THOMPSON AGRICULTURE ALTERNATIVES

2009 REPORT

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COVER CROPS

Since 1981, cover crops have been used in the ridge–till system. Cover crops fill an important role by improving soil tilth and increasing soil moisture holding capacity. In addition, cover crops are beneficial for reducing soil erosion caused by spring rains. Plant biomass prevents direct rain to soil contact and the root systems help hold soil in place. During 1989 and 1990, grain or cereal rye and a combination of oats with hairy vetch were the primary cover crop species grown at the Thompson farm. Starting in 1991 rye alone on top of ridges has been the cover crop program.

Cover crops are used to decrease weed pressure in spring. Crops that possess allelopathic properties, like cereal rye, are used specifically for this reason. Toxins manufactured in the rye plants roots inhibit germination of small seeded weeds. Toxins are released when rye is removed from the ridge prior to planting the main crop. Rain carries them down through the soil into the weed seed zone. Although the toxins affect small seeded plants, they do not appear to inhibit germination of the larger seeded main crop in the ridge–till system. Over the years, it was learned that in order to achieve this allelopathic effect, the cover crop must be planted in the crop row area.

While cover crops have many benefits, there are also some negative aspects to be considered. For example, when conditions are dry, the cover crop can deplete soil moisture needed to raise the primary crop. Tilling the dry ridge to remove the cover is not recommended because it further depletes moisture and wakes up weed seeds. Shredding the cover does not disturb the soil surface; however, the roots will continue to draw moisture from the soil.

In dry years, the cover crops are eliminated early in the season by shredding, then we plant early. Because the cover crop is planted only on the ridge, the planter sweep easily removes remaining cover crop material at planting.

In emergencies, a burndown herbicide can be used to kill the cover crop. This also eliminates the cover crop without disturbing the soil. Plant residue serves as a mulch which helps to decrease evaporation, as well as collect and retain moisture.

In addition to removing soil moisture, cover crops also recycle soil nitrogen in late fall and early spring. While this reduces nitrate leaching into the groundwater, it also decreases nitrogen availability to the main crop early in the season due to decomposition needs.

Traditionally, cover crops are plowed under two weeks prior to planting. This waiting period allows sufficient time for soil microbes to break down green material. As decomposition nears completion, soil microbe populations decrease, and nitrogen becomes available to the newly planted seed.

Because spring tillage increases weed pressure, there is no incorporation of cover crops two weeks prior to planting the main crop with the ridge-till system. Therefore, the living cover is removed by the front planter sweep and thrown between the rows where it is left to decompose.

While this technique works well for weed control, it was observed that ridge–till corn following a fall cover crop is nitrogen deficient during the early part of the growing season.

Dr. John Doran, USDA/ARS, has conducted research at the Thompson farm on a ridge–till system that includes cover crops. Doran found that in May and early June, nitrate nitrogen levels in the ridge–till cover crop plots were lower than in the conventional till plots. To offset early season nitrogen deficiency, nitrogen is applied with the planter.

While purchased nitrogen counteracts early season deficiency problems, additional cost can reduce the profit margin. For this reason, application rates are kept low. However, yield gain from purchased nitrogen may actually offset cost.

Over the years, short term economic returns have been negative when using fall **broadcast** cover crops **(Figures 3-1 and 3-2).** Despite economic shortcomings, efforts continue to make this system cost effective because of the long term benefits of

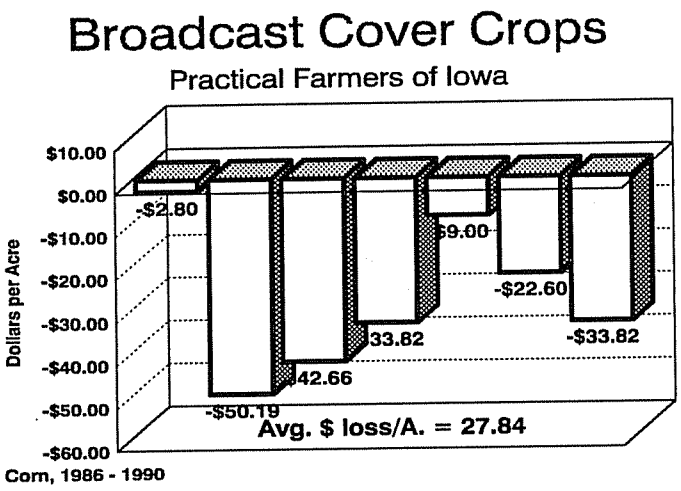

Figure 3-1.

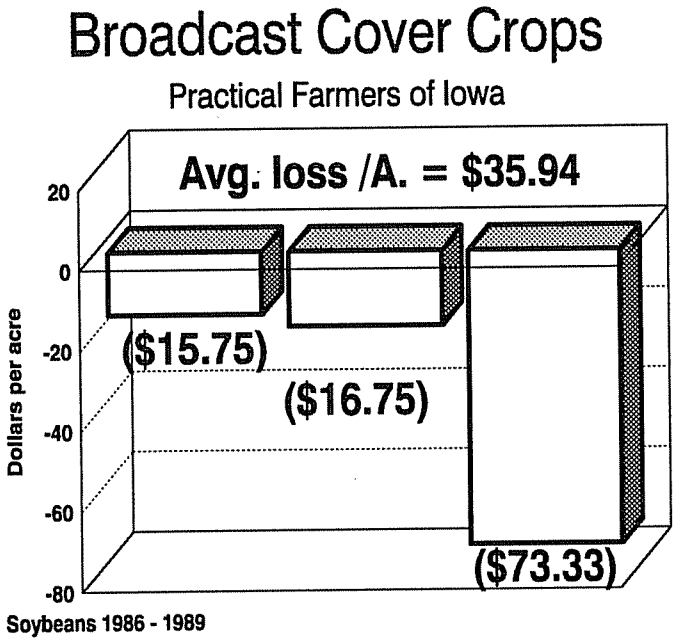

Figure 3-2

using cover crops. Achieving balance in a fall cover crop, ridge–till system has proved challenging. Despite agronomic and economic setbacks, experiments continue with various management techniques in order to take advantage of long term improvements in soil structure that cannot be given a price tag.

