GROWTH RESPONSE OF WHEELER POPLAR TO MAINTENANCE TECHNIQUES IN SOUTHERN SASKATCHEWAN

BY

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ABSTRACT

The effects of six maintenance techniques on the growth of Wheeler poplar (Populus x balsamifera L. cv. 'Wheeler # 4') in amenity plantations at Danielson Park, Saskatchewan, were studied between 1968 and 1973. The best height and stem diameter growth were achieved under cultivation treatments and the poorest under control and high mowing treatments. Herbicide and low mowing treatments produced only marginally slower growth than the cultivations. All trees survived under cultivation and low mowing. The highest mortality was observed in the control, followed by high mowing.

Control and high mowing treatments conserved the greatest amount of soil moisture from winter precipitation, but this advantage was quickly lost in the spring by high rates of evapotranspiration. Cultivated soils were more effective in conserving water from spring and early summer rains; net water loss from the soil under cultivation began one month later than from the soil receiving no treatment. Soil moisture was exhausted under each treatment by the middle of August.

RESUME

Les effets de six méthodes d'entretien sur la croissance du peuplier Wheeler (Populus x balsamifera L. cv. 'Wheeler #4') en des plantations d'agrément au parc Danielson, en Saskatchewan, furent étudiés entre 1968 et 1973. La meilleure croissance de la tige, en hauteur et en diamètre, fut obtenue par des traitements de culture et les plus pauvres résultats furent obtenus par des traitements de fauchage haut et avec les témoins. Des traitements avec herbicides et de fauchage bas produisirent une croissance plus lente que les traitements de culture, mais de façon marginale. Tous les arbres ont survécu aux traitements de culture et de fauchage bas. On a signalé la plus haute mortalité chez les témoins après le fauchage haut.

Les témoins et les arbres autour desquels on a fauché haut conservèrent le plus haut degré d'humidité dans le sol, provenant des précipitations hivernales, mais cet avantage fit vite place aux pertes printanières dues aux importants taux d'évapotranspiration. Les sols cultivés conservèrent mieux l'eau des pluies du printemps et du début de l'été; la perte nette en eau dans les sols cultivés commença un mois plus tard que dans les sols non traités. L'humidité du sol avait complètement disparu, après chacun des traitements, vers le milieu d'août.

INTRODUCTION

Approximately 2500 ha (6000 acres) of amenity plantations (trees and shrubs) were established in southern Saskatchewan between 1947 and 1972 to provide shade and shelter for campers and picnickers in a prairie environment. The most important silvicultural problems related to these plantations were species selection, site selection, and proper maintenance after establishment. Kagis' (1963-1968) studies on the effects of environmental conditions on growth and survival of trees in the Gardiner Dam area indicated that soil moisture supply and evapotranspiration were the most important factors. He concluded that soil moisture supply was inadequate to support both trees and weeds in the same area, and advised the removal of competing vegetation by cultivating the soil between the tree rows. However, cultivation is expensive and may damage tree roots.

The aim of this study was to find possible alternative methods of weed control by testing the effect of six different maintenance techniques on the growth and survival of Wheeler poplars (Populus x balsamifera L. cv. 'Wheeler # 4').

LOCATION OF STUDY

The experiment was conducted in the vicinity of Danielson Park, close to Gardiner Dam at 51°17' N and 106°52' W at an elevation of about 510 m. The area is within the subhumid continental climatic zone of Köppen (Dfb) with 305-355 mm annual precipitation. Midgrass prairie vegetation and dark brown soils are characteristic in this climatic zone (Richards and Fung 1969).

MATERIALS AND METHODS

The effects of the following postplanting maintenance treatments were tested on the growth and survival of Wheeler poplars over a 6-yr period:

1. Paraquat (Garmoxone) herbicide treatment in 11 ml/litre concentration, applied with hand sprayer
2. Shallow cultivation, about 2.5 cm deep
3. Deep cultivation, 13-15 cm deep
4. High mowing, 13-15 cm above ground
5. Cultivation in the first year and low mowing, about 2.5 cm above ground, in subsequent years
6. Control (no interference with weed growth).

