EFFECTS OF DEPTH AND TIME OF PLOWING BROOKSTON CLAY ON YIELD OF CORN AND TOMATOES

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Plowing at 10- or 20-cm depths was more effective for yield of corn than plawing at 30 cm on Brookston clay soil of southerwestern Ontario. Plowing below 20 cm for tomatoes was more suitable only in seasons with optimum rainfall and was less satisfactory over the period of investigation. Although there is a practical mechanical limitation to plowing at 10 cm, the yield results reported indicated that the current practice of plowing within the 15- to 20-cm depths is quite satisfactory. Fall plowing on this soil produced consistently higher yields of corn than spring plowing. Fall plowing was also more reliable than spring plowing for tomatoes on the basis of both plant survival and yield.

INTRODUCTION

Minimum amounts of tillage are desirable to reduce time required for soil preparation and to conserve soil and energy resources (Larson 1967). The tillage practice must, however, maintain or improve crop yield.

Choice of tillage practice is of considerable importance on fine-textured soils such as the clay soils of southwestern Ontario, where unsuitable tillage may not only impair soil tilth but severely reduce crop yield (Bolton and Aylesworth 1957). Brookston clay is one of the soil types where crop production is sensitive to tillage treatment.

This soil is described by Richards et al. (1949) and is currently classified as an Orthic Humic Gleysol. The high density of Brookston clay, especially below 10 cm, invites an attempt to alter this soil physically by mechanical means below this depth. Such an approach appears particularly feasible, since the ameliorating effect of alfalfa has been attributed in part to the loosening action of this legume at sub-plowsole depth (Ripley 1969).

Mechanical modification of soil at depth has been achieved by a number of workers and the results reviewed by Burnett et al. (1967). It was concluded that such treatment increased yields where compacted layers existed in the soil but only where soil moisture was limiting. In contrast, Triplett and Van Doren (1969) have shown that plowing was unnecessary for seedbed preparation on coarser textured soils where corn was grown.

Studies (Bolton and Aylesworth 1957) on Brookston clay indicated that the widely used practice of fall plowing was more reliable for corn yield than other tillage methods. Plowing was conducted at a depth of 15-20 cm in these experiments. Because of the high density of this soil below the plow depth of these treatments, it was considered that plowing at greater depth might enhance the benefit of fall plowing.

An experiment was established to determine the effects of plowing Brookston clay at 10-, 20-, and 30-cm depths on yields of grain corn and processing tomatoes. Although fall plowing had been shown to be superior to spring plowing in previous studies, it was considered important to measure the effect of plowing depth for both spring and fall-plowed treatments. At the outset it was decided to carry out the experiments for several years to expose the treatments to a range of anticipated seasonal conditions, particularly moisture.

EXPERIMENTAL PROCEDURES

Moldboard plowing treatments were carried out at the 10-, 20- and 30-cm depths on Brookston clay soil at Woodslee in Southwestern Ontario during the 1968-74 period. One such series of treatments was conducted each fall and a second series carried out the following spring. For each series the plowing treatments were repeated annually on the same plots.

Plowing treatments were carried out with a tractor rated at 38.3 drawbar kW equipped with a rear-mounted plow that had three 30-cm bottoms. Depth control was maintained with a gauge wheel attached to the plow. Plowing at 30 cm during fall seasons when soil moisture was below 20% required the full operating capacity of the tractor. Final seedbed preparation in the spring was achieved by two diskings with a set of tandem disks equipped with 40-cm-diam plates spaced 22 dm apart on the axle and to which levelling harrows were attached.

Two adjacent experiments were established on wheat stubble at Woodslee, each consisting of four replications, with treatments randomized. Plots were 15 m long, 6 m wide and once allocated to a specific tillage treatment, remained with that treatment, so that a particular plot would represent an ongoing management practice with whatever cumulative effects might develop.

Each crop alternated with set effects confounded by years.

Fertilizer at planting and as a sidedress treatment was provided in accordance with fertilizer recommendations (Field Crop Recommendations. Ontario Ministry of Agriculture and Food Publication 296.). The application at planting was made following the initial disking.

Both corn and tomatoes were planted as early as soil and weather conditions permitted. Corn was most often seeded during the 1st 2 wk of May, while tomatoes were established as seedlings, usually after mid-May. Cultivar choice, and cultural methods for both corn and tomatoes were in accordance with recommended practice for these crops.

Corn or tomato yields were determined on the center two rows of each 6-row corn plot and of each 4-row tomato plot. Grain corn yield was expressed in kg/ha on a 15.5% moisture basis, while tomato yield was expressed as tonnes/ha total harvest.

