EFFECT OF CONSERVATION TILLAGE ON CORN YIELDS AND SELECTED SOIL PHYSICAL PROPERTIES

Peter F. Waldron, Peter L.M. Veneman and Stephen J. Herbert
Department of Plant and Soil Sciences
University of Massachusetts

Tillage research has been carried out at the University of Massachusetts Agricultural Experiment Station farm in South Deerfield since 1981. The 1981 season showed no yield differences in the various tillage treatments of conventional tillage (moldboard plow-disk), disk-disk, and no-tillage. In 1982 yields in the moldboard plow-disk treatment were slightly higher than in conservation tillage treatments, which in 1982 also included a chisel-disk treatment. During the 1983 growing season we are concentrating on the influence various tillage practices have on soil peroperties as well as plant growth. Several growth factors which influence final yield are currently being investigated. These factors are:

1. Soil Temperature

Loosening the top soil reduces the heat transfer through the soil, and facilitates the heat exchange in the surface soil. Soil temperatures taken at a depth of 5 cm (2 inches) are reported in Fig. 1. Readings were taken at 9:00 a.m. three days a week. During the spring warm-up and prior to tillage, soils which had been tilled in previous years, moldboard plow-disk and double disk, appear warmer at the surface. Those soils less disturbed, chisel-disk and no-till were cooler. After tillage, the heat exchange of the moldboard plow, double-disk and chisel-disk actually reduced soil temperature, when compared to the no-tillage practice, possibly through increased evaporation rates.

2. Bulk Density

Each tillage operation, regardless of the particular tillage implement alters the bulk density. For example, the moldboard plow loosens, shears and inverts the upper 20-30 cm (8-12 inches) of the soil while at the same time the tractor wheels compact the soil below the furrow. The most dramatic change in bulk density for all the tillage treatments (Fig. 2) is that between the soil before tillage and that same soil beneath the tire tracks after tillage. Frequent traverses through the field may cause unnecessary compaction and produce bulk densities that may become restrictive to plant root growth, infiltration and gas exchange. Excessive compaction of the seedbed in 1982 may have been one of the reasons for reduced yields in the conservation tillage treatments.

Controlled traffic is very important in the no-tillage treatments and at the same time often the most difficult to maintain. Bulk densities in the no-till treatments prior to planting and in the between-tire tracks after tillage show a considerable decrease, possibly the result of dessication cracks caused by wetting and drying. These cracks are desirable and perhaps even necessary for no-till and other conservation tillage treatments.

3. Organic Matter Content

The inherent capacity of soils to produce crops is directly related to their organic matter and nitrogen contents. Even after two years of conservation tillage the treatments which received manure slurry in 1980, still showed higher organic

