EFFECT OF TIME AND METHOD OF SEEDING AND CORN ROW WIDTH ON THE ESTABLISHMENT OF VARIOUS SPECIES INTERSEEDED AS A COVER CROP IN CORN

Thesis for the Degree of M. S.
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by

WILLIAM A. HAYES

AN ABSTRACT

Submitted to the College of Agriculture of Michigan State University in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

1958

Department of Farm Crops

Approved by 

William A. Hayes
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ABSTRACT

Alfalfa, red clover, field bromegrass and annual ryegrass interseeded in 42- and 56-inch corn rows by band seeding with press wheels on June 10 and 22nd; band seeding (without press wheels) on July 1; and broadcast seeding on July 1 were evaluated as a winter cover crop in late September.

Corn yields were significantly lower in the wide rows. Seedings were generally better between the wide rows but good stands of grass were obtained between the narrow corn rows.

The weights of weeds in alfalfa interseeded on June 10 and 22 were greater than on July 1 by 730 and 240%, respectively. Early emergence of grasses suppressed weed growth, accounting for 25% more weeds in legume seedings.

With increasing distance from the corn row, seedings became stronger, especially at the later dates of seeding because of less weed competition.

Grasses gave 83% more cover than legumes for all dates of seeding and 133% more cover than legumes when broadcast seeded on July 1.

Field bromegrass broadcast on July 1 gave the best seedings of all treatments although ryegrass gave the best average seedings for the experiment. Alfalfa, red clover, and ryegrass were best when seeded on June 22; ryegrass was almost as good when broadcast on July 1.

Either field bromegrass or domestic ryegrass broadcast about July 1, immediately after the last cultivation, should provide a good over-winter cover crop if moisture conditions are adequate after seeding.

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ACKNOWLEDGMENT

I wish to take this opportunity to express my appreciation to Dr. M. B. Tesar, associate professor of the department of Farm Crops, Michigan State University, for his very able assistance in the planning, execution, and evaluation of this research problem.

DEDICATION

This paper is dedicated to my wife, father, and mother in appreciation of the encouragement given and the immeasurable sacrifices made that I might further my education.

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INTRODUCTION

The number of acres of corn interseeded with a cover crop has increased slowly in recent years. Although the practice of establishing cover crops in corn has been recommended for several years, little research data are available regarding the best method of establishment of forages for this purpose. However, the information obtained from the recent studies on the interaction of corn row width, methods of seeding, and dates of seeding various species for hay and pasture purposes should be useful in interpreting the results of this study on the establishment of forages as a cover crop.

Peterson (7) in Wisconsin reported excellent alfalfa stands were obtained in 60-inch corn rows but poor alfalfa stands were obtained in 40-inch corn rows. Stringfield and Thatcher (10) in Ohio broadcast domestic ryegrass in early June and reported hay yields the next year of 1.3 tons per acre when seeded between 30-inch corn rows, 1.9 tons between 60-inch rows, and 2.2 tons between 70- and 80-inch rows. They also reported unsatisfactory stands of alfalfa in narrow corn row spaces but fair to good stands of alfalfa in the 60- and 70-inch spaces. Tesar (11) in Michigan reported that increasing the row width resulted in better alfalfa stands. Stands were stronger with increasing distance from the corn row. Schaller and Larson (8) in Iowa reported that

forage seedings in corn were much more successful in corn spaced in 80- than in 40-inch rows.

