BLACK POLYETHYLENE MULCH-AN ALTERNATIVE TO MECHANICAL CULTIVATION FOR ESTABLISHING HYBRID POPLARS [1]

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The success of establishing hybrid poplar plantations from unrooted, dormant cuttings is largely dependent on the ability to control competitive vegetation during the root initiation period. Schreiner (1940, 1945) has demonstrated the inhibiting effects of sod on the growth and development of hybid poplar. Cover crops (Ford and Williamson 1952) or the use of simazine (Cunningham and Sowers 1962) to control unwanted vegetation proved unsatisfactory in establishing hybid poplars. These studies indicate that a prepared site, combined with mechanical cultivation during the first growing season, is necessary to establish hybrid poplars.

Polyethylene mulches have proved beneficial in some agricultural crops, as illustrated by Moore (1963) in grape culture. Waggoner et al. (1960) conducted an intensive study on the principles and benefits of polyethylene films. Their results indicated that black films had the least modifying effect on soil energy budgets and had a high ability to conserve soil moisture. The black film by reducing light transmission also exerted the greatest control of unwanted vegetation.

The object of this study was to evaluate black polyethylene mulch as an alternative to mechanical cultivation in establishing plantations of hybrid poplars.

Procedure

Two plantations of hybrid poplar (Clone NE 388), with cuttings at equivalent spacings, were established in a plowed, Morrison sandy loam soil in central Pennsylvania. One plantation was established in 1966 and the second in 1967. Each plantation contained seven replicated blocks with 90 sample trees per block. Each block was split to examine the two methods of weed control-black polyethylene mulch and mechanical cultivation.

Polyethylene film of 4 millimeter thickness was placed between the rows of 10-inch, dormat, unrooted cuttings at planting time. One to two inches of soil separated each polyethylene strip to facilitate water percolation. The 1966 plantation was mechanically weeded three times and the 1967 plantation four times during their respective first growing seasons.

Soil moisture was monitored throughout the growing season, at the midpoint of the time interval between elongation and survival measurements. In 1966, soil moisture was measured at the 2-inch depth by gravimetric method. The 1967 soil moisture measurements were collected at similar intervals by the radio-nuclear method at depths of 2, 6, 18, and 30 inches.

One month after planting, all shoots were removed from a cutting except the shoot that exhibited the greatest elongation. This procedure concentrated tree growth on one shoot per tree. Shoot elongation was measured to the nearest inch from the point of cutting connection to apical meristem. Survival was recorded concomitantly with shoot elongation. Since all the original 45 trees per treatment per block-replication did not survive, 27 living trees were randomly selected on each plot to evaluate tree growth.

Independent statistical analyses were conducted on soil moisture, survival, and elongation measurements taken at each observation period during the growing season. Significant differences indicated in the text are at the 95-percent level of confidence.

Results and Discussion

Soil Moisture

On July 1 of the first growing season of the 1966 plantation, the polyethylene-mulched areas exhibited a significantly greater soil moisture content than the mechanically weeded area (fig. 1). Between July 1 and July 26, there were no soil moisture differences between the two weed control methods. From August 9 to the end of the grow-

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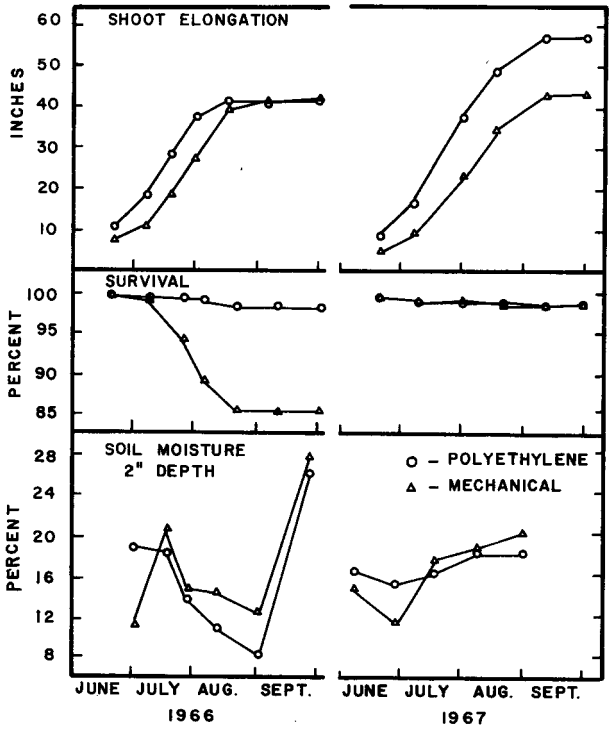

