Nitrogen Fertilizer Requirements for Corn with No-Tillage and Cropping Systems

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Introduction

The need to develop alternate and renewable sources of energy due to the rising cost and potential shortage of fossil fuel, and the need to reduce crop production costs, have promoted a renewed interest in utilizing legumes as a source of nitrogen (N) for non-leguminous summer crops.

Early-maturing winter legumes can often be used as the sole nitrogen source for summer crops that have a low N requirement or that have a relatively late optimum planting date. These legumes, however, do not provide sufficient N for corn, a crop with a high N requirement that must be planted early. In addition, comparing current legume seed and seeding costs to commercial N prices shows that the legume must provide about 80 lb/acre to cover production costs. If reseeding legumes can be used, however, production costs can be greatly reduced (Touchton et al., 1982).

A good crop of soybeans can provide one-fourth to one-third of the total N needed by a subsequent corn crop. Since soybeans in Alabama do not need to be planted until mid-May, it is possible to reseed legumes in a soybean - winter legume - corn rotation.

The major objective of this study was to determine the effects of a winter legume reseeding system in combination with a soybean-corn rotation on N fertilizer requirements of corn grown in a no-tillage system.

Review of Literature

Numerous researchers have found that winter legumes can replace some or all of the nitrogen necessary for maximum yields of subsequent non-leguminous crops (Ebelhar et al., 1984; Hargrove, 1986; Mitchell and Teel, 1977; Neely et al., 1987; Touchton et al., 1982; Touchton et al., 1984).

Selection and management of winter legume crops are several of the most important considerations in no-tillage crop production. More research has focused on these in the last several years in order to reduce legume establishment costs and improve legume cover crop yield and subsequent N production.

Crimson clover appears to be a suitable species to include in no-tillage corn production systems in Ultisol soils of Alabama, Georgia, and Florida. The suitability of crimson clover is based on its relatively high acid tolerance, relatively early date of full bloom, high dry matter production, high N production, and reseeding capability (high percentage of hard seed) (Donnelly and Cope, 1961; Fleming et al., 1981; Hargrove, 1986; Leidner, 1987, Stanley and Wright, 1984; Touchton et al., 1982).

One approach being investigated to allow for perenniation of legume cover crops, and thus reduce legume establishment costs, includes natural reseeding systems. Reseeding systems have worked best in the Deep South where legume seeds lying in the surface mulch germinate in late summer. Since germination occurs prior to harvest of the summer crop, this allows the legume to produce considerable growth before winter dormancy. The additional fall growth of these reseeded legumes results in better tolerance to severe winters and high N production by early spring (Rickerl and Touchton, 1986; Touchton and Wells, 1985). Unfortunately, the optimum planting date for corn often occurs prior to maximum N accumulation and seed set by the winter legume cover crop.

In Alabama, several cropping systems, which will permit corn to be planted during the optimum period without losing the reseeding potential of the legume, have been investigated. Strip killing narrow bands of crimson clover over the corn row at planting allows clover in the row middles to continue growing, accumulate N, and produce seed (Touchton and Whitwell, 1984). However, higher corn yields in dry years were obtained when the clover was completely killed, probably due to soil moisture depletion by the clover.

In another system, grain sorghum or soybeans are planted into the first mature legume crop. 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 before planting sorghum or soybeans (Touchton and Wells, 1985). Corn yields grown under this system, with vetch as reseeding legume and soybean as full-season legume in the rotation, were adequate.

Materials and Methods

This study was conducted for 4 years (1984, 1985, 1986, and 1987) at two locations in Alabama. The Appalachian Plateau soil at the Sand Mountain Substation was a Wynnville sandy loam and the Coastal Plain soil at the Wiregrass Substation was a Dothan fine-sandy loam.

Two-year cropping systems consisted of (1) continuous corn with no winter crops; (2) soybean-corn rotation with no

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winter crops; (3) continuous corn with fall-planted crimson clover; and (4) soybean-corn rotation with reseeding crimson clover. As a split plot treatment, each cropping system received nitrogen fertilizer at rates of 0, 60, 120, and 180 lb N/acre as ammonium nitrate, sidedressed approximately 4 weeks after corn planting.