All mechanical treatments were carried out at monthly intervals between June 15 and August 15. Herbicide was applied approximately three times during the growing season when growth of weeds was evident. The rate of application was about 880 litres/ha.

The six treatments were replicated in five contiguous blocks on randomly chosen 10 x 15 m sample plots within each block (Figure 1). Fifteen 30-cm long rooted cuttings were planted in three rows within each sample plot. The planting was carried out in spring 1968 using 3 x 3 m spacing. From 1969 to 1973 yearly measurements of height and stem diameter (30 cm above ground) was taken after the growing season on three trees in the center of each plot to eliminate edge effect. Condition of the measured trees was appraised by visual observation and classified into the following categories: healthy--normal appearance of twigs and foliage, poor--dead top and/or abnormally thin foliage, dead--no sign of life in the tree. During the summer of 1973 soil moisture was measured by the gravimetric method. Two samples were taken at 10-cm and 60-cm depths from a sample plot of each treatment at biweekly intervals from April to early October. The soil was a loam with about 10% available water-holding capacity.

The growth data were analyzed statistically by analysis of variance method and Duncan's multiple range test. Degree of freedom was reduced in the error term and the analytical method for unequal number of observations was used when trees were lost from the experiment.

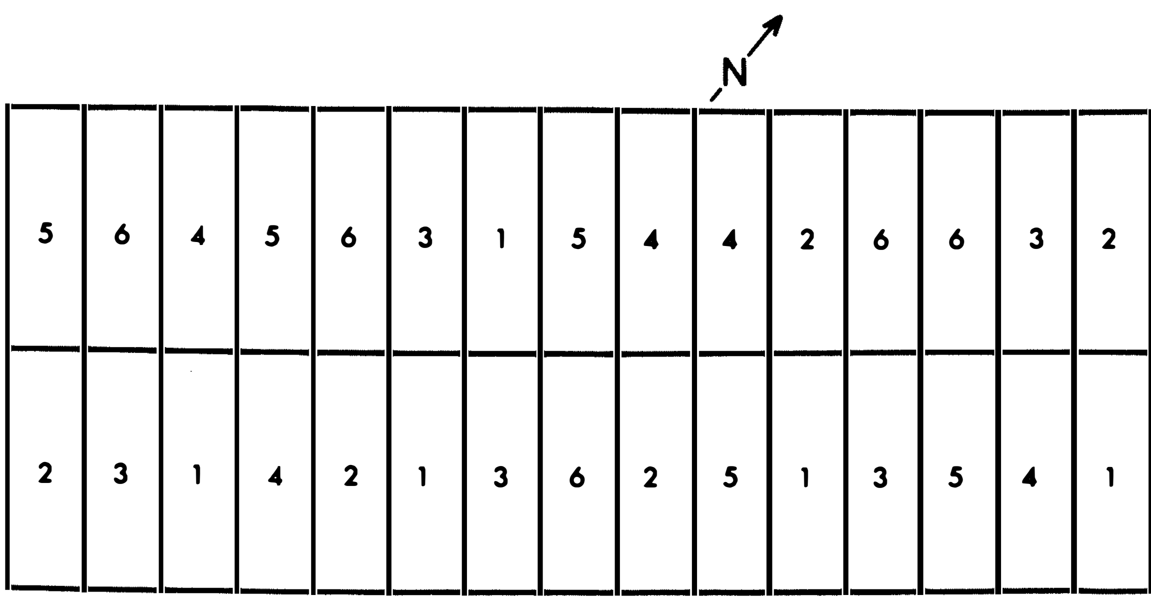

Figure 1. Layout of treatments in the experiment:

1-Herbicide, 2-Shallow cultivation, 3-Deep cultivation, 4-High mowing, 5-Low mowing, 6-Control.

RESULTS AND DISCUSSION

HEIGHT AND DIAMETER GROWTH

The effect of postplanting treatments on the height growth of hybrid poplars was apparent after two growing seasons (Figure 2). Trees under shallow cultivation and low mowing had the most vigorous height growth, while those under high mowing and control treatments were the lowest in 1969. This pattern continued through 1970. In 1971 and 1972 the treatments produced two distinct groups: high mowing and control in the slow growth group and the other treatments in the rapid growth group. There were no statistically significant differences within groups until 1973, when trees under low mowing had significantly lower heights than those under shallow cultivation. The cause of this may have been an adaptation of the weeds to low mowing.

