No-Tillage Research in Georgia

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Introduction

In this report, we summarize ongoing research on no-tillage in Georgia. Several disciplines are involved in researching the many aspects of no-tillage production. The project leaders are inaicated for each discipline.

No-tillage adoption (J. E. Dean, USDA-SCS)

The no-till acreage for 1985 is shown in Table 1. The amount of no-tillage remains a small fraction of the total crop production in Georgia, averaging only 4.2%. Conservation tillage makes up a much larger fraction averaging 23% of the total. No-tillage has actually declined somewhat in

Table 1. No-till acreage in Georgia, 1985.

Crop	Total Production	No-Till	Total[1/] Conservation Till	Conservation Till
	----------------	---------- acres	---------------	% of total
Corn	1,130,552	43,967	328,899	29.1
Small grain	1,233,573	25,966	355,533	28.8
Soybean	1,993,698	111,386	528,197	26.5
Cotton	251,041	700	4,564	1.8
Sorghum	255,278	26,917	84,561	33.1
Vegetable Crops	156,654	1,205	7,154	4.5
Forage[2/]	124,233	9,601	21,717	17.5
Total	5,888,599	246,396	1,369,811	23.3

[1/] Includes no-tillage, ridge-till, strip-till, mulch till, and any other reduced-till system which leaves at least 30% residue cover.

[2/] Excluding permanent pasture.

the last 2 to 3 years as a result of the depressed farm situation arid the high cost of inputs. Soybean continues to be the number one no-till crop in Georgia. Of the total soybean acres, about 40% are double-cropped following small grains, and of the double-cropped soybeans, 11% and 36% are no-till and conservation till, respectively.

More row-crop acreage in Georgia needs to be in no-tillage production due to excessive soil erosion. Continued research and extension efforts, especially in weed control, should enable the amount of no-till production to increase.

Soil erosion research (G. W. Langdale, A. W. Thomas, and W. C. Mills, USDA-ARS)

The influence of cropping/tillage systems on soil loss probabilities from a southern Piedmont landscape was recently computed stochastically (Fig. 1). The model used was weighted with rainfall depth (100 years), rainfall energy (34 years), and observed runoff (12 years) from a 6.7 acre watershed with slopes up to 7.0%. This model suggests that a more than 80% probability is required for soil erosion, associated with double-cropped conservation systems, to exceed 0.5 tons/acre/year. At the same probability levels, soil losses associated with mono-cropped conventional tillage exceed 50 tons/acre/year. Coulter-in row chiseling grain sorghum into crimson clover residues virtually eliminated soil losses. Double-cropped conservation tillage systems also reduced total P loss from 3.6 to 0.09 lbs/acre/year on the same watershed, at the expense of increasing PO_4-P by 40%.

Soil fertility research (W. L. Hargrove and D. O. Wilson, UGA)

Research with legume cover crops showed that crimson clover continues to be the best adapted species to the soils and climate of Georgia. Yields of no-till corn were 180 bu/A following crimson clover with no fertilizer-N on a Cedarbluff silt loam soil. Yields of no-till grain sorghum were 100 bu/A following crimson clover with no fertilizer-N on a Greenville sandy clay loan soil. Crimson clover replaced as much as 120 lbs fertilizer-N per acre. Since fertilizer-N represents a sizeable portion of the fossil fuel energy required for non-leguminous row crop production, this represents a significant energy savings, enhancing the conservation value of a no-tillage production system.

The effects of legume cover crops on soil fertility status include: 1) a lower pH, 2) a redistribution of K^+ to the soil surface from deeper in the soil profile, and 3) a lower C/N ratio in soil organic matter.

Results from a study of nutrient uptake and yield of corn as affected by tillage showed that the redistribution and concentration of nutrients at the soil surface was not a disadvantage but appeared to be an advantage especially for P and micronutrient uptake. Though plant roots tended to be concentrated also near the soil surface with no-tillage, root activity was greater outside of the row and deeper in the soil profile under no-tillage management compared to conventional tillage.