Crimson clover was killed with 2 qt/acre Roundup@ just prior to corn planting. Ring Around 1502 corn was planted in mid-April in 36-inch rows at the Sand Mountain Substation and Dekalb TI230 was planted in late March in twin 7-inch rows on 36-inch centers at the Wiregrass Substation. Irrigation was not available at the Sand Mountain Substation nor at the Wiregrass Substation during the 1987 growing season.

Results and Discussion

Reseeded clover behind soybeans produced greater dry matter and total N than planted clover following corn at both locations (Tables 1 and 2). This is probably due to earlier establishment and more fall growth obtained with the reseeded clover than planted clover.

At the Sand Mountain Substation, corn grain yields in 1985 peaked at 120 Ib N/acre with each cropping system (Table 3). However, the soybean - reseeded clover - corn cropping system increased the yield potential, producing 156 bu/acre compared to 110 bu/acre for continuous corn. In 1987, when precipitation was limiting during grain fill, yields at Sand Mountain Substation (Table 4) peaked with 180 lb N/acre on the continuous corn and soybean-corn systems and 120 Ib N/acre on the clover-corn and soybean-clover-corn systems. The soybean-clover-corn system reduced the N fertilizer requirement for corn by 60 to 120 Ib/acre.

At the Wiregrass Substation, corn grain yields in 1985 (Table 5) were not greatly affected by cropping systems when N was at optimum levels (180, 180, 180, and 120 lb/acre for the cropping systems, respectively). It appears that the soybean-reseeded clover system, but not the clover only or

Table 1. Clover weight and N content as affected by previous crop at Sand Mountain Substation.

Year/ Previous crop	Weight	N	N
	lb/a	%	lb/a
1985			
Corn	3,198	2.91	93
Soybeans	4,237	2.86	121
1987			
Corn	1,618	4.06	66
Sovbeans	2.796	4.05	113

Table 2. Clover weight and Ncontent as affected by previous crop at Wiregrass Substation.

Year/ Previous crop	Weight	N	N
	lb/a	%	lb/a
1985			
Corn	1,103	4.19	46
Soybeans	2,425	3.76	91
1987			
Corn	1,213	3.92	48
Soybeans	2,812	4.04	I14

Table 3. Corn grain yields at Sand Mountain Substation, 1985.

	N applied (lb/a)			
Cropping system	**0**	**60**	**120**	**180**
	bu/a			
Continuous corn	12	67	**110**	**110**
Soybean-corn	39	102	123	135
Clover-corn	53	**104**	132	131
Soybean-clover-corn	81	135	156	155

Int. FLSD (0.10) = 14.

Table 4. Corn grain yields at Sand Mountain Substation. 1987.

	N applied (lb/a)			
Cropping system	**0**	**60**	**120**	**180**
	bu/a			
Continuous corn	11	71	**101**	**114**
Soybean-corn	53	108	132	141
Clover-corn	79	119	126	120
Soybean-clover-corn	**104**	125	I29	123

Int. **FLSD** (0.10) = **18.**

Table 5. Corn grain yields at Wiregrass Substation. 1985.

	N applied (lb/a)			
Cropping system	*0*	**60**	**120**	**180**
	bu/a			
Continuous corn	61	138	155	186
Soybean-corn	89	125	165	171
Clover-corn	85	139	152	**164**
Soybean-clover.com	139	170	182	I63

Int. FLSD (0.10) = 26

Table 6. Corn grain yields at Wiregrass Substation, 1987.

	N applied (lb/a)			
Cropping system	**0**	**60**	**120**	**180**
	bu/a			
Continuous corn	6	57	78	87
Soybean-corn	20	65	82	80
Clover-corn	39	65	69	76
Soybean-clover-corn	75	96	92	85

Int. **FLSD** (0.10) = 20.

soybean only systems, reduced N fertilizer requirements for corn by at least 60lb/acre. In 1987, grain yields (Table 6) were reduced by rainfall limitations during grain fill. The soybean-clover-corn system reduced the N fertilizer requirement for corn by 60 to 120 lb/acre.

Conclusions

The reseeding crimson clover system in combination with a soybean-corn rotation appears to be **an** agronomically viable system for no-till corn production in Alabama. The soybean-clover-corn system consistently produced the highest yields of the systems studied, in both optimal and inadequate rainfall years, and precluded a 60 to 120 lb/acre N fertilizer requirement for corn. Further evaluation of the potential benefits of reseeding systems, production cost reductions, increase in yield potential, and reduction in N fertilizer requirements, will be continued.

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