ROTATION OF ANNUAL CROPS WITH SOD IN NO-TILLAGE SYSTEMS

Glover Triplett, William Kingery, and Mark Shankle

Department of Plant and Soil Sciences, Mississippi State University, Mississippi State, MS 39763

E-mail: gtriplett@pss.msstate.edu

INTRODUCTION

Before and during the 1950's, sod based cropping systems were almost universal in the Midwest. Typically, a meadow crop, such as alfalfa or red clover, often seeded with a cool season perennial grass, was produced for one to three years. Then the legume and grass mix was incorporated with tillage and corn was planted. The N produced by the legume crop was utilized as a fertilizer source by the corn crop. After the corn was harvested, a small grain, spring oats or winter wheat crop was planted. In addition, a legume crop of alfalfa or red clover was seeded with the oats or frost seeded into the wheat in late winter. Following grain harvest, the legume developed and was harvested for forage during succeeding years. When productivity declined, the meadow was tilled and the cycle repeated. Ruminant animals were an important component of this system and served as a means of marketing the forage produced. Failures of meadow seedings, primarily alfalfa, began to occur as increased N rates were applied to improve wheat yields. This problem was solved by summer seeding following wheat harvest. As N fertilizer became less expensive, it supplemented N from legumes to produce a second year of corn. Increased production of annual crops, corn and soybean, replaced the meadow component, provided cash flow from grain sales, reduced the need for livestock to consume forage, and increased the potential for soil loss since fields were tilled more frequently. A joke was that some Midwest farmers were following a CBM rotation: corn, beans and Miami.

Crop rotations like those described above were never widely used in the Southeast, primarily because no suitable perennial legumes were available for the region. Agronomists trained in Northern Universities and employed in the South might spend the first five yrs of their career trying to establish rotation systems to illustrate their benefits, but Southern growers never adopted these practices. Cleared land was labeled as "New ground" and highly prized in the South. Land was cleared, tilled, and farmed in annual crops until productivity declined. At this point, the focus shifted from annual crop production to pasture or tree establishment and the owners moved west in search of new areas to clear and farm. This was hardly a sustainable system and today there are no new areas to clear and farm. Therefore, in order to maintain the viability of agriculture a more sustainable approach must be achieved. Fortunately, under permanent vegetation, land degraded by intensive cropping recovers organic matter and soil structure that will support increased levels of crop productivity. Eroded soils with shallow depth to an impervious layer, such as chalk in the Black Belt, would be an exception. The latest cycle in cropping occurred during the 1970's when soybean prices were as high as $8 to $10/bu. Fences were removed, trees were pushed up and cleared land was tilled and planted to soybeans. In short order, both productivity and prices declined to unprofitable levels. When another surge in commodity prices occurs, land now in pasture or the Conservation Reserve Program (CRP) will become a candidate for annual crop production. Development of sustainable production systems that will protect the land resource while growing annual crops should be a high priority.

No-tillage crop production in sod retains soil organic matter and soil structure developed under perennial vegetation. Soil loss is reduced to levels that will sustain long term productivity, compared to tilled culture and macropores developed under the sod are not destroyed but remain functional. However, no-tillage development has been slow across the Southeast. In early no-tillage development in the Midwest, corn was planted into sod comprised of cool season (C-3) grasses that were controlled with applications of atrazine alone or atrazine plus paraquat. Dicamba and/or 2,4-D controlled forage legumes as well as a wide range of perennial broadleaf species. Triplett et al. (1979) reported that the sward did not have to be tilled to make N contained in legumes available for the corn crop that followed. Warm season perennial grasses common in the Southeast were not controlled with herbicides available at the time and without satisfactory vegetation control, no-tillage does not function properly.

Development of genetically modified crops tolerant to post-emergence applications of broad-spectrum herbicides (glyphosate, glufosinate) make possible no-tillage crop production in sod comprised of warm season perennial grass species. In our studies, we plant corn or soybean into sod and make a preemergence application of glyphosate or paraquat. At this time, late March or early April, the sward is comprised of cool season annuals near the reproductive stage and warm season perennials initiating spring growth. In three to 4 wks, after crop emergence and regrowth of species in the sod is initiated, an application of glyphosate is made. Some species present in the sod survive and regrow, including annuals from seed present in the soil, but are usually not competitive with the crop. Bermudagrass survives this treatment, insuring continuity of the sward. Undesirable species surviving include horsenettle and root knot foxtail. If more aggressive treatment is necessary, a second application of glyphosate is available. Stage of growth of vegetation and timing of application can influence herbicide effectiveness with control of cool season grasses more difficult as plant development proceeds from vegetative to reproductive stages (Triplett, 1985). This appears to be true for vegetation in southeastern swards, but has not been fully established. Also, early vegetation control decreases soil moisture use by the developing sward thereby making more water available for the annual crop.

MATERIALS AND METHODS

In 2001 and 2002 research studies were established at the Pontotoc Experiment Station Bude silt loam soil (fine, silty, mixed, thermic, Glossaquic Fragiudalf) to evaluate weed control in corn and soybean sod based systems. The herbicide treatments used for soybean and corn systems are given in Tables 1 and 2.

RESULTS AND DISCUSSION

In these studies, we have recorded soybean yields near 40 bu/a (Table 1). This was achieved with sequential POST applications of glyphosate. Insect pressure was an issue both years. Therefore, it is possible to produce even higher yields if fields are scouted and insect populations are minimized. In the corn system, a yield of 133 bu/A was achieved with a single POST application of glyphosate in 2001(Table 2). Timely rainfall events did not occur in 2002, but yield was still 115 bu/A with a sequential application of glyphosate. These results indicate that the sod-based system is possible and economical.