The average growth rate for all treatments peaked in the third growing season after planting at approximately 1 m new growth (Figure 3). In the following years the rate of height growth decreased gradually to about 30 cm in the fifth year after planting. This pattern of development was probably strongly influenced by the distribution of precipitation from May to October in those years. In 1970 and 1971 the precipitation was 20.1% and 18.5% respectively higher than the mean, while in 1972 and 1973 it was 17.1% and 17.7% lower than the average (Environment Canada 1970-1973). All treatments, with the exception of the control, followed the previously described growth pattern. Trees under the control treatment had very small growth in the wet summer years (1970-1971), and unexpectedly large growth during the dry years, 1972 and 1973. Although

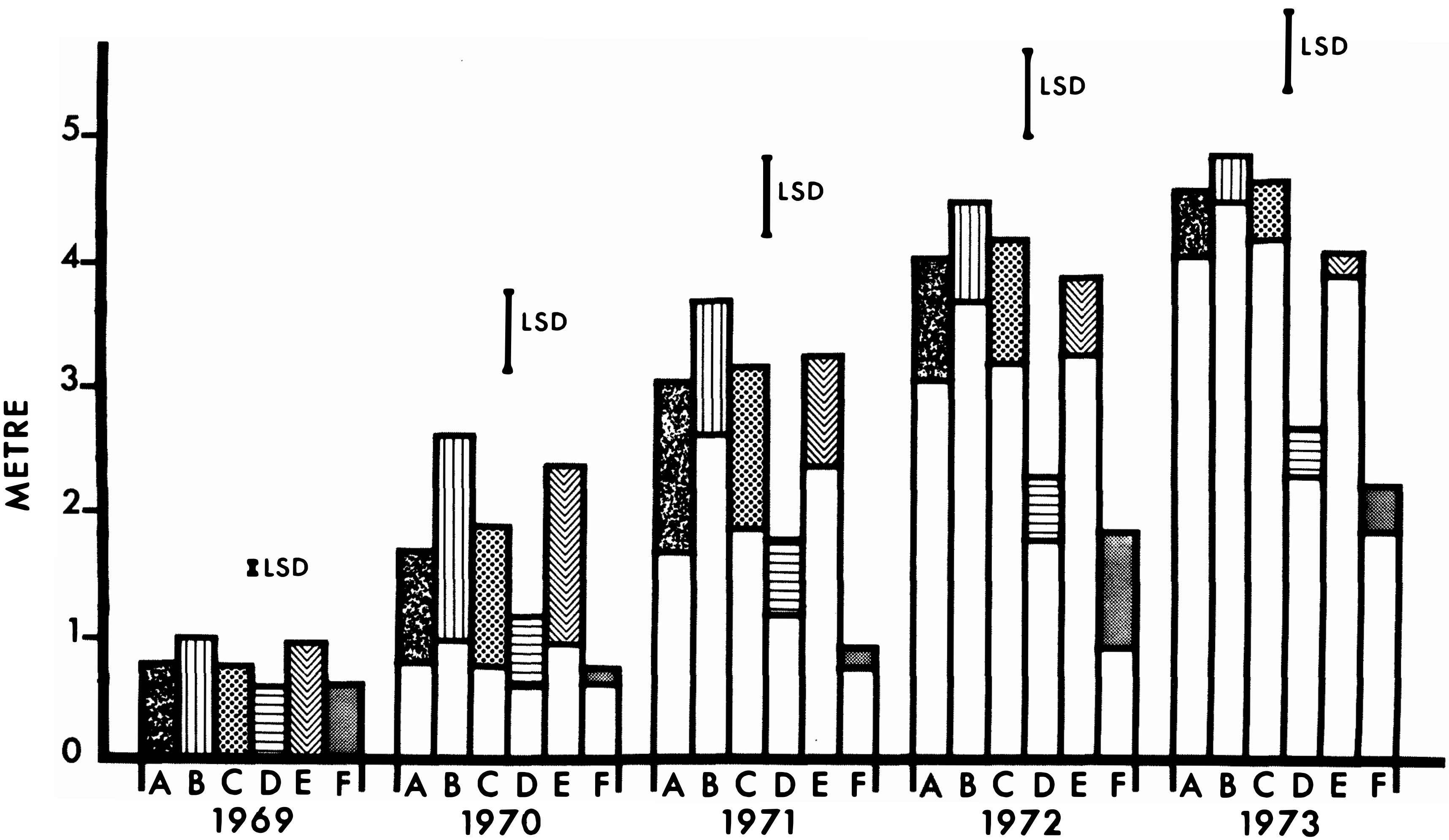

Figure 2: Height growth of hybrid poplars under the following postplanting treatments: A-Herbicide, B- Shallow cultivation, C-Deep cultivation, D-High mowing, E-Low Mowing, F- Control.

Figure 3: Height growth of Wheeler poplars in the third growing season after planting. Cultivation treatment in the right and control in the left foreground.

the growth rate was sharply reduced in the second dry summer (1973), it was still more than twice as large as in the wet years. A possible explanation of this result is the combined effect of water storage and competition. During summers with relatively high moisture the vigorously growing weeds competed successfully for available nutrients and water. On the other hand, during seasons with low precipitation trees were able to utilize water and nutrients more efficiently because of reduced competition of the weeds. The soil under the control treatment also had a larger water reserve in the spring than the weed control treatments, and thus would be less affected in a dry year. (See discussion of soil moisture.)

Diameter growth of the trees followed very closely the pattern of height growth (Figure 4). The only exception was that peak diameter growth occurred in the third year after planting instead of the second.

SURVIVAL

The small number of trees sampled (15 in each treatment) did not allow mortality to be evaluated as a percentage of the total number. Instead, the condition of sample trees is provided in Table 1.

TABLE 1. Condition of trees under different postplanting treatments after 5 growing seasons, shown as number of trees in each category

CONDITION	TREATMENT					
	Herbicide	Shallow Cultivation	Deep Cultivation	High Mowing	Low Mowing	Control
Healthy	11	15	15	13	15	10
Poor	0	0	0	0	0	2
Dead	4	0	0	2	0	3