FALL COVER CROP HISTORY

End Gate Seeder

The first experience with fall seeded cover crops was in 1981 (Field #1), when hairy vetch and rye were established separately using an endgate seeder. Seeding was done in October following corn silage. The following spring there was no trace of the vetch. However, rye was abundant. In this particular year, the thick stand of rye was beneficial because it removed excess moisture from the ridge. Heavy rains delayed soybean planting until June that year.

Clovers at Cultivation

In 1982, individual strips of red, mammoth, alsike, and sweet clovers, along with alfalfa, were seeded at last corn cultivation in June (Field #4CD). Frequent rains provided an excellent environment for the germinating covers. Also, corn population was under 20,000 plants per acre which was advantageous for cover crop establishment.

While these plantings looked promising in 1982, removal of perennial species the following spring was difficult. Moreover, during hot, dry summers, seedling establishment was unsuccessful. For these reasons, the use of perennial species and clover establishment at last cultivation were discontinued.

Airplane Overseeding

In September 1983, oats and rye were broadcast separately by airplane into soybeans (Field #2). Fields were very muddy and both crops established very well, providing excellent weed control for the following year's corn crop. Again, problems arose with cover crop management the following season. While winter killed oat cover was easy to handle, rye was difficult to remove. Unlike the 1981 growing season, 1984 was very dry and rye depleted soil moisture. Corn yields were reduced by 40 bushels per acre that year.

Despite reduced yields, the rye cover provided excellent weed control. However, application cost was over $6.00 per acre. Due to cost and a lack of

custom applicators, airplane overseeding was discontinued.

Cultivator Interseeding

Experimenting continues with cereal grain rye despite management problems encountered in previous years.

In 1984, rye was seeded using herbicide attachments on the cultivator. Seed was dropped into the row area during ridge construction in September following a hay crop (Field #3). Better control of the seeding rate was achieved using this technique in comparison to broadcasting by airplane. Weed control was excellent the following year, but nitrogen deficiencies were obvious early in the growing season.

A number of PFI cooperators had similar results when broadcast rye preceded corn. Three out of seven trials conducted over a four-year period resulted in reduced yield **(Figure 3-1 & 3-2).**

In 1988, corn yields on the Thompson farm were reduced by 16 bushels per acre when rye was used as a cover crop prior to corn (Field #6). An additional 10 pounds per acre of planter applied nitrogen did not offset yield reduction. Dry conditions that year no doubt further affected corn yield.

In 1989, yield was again reduced by 12 bushels per acre (Field #2). No additional planter applied nitrogen was used. A 10 bushel per acre reduction on the Hagensick farm (a PFI member) was noted the same year. No increase in yield was noted where rye was broadcast as a cover crop on any of the PFI cooperators' farms, either alone or companion planted with hairy vetch and/or oats. The average loss per acre on the seven farms was $27.84. Costs included seed, application charge and crop loss **(Figure 3-1)**.

While corn yields were reduced following a rye cover crop, there was little effect on soybean yield at the Thompson farm. Only once, in 1989, was a significant difference in soybean yield noted between the control and cover crop plots. Despite this, management returns were again negative. The average loss for broadcast seed and yield reduction on PFI farms was $35.94 per acre **(Figure 3-2)**.

Hairy vetch was also interseeded into corn using herbicide attachments at last cultivation. This technique worked well during the years when corn populations were under 20,000 plants per acre. However, as corn populations increased, survival of the interseeded hairy vetch declined due to shading. In addition, nitrogen provided by the leguminous cover crop was not needed by the soybean crop that was planted the following year. As a result, this process was eventually discontinued.

Hi-Boy Overseeding

In 1985, two used detasseling machines were purchased and modified by Lee Blum and Allyn Hagensick to overseed cover crops into standing corn and into soybeans at leaf yellow. By establishing the cover crop at this time, they hoped to maximize winter cover crop survival. Impressed by Blum and Hagensick's success, we leased a detasseling machine and eventually purchased one.

By overseeding into a standing crop at leaf yellow, it was hoped to establish a cover crop earlier in the fall to maximize winter survival.

In the short run, the hi-boy applicator reduced application costs and seeding rates and was more accurate than airplane broadcasting. However, problems arose in dry years when little, if any, germination occurred. The rye seed that did germinate tended to establish in the valley areas, making removal the following spring difficult.

The Hi-Boy is used as a standard practice to overseed oats at 2 bushels per acre into soybeans at leaf yellow. Corn will be ridge-till planted into the dead mulch the next spring.

Pre-Plant Cultivation

In spring of 1989, the valley areas between ridges were cultivated with the sweep pitched to throw soil on the ridge. This was done in an effort to eliminate the broadcast rye cover crop. Although this technique was effective in removing the cover crops, weed populations in field 6 increased significantly **(Figure 3-3)**.

Also in 1989, field #4CD was pre-cultivated to eliminate fall broadcast rye cover crop. This ex-

