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ABSTRACT

The use of legumes in a cropping system may provide a variety of benefits. In this study, the effectiveness of selected legume species in providing surface cover was examined. The legumes were interseeded into either conventional or no-till corn, with or without N fertilizer. Both maximum legume cover and maximum cover furnished by corn plus legumes were examined. Mean cover provided during the study period by both the cover crop, and corn plus cover crop was also determined.

INTRODUCTION

Legumes may play an important role in crop management systems. During periods of active growth, legumes will fix nitrogen under favorable conditions. Fertilizer requirements and subsequent cost of crop production may decrease as a result of nitrogen fixation. Legumes left on the soil surface as a mulch can release as much nitrogen as when incorporated into the soil (Martin and Touchton, 1983) especially in humid environments. Improved surface and groundwater quality, increased soil organic matter, enhanced infiltration and aggregate stability, and decreased erosion are additional benefits which may result from the use of legumes in cropping systems (Power et al., 1983).

Research conducted during the first half of this century at a number of locations showed that perennial legumes in the crop rotation usually reduced soil erosion losses (Hargrove, 1983). Runoff was found to decrease because of the greater residue cover, increased evapotranspiration, improved water infiltration, and enhanced hydraulic conductivity provided by the legumes. Protection from soil erosion was provided by selected legumes used alone or in combination with nonlegumes (Beale et al., 1955; Bruce et al., 1987; Hendrickson et al., 1963; and Zachariassen and Power, 1987). Cool season legumes may help restore productivity to previously eroded land by returning large quantities of crop residue to the soil (Langdale et al., 1987).

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Climatological conditions, surface cover and management requirements, fertilizer needs, insect and disease problems, cropping practices, weed control, and soil water conditions must all be considered when selecting a legume species best suited for a particular crop production system. To be satisfactory as a cover crop, the legume should provide a protective vegetative cover to reduce the potential for erosion. Competition between plant species and excessive soil water depletion should also be considered when legumes are interseeded into other crops.

The economics of legume production should be examined by producers. Legumes such as alfalfa can be sold in many areas while a market for other cover crops may not exist. Thus, legume production costs must be compared with savings caused from reduced fertilizer requirements.

Planting date may be especially important for interseeded legumes. The legume should become well established and provide an effective surface cover prior to the first killing frost. If planted too early in the season, the legume may furnish undesired competition and reduce the yield of the crop with which it is interseeded. Because legume species differ in optimum temperature for growth, date of planting may affect selected species differently (Zachariassen and Power, 1987).

If an interseeded legume is to be used for erosion protection, the degree of surface cover provided throughout the year by both the legume and the crop with which it interseeded should be examined. For taller crops like corn, the distribution of both standing and fallen residue will also be important for erosion control. Thus, several factors must be considered before the most appropriate crop management system can be identified. The objective of this study was to determine the effects of selected tillage treatments and fertilizer application on corn and legume cover.

PROCEDURE

The study was conducted at the University of Nebraska Agronomy Farm located in Lancaster County near Lincoln, Nebraska on a Crete-Butler silty clay loam soil (fine, montmorillonitic, mesic Pachic Argiustolls -Abruptic Argiaquolls). The experimental variables were cover crop, tillage treatment, and fertilizer application. A total of 60 plots (5 cover crops X 2 tillage treatments X 2 fertilizer application rates X 3 replications) were established in 1986 using a split-plot design. Plots having dimensions of 3.1 m (10.2 ft) by 12.2 m (40.0 ft.) were established on an area with a slope of approximately 3%.

The cover crops consisted of hairy vetch, soybean, white clover, and winter rye in addition to a no cover crop treatment. Winter rye, a non-legume, was used as a

TABLE 1. Plant species for which cover measurements were made

Corn, *Zea Mays*, L. (41 300 plants/ha, 16,700 plants/acre)	
Hairy vetch, *Vicia villosa*, Roth "Madison", (33.6 kg/ha, 30 lb/acre)	
Soybean, *Glycine max*, L. Merr. "Century", (67.3 kg/ha, 60 lb/acre)	
White Clover, *Trifolium repens*, L. "Merit", (8.4 kg/ha, 7.5 lb/acre)	
Winter Rye, *Secale cereale*, L. Cougar", (33.6 kg/ha, 30 lb/acre)	

*Values listed in parentheses are seeding rates

reference species. Seeding rates for the various crops are shown in Table 1. Different seeding rates were required because of the wide variation in size of seeds between plant species.