RESULTS AND DISCUSSION

The data for the two adjacent sets of plots were summarized together, since homogeneity of error variance was indicated, and there were no interactions between set of plots and treatment effect for either corn or tomatoes. Results are summarized over years.

Depth and Time of Plowing for Corn

Plowing at 10- and 20-cm depths in the fall increased average corn yield by 290 and 150 kg/ha, respectively, over yield on the deep 30-cm plowing treatment for the 1968-74 period (Table I).

Season exerted a marked influence on yield and upon the effect of plowing depth on yield. Since the effect of season was obviously associated with moisture, the yield results were grouped in accordance with rainfall received during the growing season. The seasons were described as being dry, favorable or having excessive precipitation in relation to long-term average precipitation for Woodslee as presented by Sanderson (1976).

TABLE I EFFECT OF DEPTH AND TIME OF PLOWING BROOKSTON CLAY SOIL ON YIELD OF FIELD CORN IN KG/HA, WOODSLEE, ONTARIO 1968-74

	Time of plowing		
Depth of plowing	Fall	Spring	Mean
10 cm	6,730 *a*	6,210 *a*	6,470 *a*
20 cm	6,590 *ab*	5,740 *b*	6,160 *b*
30 cm	6,440 *b*	5,370 *c*	5,900 *c*
Mean	6,580	5,770	6,180

a - c Means in same column with common letter not significantly different from each other using Duncan's Multiple Range Test. $P \leqslant 0.05$. Yield on fall plowing significantly greater than on spring plowing at each depth, $P \leqslant 0.01$, and for mean, $P \leqslant 0.01$.

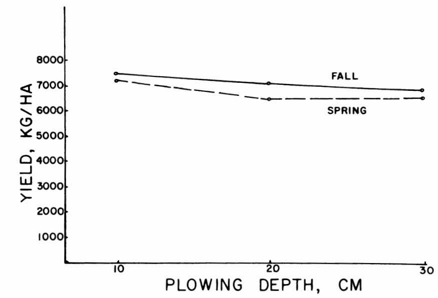

Figure 1. Effects of plowing depth on corn yield on Brookston clay soil in seasons with above average rainfall, 1968-70.

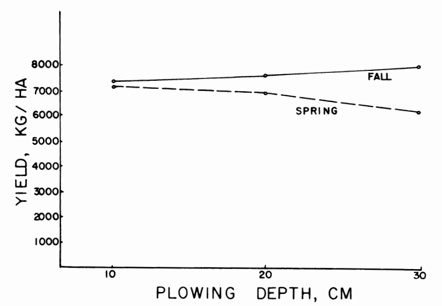

Figure 2. Effects of plowing depth on corn yield in seasons with average rainfall, 1971-72.

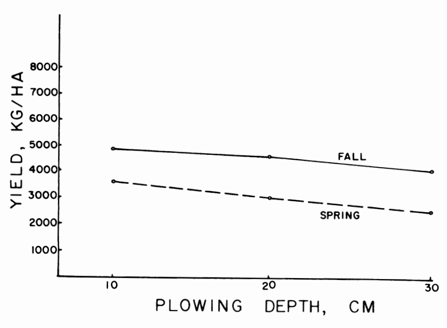

Figure 3. Effects of plowing depth on corn yield in seasons with below average rainfall, 1973-74.

TABLE II EFFECTS OF DEPTH AND TIME OF PLOWING BROOKSTON CLAY SOIL ON YIELD OF TOMATOES IN TONNES/HA: WOODSLEE, ONTARIO 1968-74†

	Time of plowing		
Depth of plowing	Fall	Spring	Mean
10 cm	54.05	45.16	49.60
20 cm	54.13	47.71	50.92
30 cm	52.53	49.92	51.23
Mean	53.57‡	47.60	50.58

†Six-yr average; no crop in 1969.
‡Average yield on fall plowing greater than on spring plowing: $P \leqslant 0.01$.

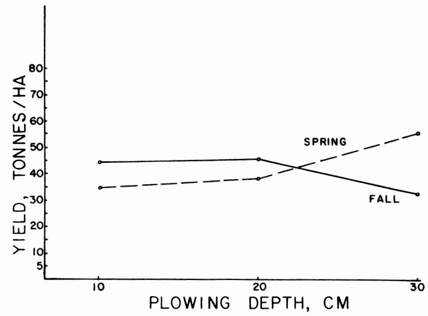

Figure 4. Effects of plowing depth on tomato yield in seasons with above average rainfall, 1968-70.