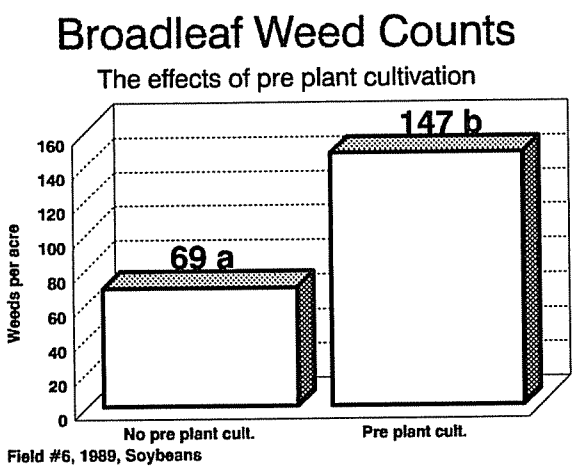

Figure 3-3

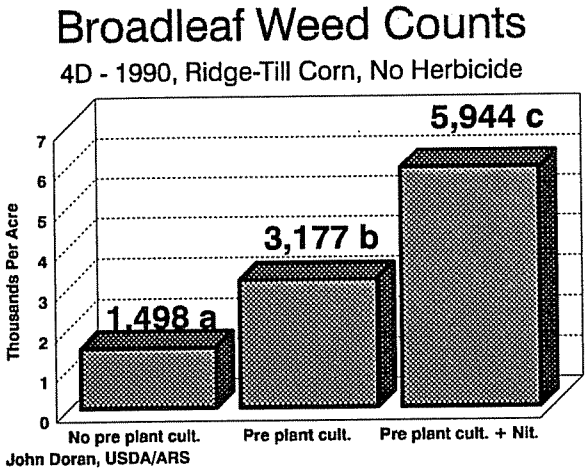

Figure 3-5

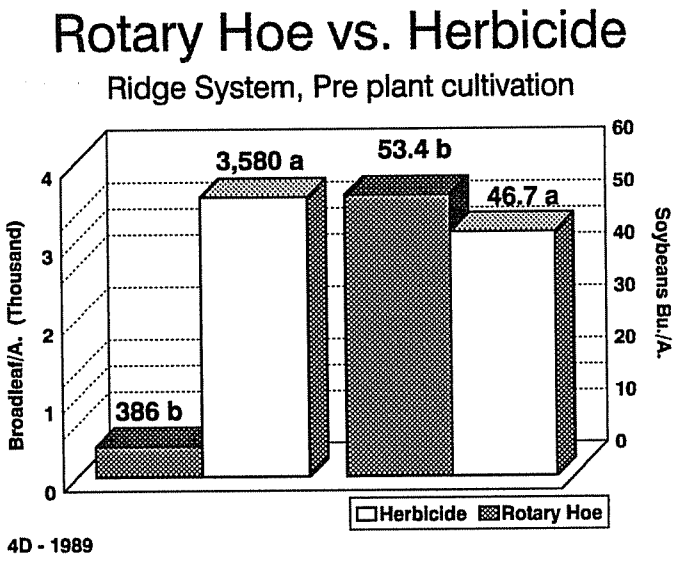

Figure 3-4

periment was designed to compare rotary hoe versus herbicide for weed control. A 3 inch rain which fell after planting no doubt diluted the herbicide application. A significant increase in weed numbers in the herbicide treatment was observed (**Figure 3-4**). The 3,580 in-row broadleaf per acre weed count expresses the weed potential with pre-plant tillage. Since the herbicide was washed away and these plots were not rotary hoed, we allowed full expression of in-row broadleaf weeds. The foxtail was abundant, but no counts were taken.

Weed populations also increased in a 1990 experiment designed to evaluate the effectiveness of pre-plant cultivation to increase early nitrogen release in a ridge–till cover crop system. This research work was done by John Doran USDA/ARS. A significant increase in weed counts was observed in pre-plant cultivation and pre-plant cultivation with surface broadcast nitrogen when compared to the no pre-plant cultivation treatment (**Figure 3-5**). The pre-plant cultivator sweeps in 1990 were run flat not to throw soil into the row, but the in-row weeds still increased.

Pre-plant cultivation in field #6 produced a significant increase in volunteer corn in the soybean plots (**Figure 3-6**). This experiment was in 1989 and since that time the planter coulters and depth gauge wheels are no longer on top of the ridge. The reason was to reduce soil disturbance caused by the planter. The volunteer corn now is very close to zero.

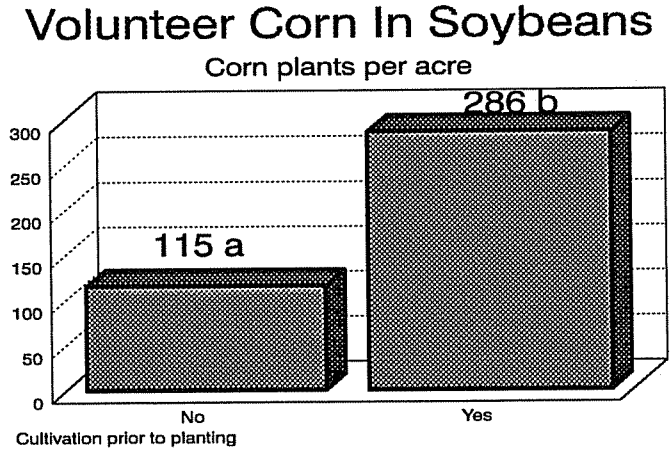

Figure 3-6

Due to the above experiences with increased weed populations, pre-plant cultivation has been discontinued.

Drilling Cover Crops After Harvest

In 1990, we began to drill fall cover crops in a 15 inch spread (three rows spaced 7 1/2 inches apart) on top of the ridge. This was done to maximize weed control, minimize seeding cost, confine plant stands to an area where they could be easily managed, and provide effective winter cover.

While drilling cover crops only on the ridge area looked promising, problems developed that required some modification. Placement of the center cover crop row, which was seeded into the area of the main crop row, was a problem as stubble remaining from the main crop made cover crop establishment difficult. Also, modifications of end drive wheels on the drill were necessary in order to keep them off the ridge.

Early in 1991, a 12-foot Great Plains drill was purchased which greatly improved field operations. Drive wheels are mounted on the front of the drill and spaced at 144 inches, giving a full 12 foot solid seeding of four, 36 inch rows. Drill openers are spaced at 6 inches, allowing two rows to be drilled on the ridge 6 inches apart, 3 inches off center from the main crop row. Press wheels are attached directly to the disk openers for good seed to soil contact.

Rye was established at 20 pounds per acre on April 1, using the Great Plains drill. All operations proceeded smoothly using this technique. Rye was approximately 6 to 8 inches tall before being removed by the planter sweep prior to planting corn and soybeans, without the need for burndown herbicide.

Both the three and two row rye establishment techniques were tested in four experiments in 1991. In three of these experiments, rye was drilled April 1 in two 6 inch rows at the rate of 20 pounds per acre. Fall drilled rye was planted October 20, 1990, at a rate of 28 pounds per acre in three 7 1/2 inch rows. In all but one experiment, soybeans followed the rye cover. The fourth experiment was planted to corn.

In 1991 the plans were to compare spring and fall drilled rye to a no cover treatment. However, wet weather delayed soybean planting until June 8. One of the main evaluations intended was differences in weed populations between areas that had drilled cover crops and areas with no cover. Delayed planting quickly turned the no cover treatments into "weed-cover" treatments. Some unanticipated discoveries were made as a result of the altered experimental design.