Conventional and no till systems were evaluated. For the conventional tillage treatments, double-disking occurred just prior to corn planting with a single cultivation taking place before seeding of the cover crop. No-till plots were sprayed with glyphosate before planting and with alachlor after planting at rates of 2.3 L/ha (1 qt/acre) and 5.8 L/ha (2.5 qts/acre), respectively. The plots were planted to corn on 14 May 1986 and interseeded with a cover crop on 21 June 1986.

Fertilizer treatments included application of ammonium nitrate at rates of 0 and 60 kg/ha (54 lb/acre) of N. Fertilizer was surface broadcast before the area was seeded to corn. Weeds which appeared on the plots were removed by hand.

Cover was photographed using 35 mm color slide film. Slides were taken at two locations per plot on each measurement date for a total of six measurements for a given cover crop, tillage, and fertilizer treatment. Photographs were taken at intervals of approximately one week during the summer season to about one month during the winter period. Flags were used to identify the location of the tripod legs so the camera could be positioned in the same location on each date.

Surface cover measurements were made using a photographic grid procedure (Laflen et al., 1978). Slides were projected onto a screen on which a grid had been superimposed. The number of grid intersections over vegetative material was determined visually from the projected slides and the percentage of surface cover was then calculated. Crop residue remaining from the previous season was not included in the surface cover measurements.

Duncan's multiple range test (SAS Institute, Inc., 1985) was used to evaluate differences in maximum cover between the various experimental treatments (Table 2). The effects, if any, of tillage treatment or fertilizer application on maximum cover for a particular cover crop treatment were determined. Cover measurements between experimental treatments were considered to be significantly different if they exceeded the 5% confidence level.

Cover measurements were made at several dates throughout the study period. A statistical test was therefore needed which allowed comparison in cover measurements between experimental treatments during

TABLE 2. The effects of plant species, tillage treatment, and fertilizer application on cover during the study period

Experimental Treatment			Maximum Surface Cover*		Mean Cover During the Study Period†	
Cover Crop	Tillage	Nitrogen Fertilizer,‡ kg/ha	Cover crop, %	Corn plus cover crop, %	Cover crop, %	Corn plus cover crop, %
None	Conventional	0		85 bc		53 b
None	Conventional	60		95 a		56 a
None	No-till	0		81 c		52 b
None	No-till	60		88 b		56 a
Hairy Vetch	Conventional	0	12 a	88 ab	3 a	56 b
Hairy Vetch	Conventional	60	11 ab	94 a	2 a	59 a
Hairy Vetch	No-till	0	6 ab	82 b	1 b	50 c
Hairy Vetch	No-till	60	6 b	90 a	1 b	58 b
Rye	Conventional	0	4 a	86 b	1 b	53 b
Rye	Conventional	60	14 a	93 a	2 a	59 a
Rye	No-till	0	4 a	82 b	1 b	52 b
Rye	No-till	60	4 a	88 ab	1 b	52 b
Soybean	Conventional	0	9 a	86 b	1 b	52 c
Soybean	Conventional	60	14 a	95 a	1 ab	61 a
Soybean	No-till	0	21 a	88 b	2 a	56 b
Soybean	No-till	60	19 a	90 b	2 a	57 b
White Clover	Conventional	0	8 b	89 ab	1 b	54 b
White Clover	Conventional	60	13 a	93 a	2 a	58 a
White Clover	No-till	0	6 b	84 b	1 b	50 c
White Clover	No-till	60	3 c	87 b	0 c	55 b

*Differences in maximum cover between tillage and fertilizer treatments for a given cover crop treatment are significant at the 5% level (Duncan's multiple range test) if the same letter does not appear.

†Differences in cover between tillage and fertilizer treatments for a given cover crop treatment are significant at the 5% level (paired students - t test) if the same letter does not appear. This test allows comparisons in cover measurements obtained during the entire study period.

‡60 kg/ha of nitrogen fertilizer equals 54 lb/acre

TABLE 3. Comparison of surface cover provided by selected cover crop species during the study period

Cover crop	Maximum Surface Cover*		Mean Cover During the Study Period†	
	Cover crop, %	Corn plus cover crop, %	Cover crop, %	Corn plus cover crop, %
None	0 c	87 a	0 c	54 b
Hairy Vetch	9 b	89 a	2 a	56 a
Rye	6 b	87 a	1 b	54 b
Soybean	16 a	90 a	1 b	57 a
White Clover	7 b	88 a	1 b	54 b

*Differences in maximum cover within a column are significant at the 5% level (Duncan's multiple range test) if the same letter does not appear.
†Differences in cover within a column are significant at the 5% level (paired students - t test) if the same letter does not appear. This test allows comparisons in cover measurements obtained during the entire study period.

the entire period of study. The paired student's t-test (SAS Institute, Inc., 1985) was used to make these comparisons (Table 2).

