Agronomy Guide

Purdue University Cooperative Extension Service

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Management Considerations for Relay Intercropping: II. Soybean

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Double cropping of wheat and soybeans in Indiana has been mostly limited to the southern third of the state. The primary reason for this is the longer growing season available to growers in southern Indiana because of earlier wheat harvest and later fall frosts. In some cases, southern Indiana farmers have an extra month for the double-cropped soybeans to develop. By the time farmers in northern Indiana are able to harvest their wheat, there is usually insufficient time and soil moisture to produce a satisfactory soybean crop.

By relay cropping wheat and soybeans, farmers may be able to effectively extend the growing season by several weeks. This is accomplished by planting the second crop, soybeans in this case, into standing wheat before the wheat is harvested. The word "relay" alludes to the fact that the life cycles of the two crops are out of synchrony. As the soybeans are planted and emerging, the wheat is entering its reproductive stages.

This system allows producers to spread production risk and fixed costs of land and equipment (rent, taxes, interest, etc.) over two crops. While neither crop will generate more income than it would when grown by itself, together they may be able to produce more. Thus, it may be possible for farmers in more northerly areas to enjoy the economic benefits of double cropping that those in the southern part of the state already do.

Management Guidelines

Nutrient Applications

Phosphorus and potassium, where needed, should be applied in the fall in the quantities required for both the wheat and soybean crops. Yield goals of 70 bushels per acre for wheat and 40 bushels per acre for soybeans are attainable with this system in good years. Test your soil and consult the Tri-State Fertilizer Recommendations for specific application recommendations.

Soybean Seeding Systems

Planting time of relay intercropped soybean is usually based on the wheat's physiological stage rather than calendar date. Most studies have shown that soybeans should be seeded before head emergence of the wheat.

Soybeans Intercropped with Wheat

This usually occurs in the first two weeks of May in Indiana. Planting after this time may result in insufficient soil moisture for adequate stand establishment. Irrigated fields and fields with good water holding capacity work well in this system because relay intercropped soybeans encounter more moisture stress when competing with winter wheat than do mono-crop soybeans.

Relay planting equipment should be selected with care. It is important to use equipment that minimizes damage to the standing wheat crop while, at the same time, ensuring accurate depth control and seed slot closure during soybean seeding. Several commercially available grain drills and planters can be easily converted.

Planting Soybeans into Wheat Seeded in 15 Inch Rows

The recommended seeding rate for relay intercropped soybeans is 200,000 seeds per acre. Although this rate is higher than farmers normally plant in 15-inch rows, intercropped soybeans will be under more stress than their mono-cropped counterparts, and lower plant survival should be expected. The 200,000 seeding rate is still lower than that normally recommended for double-crop planting. The soybean variety selected should have good wide-spectrum resistance to soil-borne diseases such as phytophthora, as the additional stress to soybean seedlings in the relay system tend to increase plant susceptibility to pests.

Planting polymer-coated soybeans may be a viable option for some producers considering the relay crop system. Temperature-sensitive polymer coatings delay emergence of coated soybean an average of 1 to 3 weeks relative to uncoated soybeans (Table 1 and Figure 1) by postponing the entry of water vapor into seeds. This could mean several things for farmers. First, they may be able to plant soybeans sooner and minimize crop stress (in the form of traffic damage to wheat, or competitive growth stress to soybeans). Second, shorter plants at wheat harvest resulting from seed coating treatments (Table 1) may reduce soybean damage during wheat harvest and permit lower header heights while combining wheat. Third, polymer seed coatings may allow producers to lower seeding rates because stand losses after emergence are often reduced in relay-cropped soybeans (Table 2). However, initial emergence may also be lower with coated soybean seeds (Table 2) because of soil moisture fluctuations, and final yields after coated seed may, or may not, be higher than those after uncoated soybeans.

Weed Control

Glyphosate-resistant soybeans are recommended for this system because of this herbicide's excellent crop safety and its ability to control volunteer wheat and other late-

Successful Establishment of Relay Soybean versus Mono-crop Soybean Seeded the Same Day

Table 1. Seed Coating Effects on Average Emergence Delay and Height of Intercropped Soybeans at Wheat Harvest (1999-2001)

Coating Treatment	Emergence Delay (days relative to uncoated)			Height at Harvest (inches)		
	North	Central	South	North	Central	South
Coated	14	14	16	10	11	6
Uncoated	-	-	-	13	14	9

Table 2. Soybean Seeding System Impacts on Initial Soybean Population and Relative Stand Loss After Emergence in Indiana (1999-2001)

Seeding System (at uniform seeding rates)	Emerged Soybean Population ('000 plants / acre)			Stand Loss from Emergence to Maturity (%)		
	North†	Central‡	South§	North†	Central‡	South§
Mono-crop	150	145	127	10	14	12
Intercrop Coated	146	136	145	28	17	28
Intercrop Uncoated	160	164	157	35	28	28

†Average of 6 site-years ‡Average of 5 site-years §Average of 3 site-years

emerging weeds. Other herbicide choices are available, but they tend to offer producers less flexibility in efficacy and application timing. It may be advantageous to wait until volunteer wheat is established to apply herbicides. This allows for season-long weed control in a single spraying pass.

Harvest

The wheat in this system should be combined as soon as possible to reduce light competition with the soybeans as early as possible. Harvest at moistures above 20 percent if adequate grain drying facilities are available. With a stripper header, it may be possible to harvest wheat as wet as 25 percent moisture, but the standing residue may reduce light interception by the soybeans.