One surprise was that the early undisturbed weed cover was better able to suppress in-row weed growth than the spring drilled rye cover in two out of the three experiments. Soil disturbance caused by early spring cover crop planting increased broadleaf weed counts in both corn and soybean plots **(Figure 3-7 & Table 3-1).**

Despite increased in-row weed suppression, neither spring nor fall seeded rye resulted in reduced corn or soybean populations in 1991 experiments **(Figure 3-8).**

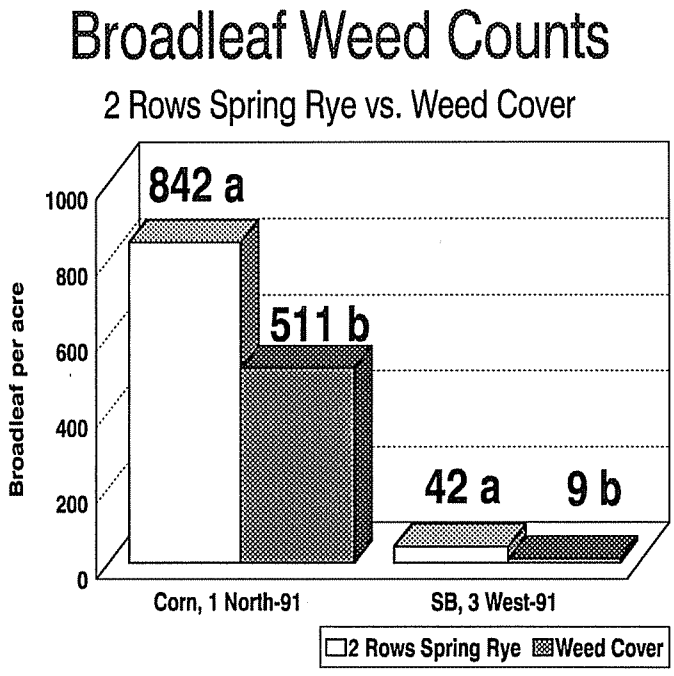

Figure 3-7

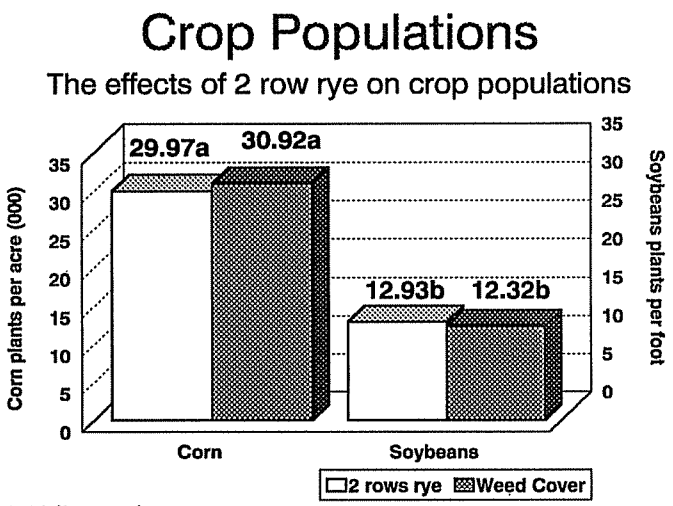

Figure 3-8

1991 Spring Seeded Rye Cover Crop Comparisons

Corn was planted as the main crop in only one rye cover crop experiment in 1991. In the experiment, spring seeded rye was compared to a weed cover treatment. The two treatment areas were divided in half and each area was post emergence rotary hoed once.

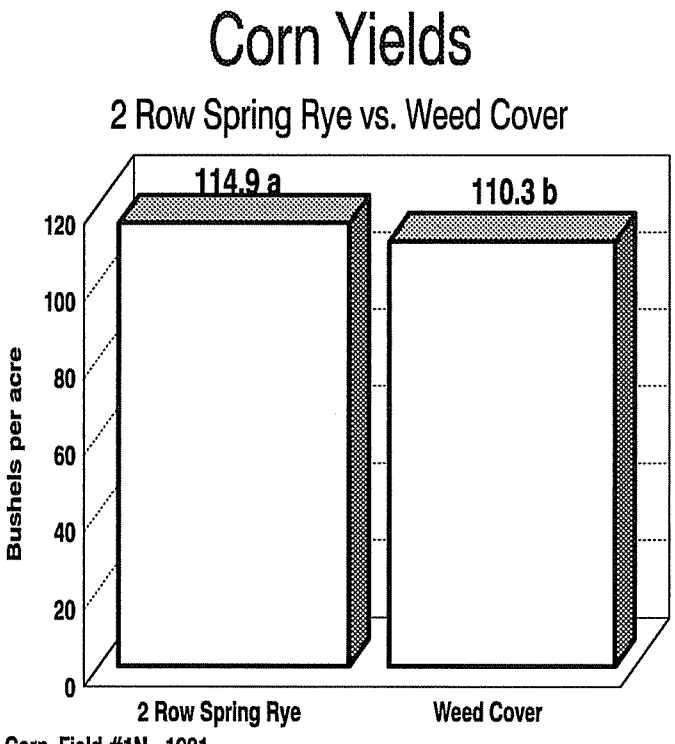

Figure 3-9

In addition to being the only experiment where corn was the main crop, it was also the only instance in the four experiments where the rye cover crop produced a higher yield than the weed cover area. The 4.7 bushels per acre increase with the rye cover crop was statistically different and produced a positive return of $1.91 per acre, the only positive return of the four treatments **(Figure 3-9 & Table 3-1).**

It is interesting to note that corn grown in the rye cover area was noticeably shorter early in the growing season. In addition, broadleaf weed populations were significantly higher in the rye area early in the season, which could have reduced yield. Corn tasseling and pollination were also later than in the weed cover area. Despite these differences, plant nutrient analysis revealed no differences between treatments.