Measurements of cover existing for the various tillage and fertilizer treatments were combined to obtain the values shown in Table 3. Significant differences in maximum cover between experimental treatments were identified using Duncan's multiple range test. The paired student's t-test was used to determine the effects, if any, of cover crop treatment on cover during the entire study period (Table 3).

Tillage practice and fertilizer application effects on cover measurements are summarized in Tables 4 and 5,

TABLE 4. The effects of tillage practice on mean cover measurements during the study period*

Tillage treatment	Mean Cover During the Study Period	
	Cover crop, %	Corn plus cover crop, %
Conventional	2 a	56 a
No-till	1 b	54 b

*Differences in surface cover within a column are significant at the 5% level (paired student's - t test) if the same letter does not appear. This test allows comparisons in cover measurements obtained during the entire study period.

TABLE 5. The effects of fertilizer application on mean cover measurements during the study period*

Fertilizer application	Mean Cover During the Study Period	
	Cover crop, %	Corn plus cover crop, %
Fertilizer	1 a	57 a
No fertilizer	1 a	53 b

*Differences in surface cover within a column are significant at the 5% level (paired student's - t test) if the same letter does not appear. This test allows comparisons in cover measurements obtained during the entire study period.

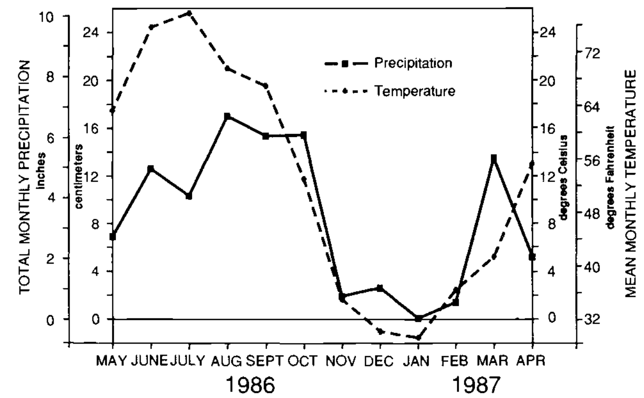

Fig. 1—Total monthly precipitation and mean monthly temperature at the study site.

respectively. Significant differences in cover measurements during the period of investigation were identified using the paired student's t-test. Again, the 5% confidence level was used to determine significant differences between tillage and fertilizer treatments.

RESULTS AND DISCUSSION

Total monthly precipitation and mean monthly temperature for the study period are shown in Table 1. The first freezing temperatures of the season occurred on 13 October, when air temperatures fell to −1° C (30° F). These temperatures occurred 152 and 114 days after the 14 May and 21 June planting dates, respectively. The weather remained mild until 10 November when air temperatures decreased to -17° C (1° F). These freezing temperatures occurred 180 and 142 days after the 14 May and 21 June planting dates, respectively. For most of the plant species, surface cover decreased after this date.

The final series of surface cover measurements were obtained on 17 April 1987. For several of the plant species, surface cover increased from previous observations. New spring growth had begun for many of the species as a result of warmer temperatures. On some of the plots, previously standing residue had fallen onto the soil surface, also increasing cover measurements.

Effects of Tillage Treatment and Fertilizer Application on Surface Cover

For a given cover crop and tillage treatment, maximum cover provided by a particular fertilizer treatment is shown in Fig. 2. Information on both maximum cover and cover provided throughout the study period is presented in Table 2. Results of statistical tests reported in Table 2 relate only to a given cover crop.

For both rye and soybean, no significant difference in maximum surface cover provided by the cover crops occurred between the various tillage and fertilizer treatments (Table 2). However, significant differences between treatments did result for hairy vetch and white clover. The greatest variation in maximum cover between experimental cover crop treatments occurred for white clover.

