FERTILIZATION AND COVER CROP CONSIDERATIONS IN NO-TILL CROPPING SYSTEMS

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Throughout the Southeast, extensive research studies have been conducted to identify optimum management practices for no-till cropping systems. The data presented in this paper are from previous and on-going fertility related management studies in Alabama. Some of the information presented represents only one year of data. Therefore, firm recommendations should not be drawn from this information.

<u>Lime, Phosphorus, and Potassium</u>

The fertilization of crops using soil test results does not differ greatly between tillage systems. Plants grow best within certain soil pH ranges and require a specific quantity of each major nutrient to produce optimum yields regardless of the tillage system. In a continuous no-till system, however, a soil sample from the top 2 to 3 inches should be taken for determining lime and other fertilizer requirements. Research conducted in several states has shown that the pH of the soil surface drops rapidly in no-till systems. A low pH in the top surface inch of soil may not be detrimental to crop growth, hut it may result in poor herbicide activity. Chemical weed control is essential in no-till systems, and lime is too inexpensive to allow low soil pH to reduce the activity of herbicides.

Since phosphorus (P) does not move down through the soil like nitrogen (N) and potassium (K), there have been some questions about the effectiveness of surface-applied P fertilizers. However, research conducted in several

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states during the past few years has shown that surface applications of P do not result in lower yields than incorporated P, even if the original soil phosphorus levels were low. Data presented in Table 1 are from studies conducted in Georgia, and these are typical of other studies conducted in the Southeast with surface P applications. Data from studies conducted in Georgia (Table 2) also suggest that a 0 to 3 in soil sample may be suitable for determining the P fertilizer requirements for a continuous no-till system.

Table 1. No-till soybean yields as affected hy P applied to a Cecil sandy loam soil in the Southern Piedmont of Georgia.*

	Applied P (lb/acre)			
Year	0	30	80	120
	.... yield, bu/acre------------			
1978	34	46	48	45
1979	30	39	39	40
1980	34	35	35	37

*J. T. Touchton et al, 1982, Soil Sci. Soc. Am. J. (In press).

Table 2. Soil test P levels as affected by P applied to a Cecil sandy loam soil in the Southern Piedmont of Georgia, 1980.*

	Applied P (lb/acre)			
Sample depth	0	30	60	120
------In-----	-----------------soil P, lb/acre-----------------			
0 to 3	11	20	38	72
3 to 6	4	7	9	16

*J. T. Touchton et al., 1982, Soil Sci. Soc. Am. J. (In press).

Nitrogen Fertilizers

Nitrogen sources and application methods should he carefully selected in no-till systems. It is not uncommon to hear "a pound of N is a pound of N regardless of source". However, this statement is true only if proper application methods are used. Proper application methods in no-till systems are extremely important for urea and some of the N solutions.

If solid urea is surface applied to a pasture, lawn, or no-till crop, severe N losses can occur through ammonia volatilization. Such losses due to ammonia volatilization can also occur with surface applications of N solutions containing a mixture of urea and ammonium nitrate. N solutions containing more than 19% N are most likely made from urea-ammonium nitrate combinations. The most common solutions (28, 30, and 32% N) contain approximately 50% urea N, and urea in solution is just as susceptible to N losses through ammonia volatilization as is the N in solid urea.

The most inefficient N applications probably occur in no-till systems. These inefficient applications occur primarily when N solutions are used as a carrier for pre-emergence or post-directed herbicides. Data from research conducted in the Piedmont of Georgia in 1979 (Table 3) illustrate the inefficiency of 32% N solutions when applied as a spray application. Corn fertilized with N at 240 lb/acre applied as a spray application yielded approximately 15 bushels per acre less than did corn fertilized with 80 lb of surface-applied ammonium nitrate or incorporated N solution. The yield of corn fertilized with the surface dribble application of N solution was less than yields obtained at the lower N rates when the solution was incorporated. This indicates that some N losses did occur with the surface dribble application.

The data in Table 3 clearly indicate that spray applications of N solutions containing urea should not be used. Reasonable responses to N can be obtained with the surface dribble system, but some N losses can be expected. If the surface dribble system is used, every effort should he made to place the N below the no-till mulch.

Table 3. Yields of irrigated corn as affected by nitrogen source and application method.*

	Nitrogen Source and Method of Application			
Applied Nitrogen	Ammonium Nitrate Surface band	Incorporated	Surface band	Broadcast Spray
lb/acre	BU/Acre			
80	130	135	120	80
160	160	165	145	100
240	170	160	160	115

*J. T. Touchton and W. L. Hargrove. 1982. Agron. J. 74 (In Press).

Cover Crop Considerations and Nitrogen

Many growers plant winter crops for the sole purpose of providing a mulch for no-till summer crops. Rye and wheat are probably the most common crops planted for use as no-till mulches. If these crops are planted for mulch purposes only and not for grain harvest, they may not be the most desirable mulch crops. Various winter legumes will provide the same mulch benefits as rye and wheat, and in addition, they may provide part or all of the nitrogen required hy non-leguminous summer crops such as corn, sorghum, and cotton.