Peterson (7) reported corn yields were about the same in 40- and 60-inch rows, but corn yields decreased by 20% in 80-inch rows. When compared to yields of corn in 40-inch rows, Tesar (11) reported a decrease in yield of 4.6% in 60- and 13.2% in 80-inch rows. Pendleton et al. (6) reported that corn in 60- and 80-inch rows produced 92 and 80% as much, respectively, as corn in 40-inch rows. According to Stringfield and Haynes (9), the work in Ohio demonstrated that corn in rows up to 50-inch spacing yielded equally as well as corn rows spaced 30 or 40 inches apart. They reported "this was only true when soil and weather were good enough for a crop of 75 bushels or more." They reported an average loss of 4 to 5 bushels per acre when the corn row spacing was extended from 40 to 60 inches. Stringfield and Thatcher (10) found that where the soil and season would only produce 30 bushels of corn per acre, the corn yields dropped as row spaces were widened beyond 30 inches. However, with an increase in productivity, the row spacing could be wider without reducing yields. Where the soil and season were such that yields of 70 to 100 bushels of corn per acre were obtained, there was no appreciable loss by widening the corn rows to 50 inches. They experienced a decrease of 4 bushels at a 60-inch row width and about 9 bushels at a 70-inch row width.

Haynes and Thatcher (3) and Tesar et al. (12) reported that legumes seeded by the banding method grew faster and became

established earlier than when broadcast seeded. Tesar (11) found "packing after drilling resulted in stands 28 to 109% better than stands established without packing in three years of tests."

Pendleton et al. (6) reported that early dates of seeding (May and early June) are most favorable for seeding legumes in in corn. When alfalfa and corn were seeded at the same time, the alfalfa competed with the corn for nutrients and water according to Peterson (7). Schaller and Larson (8) reported that corn yields were influenced by the date of interseeding forages. Corn interseeded on May 12, June 10, and 24 yielded 27.7, 59.5, and 79.4 bushels per acre, respectively. Stands of forage were best at the earlier dates of seeding.

The purpose of this study was to determine the effect of the seeding date, method of seeding, and corn row width on the establishment of legumes and annual grasses interseeded between corn rows for the purpose of providing an over-winter cover crop.

MATERIALS AND METHODS

The experiment was conducted in 1957 at the W. K. Kellogg farm near Battle Creek, Michigan. A randomized split-plot design of 4 replications was used. Each ultimate plot was 40 feet long and equalled the width of 4 corn rows. This was 10.5 and 14.0 feet wide in the 42- and 56-inch row spaces, respectively. The soil was a nearly level Kalamazoo loam of moderately low inherent fertility and poor water-holding capacity because of summer fallowing in 1956 to control quackgrass. Since Kalamazoo loam has a low capacity for water storage, this soil is not too productive during seasons of low rainfall.

Corn was planted on May 26 and 27 in 42- and 56-inch rows. A population of about 14,000 plants per acre was obtained. The corn was fertilized at planting time with 200 pounds of 12-12-12 fertilizer per acre in bands 2 inches to the side and 2 inches below the corn. After the second cultivation on June 22, the corn was side dressed with 50 pounds of nitrogen per acre. Seedings were fertilized with 400 pounds of 12-12-12 fertilizer per acre. All species were interseeded in corn with a grain drill, Figure 1. Fertilizer was applied in bands below the seed when alfalfa, red clover, and sweet clover were band seeded (3, 12). The fertilizer was in contact with the seed of hairy vetch, ryegrass, and field bromegrass since these three species were too large to be seeded through the small grass seeder box. They were seeded in

Fig. 1. Grain drill used to make seedings. June 10 and 22 seedings were made with the press wheels attached as above. Press wheels were not used when making July 1 seedings. Broadcast seedings were made by first drilling the fertilizer in the plots and then, in a separate operation, the seed was sown on the surface through the drill by securing the discs to the frame of the drill.

the same manner as small grains through the large seed box. Adjustments were made on the grain drill to place these three species about 3/4-inch deep. Although these three species were not band seeded as this method is commonly known (seed placed on top of the ground directly over and separated from the fertilizer by soil) (3, 12), they will be referred to as being band seeded since all the seed in contact with the fertilizer was stimulated in establishment.

The four seeding variables used were (1) band seeding with press wheels on June 10, (2) band seeding with press wheels on June 22, (3) band seeding without press wheels or any compaction on July 1, and (4) broadcast seeding without any compaction on July 1, Figure 1. It was first intended to use press wheels when band seeding on July 1 but the corn was about 24 inches tall and the supporting bar of the press wheels damaged the corn so the press wheels were not used.