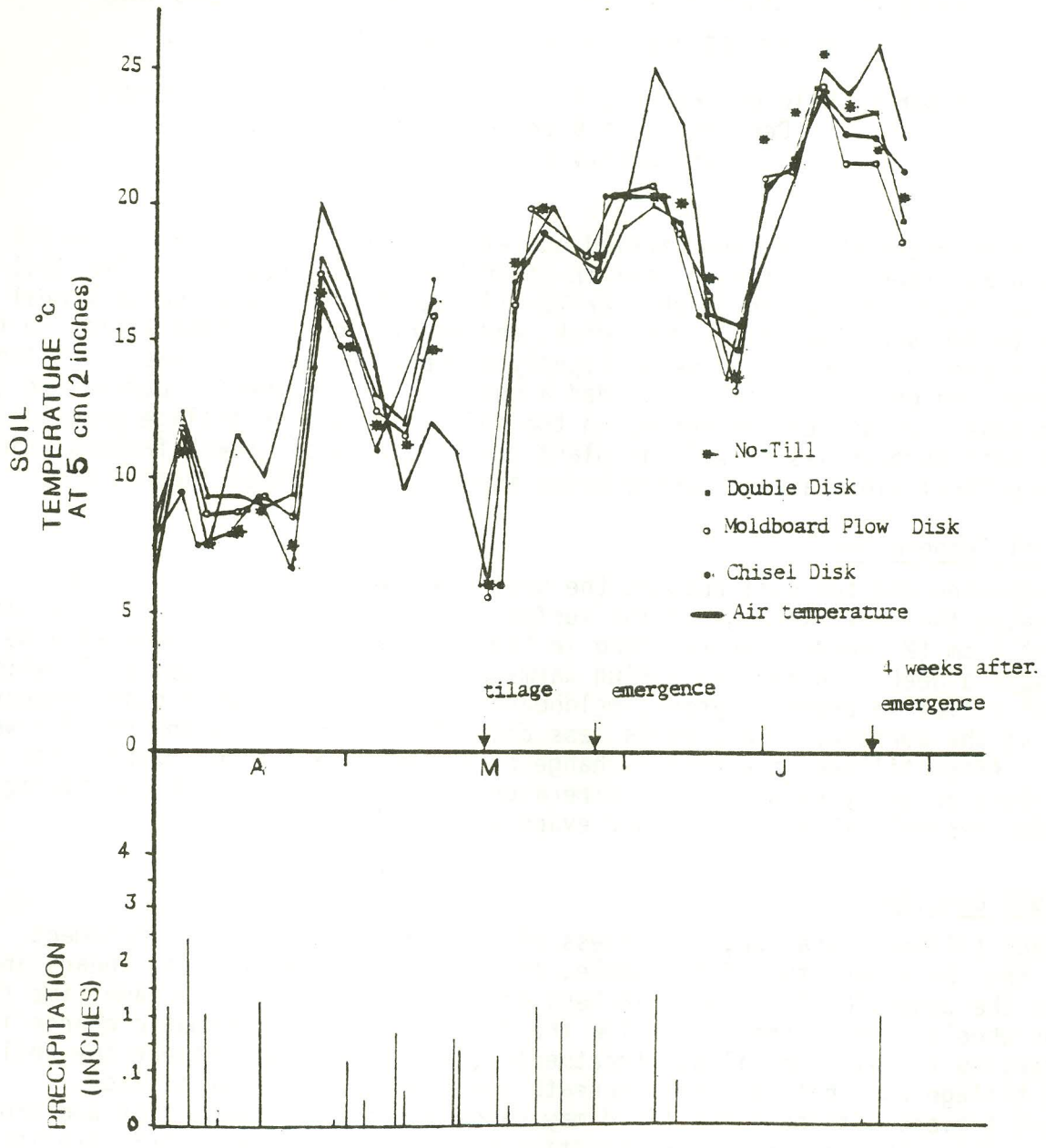

Fig. 1. Soil temperature at 5 cm and precipitation influence before and after tillage. Data taken at 9:00 a.m. 1983.