While corn yield increased, a slight decrease in soybean yield was noted in one of the spring seeded rye experiments (Field 3 West). In this experiment a three way comparison was made between the following treatments: weed cover and rotary hoeing (double pre and single post-emergence), two rows of spring drilled rye on the ridge, and 7 pounds per acre of Amiben herbicide granules row banded. All treatments were cultivated twice.

Weed counts followed a similar trend to those observed in the other spring drilled rye experiments. The spring drilled rye treatment had the highest incidence of in-row weeds (42 broadleaf per acre), while the weed cover and herbicide treatment had significantly lower broadleaf populations (9 and 3 broadleaf per acre, respectively). Inter-row weed control in the spring drilled rye was very good and comparable to the herbicide treatment. The weed cover and rotary hoe treatment had a significantly higher incidence of broadleaf weeds in the inter-row area. All in all, weed counts were low across all treatments.

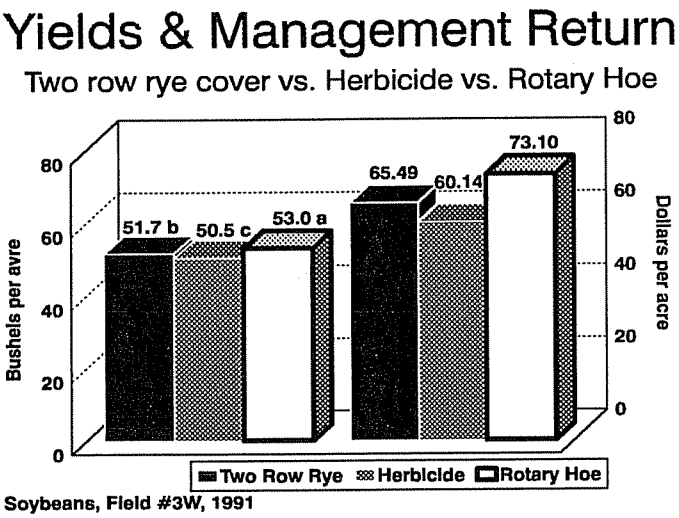

Figure 3-10

In field 9, two row spring drilled rye (2RSR) was compared to weed cover treatment. Each treatment was divided in half and rotary hoed three times (3XRH), twice before the soybean crop emerged and once after emergence was compared to no rotary hoe (NoRH).

In-row broadleaf weed counts per acre were very low in each treatment **(Figure 3-11).** In this experiment, rotary hoeing was not worth the total operational cost of $8.25 per acre for the three trips across the field ($2.75 per trip). As in other experiments, rye suppressed inter-row weed growth well. Rotary hoeing in the weed cover reduced inter-row weed numbers, but the reduction was not economically justifiable.

Significant yield differences were found between the three treatments. Soybeans yields in the spring seeded rye treatment were 1.2 bushels per acre less than yields in the weed cover/rotary hoe treatment, and the soybean yields in the herbicide treatment were 2.5 bushels per acre less than the weed cover treatment. The weed cover/rotary hoe treatment had the highest return at $73.10 per acre, followed by spring seeded rye at $65.49 management return per acre. Despite having the lowest treatment cost and weed count, the herbicide plots produced the poorest return at $60.14 per acre **(Figure 3-10 & Table 3-1).**

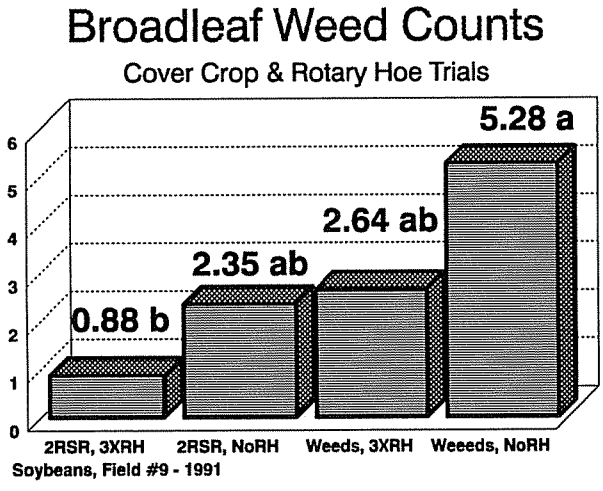

Figure 3-11

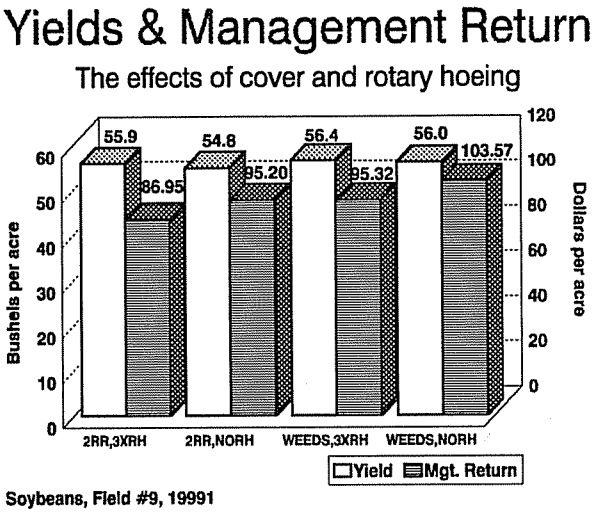

Figure 3-12

There was no significant difference in soybean yields or plant populations between the four treatments. Treatment differences were apparent only in terms of management return. Weed cover treatments produced the highest return at $103.57 per acre with no rotary hoeing (NoRH), and $95.32 per acre with three rotary hoeings (3XRH). Rye cover alone (2RR) returned $95.20 per acre and rye in combination with rotary hoeing decreased returns to $86.95 **(Figure 3-12).**

1991 Soybean Responses to Rye Cover Drilled the Previous Fall

The 1990 fall seeded rye experiments were relatively similar to spring seeded rye experiments (Field 3 East). The planting date and having three rather than two rows of rye on the ridge area were the exceptions. Rye was compared to a no cover or weed cover treatment. Each treatment was divided in half and the section was rotary hoed twice prior to soybean germination and once after germination. Fall seeded rye results differed slightly from the spring seeded rye experiments.