Figure 1.—The shoot elongation, survival, and soil moisture average values of the black, polyethylene-mulched and mechanically-weeded areas during the first growing seasons of the 1966 and 1967 plantations.

ing season, the mechanically weeded area displayed a significantly higher level of soil moisture than the mulched area.

The 1966 growing season precipitation for the State College area was very low. During June, the precipitation was 0.29 inches (3.65 inches less than average) ; July, 2.51 inches (1.27 inches less than average) ; and August, 0.65 inches (1.53 inches less than average). The rainfall received in early July increased the amount of soil moisture on the mechanically weeded area, but the soil moisture level on the polyethylene area continued to decrease (fig. 1) . Not until 5.64 inches of rain fell in September was the soil moisture level on the polyethylene area increased.

There were slight differences in soil moisture content between the two weed control treatment areas during the first growing season on the 1967 plantation (fig. 1). A significant difference was indicated only at the June 28 observation date, when the mulched area had the greater percentage of soil moisture.

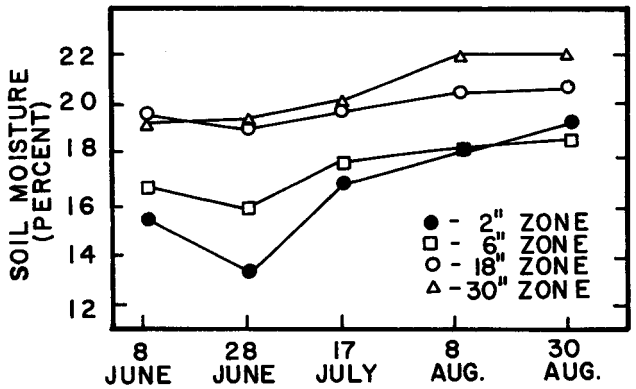

Figure 2.—The percent of soil moisture at the 2-, 6-, 18-, and 30-inch depths for both weed control methods during the first growing season of the 1967 plantation.

The percent of soil moisture was significantly different among the four depth zones throughout the 1967 growing season (fig. 2). However, the weed control-depth interaction was not significant, indicating that there was not a differential amount of soil moisture at depth of observation for the two weed control methods. The soil moisture of the 2-inch depth is presented for comparison (fig. 1).

The total precipitation for the 1967 growing season was 12.01 inches, 2.00 inches above average. During June, the precipitation was 2.22 inches (1.72 inches below average); July, 6.76 inches (+ 2.98 inches) ; and August, 3.03 inches (+0.85 inches) .

The sharp contrast between the soil moisture patterns of the 1966 and 1967 growing season (with a first growing season represented in each year) provided a good evaluation of the influence of the two weed control methods. The weather of the 1967 growing season favored a low transpirationevaporation rate in comparison to 1966. The months of July and August, 1967, were characterized by above average precipitation, high relative humidity, and below average daily temperatures (July 2.6° F., and August 2.3° F. below average). The antithesis of these conditions prevailed during July and August, 1966.

The water conserving potential of the black polyethylene mulch was of particular importance during the month of June. During a limited drought, the soil moisture beneath the polyethyl-

ene was maintained at a higher level than on the mechanically weeded area. However, following a prolonged period of drought, a high amount of precipitation was required (September 1966) to resupply the depleted soil moisture under the mulch because the plastic prevented penetration of light rainfalls. In a season when a sufficient amount of precipitation was received, the moisture difference between the two weed control methods was negligible.