Significant differences in total maximum surface cover (corn plus cover crop) between tillage and fertilizer treatments were recorded for each of the cover crop

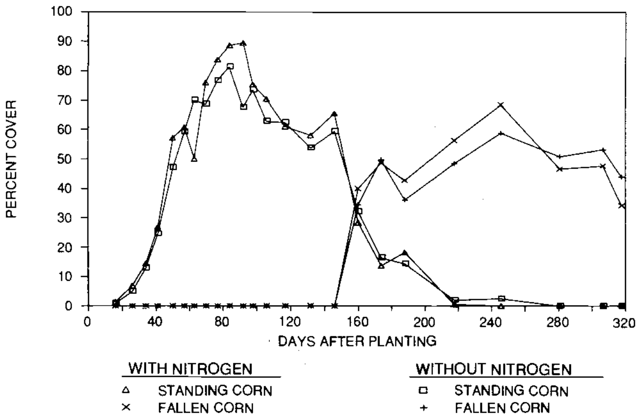

Fig. 2a—Surface cover provided by corn without a cover crop using a conventional till system.

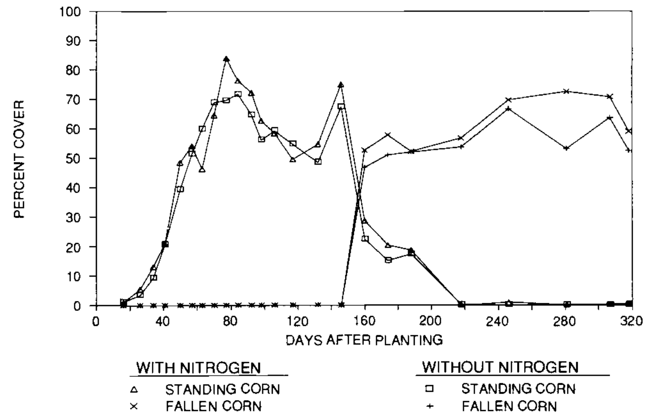

Fig. 2b—Surface cover provided by corn without a cover crop using a no-till system.

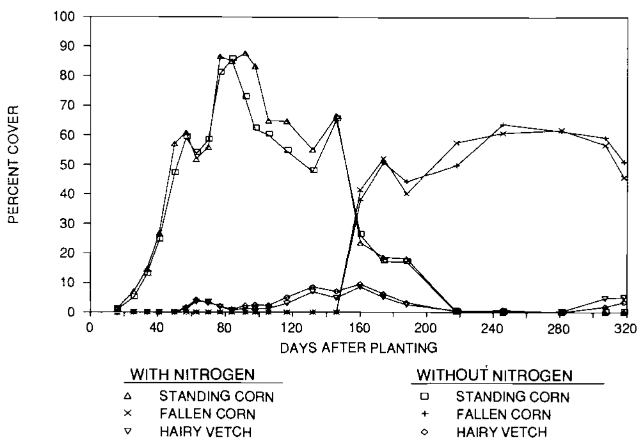

Fig. 2c—Surface cover provided by corn and hairy vetch using a conventional till system.

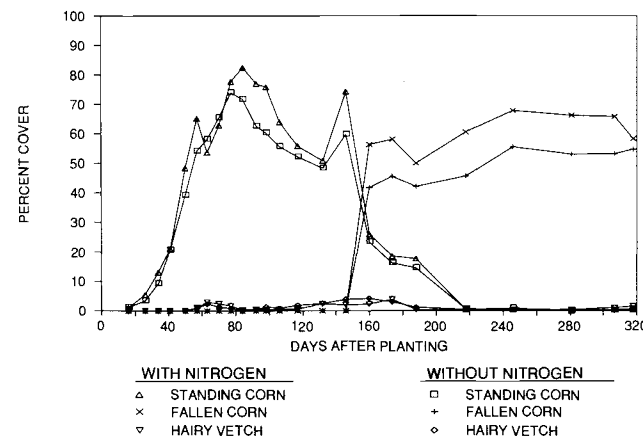

Fig. 2d—Surface cover provided by corn and hairy vetch using a no-till system.