In addition to providing effective inter-row weed control, fall seeded rye controlled in-row weeds as well as the weed cover treatment, the weed cover with rotary hoeing treatment, and the rye cover with rotary hoeing treatment. In-row weed counts were approximately one per 80 rod row for all treatments.

Like the spring drilled rye experiments, fall drilled rye did not affect soybean population. Rye cover and weed cover treatments were harvested as a single unit, rather than being divided into rotary hoeing treatments. Yield was almost identical for the two treatments. However, cover crop seed and fuel cost decreased management return in all treatments but the weed cover. Weed cover provided the highest return at $83.02 per acre, followed by the combination of weed cover and hoeing at $74.77 per acre. Fall seeded rye alone returned $73.65 per acre, and rye in combination with hoeing reduced management return to $65.40 per acre.

1992 Crop Responses to Cover Crops on the Ridge

The two-row rye cover for soybeans was spring drilled on March 22, 1992 (Field #1 North). The other two treatments were no cover and spring drill without seed. None of the treatments were rotary hoed. The soybean yields were the same for rye and no cover **(Figure 3-13).** The rye reduced the broadleaf weed counts from 199 to 113 per acre when compared to the spring drill disturbance without seed **(Figure 3-14 & Table 3-1).**

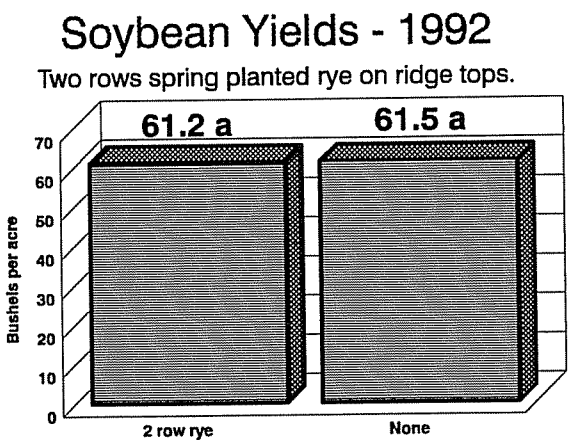

Figure 3-13

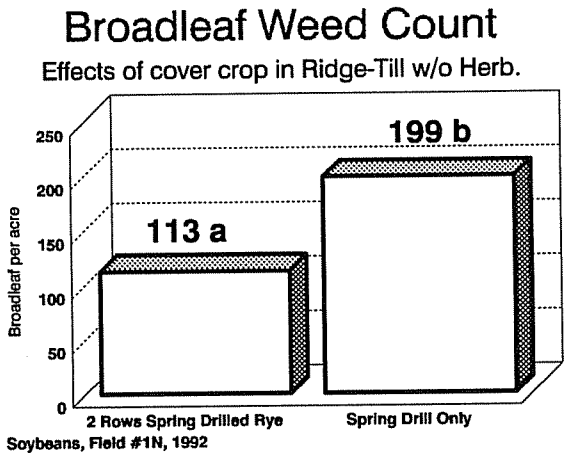

Figure 3-14

The two-row rye cover plots for corn, drilled the previous fall, gave mixed results (Field 2 North). September drilled rye on fall made ridges following hay, grew too tall for the dry May and June of 1992. The September rye at 20 pounds per acre reduced the corn yields by 16 bushels per acre and the 10 pound rate reduced the yield by 11 bushels when compared to the no cover treatment. In field 3 West, rye was drilled at 20 pounds per acre into soybean stubble in October and the corn yields were the same as the no cover treatment **(Figure 3-15 & Table 3-1).**

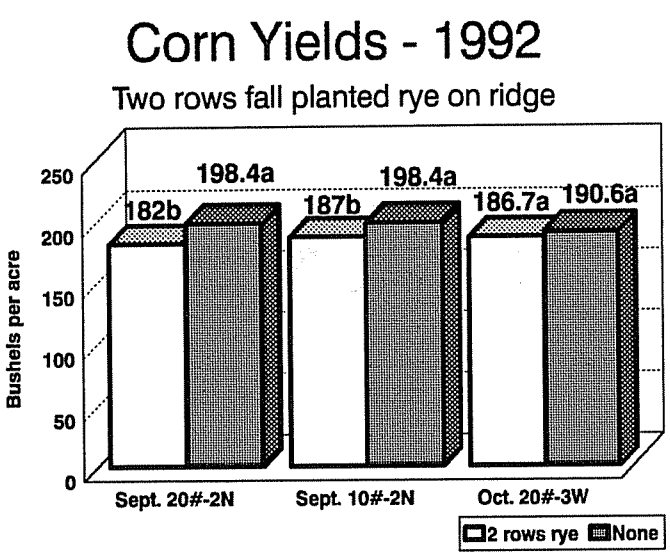

Figure 3-15

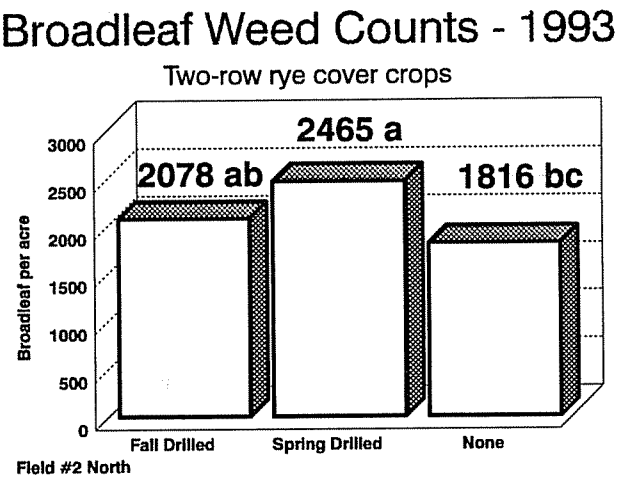

Figure 3-16

1993 Cover Crops For Soybeans

The 1993 two-row rye cover crop trials for soybeans were: 1) 20 pounds rye fall drilled on November 13, 1992. 2) 20 pounds rye spring drilled on April 13, 1993. 3) no cover. The spring drilled rye seemed hard to remove from the ridge by the planter. The soybeans in this experiment (Field #2 North) were ridge-till planted May 26, 1993 after spring manuring and then it rained and rained and rained. The broadleaf weed counts, which are in the thousands per acre are shown in **Figure 3-16 & Table 3-1**. These plots were not rotary hoed and no herbicides were used in order to get weed expression from the different treatments. The two cultivations took care of the weeds between the rows but not in the row. The two-row rye cover crop did not reduce broadleaf weeds in 1993 when the soybeans were planted on May 26.