The number of cultivations which the corn received varied according to the date of interseeding. Corn interseeded on June 10, 22, and July 1 received 1, 2, and 3 cultivations, respectively. All plots were cultivated on June 10; on June 22 all plots were cultivated except those seeded immediately after the June 10 cultivation; on July 1 all plots were cultivated that had not been seeded on June 10 and 22.

Vernal alfalfa (Medicago sativa L.), Pennscott red clover (Trifolium pratense L.), and yellow sweet clover (Melilotus officinalis L.) were seeded at 7.8 pounds per acre. Hairy vetch

(Vicia villosa Roth) was seeded at 34.6 pounds per acre. The two grasses, domestic ryegrass (a mixture of Lolium perenne L. and Lolium multiflorum L.) and field bromegrass (Bromus arvensis L.) were seeded at 15.0 pounds per acre.

Seedling counts of alfalfa were made in each plot. Each count was made in an area 42 inches in length (the distance between 2 corn rows) and 12 inches wide between corn in 42-inch rows and 56 inches in length and 12 inches wide between corn in 56-inch rows. Three samples were taken on each plot. The sampled area covered a total of 10.5 square feet in the 42-inch row spacings and 14 square feet in the 56-inch rows.

The weight of weeds was determined in an area 42 by 56 inches in size in both 56- and 42-inch corn rows in mid-September on all corn plots interseeded with alfalfa. Stands of seedlings on the basis of percent of ground cover and weed density were rated from 0 to 100 on all plots during the latter part of September. Seedling ratings of legumes and grasses were made on each of the drill rows spaced 7 inches apart.

A length of 30 feet of the two center rows of corn was harvested by hand in each plot interseeded by the broadcast method on July 1. Yields are expressed on the basis of bushels per acre of shelled corn having 15.5% moisture.

EXPERIMENTAL RESULTS

Yields of Corn

Corn yields were significantly higher at the 1% level in the 42- than in the 56-inch rows, Table 1. In the control where no interseedings were made, the corn in 42-inch rows yielded 43.5 bushels per acre while the corn in the 56-inch rows produced only 26.1 bushels per acre. This amounts to a 40 percent decrease in yield in the 56- when compared to the 42-inch corn rows. Yields were similar in the narrow rows regardless of the species interseeded on July 1. Corn yields in the wide rows varied considerably within the individual treatments and with various species when compared to the control. Consequently, there was no significant difference between corn yields attributable to different species interseeded.

Corn yields were low because of the relatively low water-holding capacity of the soil and poor distribution of rainfall in July, August and September, Table 2. The first part of July was unusually wet with 2.95 inches of rain within the first 8 days and a total of 4.62 inches for the month. On July 22, 1.30 inches of rain fell, but in the next 32 days there was only 1.00 inch of rainfall followed by 1.00 inch on August 24. During September, precipitation ranging from 0.03 to 0.35 inches was recorded on 8 different days.

TABLE 1

EFFECT OF ROW WIDTH ON YIELDS OF CORN INTERSEEDED ON JULY 1 BY THE BROADCAST SEEDING METHOD W. K. KELLOGG FARM, 1957

Species	Row Width, Inches		Average
	42	56	
	bu./A.	bu./A.	bu./A.
Alfalfa	43.1	39.4	41.2
Red Clover	43.4	21.2	32.3
Sweet Clover	43.3	26.9	35.1
Hairy Vetch	44.2	20.0	32.1
Annual Ryegrass	45.2	22.6	33.9
Field Bromegrass	42.6	19.7	31.2
None (control)	42.6	32.8	37.7
Average	43.5**	26.1**	34.8

