Effects of Conservation Tillage on Weed Succession and Crop Yield on a Coastal Plain Soil

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Reduced tillage has gained much favor in the Southeastern Coastal Plain from the standpoint of time, labor, and soil conservation, but no-tillage has generally not been accepted due to poor stands, high weed pressure, and associated lower yields when compared to a more conventional tillage and weed management regime. In order to assess the interaction of crop rotations, tillage systems, and weed management levels, on insects, weeds, diseases, and crop yield, a long-term interdisciplinary study was established at the Edisto Research and Education Center in 1983. This project involves personnel from the Departments of Agronomy and Soils, Entomology, Plant Pathology, Agricultural Economics, Agricultural Engineering, and Experimental Statistics. The objectives of this research are:

1. To determine weed growth, herbicide efficacy, and population dynamics encountered under various levels of management, tillage, and cropping schemes for soybeans;

2. To determine changes in insect, nematode, and disease levels under each agroecosystem studied;

3. To prepare crop production budgets for each agroecosystem and determine profitability of each.

Although there are data available dealing with discipline-oriented research on specific pests, there are essentially no pulished papers dealing with this type of integrated approach.

Three different tillage systems, representing those commonly in use, or which could be readily adapted by soybean growers, are under study:

1. Conventional tillage--to include discing, subsoiling, and cultivation as needed:

2. Minimum tillage--discing once prior to planting and subsoiling at planting;

3. No-till--plots are disced and chisel-plowed before wheat planting, but are only subsoiled prior to planting the summer crop.

Cropping systems include continuous soybeans, wheat followed by soybeans, or wheat/soybeans followed by corn the following year. A low level of weed management (preemergence herbicides plus cultivation only) is being compared to a high level of weed management (preemergence plus postemergence herbicides as needed plus cultivation).

At the conclusion of the third year of the study (one complete crop rotation cycle) there have been no differences observed among treatments (tillage system, rotation, or weed management level) on effects on beneficial or harmful insects or diseases. There also have been no significant shifts in nematode populations, but one rotation cycle may be too short to see any effects with this pest group.

Weed infestation levels have been higher under all rotations and herbicide levels in the no-tillage systems. The biomass of grassy and perennial weeds also appears to increase as tillage is reduced. With the use of preemergence and postemergence herbicides, weed infestation can be reduced to a non yield-reducing level. Minimum tillage systems appear comparable to conventional tillage in terms of weed biomass except in the continuous double-cropping of wheat and soybeans. In this system biomass is significantly higher than in all other rotations. Soybean yields for the no-till treatments declined in 1984 and were significantly lower than for conventional or minimum tillage treatments in 1985, Corn stand and yields have been reduced in the no-till plots compared to conventional or minimum tillage. Rotation has had no effect on soybean yield, but wheat yield seems to improve in the system with corn in the rotation.

Crop producing budgets are currently being prepared to compare the economic impact of these practices. The project will continue through the 1987 growing season.

Conservation tillage research is also being conducted in South Carolina by USDA-ARS scientists at the Coastal Plains Soil and Water Conservation Research Center (CPSWCRC) near Florence, SC. The scientists conducting this research are D.L. Karlen, W.J. Busscher, M.J. Kasperbauer and P.G. Hunt. The objective of their research program is to improve soil tilth and productivity by optimizing conservation tillage systems, cropping sequences, plant and microbial manipulations, and water management practices for the predominant soil associations in the southeastern Coastal Plains. They have found that currently, conservation tillage is not being used in the southeastern Coastal Plains because yield penalties often reduce the profitability of those systems compared to conventional tillage practices. For corn, conservation tillage apparently causes a yield penalty because seedbed characteristics for germination, growth, and development are poorer than for conventional tillage systems. This occurs even though in-row subsoiling is used to alleviate soil strength problems for both tillage systems.

To increase the use of conservation tillage systems, alternative commercial and experimental tillage implements, planters, and weed control equipment are being evaluated and modified for southeastern Coastal Plain soils. Fertilizer practices for improved plant nutrition are being studied and related to inherent soil productivity and nutrient leaching. The effects of alternative tillage practices on soil color (bare vs residue covered), light environment, and seedling growth are being evaluated. The basic studies are providing valuable information regarding the effects of soil color on transmission of light to the root zone and its effect on root growth, soil microorganisms, nodulation, and other micorhizal processes. Field studies are being conducted with and without supplemental irrigation so that the most profitable conservation tillage system can be determined for this region.