The remainder of this same field had two-row fall drilled rye on Field #2 South. After the rains, the rye was shredded and soybeans planted on June 6,1993. The three rotary hoeing versus no rotary hoeing experiment was in this part of the field. The broadleaf weed counts are shown in **Figure 3-17**. The broadleaf weed counts were dramatically lower with the June 6 planting. You could tell right to the row where the planting date changed. It would not be economical to rotary hoe three times to lower the broadleaf weed counts from 14 to 6 per acre.

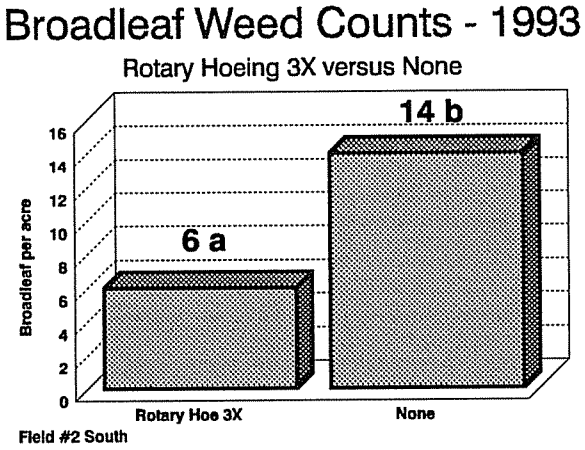

Figure 3-17

The later ridge-till planting without herbicides in June with the 12 inch rye growth on the ridge controlled the later weeds very well without rotary hoeing. The soybeans planted on May 26 are the ones that should have received the three rotary hoeings. The earlier planting with the thousands of broadleaf weeds per acre yielded 45.8 bushels per while the later planted clean soybeans had a yield of 44.9 **(Figure 3-18)**.

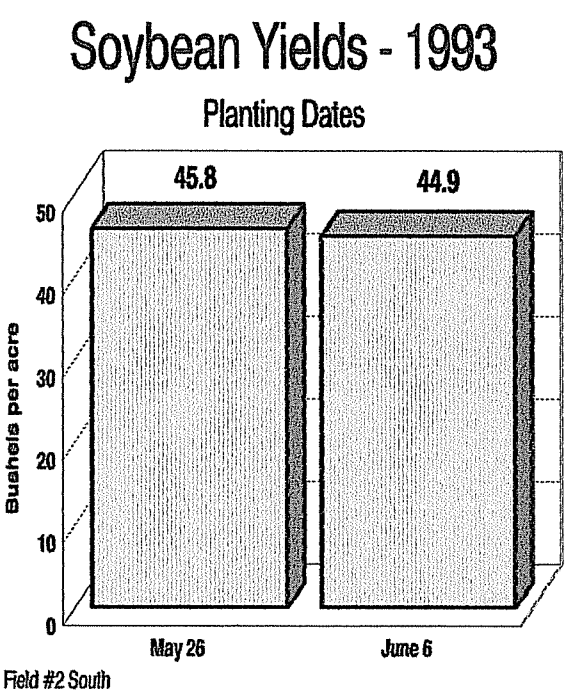

Figure 3-18

1993 Cover Crops For Corn

The 1993 two-row cover crop trials for corn were: 1) 20 pounds per acre of rye drilled on October 13, 1992. 2) 10 pounds per acre of rye drilled on October 13, 1992. 3) 25 pounds of fava beans spring drilled on April 13, 1993. 4) no cover. The fava bean is a large seed and the population in the row was very sparse and the 5 week growing time gave only 4 inches of growth. This experiment stood in water most of the summer, therefore no data was collected.

COVER CROP SUMMARY

Figure 2-36 illustrates fall ground cover four out of the five years. Weeds serve as a cover crop before planting, weeds between the rows between cultivations act as cover and then become green manure after cultivation.

For Soybeans

Fall drill 20 pounds per acre grain rye in twin rows on top of ridge following corn harvest. A rye growth of 8 to 12 inches in the spring is removed with the ridge-till planter. If the rye is too tall shred with a stalk chopper. The results from this practice are shown in **Table 3-1 & Figure 3-19.** The ridge till planter and cultivator along with two rotary hoeings most generally gave good weed management for the soybean crop. Soybean yields were not reduced by the rye cover.

Twin Rows Fall Rye For SB

Soybean Bdlf. Weed Counts & Yields per acre

Year	Field #	Rye Weeds	No Rye Weeds	Rye Yields	No Rye Yields	Rye Costs
1991	9	12a	20a	54.8a	56.0a	-10.19
1991	3E	28a	41a	53.6a	53.1a	-10.19
1993	2N	2078a	1816a	46.7a	45.5a	-12.09
2004	1	51a	18a	64.38a	63.71a	-13.64

Figure 3-19

For Corn

We did eight experiments with twin rows of fall rye drilled on a soybean ridge. There were no reduction in weed counts from the rye cover. In five trials there was a yield reduction from the rye. One rye trial in 1991, the corn tasseled 2 weeks later in cooler temperatures which caused a 4.6 bushel better

Twin Rows Fall Rye for Corn

Bdlf. Weed Counts & Yields

Year	Field #	Rye Weeds	No Rye Weeds	Rye Yields	No Rye Yields	Rye Costs
1988	6	nc	nc	80.78b	101.8a	-57.23
1991	1N	842a	511a	114.9b	110.3a	0.16
1992	3W	104a	89a	186.7a	190.6a	-10.19
1992	2N	250a	207a	182.0b	198.4a	-41.35
1992	2N	234a	207a	187.0b	198.4a	-30.56
2001	5E	0a	7a	142.7a	143.9a	-11.84
2003	4	nc	nc	173.0a	182.6a	-12.09
2004	1	nc	nc	208.8b	216.3a	-24.65

Figure 3-20

yield. The other three trials showed no yield difference between twin rows of rye and no rye. The average rye cover cost including yield reduction, rye seed and drill cost was $21.99 per acre **(Table 3-1 & Figure 3-20). Grain rye ahead of corn is not compatible in a non-herbicide ridge-till system.** The rye may grow too tall, use up too much moisture, and tie-up too much nitrogen during decomposition for corn production. The other problem is having enough time after corn harvest and stacking all the corn-stalks for cow feed and bedding to get the twin rows of fall rye drilled on the corn ridges.