While producing crops in sod comprised of warm season perennials is made feasible by changes in technology, economics will determine acceptance of the practice. The cow-calf producer nets $30 to $50 per cow on an annual basis, according to budgets generated by economists. With 2 to 3 acres required for grazing and hay production to support each cow, return per acre ranges from $10 to $15. Even so, these prices of calves have been reduced in recent months, reflecting the increases in corn and soybean prices so that presently the net may be even less. Budgets for soybean production list direct costs at $150/A. If soybean prices are in the $5.50 range and yields average 40 bu, returns above direct expenses would be <$70/A, probably not enough to interest limited scale producers in beginning production. Presently, with prices in the $7.50 range, returns of $150/A. could generate interest in planting soybeans in sod.

While the most common use for sod systems is on-farm animal grazing, a ready market exists in the region for hay to feed cattle and horses, and could offer an alternative for the sod phase of the system. This market prefers weed- and mold-free, especially for horses. Weeds, especially coarse-stemmed ones, slow curing and lead to moldy pockets in the resulting hay. A rotation system in which profitable crops were available for each year of the rotation could make it easier, or less expensive, for hay producers to maintain weed free bermudagrass stands.

Budgets for corn have greater expense, partly because of N fertilizer costs, with direct costs at $270/A. At an estimated yield of 130 bu/A, corn at $2.50/bu (2006 mid-year prices) would gross $325/A, providing a return above direct expenses of $55/A. At $3.50/bu, a gross of $455/A would provide a return of $180/A above direct expenses and could interest growers.

CONCLUSIONS

A sod-based rotation of annual crops planted with no-tillage offers producers several advantages:

1. Annual crop production is possible on many sloping fields while staying in compliance with Federal restrictions on soil loss. Fields can be cropped for one or several years and managed for sod recovery.
2. Producers can respond to favorable price levels for grain crops by rapidly expanding production.
3. Rotating through an annual crop can improve forage quality and productivity of the sward. In one trial planted into a field infested with smutgrass, control was 80 to 90 percent, other undesirable vegetation is controlled, as well. Pastures containing toxic tall fescue can be renovated while producing an economic crop, then replanted following harvest. Soil amendments, lime and fertilizer applied for the annual crop, will increase forage productivity in years that follow.
4. Weed competition is a factor in unsatisfactory performance of alfalfa in the humid Southeast. With development of glyphosate tolerant alfalfa cultivars, maintaining alfalfa stands for multiple years becomes a possibility that should be investigated. If so, sod

based rotations with alfalfa furnishing much of the nitrogen required for a grain crop, such as corn, should be investigated.

5. Except for harvest machinery, equipment investment should not be prohibitive for small-scale growers.

REFERENCES

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Table 1. Herbicide treatments and yield of soybean planted into established sod at Pontotoc, MS.

Treatment Name	Rate lb ai/ac	Application Timing	Yield 2001 bu/ac	Yield 2002 bu/ac
Roundup Canopy Prowl Roundup Roundup	1 0.22 0.75 0.75 1	PRE* PRE PRE 2WAP** 4WAP	36	18
Roundup Roundup Roundup	1 0.75 1	PRE 2 WAP 4 WAP	39	24
Roundup Roundup	1 1	PRE 3 WAP	31	20
Roundup Roundup Roundup Roundup	1 0.5 0.5 0.5	PRE 2 WAP 3 WAP 4 WAP	32	22
Paraquat Canopy Prowl Roundup Roundup	1 0.22 0.75 0.75 1	PRE PRE PRE 2WAP 4WAP	38	18
Paraquat Roundup Roundup	1 0.75 1	PRE 2 WAP 4 WAP	33	16
Paraquat Roundup	1 1	PRE 3 WAP	29	9
Paraquat Roundup Roundup Roundup	1 0.5 0.5 0.5	PRE 2 WAP 3 WAP 4 WAP	30	13
No herbicide			1	0
LSD .05			7.3	6.4

*PRE – Herbicide applied prior to emergence of the annual crop.
**WAP- Herbicide applied weeks after planting.

Table 2. Herbicide treatments and yield of corn planted into established sod at Pontotoc, MS.

Treatment Name	Rate lb ai/ac	Application Timing	Yield 2001 bu/ac	Yield 2002
Roundup Roundup	1 1	PRE* 3WAP**	133	99
Roundup Roundup Roundup	1 1 0.75	PRE 3WAP 6WAP		115
Roundup Bicep Atrazine	1 2.8 0.5	PRE PRE PRE	74	84
Roundup Bicep Atrazine Roundup	1 1.4 0.25 0.75	PRE PRE PRE 3WAP	115	101
Roundup Roundup Exceed	1 1 0.64 oz	PRE 3WAP 3WAP	116	86
Roundup Roundup Weedar 64	1 1 0.5	PRE 3WAP 3WAP	121	97
Roundup Roundup Simazine	1 1 3	PRE 3WAP 3WAP	124	97
Paraquat + Surf. Roundup	0.625 1	PRE 3WAP	97	90
Paraquat + Surf Bicep Atrazine	0.625 2.8 0.5	PRE PRE PRE	52	75
Paraquat + Surf Bicep Atrazine Roundup	0.625 1.4 0.25 0.75	PRE PRE PRE 3WAP	105	89
Paraquat + Surf Roundup Exceed	0.625 1 0.64 oz	PRE 3WAP 3WAP	60	61
Paraquat + Surf Roundup Weedar 64	0.625 1 0.5	PRE 3WAP 3WAP	116	77
Paraquat + Surf Roundup Simazine	0.625 1 3	PRE 3WAP 3WAP	69	69
LSD 0.5			40.4	21.4

*PRE – Herbicide applied prior to emergence of the annual crop.
**WAP- Herbicide applied weeks after planting.