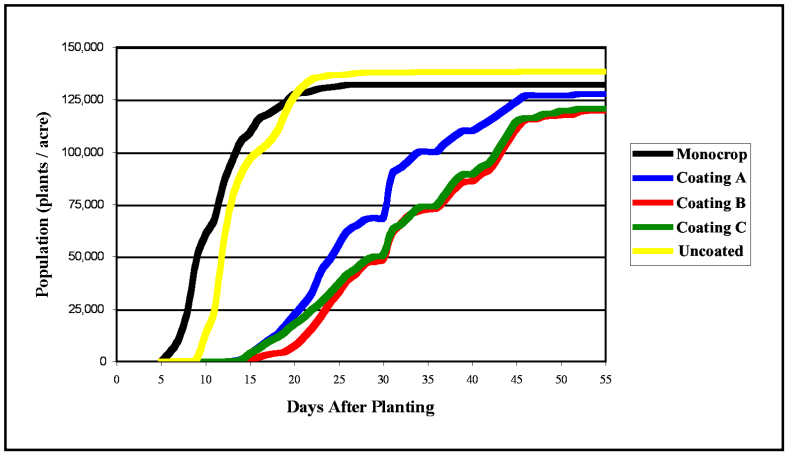

Figure 1. Typical Emergence Patterns of Coated and Uncoated Relay Soybeans Relative to Uncoated Mono-crop Soybeans

The wheat stubble should be cut as low as possible without clipping growing points of the soybean plants since the latter will reduce soybean yield. Narrow combine tires and a wide grain table will result in less traffic damage to the soybeans. A straw chopper and chaff spreader that distributes tailings in a uniform, wide pattern will prevent smothering of soybean plants by wheat residue.

Intercropped soybeans usually reach physiological maturity 2 or 3 weeks sooner than double-crop soybeans of similar maturity rating. Soybean harvest is identical to that for mono-cropped soybeans, except that some wheat stubble residue will necessarily be threshed at the same time. This should pose no problems for soybean threshing.

Yield Loss Expectations

Relay intercropped soybean yields are usually not comparable to those of mono-crop soybeans, but are considerably higher than those from double-crop planting in northern and central Indiana (Table 3). Yield results in Table 3 are based on Purdue University research in 250-foot long replicated plots, and where coating system comparisons were based on the best of the 2 or 3 polymer coatings tested in each area-year. Overall relay soybean yields were somewhat lower than expected due to excessive traffic damage in wheat harvest (resulting from combine tire widths totaling almost 5 feet in the narrow 15-foot plots) and the inclusion of data from 1999 (with well below-normal rainfall in July and August). In growing seasons with sufficient moisture, a reasonable expectation is that relay soybean yields between 50 and 60 percent of full-season soybean.

Maturity Differences Between Double-crop (left) and Relay Soybean Between Rows of Winter Wheat (right)

Table 3. Soybean Seeding and Harvest System Impacts on Soybean Yield in Indiana (1999-2001)

Seeding System	Full Plot Yield (bushels / acre)			Small Plot Yield in 2000-2001 (bushels / acre)			
	North†	Central‡	South§	North-		Central*	
				With Tracks	No Tracks	With Tracks	No Tracks
Mono-crop	47.6	51.6	58.4	-	-	-	-
Intercrop Coated	17.2	20.9	41.5	23.4	26.4	23.3	32.5
Intercrop Uncoated	11.4	19.5	42.4	21.6	24.0	19.6	29.9
Double Crop	3.7	10.4	35.1	-	-	-	-

†Average of 6 site-years (1999-2001) ‡Average of 5 site-years (1999-2001) §Average of 3 site-years (1999-2001)
-Average of 2 site-years (2000-2001) *Average of 4 site-years (2000-2001)

Soybean yields in areas without combine-wheel-track damage during wheat harvest yielded from 11 to 52 % more than the soybean means of the entire plot area (Table 3). This shows the importance of minimizing damage during wheat harvest. With 30-foot wide plots, a corresponding grain table width, and drive wheels totaling 5 feet in width, average soybean yields would have been intermediate to the two columns of small-plot yields summarized in Table 3.

Summary of Key Points

1. Select fields with good water supplying capacity. Irrigated fields would be ideal for this system.
2. Select a soybean variety with good disease resistance and consider additional seed treatment for pests.
3. Consider using polymer-coated seed to permit earlier planting into wheat, and help achieve shorter soybean plants at wheat harvest.
4. Plant 200,000 seeds per acre with equipment that places seed accurately, covers it well, and minimizes damage to wheat.
5. Harvest wheat carefully (minimize wheel track damage, spread straw and chaff evenly, and don't clip soybean plant growing points).
6. Use narrow-tired equipment or a tramline system.

Other Resources

Tri-State Fertilizer Recommendations for Corn, Soybeans, Wheat & Alfalfa

<www.ces.purdue.edu/extmedia/AY/AY-9-32.pdf>

Ohio State University FactSheets:

- Relay Cropping Wheat and Soybeans: <ohioline.osu.edu/agf-fact/0106.html>

Landec Ag:

- Relay Crop Soybean Production with Polymer Coated Seed: <relaycrop.com/>

Clemson University Extension:

- Relay Intercropping with Wheat: <www.clemson.edu/public/>

University of Nebraska NebGuide:

- Two Crops in One Year: Relay Intercropping: <www.ianr.unl.edu/pubs/fieldcrops/g1024.htm>

** Pictures taken by Scott McCoy and Dr. Tony Vyn, Purdue University*

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