Survival

The average percent survival of the trees at the end of the 1966 growing season was significantly greater on the mulched area (98) than on the mechanically weeded area (85) (fig. 1).

Most of the tree deaths, on both weed control areas, occurred during the period of rapid soil moisture depletion between July 7 and August 18. The low soil moisture content of this period was primarily the result of the light precipitation for the month of June, a mere 0.26 inches. The average soil moisture content between June 21 and July 5 was 11.2 percent for the mechanically weeded area and 18.7 percent for the mulched area.

Root cutting on the mechanically weeded area may possibly have contributed to the high mortality during the droughty year. However, this effect was probably minor because of the shallowness of cultivation (less than 2 inches) .

In the 1967 plantation, 98 of 100 planted trees survived, irrespective of the weed control method. Since there was little or no difference in mortality between treatments, there was no need for statistically analyzing the survival rates.

When the soil moisture levels for 1966 and 1967 (fig. 1) are compared with the percent survival of the trees for each year, it is evident that the greater survival of 1967 can be ascribed to the greater precipitation in 1967, particularly during the month of June. In 1967, 2.22 inches of precipitation fell compared to 0.29 inches in 1966. The lack of a difference between the survival rates of the mechanical and polyethylene weed control areas in 1967 and the lack of a prominent soil moisture difference further supports the premise that the survival differences in 1966 were the result of soil moisture differences.

Shoot Elongation

The trees on the black, polyethylene-mulched area of the 1966 plantation exhibited a significantly greater total shoot elongation between June 21 and August 1 than those on the mechanically weeded area (fig. 1). At the end of the growing season, the trees on the mechanically weeded area had an average length of 42.0 inches as compared with 41.5 inches for the trees on the mulched area. These averages were not signicantly different from each other.

Comparison of first-year, shoot growth for trees of the two weed control methods indicates that the mulched trees developed at a greater rate early in the growing season, and the mechanically weeded trees grew faster later in this period. The changes in rate of shoot development within the growing season can be ascribed to the same soil moisture changes that affected survival.

The water conserving influence of the polyethylene during the early part of the growing season, when precipitation was low, encouraged faster shoot development. However, when the soil moisture was depleted and not replenished, shoot elongation was restricted on the mulched trees.

Although the intervals of greatest shoot growth were different for the two weed control areas, the durations were similar (40 days for the mulched area and 44 days for the mechanically weeded area).

Trees on the mulched area of the 1967 plantation exhibited a significantly greater shoot elongation throughout the entire growing season (fig. 1) . At the end of this period, the mulched trees had an average length of 57.1 inches as compared with 42.5 inches for the mechanically weeded trees.

The first-year, shoot-elongation response to the two methods of weed control was similar in 1966 and 1967. The trees on the black, polyethylenemulched area developed at a greater rate, earlier in the growing season. The 1966 pattern was unlike that of 1967 since the mulched trees in 1967 maintained shoot elongation longer (56 days) than the mechanically weeded trees (40 days). This pattern can be attributed to a greater soil moisture level on the mulched area up to June 28, 1967. After June 28, the two areas were equal in the percentage of soil moisture present. This contrasts with

the reversal of soil moisture values on the two areas during the 1966 growing season and the balancing of the shoot elongation values. In 1967, the growing season soil moisture regime on the mulch area was consistently favorable for tree growth. On the mechanically weeded area, low soil moisture at the beginning of the growing season hindered shoot development. The net result was a 14.6-inch average difference in shoot length between the two weed control methods at the end of the growing season.

Summary

The applicability of black, polyethylene mulch in establishing plantations of hybrid poplar (clone NE 388) was compared with mechanical cultivation during two dissimilar growing seasons. Lower mortality and greater shoot growth characterized the mulched trees during periods of average rainfall or limited drought. In a season of prolonged drought, the polyethylene film hindered the recharge of soil moisture by light rainfalls, nullifying the early growth advantage of the mulched trees. The results of this study indicate that establishment success using black, polyethylene mulch can equal or exceed that of mechanical cultivation.

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