Soil physical properties (D. E. Radcliffe, E. W. Tollner, and W. L. hargrove, UGA)

Results from studies of tillage and residue management practices for double-cropped soybeans at several locations in Georgia have shown that soil compaction and shallow tillage "pans" are serious problems on sandy Ultisol with poorly developed structure. By restriction of root proliferation, compacted soil layers can be detrimental to crop yields under no-tillage production. However, in long-term (10 years) no-tillage plots on a Cecil soil, crop performance has been maintained or improved in years 5 through 10 even though dense compacted layers are present. It is hypothesized that large continuous pores through the compacted layers have been established and preserved through no-tillage management, that allowed root proliferation into the subsoil. This hypothesis will be the subject of continuing studies.

Weed control and interference research (P. A. Banks, UGA)

Soybean yields were significantly greater when grown under a no-till, straw-mulched double-cropped system with wheat compared to a conventionally tilled double-crop system when both were infested with sicklepod (Banks et al, 1986). Yields under weed-free conditions were not different. The yield differences where sicklepod was present were attributed to soil-water content differences between the two systems; more water was available during the soybean reproductive stage of growth in the no-till system. It is also likely, ihat under the conditions of these experiments, the soybeans were better able to compete with the sicklepod under the nontilled conditions. This research demonstrates that weed interference studies conducted under conventionally tilled conditions cannot be used to predict the effects of weeds on soybeans grown under nontilled conditions.

Experiments to evaluate the influence of a wheat straw mulch on soil-active herbicides have been reported for rnetribuzin (Banks and Robinson, 1982), oryzalin (Banks and Robinson, 1984), acetochlor, alachlor, and metolachlor (Banks and Robinson, 1986). The chloroacetamide herbicides, (acetochlor, alachlor, and metolachlor) were retained more by the straw than the other herbicides following 0.5 inch of sprinkle irrigation. Oryzalin was least affected of the herbicides studied. The persistence of oryzalin in the soil was also less under the straw mulched conditions. The persistence of the other herbicides was not affected by the straw mulch. In the experiments with the chloroacetamide herbicides, it was documented that the herbicide retention by the wheat straw adversely affected herbicidal activity. Alachlor was most affected and acetochlor least affected. Metolachlor was more persistent than the other two herbicides. Research is continuing with other herbicides and also to determine the effect of straw-burning on herbicide persistence in these doublecropping systems.

The indeterminate soybean variety 'Duocrop' was show to provide an advantage in weed control over the determinate varieties 'Wright', 'Ransom', and 'Hutton' (Giraudo, 1986). Canopy closure was more rapid with Duocrop and the end of season weed weights were less compared to the other varieties. Research has continued to deterimine if the affect of soybean variety on weed interference is due totally to a 'physical' effect or if allelopathy nay play a part.

Numerous herbicides and herbicide combinations have been evaluated for weed control in nontilled soybean culture following small grain harvest. Regardless of what soil residual herbicide is used, the nonselective, foliar active herbicide applied at the time of planting is the most important component of the weed control program (Banks and Kvien, 1983). Several of these herbicides have been evaluated (paraquat, glyphosate, HOE-662, and SC 0224). For small, annual weeds all provided good control. Many times, weeds are several months old at the time of wheat harvest and paraquat has not provided adequate control of common ragweed, lambsquarters, horseweed, or large crabgrass.

In general, herbicides used in conventionally tilled soybean culture provide similar results under nontilled conditions with a few exceptions. Control of large seeded annual grasses and perennial grasses has been more difficult, although the new postemergence herbicides, sethoxydim and fluazifop, have provided excellent control when applied correctly (Hutchinson, 1985; Whiddon, 1985).

Several new broadleaf herbicides, imazaquin (Scepter), chlorimuron (Classic), and fomesafen (Reflex), have shown potential for use in nontilled culture. Research will continue with these, as well as with dimethazone (Command) and Canopy (metribuzin plus chlorimuron) to determine activity and potential residual hazards with fall-planted small grain or various rotational crops planted the following spring.