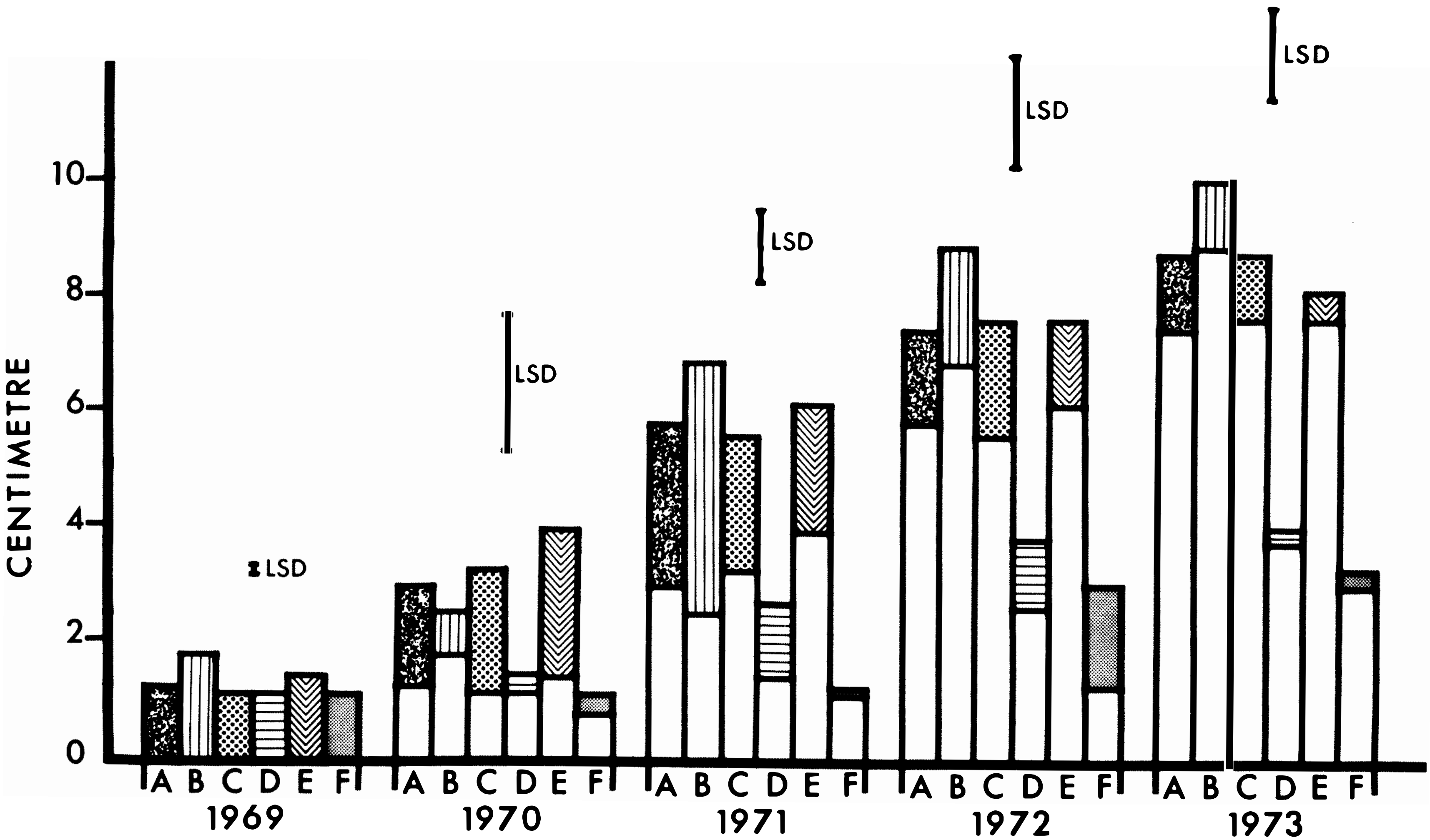

Figure 4: Stem diameter growth of hybrid poplars under the following treatments: A-Herbicide, B-Shallow cultivation, C-Deep cultivation, D-High mowing, E-Low mowing, F-Control.

Mortality and poor condition occurred in treatments with slow height and diameter growth. High mortality under the herbicide treatment was the result of inadequate protection of the trees during application of chemicals.

SOIL MOISTURE

The range of stored soil water was between 14-25% at 10-cm depth and between 9.5-25% at 60-cm depth on April 17, 1973, depending on maintenance treatment (Figure 5). The greatest amount of winter moisture was stored under the control, followed by high and low mowing. The smallest amount of stored moisture was found under the shallow and deep cultivation treatments. The rate of water storage from winter precipitation seemed to be related to the height of weeds on the sample plots. The tall ground vegetation in the control plots retained more snow than the shorter grass left by mowing, and the shorter grass retained more snow than the soil cleared completely by cultivation.

The initial advantage of the control treatment was lost by the end of May because of higher rates of evapotranspiration losses. The amount of stored water decreased much more slowly under mowing and herbicide treatments, and even increased under cultivation, especially at the 60-cm depth, during the same period (Figure 6). Depletion rates were similar in all treatments between the end of May and the middle of August. The lowest moisture contents were measured on August 13 in all treatments and the soils began to recharge from this date.