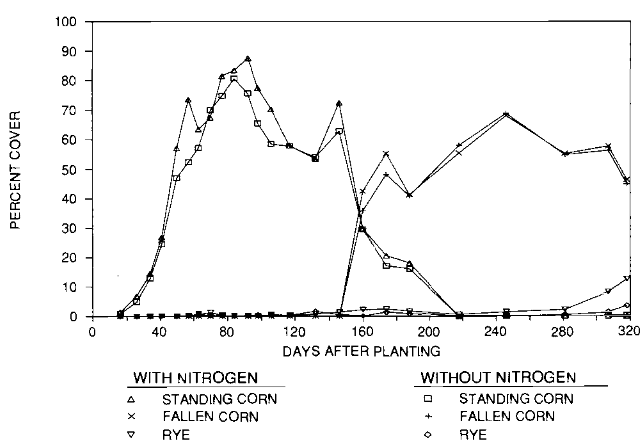

Fig. 2e—Surface cover provide by corn and rye using a conventional till system.

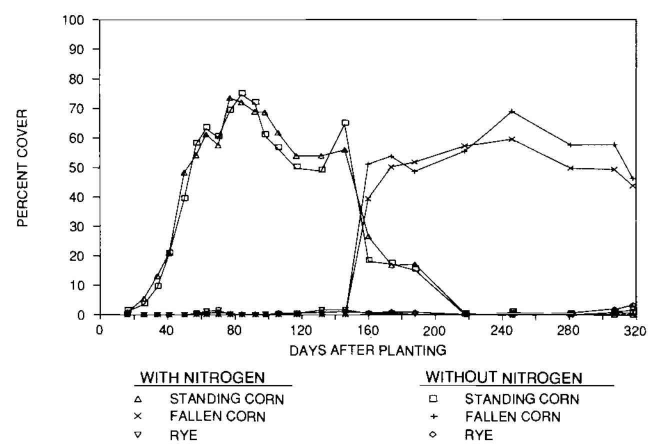

Fig. 2f—Surface cover provided by corn and rye using a no-till system.

species. Total maximum surface cover exceeded 80% for all treatment combinations (Table 2). For each of the cover crop treatments, no treatment provided greater maximum surface cover than the conventional till plus N fertilizer treatment. The no cover crop treatment displayed the largest variation in total maximum cover between experimental treatments.

For each of the cover crop species, significant differences in mean cover provided by the cover crop throughout the study period were found between the various tillage and fertilizer treatments (Table 2), although absolute differences between experimental treatments were small. Greatest variation in cover between experimental treatments occurred for white clover. Similarly, the different tillage and fertilizer treatment combinations within a cover crop treatment also provided significant differences in total cover throughout the study period. The conventional till plus

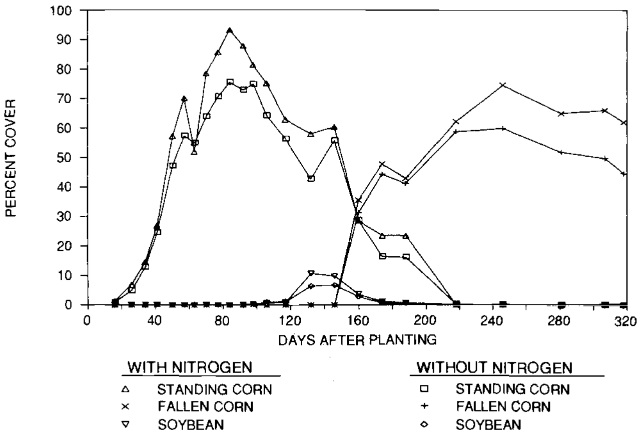

Fig. 2g—Surface cover provided by corn and soybean using a conventional till system.

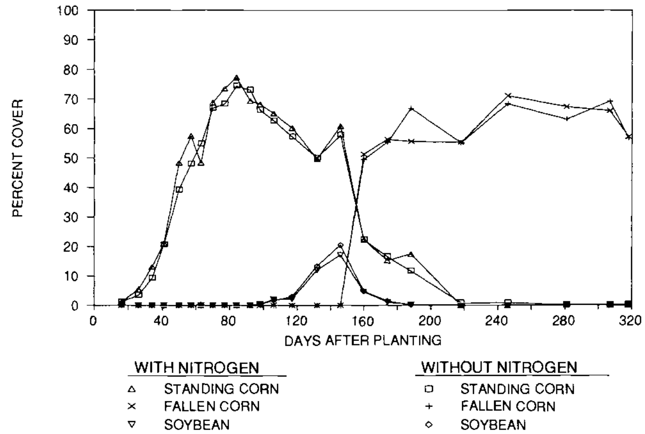

Fig. 2h—Surface cover provided by corn and soybean using a no-till system.