**Significant at 1% level

TABLE 2

INCHES OF RAINFALL AT THE W. K. KELLOGG FARM
DURING THE GROWING SEASON OF 1957

Day	Month					Total
	May	June	July	August	September	
1						
2					.31	
3					T	
4			T		.10	
5			.50			
6			T			
7		.05				
8		T	2.45			
9						
10	.85			.38	T	
11	.56	.20				
12	T				.35	
13		.05	.32		.30	
14	.15	.29				
15	.10			.62	.32	
16						
17	.15					
18	.53	.10				
19	1.60	.05				
20	.10				T	
21					.26	
22			1.30		.03	
23	T	.25	.05		.15	
24		.25		1.00		
25	.25	T				
26		.11				
27		.10				
28		.70		.20		
29		.01		T		
30				.85		
31				T		
Total	4.29	3.01	4.62	3.05	1.82	16.79
*Normal	4.02	4.25	2.66	3.19	3.02	17.14
Deviation from Normal	+.27	-1.24	+1.96	-.14	-1.20	-.35

*Normal - Battle Creek airport, Battle Creek, Michigan

Distance of Species from Corn Row and Corn Row Width

Table 3 shows the effect of distance between the alfalfa row and the corn row on the number of seedlings established per square foot. In both 42- and 56-inch corn rows, the greatest number of alfalfa seedlings was obtained 14 inches from the corn row with all methods and dates of seedings except when seedings were made by broadcasting on July 1 in 42-inch rows. Under this treatment the number of seedlings per square foot was practically equal in rows 14 or 21 inches away from the corn. The number of alfalfa plants per square foot in rows 7, 21, and 28 inches from the corn were less than in rows 14 inches away from the corn because of the greater competition from the corn when the alfalfa row was 7 inches away from the corn row, and because of increased weed competition when the alfalfa row was 21 or 28 inches from the corn row.

Counts were made only on the alfalfa plots. All species in all plots were rated from 0-100 according to the percentage of ground cover furnished in late September. Reasonably good accuracy of the ratings is evidenced by comparing the alfalfa counts in Table 3 with the ratings in Table 4. Both tables show that the best seedings were obtained when made on June 22 and July 1; both tables confirm band seeding was better than broadcast seeding and that the poorest seedings were obtained on June 10.

All the legumes interseeded in corn except red clover were better in the wide than in the narrow rows, Table 4. Weed competition increased with increasing distance beyond 14 inches from

TABLE 3

EFFECT OF DISTANCE BETWEEN THE ALFALFA ROW AND THE CORN ROW ON THE NUMBER OF SEEDLINGS PER SQUARE FOOT ESTABLISHED IN CORN AT DIFFERENT TIMES AND WITH DIFFERENT METHODS OF SEEDING

Corn Row Width, inches	Time and Method									
	June 10 Band and press wheels					June 22 Band and press wheels				
	Inches between									
	7	14	21	28	Ave.	7	14	21	28	Ave.
56	4.8	6.1	3.1	1.6	3.9	8.4	12.8	7.8	8.5	9.4
42	2.3	2.5	2.1	---	2.3	7.4	9.0	7.4	---	7.8
Ave.	3.6	4.3	2.6	---	3.5	7.9	10.9	7.6	---	8.8

TABLE 3 (Cont.)

of Seeding														
July 1 Band Corn					July 1 Broadcast and Alfalfa					Average				
7	14	21	28	Ave.	7	14	21	28	Ave.	7	14	21	28	Ave.
5.8	10.7	8.6	6.4	7.9	2.2	7.6	5.0	6.1	5.2	5.3	9.3	6.1	5.4	6.5
4.6	9.8	8.4	--	7.5	3.2	8.2	8.9	--	6.7	4.4	7.4	6.7	--	6.1
5.2	10.2	8.5	--	8.0	2.7	7.9	7.0	--	5.9	4.8	8.4	6.4	--	6.5

TABLE 4

EFFECT OF DISTANCE BETWEEN THE SEEDED SPECIES AND THE CORN ROW, THE WIDTH OF CORN ROW, AND TIME AND METHOD OF SEEDING ON THE ESTABLISHMENT OF SPECIES AS RATED(1) FROM 0 - 100