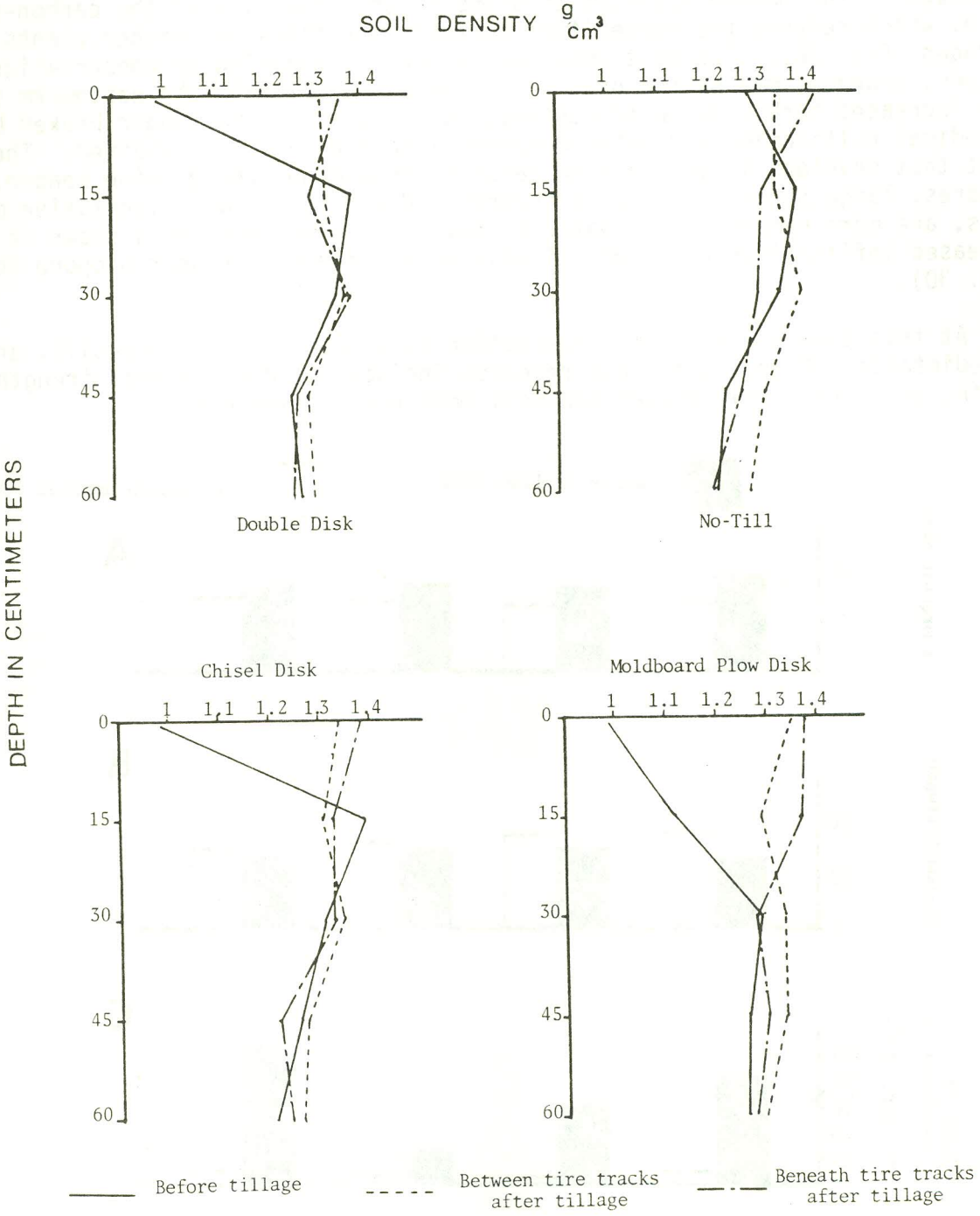

Fig. 2. Comparison of bulk density between treatments before and after tillage, 1983.

matter contents than corresponding non-manured treatments (Fig. 3A). Another advantage of the manure application seems to be a lowering of the carbon-nitrogen ratio, which reduces the competition between microflora and higher plants for nitrogen (Fig. 3B). The most important aspect of manuring in conservation tillage systems, however, may be the need to increase and maintain the earthworm population. With increased herbicidal weed control, soil crusts are no longer broken by periodical cultivation and water movement into the soil is inhibited. The first crust that develops after planting persists throughout the growing season. Biopores, large pores mined by earthworms and associated with vegetative mounds or casts, are more numerous in treatments having received manure as shown in Fig. 3C. Increased infiltration rates are closely correlated with higher biopore counts (Fig. 3D).

At this time yields from conservation tillage, especially no-till, are still unpredictable. On-going tillage research includes studies on soil strength, root growth, soil crust development and soil moisture differences.