The classification of seasons was based on significant deviation from Sanderson's norm, with special stress on July and August precipitation, so essential to full season crops. On the basis of this, the seasons 1968-70 had significantly excessive rainfall, the 1971-72 seasons were normal, and the 1973-74 years had a significant precipitation shortfall and were classed as "dry."

The shallower fall-plow depths were superior to the 30-cm treatment during the 1968-70 seasons of excessive precipitation (Fig. 1) and in the exceedingly dry seasons of 1973-74 (Fig. 3). When precipitation distribution and quantity appeared normal or optimum in the 1971-72 period, corn yield showed some response to deeper fall plowing (Fig. 2).

Within spring treatments, plowing at 30 cm consistently reduced corn yield in relation to the shallower depths: an average yield reduction of 840 kg/ha occurred from the 10- to 30-cm depth. There were no years when deep plowing in the spring increased yield, while the largest yield reduction of all, 2200 kg/ha, resulting from 30-cm as compared with 10-cm spring plowing, occurred in 1972 when soil moisture and growing conditions were excellent. Yield reductions due to deep spring plowing also occurred in 1968 and 1969 when excessive moisture conditions prevailed.

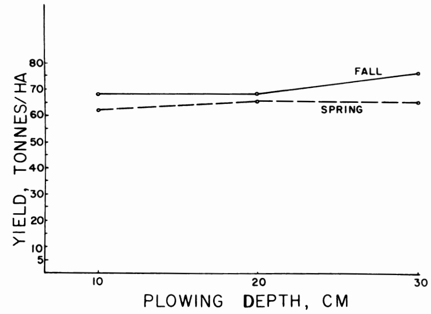

Figure 5. Effects of plowing depth on tomato yield in seasons with average rainfall, 1971-72.

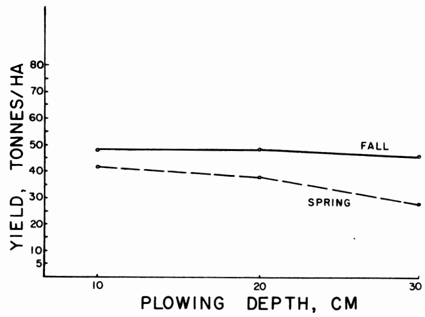

Figure 6. Effects of plowing depth on tomato yield in seasons with below average rainfall, 1973-74.

The advantage of fall plowing over spring plowing was evidenced by greater average corn yield with fall plowing at each depth for the entire 1968-74 period. Even during seasons of above average precipitation the average corn yield was as good or better on fall treatments compared with spring plowing. Spring plowing in 1973 and 1974 resulted in disastrously low corn yields that reflected the low precipitation received during these seasons.

Depth and Time of Plowing for Tomatoes

Plowing at the conventional depth of 20 cm in the fall was as effective for tomatoes as plowing at 10- or 30-cm depths on the basis of average yield for 1968-74 (Table II). Flooding in 1969 resulted in the loss of that year's crop for all depths of plowing. The same classification of growing seasons used for corn was applied to tomatoes.

Deep fall plowing reduced yield below that on shallower depths in 1968 and 1970 (Fig. 4), when precipitation was more than adequate. During the 1971-72 period (Fig. 5) when precipitation was most suitable for growth, deep fall plowing at 30 cm increased tomato yield by 8.58 tonnes/ha over the 20-cm treatment.

Deep spring plowing at 30 cm during the 1968 and 1970 seasons when precipitation was excessive increased tomato yield over the 10- and 20- cm plowing treatments (Fig. 4). Deep fall plowing had the opposite effect on yield during this period. It is suggested that the loosened soil condition that existed following spring plowing in contrast to the subsided condition on fall plowing brought about this anomaly.

Spring plowing at 30 cm reduced yield below that for the shallower depths in 1973 and 1974 (Fig. 6); both very dry seasons.

Fall plowing was more suitable for tomatoes than spring plowing and increased average yields at each plowing depth (Table II) over the respective spring treatments. In addition, it was noted that extensive replanting of transplants was essential on spring plowing to obtain an adequate stand, while such replanting was not required on fall-plowed treatments. This difference in plant establishment was attributed to the coarse, dry seedbed on spring-plowed treatments.

The advantage of fall plowing was most pronounced in dry seasons such as 1974 when fall plowing increased average yield by 13.44 tonnes/ha over spring plowing. Tomato yield on spring plowing equalled yield on fall plowing in 1968 and 1970 (Fig. 4) when excessive soil moisture existed.

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