Time and Method of Seeding	Inches between Corn and Species	Alfalfa			Red Clover			Sweet Clover		
		Corn row width								
		42	56	Ave.	42	56	Ave.	42	56	Ave.
June 10	7	5.2	11.8	8.5	23.6	12.9	18.2	0.8	2.1	1.4
Band	14	5.0	16.4	10.7	25.0	21.7	23.4	5.4	2.7	4.0
and	21	5.4	12.7	9.0	18.4	16.7	17.6	2.5	3.1	2.8
press	28	--	8.8	--	--	15.0	--	--	6.7	--
wheels	Ave.	5.2	12.4	8.8(2)	22.3	16.6	19.4	2.9	3.6	3.2
June 22	7	15.8	30.4	23.1	27.4	14.8	21.1	0.6	0.0	0.3
Band	14	23.6	35.0	29.3	38.8	30.4	34.6	4.0	2.1	3.0
and	21	25.0	28.4	26.7	32.1	35.6	33.8	5.8	1.4	3.6
press	28	--	29.2	--	--	38.8	--	--	8.3	--
wheels	Ave.	21.4	30.8	26.1	32.7	29.9	31.3	3.5	3.0	3.2
July 1	7	14.7	8.8	11.8	13.3	14.6	14.0	5.2	3.3	4.2
	14	37.9	27.2	32.6	32.1	21.9	27.0	8.1	11.9	10.0
Band	21	29.2	32.5	30.8	38.7	26.9	32.8	11.6	21.7	16.6
	28	--	38.6	--	--	29.6	--	--	27.1	--
	Ave.	27.2	26.8	27.0	28.0	23.2	25.6	8.3	16.0	12.2
July 1	7	10.5	9.3	9.9	15.2	2.5	8.8	3.6	0.0	1.8
	14	26.8	21.2	24.0	27.4	8.6	18.0	7.3	0.6	4.0
Broad-	21	28.8	26.8	27.8	35.0	19.2	27.1	7.5	3.8	5.6
cast	28	--	29.2	--	--	20.4	--	--	6.0	--
	Ave.	22.0	21.6	21.8	25.8	12.6	19.2	6.1	2.6	4.4
Average	7	11.6	15.1	13.4	19.9	11.2	15.6	2.6	1.4	2.0
	14	23.3	25.0	24.2	30.8	20.6	25.7	6.2	4.3	5.2
	21	22.1	25.1	23.6	31.0	24.6	27.8	6.8	7.5	7.2
	28	--	26.4	--	--	26.0	--	--	12.0	--
	Ave.	19.0	22.9	21.0	27.2	20.6	23.9	5.2	6.3	5.8

(1) Average ratings were made the last of September.
Ratings: Poor 0 - 20 Fair 21 - 40 Good 41 - 60

(2) Average ratings of species in 42- and 56-inch row width includes

TABLE 4 (Cont.)