Entomological studies (J. N. All, W. A. Gardner, J. M. Cheshire, and D. Buntin, UGA)

Research over the past 12 years has revealed that the unique environments that are created in conservation tillage systems may have positive, negative, or neutral effects on insect pest potential. The lesser cornstalk borer, Elasmooalpus *lignosellus*, is a devastating soil pest of many southern field crops Infestations are significantly reduced in conservation tillage as compared to plow tillage systems. Reduced damage in conservation tillage is related to the saprophytic behavior of larvae which feed actively on the surface mulch in conservation tillage systems. In contrast, the southern corn billbug, Sphenophorus *callosus*, produces devastating infestations in conservation tillage corn and infestations appear to be enhanced by the increased cover provided by surface debris in these cropping systems.

The effects of wheat stubble management on Hessian fly (*Mayetiola destructor*) populations in winter wheat are being investigated. In a preliminary study, burning of wheat stubble had no significant ($P<.05$) effect on Hessian fly infestation. Conventional tillage significantly ($P>.05$) increased the percentage of uninfested tillers as compared with no-ti 11age.

In studies of the ecology and enhancement of entomoyenous pathogens in crop production systems, it has been found that tillage may distribute the overwintering inoculum of naturally-occurring pathogens, such as *Nomuraea rileyi*, in the soil, increasing the probability of contaminating plant surfaces where foliage-feeding larvae reside. Quantification of the vertical movement and persistence of an entomogenous fungus in response to tillage will be determined utilizing *Beauveria bassiana* as a model.

Soil microflora and plant diseases (C. S. Rothrock and B. M. Cunfer)

Microbial changes due to conservation tillage were examined in a long-term tillage experiment. No differences were found in the major groups of microorganisms (fungi, actinomycetes, and bacteria) in the upper 5 cm of soil. However, fungal, actinomycete, and bacterial populations were all lower from soil samples at the 5 to 15 cm depth under the no-tillage treatment compared to the conventional tillage treatment (moldboard plow).

Southern stem canker of soybean, caused by Oiaporthe phaseolorum var. caulivora, has increased under no-tillage, both in terms of severity and incidence. However, preliminary results from a study of cultivar x tillage interaction show no significant difference in yield of a resistant cultivar (Coker 368) between conventional and no-tillage. For a susceptible cultivar (Hutton), yield was 29% less than Coker 368 with conventional tillage, but 49% less with no-tillage. These data indicate that resistant cultivars can be incorporated into no-tillage systems to effectively control stem canker even under extreme disease pressure.

Take-all of wheat, caused by Gaeumannomyces graminis var. tritici, has been reported to be increased, decreased, or not affected by tillage. In our studies, take-all was found to increase in incidence and severity with conventional tillage. This increase in disease resulted from the movement of residues infested with the pathogen, spreading inoculum.

Wheat is one of the few crops where comparable yields have not been observed between no-tillage and conventional tillage systems. Research has demonstrated by fumigation that these reduced yields are associated with biotic factors. Research is also ongoing to develop disease-resistant small grain cultivars that can be used effectively in conservation tillage systems.

Ecological studies (P. F. Hendrix, D. A. Crossley, and K. W. Parmelee, UGA)

Recent studies by the Institute of Ecology suggest that organisms responsible for plant residue decomposition have shown distinct responses to tillage. Community structure of the soil biota suggests that microbial decomposition may be dominated by fungi in no-tillage and bacteria in conventional tillage. Earthworms and soil arthropods were more abundant in no-ti1lage, whereas enchytraeids and bactivorous nematodes were more abundant in conventional tillage. Insect herbivory on plant foliage has generally been higher in conventional tillage than in no-tillage, possibly due to greater abundance of predators in no-tillage systems and other unexplained agroecosysten dynamics.

Economic research (J. Allison and S. Ott, UGA)

Current economic research centers around:

1) Collection of production data from five local producers who use conservation tillage and/or legume cover crop production practices to estimate inputs and yields associated with conservation tillage ancl legume cover crops.

2) Estimate production response coefficients or surfaces of various crops grown in conservatio tillage/legume cover crop production systems.

3) Determine the economics (profit and risk) of various production systems using conservation tillage/legume cover crops.

