms of active ingredient per hectare on October 26, and the tilled areas were plowed November 6, 1981 and disked May 15, 1982. All areas were machine planted on May 25-26, 1982. Linuron was applied over the cuttings after planting at 2.2 kilograms of active ingredient per hectare. No further treatments were applied thereafter.

Hybrid poplar clones used for the study were NE-19 *Populus nigra charkowiensis x P. nigra caudina and* DN-34 (*P. x euramericana* 'Eugenei'). Planting stock produced by the PCA nursery consisted of 1year-old (1 +0) bareroot stock grown from cuttings and unsoaked unrooted hardwood cuttings. Half of the hardwood cuttings were soaked, but only for 1 or 2 days; there was no noticeable soaking response and all hardwood cuttings were therefore considered as "unsoaked" in the analysis.

Tree survival and height growth were sampled by establishing a straight-line transect across the entire plot perpendicular to the treatments. Within each row, the 3 closest living trees on each side of the transect were measured. Dead trees within the group of 6 living trees were also recorded. The data were collected each fall for the 3 years following planting and were analyzed by standard ANOVA techniques. Significance was evaluated at P = 0.05.

Results

Mortality. Most of the mortality occurred after the first year. By the end of the third year there were significant differences in mortality within tillage treatments, planting stock types, and clones (table 1). Although mortality was 15 percent in the no-till areas and 4 percent in the tilled areas, most of the mortality in the no-till areas was associated with the unrooted planting stock. Unrooted cuttings had significantly higher mortality than rooted stock in the no-till areas (24 versus 4 percent) but only slightly higher mortality in the tilled areas (7 versus 2 percent-not significant).

Growth. Effect of tillage, planting stock, and clone on tree height was similar each year. Consequently, only the third year's data are presented.

Trees were significantly taller on tilled areas than on no-tilled areas for both clones on all three sites (table 2). Tree height averaged 2.70 meters on tilled areas and 1.86 meters on the no-till, a 45 percent difference.

There was a significant interaction of tillage with site. Tillage produced the tallest trees on the loam site. However, the best site for no-till was the sandy loam (although tillage still produced taller trees on that site).

There was also a consistent significant advantage of till over no-till regardless of the type of planting material (table 3). Unrooted cuttings were 0.78 meter (46 percent) taller with tillage than with no-till; rooted stock was 0.90 meter (50 percent) taller. Rooted stock averaged 0.45 meter tall when planted; cutting height was negligible when planted. However, DN-34 unrooted cuttings grew faster than rooted stock, so that at the end of 3 years the rooted stock was only 0.10 meter taller than the unrooted cuttings. In contrast, NE-19

Table 1—*Effect of tillage, planting stock, and clone on mortality during the first 3 years*[1]

Treatment	Mortality (percent)
Tillage	
Till	4a
No-till	15b
Planting stock	
Rooted stock	3a
Unrooted cuttings	16b
Clone	
NE-19	6a
DN-34	13b

[1]Treatments followed by different letters are significantly different from each other.

Table 2—*Effect of clone, tillage, and site on 3-year-old hybrid poplar height (m)*

	DN-34		NE-19		
Site	Till	No-till	Till	No-till	Average
Loam	2.73	1.63	4.28	2.18	2.70
Sandy loam	2.39	1.83	3.07	2.41	2.42
Sand	1.68	1.38	2.01	1.70	1.69
Average	2.27	1.61	3.12	2.10	
	1.94		2.61		

Table 3—*Effect of clone, tillage, and planting material on 3-year-old total tree height and actual shoot growth of rooted stock (m)*

	DN-34		NE-19	
Plant material	Till	No-till	Till	No-till
Unrooted cuttings	2.19	1.60	2.80	1.82
Rooted 1 + 0	2.35	1.63	3.43	2.36
Rooted (growth)	1.89	1.12	3.03	1.93

cuttings grew somewhat slower than rooted stock, so that at the end of 3 years the rooted stock was 0.58 meter taller than the cuttings.