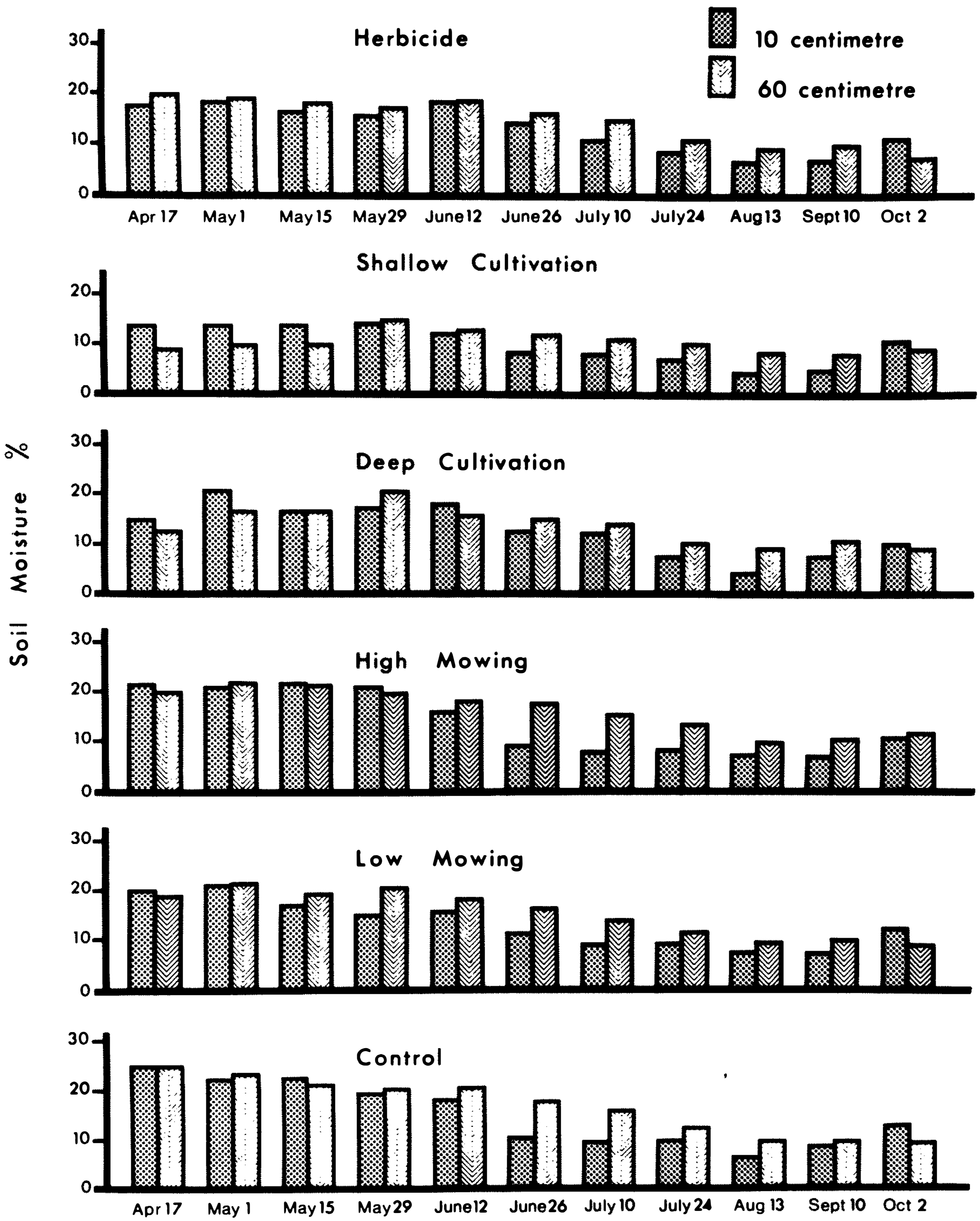

Figure 5: The advance of soil moisture at 10- and 60-cm depths under the different postplanting treatments in 1973.