4) Determine the value of reduced soil erosion, both to the producer and to society.

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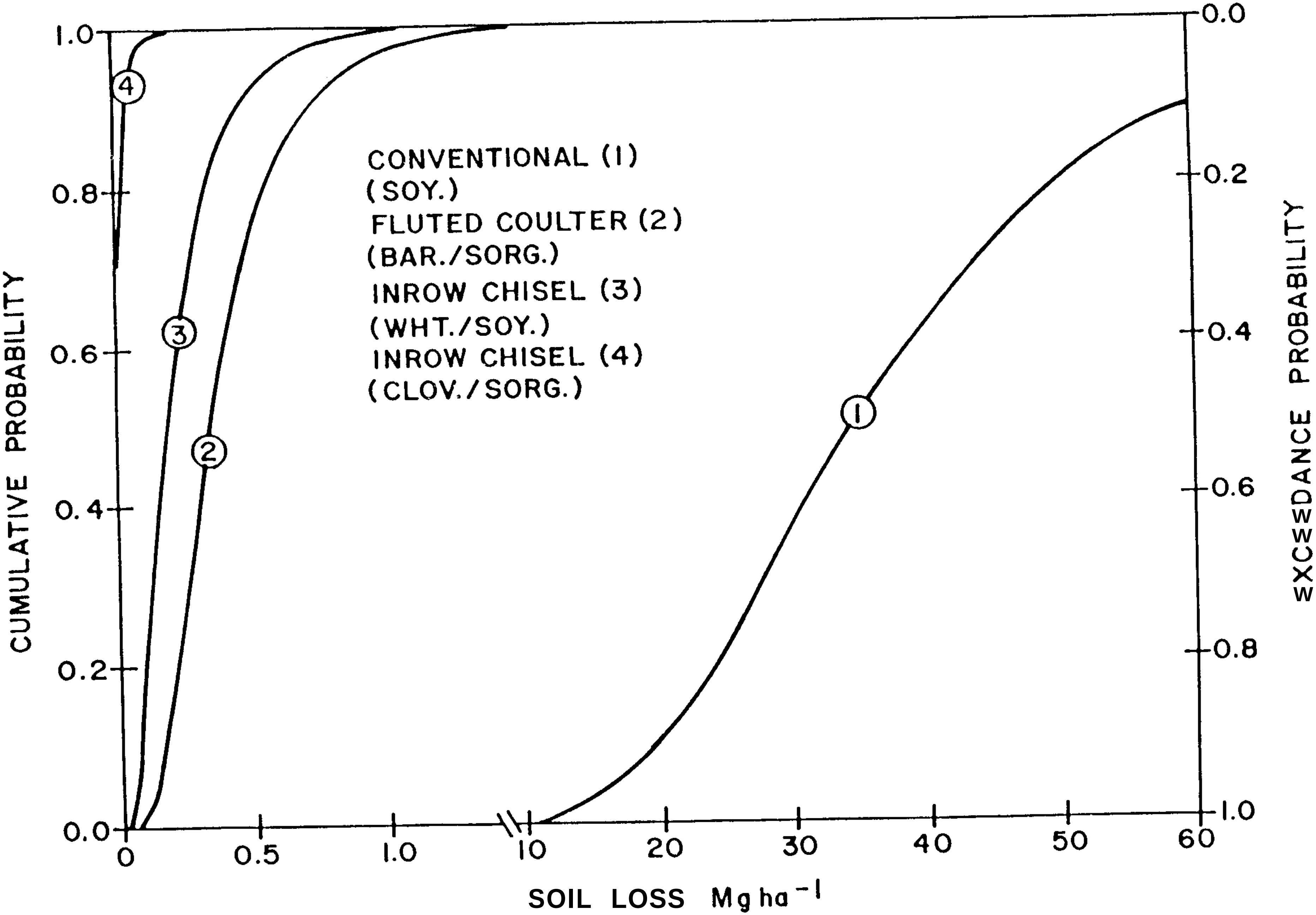

Fig. 1. Soil loss probabilities for various tillage/cropping systems.