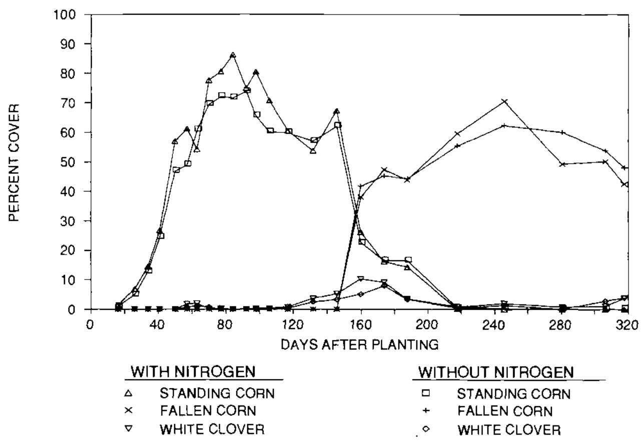

Fig. 2i—Surface cover provided by corn and white clover using a conventional till system.

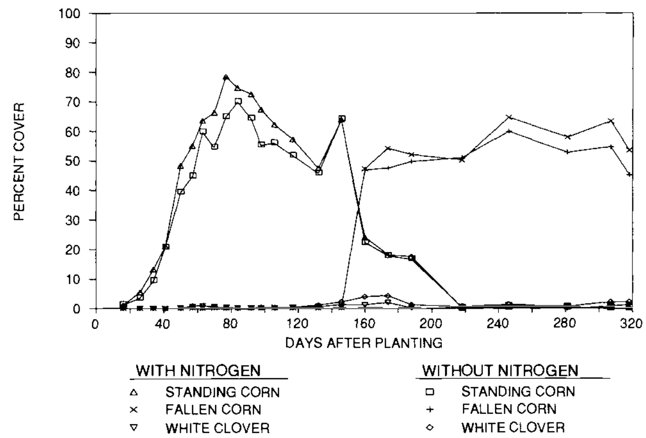

Fig. 2j—Surface cover provided by corn and white clover using a no-till system.

nitrogen fertilizer treatment provided the largest total mean cover during the study period for each of the cover crop treatments.

Cover Provided by Different Plant Species

Cover measurements for the various cover crops and fertilizer treatments were combined to identify the effect, if any, of tillage treatment on cover (Table 4). Compared to no-till, the conventional tillage system provided significantly greater cover for cover crops and also greater total cover, although differences between the tillage treatments were small. Thus, for the given soil and climatological conditions existing during the study period, the conventional tillage system appears to be better suited than the no-till system for producing additional cover. However, the no till system would be expected to be much more effective in maintaining existing surface cover.

Fertilizer effects on surface cover measurements during the study period are shown in Table 5. Application of N fertilizer provided no significant affect on surface cover provided by the cover crops. All of the cover crops except for rye are legumes and thus have their own nitrogen fixing capabilities.

Fertilizer application produced significantly greater total cover than the no-fertilizer treatments. Additional cover provided by further corn growth when fertilized was responsible for this difference. Thus, application of N fertilizer served to significantly increase total cover for the given experimental conditions.

CONCLUSIONS

Legumes may serve as valuable components of well managed crop production systems. A variety of benefits may be provided by the use of legumes. In this study, the effects of selected tillage treatments and fertilizer application on corn and legume cover were identified.

The maximum mean surface cover provided by the cover crop treatments ranged from 9% for rye to 16% for soybean. Maximum total surface cover (corn plus cover crop) varied from 87 to 90%. No significant difference in total surface cover was found between the cover crop and no cover crop treatments.

Hairy vetch yielded the largest mean legume cover (2%) during the study period. Hairy vetch and soybean provided a total mean cover (56% and 57%, respectively) significantly greater than the no cover crop treatment (54%). However, the relative difference in total mean cover between experimental treatments was small.

For each of the cover crops, no treatment provided greater maximum cover than the conventional till plus nitrogen fertilizer treatment. The conventional till plus nitrogen fertilizer treatments also produced the greatest total mean cover during the study period. However, the no-till system would be expected to be much more effective in maintaining existing surface cover.

A variety of factors must be considered when selecting a legume best suited for a particular crop production system. The type of tillage system which is used and the fertilizer application program must be evaluated. For the given experimental conditions existing in southeastern Nebraska in 1986, the use of legumes had little effect on increasing total maximum cover or mean cover. A conventional tillage system using N fertilizer application provided the greatest cover for the given experimental conditions.

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