Several studies conducted in Alabama and Georgia have demonstrated that various winter legumes will produce the entire N needs for subsequent sorghum and cotton crops. In these studies, applied N has not increased yields of grain sorghum or cotton. Some of these data are presented in Tables 4 and 5. It should be noted that yield of cotton following clover and vetch was reduced by applied N. The yield reduction with applied N has also occurred with grain sorghum at some locations.

Table 4. Yield of no-till cotton as affected by winter cover crop and applied nitrogen, Macon County, Alabama, 1981.

Winter cover crop	Applied N, lb/acre		
	0	30	60
	-----------lint yield, lb/acre----		
Fallow	457	561	543
Crimson Clover	649	568	512
Common Vetch	678	525	647

Table 5. No-till grain sorghum yields as affected by winter cover crop and applied nitrogen, Camphill, Alabama, 1981.

Cover Crop	0	30	60	90
	---------------yield, bu/acre---------------			
Fallow	56	67	70	80
Rye	53	73	77	85
Austrian Winter Pea	94	94	94	97
Crimson Clover	91	90	84	83
Common Vetch	97	104	88	92

One of the primary complaints with using winter legumes for no-till mulches is that the costs of seeding and growing the legumes are often equal to the commercial value of the N they produce. This complaint may not be completely valid. We have conducted several experiments in Alabama with legumes and seldom have situations where the value of the N produced does not exceed the costs of growing the legume. With most winter legumes, 80 lb per acre of N in the above-ground tissue is sufficient to cover the costs of growing the legume, and this does not include the mulch effect. Nitrogen produced by some winter legumes in the Piedmont and Coastal Plains of Alabama in 1981 are listed in Table 6. We have found that the best N-producing legume will vary among locations and years, and depends primarily on climatic conditions at specific locations. The key to high N production and sometimes winter survival is early planting. With some summer crops, especially cotton and some soybean varieties, adequate early planting requires flying the legumes into the summer crop just prior to leaf drop or defoliation.

Table 6. Aboveground dry weight and N production of various legumes grown in the Coastal Plains and Piedmont of Alabama, 1981.

Winter Cover Crop	Coastal Plains Dry Weight (lb/A)	Coastal Plains Nitrogen Conc. (%)	Coastal Plains Nitrogen Content (lb/A)	Piedmont Dry Weight (lb/A)	Piedmont Nitrogen Con. (%)	Piedmont Nitrogen Content (lb/A)
Arrowleaf clover	2950	2.9	86	--	--	--
Crimson clover	5540	2.4	133	4640	2.4	79
Common vetch	5800	2.0	174	5000	2.6	180
Austrian winter pea	--	--	--	5980	4.4	263

Adequate soil fertility levels and proper inoculations are essential for optimum growth and N production of legumes. The effects of pH and P on N content of common vetch are shown in Table 7.

Table 7. Nitrogen in the aboveground tissue of common vetch as affected by soil pH, soil P and plant growth stage, Macon County, Alabama, 1981.

Soil pH	Soil P (lb/acre)	Growth Stage: Bloom (N, lb/acre[1])	Growth Stage: Maturity (N, lb/acre[1])
5.0	6	9	6
	50	48	65
	94	66	R3
5.8	6	21	28
	50	77	94
	94	77	94

[1]Nitrogen produced is from ahoveground tissue only.

Specific bacteria are needed for proper nodulation of most legumes, and commercial bacteria produced for one legume are often ineffective with other legumes. For effective nodulation, line prill inoculation procedure is recommended. This involves wetting the seed with a sticker (i.e. sugar water, watered-down syrup or a commercial sticker), applying the inoculum and mixing well. Lime is then added and mixed to provide a protective coat.

A good method for reducing cost of seeding winter legumes is to develop reseeding systems. These reseeding systems have produced excellent results in Georgia and Alabama. In these systems, early maturing winter legumes are allowed to mature prior **to** the no-till planting of the summer crop. Seeds produced by the winter legumes generally germinate and reestablish a stand in the summer crop canopy during August. Due to early establishment, the reseeded winter legumes are exceptionally winter hardy and are seldom killed by severe freezes.

A drawback to the reseeding system is summer crop limitations. The earliest maturing legumes currently used in Alabama mature in early May in south Alabama and late May in north Alabama. This late maturity restricts summer crop plantings tograinsorghum in north Alabama and sorghum or late planted cotton in south Alabama.

Current work involves attempting to establish systems that will allow us to plant corn in reseeding legume systems. This system is based on the fact that a legume crop will produce a sufficient number of hard seed to allow for stand establishments for two or three consecutive years with only one seed crop. In these systems, grain sorghum and soybeans are planted behind the first mature crop of vetch and clover. The first reseeded crop is killed during the early bloom stage in March just prior to planting corn and the second reseeded crop is allowed to mature and produce another seed crop. 1982 is the second year of this study, and so far, this system has been successful.