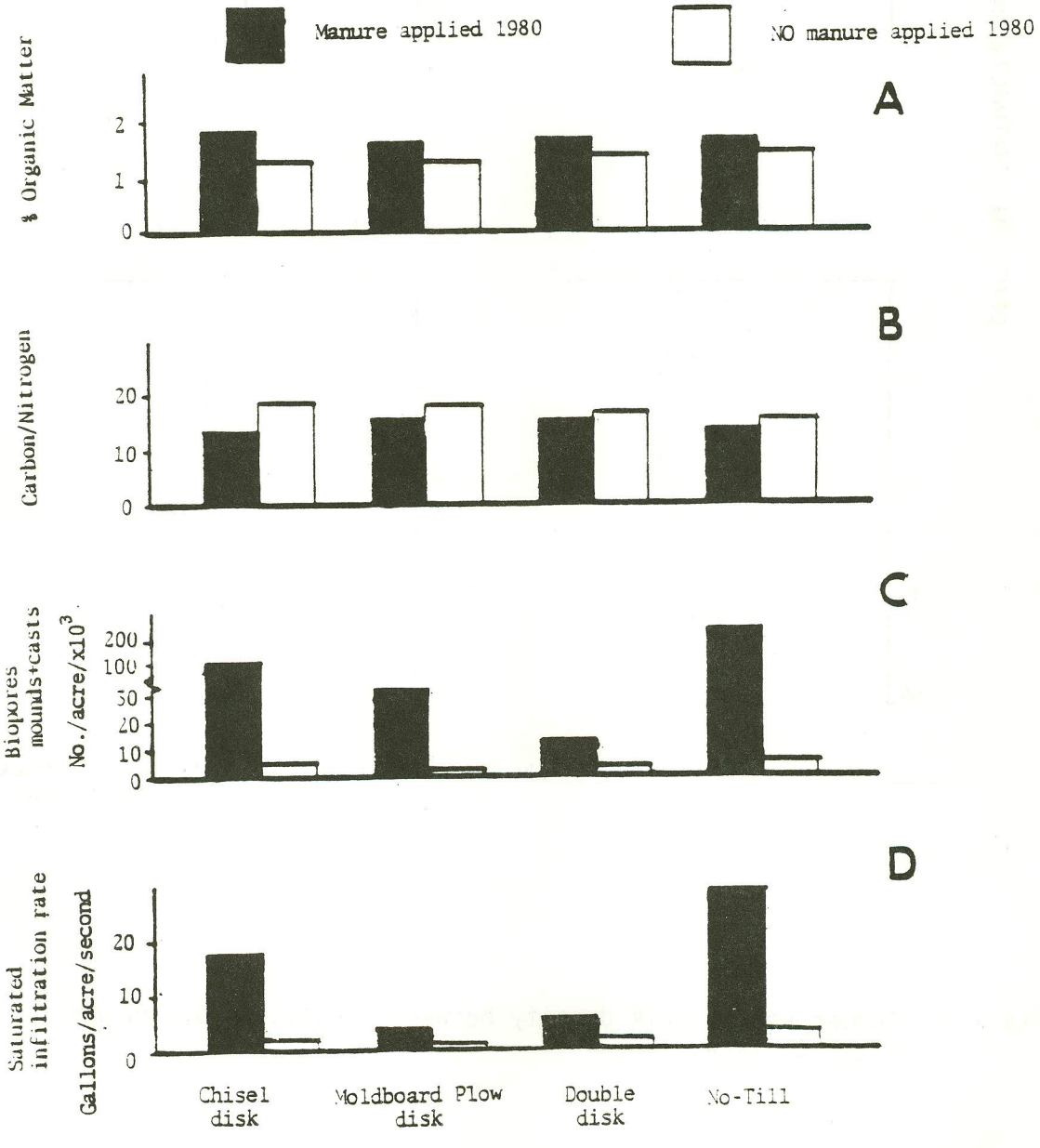

Fig. 3. Comparison of manure/slurry application, 15 tons/acre, prior to conservation tillage. Data taken Spring 1983, no cover crop.