Research funded by the Leopold Center demonstrated that fall (Aug 15-Sept 1) broad-casted oats (2-4 bushels per acre) over soybeans produced the most cover and did not reduce corn yields the following year. The oats will winter kill in Iowa. This work was done by Robert Horton, Keith Kohler, Steven Corak from ISU Agronomy Dept. and Thomas Kasper from National Soil Tilth Lab.

Our early cover crop work on the Thompson farm in 1984 also showed oats to be a low cost, low risk cover prior to corn production. It is our standard practice to overseed oats with a Hi-Boy at 2 bushel per acre at soybean leaf yellow. Corn will be ridge-till planted into the dead oat mulch the following spring. Broadcasting oats at leaf yellow still has too much competition from the soybeans. This practice has been discontinued.

Grain rye was applied with Gandy boxes attached to the moldboard plow as the plow turns under hay residue and manure in the fall of 1994, 95, and 96. The rye germinates in the fall and produces a green cover for late fall and winter. We have erosion control and nitrogen up-take in the off growing season. The four to six inch spring growth is killed with a field cultivator, the scrathers behind the cultivator leave the rye residue on the surface for weed and erosion control. Corn is planted on the flat surface and ridges are made during second row crop cultivat-ing.

2009 Update

We are trying to get our manure spreading and hay field plowed in September before soybean and corn harvest. We have an extra Herd seeder that could be attached to the plow to broadcast fall rye. The soil behind the Kverneland plow is left with small ridges and valleys which has some wind resistance. Do not use a harrow bar. Hopefully the rye will fall down into the rough surface and get started in the fall so that some green will show up on this black soil during the winter.

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	A	B	C	D	E	F	G	H	I	J	K	L
1	**Thompson Farm**											
2	**Cover Crop Experiments in Ridge-Till System, Spring Manure, w/o Herbicides**											
3	**Weed Counts and Crop Yields per Acre.**											
4	Crop			sb	sb	sb	sb	sb	sb	sb	sb	
5	Year			1991	1991	1991	1991	1992	1993	1993	2004	
6	Field#			9	3E	3E	3W	1N	2N	2N	2	
7	Kind of			inter-row	inter-row	in-row	in-row	in-row	in-row	in-row	in-row	
8	Weeds			bdlf	bdlf	bdlf	bdlf	bdlf	bdlf	bdlf	bdlf	
9	Treatment			2 rows sp.	3rows fall	3 rows fall	2 rows sp.	2 rows sp.	2 rows sp.	2 rows fall	2 rows fall	
10				rye	rye	rye	rye	rye	rye	rye	rye	
11	Control			weeds	weeds	weeds	rh	sp. drill	no cover	no cover	no cover	
12	Trt. Weed#			12a	28 a	15a	**42b**	**113 b**	**2465 b**	2078 a	51a	
13	Cont. Weed #			20a	41 a	19a	**9a**	**199 a**	**1816 a**	1816 a	18a	
14	Conditions			6/7/1991	no rh	6/8/1991	6/8/1991	5/15/1992	5/26/1993	5/26/1993	5/8/2004	
15				planting		planting	planting	planting	planting	planting	planting	
16	Trt. Bu./A.			54.8 a	53.6 a	53.6 a	**51.7 b**	61.2 a	46.3 a	46.7 a	64.38a	
17	Cont. Bu/A.			56.0 a	53.1 a	53.1 a	**53.0 a**	61.8 a	45.5 a	45.5 a	63.71a	
18	Trt. effect $/A.			-10.19	-10.19	-10.19	-17.28	-11.84	-12.09	-12.09	-13.64	
19	Comments								wet	wet		
20												
21	Crop	corn	corn	corn	corn	corn	corn	corn	corn	corn	corn	
22	Year	1984	1988	1991	1992	1992	1992	1992	2001	2003	2004	
23	Field#	2	6	1N	3W	3W	2N	2N	5E	4	1	
24	Kind of			in-row	in-row	in-row	in-row	in-row	in-row	in-row	in-row	
25	Weeds			bdlf	bdlf	bdlf	bdlf	bdlf	bdlf	bdlf	bdlf	
26	Treatment	fall bdct.	fall rye	2 rows sp.	fall drill	2 rows fall	2 rows fall	2 rows fall	2 rows fall	2 rows fall	2 rows fall	
27		rye	on ridge	rye cover	only	rye cover	rye cover	rye cover	rye cover	rye cover	rye cover	
28	Control	oats	oats	weeds	no cover	no cover	no cover	no cover	no cover	no cover	no cover	
29	Trt. Weed#	very clean		842 a	83 a	104 a	250 a	234 a	0a	nc	nc	
30	Cont. Weed #	very clean		511 a	89 a	89 a	207 a	207 a	7a	nc	nc	
31	Conditions						rye 20#/A.	rye 10#/A.	rye 20#/A.	rye 20#/A	rye 20#/A	
32												
33	Trt. Bu./A.	51.77	**80.78 b**	114.9 b	192.4 a	186.7 a	**182.0 b**	**187.0 b**	142.7a	173.01a	208.76a	
34	Cont. Bu/A.	85.77	**101.84 a**	110.3 a	190.6 a	190.6 a	**198.4 a**	**198.4 a**	143.9a	182.62a	216.28b	
35	Trt. effect $/A.		**-57.23**	0.16	-10.19	-10.19	**-41.35**	**-30.56**	-11.84	-12.09	-24.65	
36	Comments	Demo.	Drought			rye drilled	rye drilled	rye drilled	rye drilled	cult.	lodging	
37						10/12/1991	9/25/1991	9/25/1991	10/19/2000	plug	no weed ct	

Table 3-1