Several conservation tillage publications have been written by CPSWCRC scientists (1-9). Research has also been conducted to evaluate tillage systems for wheat on Ardilla, Dothan and Norfolk soils. Summarizing eight site-years of research that were conducted between 1983 and 1985 has shown that no-till treatment yields were significantly lower than where the seedbed was prepared by disking in 2 of 4 years. The best tillage treatment for wheat, however, utilized deep tillage with a moldboard plow. This treatment significantly increased grain yield by an average of 6 bu/acre in 4 of 5 site-years compared to using disk tillage to prepare the

seedbed. A N variable was included in these tillage studies because of the known reduction in available N for no-till wheat systems compared to conventional tillage systems. Tillage and **N** both increased grain yield by increasing head number and weight per unit area. Increased N compensated for tillage in 50% of the experiments, but the interaction between tillage and N was neither strong or consistant.

Another conservation tillage study was conducted to assess the effectiveness of four deep tillage implements in encouraging corn germination and in developing and maintaining a proper rooting environment throughout the growing season. The implements, which included a Brown-Harden Super Seeder (SS), BushHog Ro-till (RT), Howard Paratill (PT), and Kelley Manufacturing Co. (KMC) systems, were evaluated with and without surface disking to incorporate soybean residue and with and without irrigation. Germination and stand establishment for the conservation tillage treatments (79%)was significantly less than for the disked treatments (93%). Achieving good soil-seed contact in these systems appears to be a major limitation at this time, because when irrigation water was applied within 48 hours after planting, stand establishment for both tillage systems averaged 24,400 plants/acre.

This research also showed that at the begining of the growing season, overall soil strength for the SS and PT implements was about 0.35 MPa lower than for the RT and KMC implements in both conservation and conventional tillage systems. This was due to a larger area of disruption by the SS and PT implements, although all four units broke through the root-restricting E horizon. Conservation tillage treatments maintained a softer medium for root growth and did not recompact as much during the growing season as the conventional treatments. This may be the most important reason for adopting conservation tillage systems in the southeastern Coastal Plains. Furthermore, it suggests that for Coastal Plain soils which have been subsoiled, compaction is not the factor causing lower grain yields in conservation tillage systems.

Literature Cited

1. Busscher, W. J., R. E. Sojka, and C. W. Doty. 1986. Residual effects of tillage on coastal plain soil strength. Soil Sci. (In press).

2. Campbell, R. B., D. L. Karlen, and R. E. Sojka. 1984. Conservation tillage for maize production in the U.S. southeastern Coastal Plain. Soil & Till. Res. 4:511-529.

3. Campbell, R. B., R. E. Sojka, and D. L. Karlen. 1984. Conservation tillage for soybean in the U.S. southeastern Coastal Plain. Soil & Till. Res. 4:531-541.

4. Healy, R. G. and R. E. Sojka. 1985. Agriculture in the south: Conservation's challenge. J. Soil and Water Conserv. 40:189-194.

5. Hunt, P. G., M. J. Kasperbauer, and T. A. Matheny. 1985. Effect of surface color and rhizobium japonicum strain on soybean seedling growth and nodulation. Agron. Abs. p. 157.

6. Karlen, D. L. and R. E. Sojka. 1985. Hybrid and irrigation effects on conservation tillage corn in the Coastal Plain. Agron. J. 77:561-567.

7. Karlen, D. L. and J. P. Zublena. 1986. Fluid fertilization practices for corn in the Atlantic Coastal Plain. Fert. Issues 3:l-6.

8. Karlen, D.L. and D.T. Gooden. 1986. Tillage systems for small grain in the Atlantic Coastal Plain. S. Branch Am. Soc. Agron. Abs. 13:6.

9. Sojka, R. E., G. W. Langdale, and D. L. Karlen. 1984. Vegetative techniques for reducing water erosion of cropland in the southeastern United States. Adv. Agron. 37:155-181.