Some growers are attempting a reseeding legume-corn system involving no-tilling the corn into the legume during the early bloom stage. Herbicides are applied in a 9 to 12 in band directly over the row at planting. As soon as the plants between the rows mature and produce seed, a shielded sprayer is used to apply herbicides to the corn middle. An upright legume such as clover is more suitable in these systems than a. running legume such as vetch. In extremely dry periods, it is doubtful if the young corn seedling can compete successfully with the established legume, with the result that the legume may have to be killed with directed herbicides prior to maturity.

There have been some problems with stand establishment of no-tilled summer crops planted into the winter legumes. The problem has occurred primarily with cotton on fine-textured soils. In studies currently being conducted, it appears that killing the winter legumes two to three weeks prior to planting will reduce the detrimental effect that the legumes have on cotton seedlings.

Starter Fertilizers

Too often, no-till spring crops grow at a slower rate than conventionally-planted crops. To increase early season growth rates, starter fertilizer studies are being conducted with grain sorghum and corn. The crops in these experiments,are planted with an in-row subsoiler, and starter fertilizers are dropped directly in the subsoil track. All soils selected for these studies were high in residual P and K, and responses to any nutrient other than N would not be expected.

Early season plant growth has responded favorably to starter fertilizer applications. Growth responses to starter fertiilzer 4 to 6 weeks after plant emergence in 1981 are illustrated in Table 8. Responses in all years (5 years for sorghum and 2 for corn) are similar to the data presented in Table 8. The greater plant height obtained with the starter fertilizer (12 in for corn and 7 in for sorghum) could be critical if post-directed herbicide applications are needed.

Table 8. The effect of starter fertilizer on growth of early season corn and sorghum growth.

Growth Measurement	Starter[1] Fertilizer	Sorghum	Corn
Height (in)	no	18	17
	yes	25	26
Dry weight, (lb/acre)	no	145	69
	yes	215	238

[1]Starter fertilizer for sorghum was 120 bu/acre of 10-34-0 and 300 lb/acre of 7-14-23 for corn.

In 4 of the 5 years of studies with grain sorghum, 3 in Georgia and 2 in Alabama, starter fertilizer increased grain yield. The lowest yield increase was 7 bu per acre and the greatest was 31 bu per acre. Data from one of these studies are presented in Table 9. The data in Table 9 appears to indicate that starter fertilizer resulted in a smaller yield increase in the conventional tillage system. Without the starter fertilizer, highest yields were obtained with the conventional tillage system, but with starter fertilizer, highest yields were obtained in the no-tillage system.

Table 9. The effect of starter fertilizer and sidedress N on the yield of no-till grain sorghum, Headland, Alabama, 1980.

	Tillage and Starter Fertilizer			
	No-tilled		Tilled	
Nitrogen	Yes[1]	No	Yes	NO
lb/acre	---------yield, bu/acre---------			
0	50	39	55	44
40	72	62	73	71
80	85	72	83	81
120	92	70	88	81

Yes indicates 120 lb/acre of 10-34-,0 and No indicates no starter.

Two years of data (Table 10) from starter fertilizer studies with non-irrigated corn also indicate that if an in-row subsoiler is used for planting, fertilizer should be placed in the subsoil track at planting. In 1981, it appeared that the N-P-K starter resulted in the best yield, but in 1982, N-P resulted in yields as high as those obtained with the N-P-K combinations. Although the starter fertilizer application increased yield of both conventional and no-till corn, the greatest yield increases occurred in the no-till system. Averaged over both years, the increase due to starter fertilizer was 14 bu per acre in the conventional system and 19 bu per acre in the no-till system.

Table 10. Corn grain yield as affected by starter fertilizer and tillage.

Starter Fertilizer[1]	1981		1982	
	Till	No-Till	Till	No-Till
(%)				
N-P_2O_5-K_2O	bu/acre			
0	60	79	58	65
7-0-0	72	93	66	73
7-18-0	69	97	67	80
7-18-24	78	103	65	78

[1]Application rate was 300 lb/acre.

Although data from both the corn and sorghum studies indicate that yield increases can be obtained from in-row subsoil track fertilizer applications, these fertilizers should be applied with care. If placed too close to the seed or not dropped deep enough into the subsoil track, severe seedling damage can occur. Seedling damage can occur from both solid and solution fertilizers, but the most severe problems have been with solution fertilizers.

Summary

No-till’cropping systems do not necessarily require a higher level of management than conventional tillage systems, but they do require some practices which differ from those used with conventional tillage. Some of the factors unique to no-till systems include: lower surface-soil pH; higher ammonia volatilization potentials with some surface applied N fertilizers; selection of mulch crops; and cooler soils for spring crops. These factors require different management techniques such as pulling shallow (2 to 3 in) as well as deep (6 to 10 in) soil samples in continuous no-till systems, incorporating urea containing N solutions, and applying starter fertilizer to spring crops in order to promote early plant growth.