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Nitrate Accumulation in Soils Covered with Plastic Mulch[1]

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PLASTIC mulch frequently increases crop yields in irrigated and nonirrigated regions of the United States. Partial or complete plastic cover reduces evaporation of soil moisture and increases plant water-use efficiencies as compared with bare soil. Increases in soil moisture and temperature near the surface of plastic-covered soil, compared with bare soil, favor higher soil microbiological populations. One of the nutrient changes associated with microclimatic changes in a soil due to the presence of plastic mulch is the accumulation of soil nitrates. The significance of increased nitrate accumulation in a soil covered with plastic mulch is often neglected in moisture-yield evaluations in the field.

Procedure

Composite soil samples from the 0- to 6- and 6- to 18-inch depths of a Rago silt loam were taken from plastic-covered and bare fallow soils at 0-, 1-, 2-, 3-, 7-, and 12-week intervals beginning June 15 and terminating September 7, 1959. Soil samples were air dried prior to nitrate analyses by the phenoldisulphonic acid method.

A sheet of black polyethylene (0.006-inch thickness), measuring 12 × 12 feet, was placed over the soil on June 15. The edges of the plastic cover were buried 3 to 4 inches and carefully resealed after each sampling to prevent evaporation and exclude all rainfall. The surface of the soil under plastic mulch remained moist throughout the experiment. Soil temperature was measured at a 3-inch depth in both covered and bare fallow plots with a thermograph.

Results and Discussion

Soil samples taken to a depth of 6 feet when the experiment was initiated revealed that the soils were wet to 2 feet and contained 3.2 inches of available water. Moisture calculations were based on a measured bulk density of 1.4. Soil dykes were constructed around the bare fallow plots to prevent runoff. Precipitation received during the period totaled 5.06 inches. Soil moisture samples taken September 7 indicated no change in the moisture status of the soil under plastic cover. The bare fallow soil gained 0.8 inch available moisture during this period with no apparent change in depth of penetration. Since much of the rain was received in small showers of less than 0.2 inch each, low moisture storage efficiency would be expected when accompanied by normal high air temperature. Since water movement downward in the bare fallow soil was not apparent, leaching of nitrates would not occur to any great extent.

The total NO_3-N accumulation throughout 0 to 18 inches of soil under plastic cover and from bare fallow plots is shown in Figure 1. At the end of 12 weeks, plastic-covered soil to a depth of 18 inches contained 140 pounds NO_3-N, while bare fallow soil had 78 pounds starting from an initial NO_3-N level of 26 pounds per acre. Nitrate-nitrogen present in the 0- to 6- and 6- to 18-inch depths of soil under plastic cover was 32 and 15 pounds per acre-6-inches greater, respectively, than bare fallow soils sampled at the same depths.

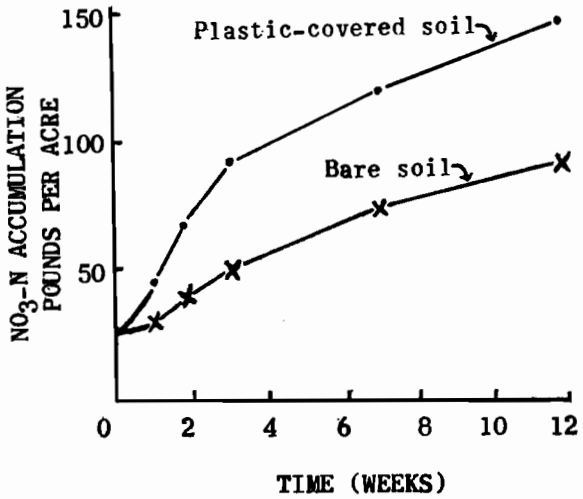

Figure 1—Accumulation of nitrate-nitrogen (pounds per acre) in 0- to 18-inches of bare fallow and plastic-covered soils.

Soil temperature averaged 3 to 7° F. warmer under plastic cover than bare fallow soil when measured at 3-inch soil depths for 24-hour periods during clear days in July and August. Plastic-mulched soil was also warmer than bare-fallow soil at night.

Soil temperature increases coupled with excellent moisture conditions near the surface of plastic-covered soils favored NO_3-N accumulation. Interpretation of moisture-yield data involving plastic mulch treatments should not neglect accumulation of soil nitrates. Greater NO_3-N production in plastic-covered soil may be partially responsible for plant yield increases.

The accumulation of NO_3-N reached 80 pounds per acre in bare fallow soil. This level of nitrogen would be considered adequate for most dryland crops grown in a summerfallow farming system because moisture more often limits the growth of plants than does nitrogen in the Central Plains region. However, if the supply of available moisture was not limiting plant growth on dryland or irrigated soils, then the increase in NO_3-N accumulation in soils covered with plastic mulch would be an important factor to plant growth and subsequent yield responses.—A. L. BLACK *and* B. W. GREB, *Soil Scientists, Northern Plains Branch, ARS, USDA, Sidney Mont., (formerly, Akron, Colo.) and Akron, Colo., respectively.*

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