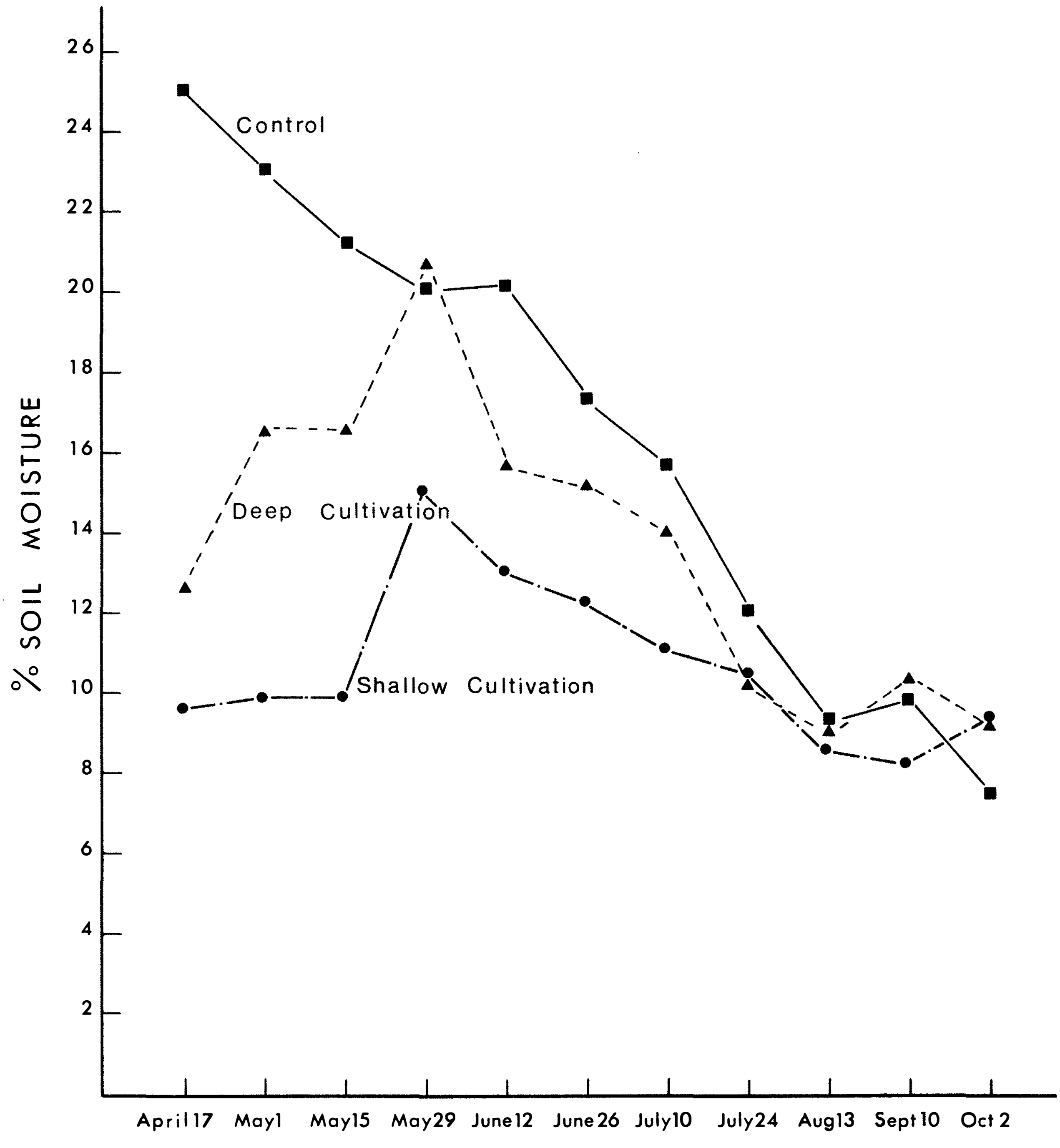

Figure 6: The run of soil moisture content under cultivation and control treatments at 60-cm depth during the 1973 growing season.

CONCLUSIONS

1. Cultivation, herbicide, and low mowing treatments produced much better growth than control or high mowing.
2. Shallow cultivation resulted in somewhat better growth than deep cultivation, probably because of less damage to tree roots, and in significantly better growth than low mowing.
3. Control and high mowing were more effective than other treatments in storing winter moisture; however, under cultivation practices more water was retained from spring and early summer precipitation.
4. Soil moisture reserves were exhausted regardless of treatment by the middle of August in 1973.
5. The small number of observed trees does not lead to a firm conclusion on survival. However, the existing data suggest that any treatment which effectively reduces weed competition increases the chance for survival.

A publication which evaluates the water-conserving efficiency of low mowing and cultivation in different regions of southern Saskatchewan, will be available later in 1976. Recommendations will be given for postplanting cultural treatment by regions.

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