There were significant differences in tree height between sites-trees on the loam site averaged 0.28 meter taller than those on the sandy loam, and 1.01 meters taller than the ones on the sand (table 4). There were also significant differences between tillage treatments, clones, and planting stock types. The best tillage practice, clone, and planting stock each individually contributed 0.84, 0.67, and 0.34 meter, respectively, to tree height. Combining the best tillage practice and clone resulted in a 1.51-meter (94 percent) height advantage over the poorest combination. And combining the best tillage practice, clone, and site resulted in a 2.90-meter or 310 percent height advantage over the poorest combination of those three variables.

A final interesting comparison is that of no-till with rooted stock versus tillage with unrooted cuttings (the major systems used by PCA and the USDA Forest Service at Rhinelander, WI, respectively) (table 4). There was only a 0.03-meter (3 percent) height advantage for the tillage and cutting system at the end of the first growing season. But by the end of 3 years, the tillage and cutting system averaged 0.50 meter (25 percent) taller than the no-till and rooted stock system.

Discussion

The poor performance of the no-till treatment in this test confirms results of earlier till and no-till site preparation trials made on an imperfectly drained clay loam soil (9) and on a well-drained silt loam soil (4). No-till and other practices that leave plant residues on the soil surface result in higher soil moisture in the plant root zone and lower spring soil temperatures (1). The moisture-retaining characteristic of no-till is an advantage on droughty soils but is a disadvantage on poorly drained soils. Agricultural studies show that tillage practices (including no-till) that leave residues on the soil surface are better adapted to the longer, warmer growing seasons in the southern half of the Corn Belt and farther south (5). The fact that no-till results were best on the sandy loam, in contrast to tillage doing best on loam, suggests that the more rapidly warming sandy soils might be partially compensating for the insulating effect of no-till; and that soil temperature is indeed a negative feature of no-till.

Another potential benefit of no-till might be the improved trafficability, particularly for early spring planting. It has been argued that the earliest possible spring planting date for hybrid poplar is best. If so, no-till with its associated better trafficability could be beneficial. However, it has been shown that later planting (when soils are warmer) results in the greatest tree growth for at least the first 2 years

Table 4—*Comparison of 3-year-old hybrid poplar tree heights showing effects of several factors, singly and in various combinations**

Treatment/condition	Tree height (m)	Difference (m)	Percent difference
Site			
1. Loam	2.70a	0.28	12
Sandy Loam	2.42b		
2. Loam	2.70a	1.01	60
Sand	1.69c		
Tillage			
Till	2.70a	0.84	45
No-till	1.86b		
Clone			
NE-19	2.61a	0.67	35
DN-34	1.94b		
Planting material			
Rooted	2.44a†	0.34	16
Cuttings	2.10b		
Tillage + clone			
Till + NE-19	3.12a	1.51	94
No-till + DN-34	1.61b		
Tillage + clone + site			
Till + NE-19 + loam	4.28a	2.90	310
No-till + DN-34 + sand	1.38b		
Tillage + planting material			
Till + cuttings	2.50	0.50	25
No-till + rooted	2.00		

*Values in a treatment class followed by different letters differ significantly.
†Data shown are total height; growth was 1.99 m.

(2). In fact, because a no-till system retards soil warming, it would tend to further delay the optimum planting date. However, even though no-till and early planting result in reduced growth, early planting with no-till may still be necessary with a large operational planting program that spans many weeks. For short-duration planting programs, early planting and no-till should probably be avoided.

The type of planting stock had no effect on which site preparation method was best; tillage was always superior to no-till. However, the best type of planting material could vary with clone. Although rooted stock was the tallest at the end of 3 years for both clones, it was only marginally taller for clone DN-34. Soaking the cuttings of clone DN-34 before planting could easily cause the unrooted cuttings to surpass the rooted stock (7).

Conclusions

Based on the consistently poorer results of no-till in this and other cited tests, we conclude that no-till will probably not be as suitable as other site preparation methods involving tillage at these northerly latitudes. Also, matching the best tillage practice and clone with the proper site can produce tree height several times that attained with the poorer combinations.

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