Hairy Vetch			Domestic Ryegrass			Field Bromegrass			Average		
in			inches								
42	56	Ave.	42	56	Ave.	42	56	Ave.	42	56	Total
2.5	9.0	5.8	25.5	21.6	25.8	24.4	16.8	20.6	13.7	12.4	13.0
2.1	10.4	6.2	32.1	36.2	34.2	16.2	26.4	21.3	14.3	19.0	16.6
3.4	10.4	6.9	37.9	44.4	41.2	8.0	27.5	17.8	12.6	19.1	15.8
--	9.6	--	--	52.5	--	--	38.4	--	--	21.8	--
2.7	9.8	6.2	31.8	38.7	35.2	16.2	27.3	21.8	13.5	18.1	15.8
13.1	18.3	15.7	30.4	40.9	35.6	16.7	11.7	14.2	17.3	19.4	18.4
17.3	28.5	22.9	49.9	52.6	51.2	42.2	29.9	36.0	29.3	29.8	29.6
14.8	37.2	26.0	61.1	64.2	62.6	51.2	50.2	50.7	31.7	36.2	34.0
--	38.6	--	--	73.4	--	--	62.1	--	--	41.7	--
15.1	30.6	22.8	47.1	57.8	52.4	36.7	38.5	37.6	26.1	31.8	29.0
19.2	24.3	21.8	9.0	6.0	7.5	12.8	12.2	12.5	12.4	11.5	12.0
38.1	39.8	39.0	37.2	27.3	32.2	24.6	29.0	26.8	29.7	26.2	28.0
41.7	52.5	47.1	47.5	59.0	53.2	32.5	54.4	43.4	33.5	41.2	37.4
--	62.9	--	--	67.1	--	--	57.1	--	--	47.1	--
33.0	44.9	39.0	31.2	39.8	35.5	23.3	38.2	30.7	25.2	31.5	28.4
3.6	1.4	2.5	35.4	28.1	31.8	36.7	27.1	31.9	17.5	11.4	14.4
11.7	6.2	9.0	54.6	44.2	49.4	65.3	65.1	65.2	32.2	24.3	28.2
19.6	15.6	17.6	66.1	63.4	64.8	71.9	83.4	77.6	38.2	35.4	36.8
--	17.4	--	--	71.2	--	--	88.3	--	--	38.8	--
11.6	10.2	10.9	52.0	51.7	51.8	57.9	66.0	62.0	29.2	27.5	28.4
9.6	13.2	11.4	25.1	24.2	24.6	22.6	17.0	19.8	15.2	13.7	14.4
17.3	21.2	19.2	43.4	40.1	41.8	37.1	37.6	37.4	26.4	24.8	25.6
19.9	28.9	24.4	53.2	57.8	55.5	40.9	53.9	47.4	29.0	33.0	31.0
--	32.1	--	--	66.0	--	--	61.5	--	--	37.3	--
15.6	23.8	19.7	40.5	47.0	43.8	33.6	42.5	38.0	23.5	27.2	25.4

Very Good 61 - 80 Excellent 81 - 100

ratings 28 inches away from the corn in 56-inch rows.

the corn row, contributing to poorer alfalfa stands in rows 21 and 28 inches away from the corn row as compared to rows 14 inches away from the corn row. Competition from the corn was greatest in rows of alfalfa 7 inches from the corn row. In all cases except when alfalfa was broadcast on July 1, Table 3, alfalfa seedings were strongest and the total combined competition of the weeds and corn was least at a distance of 14 inches from the corn row. Weed competition became less of a problem in all species seeded as the season progressed and the number of cultivations increased.

Stands of Grasses vs. Legumes

Grass ratings were higher in the wide than in the narrow corn rows, Table 4. Both field bromegrass and domestic ryegrass stands became increasingly more dense with increasing distance from the corn rows. For example, in broadcast seedings made on July 1 in the narrow rows, the rating of domestic ryegrass increased progressively from 35.4 to 66.1% as the distance from the corn row increased from 7 to 21 inches; ratings of field bromegrass increased similarly from 36.7 to 71.9%. Although the grasses in rows 21 inches away from the corn row were approximately twice as dense as in rows 7 inches from the corn, those 7 inches from the corn were still satisfactory for good cover. The grasses became established and grew more rapidly than the legumes and suppressed the weed growth more than the legumes.

Considering the average of all treatments, Table 4, stands of alfalfa, sweet clover, hairy vetch, domestic ryegrass, and field

bromegrass stands were superior when interseeded in wide as compared to narrow corn rows. Red clover stands in all cases were superior between the narrow corn rows.

Dates and Methods of Seeding

Poor stands of sweet clover were obtained throughout the experiment as shown in Table 4. The average rating of 5.8 in both narrow and wide rows was the poorest of all seeded species.

The best seedings of alfalfa, red clover, and domestic ryegrass were obtained by band seeding with press wheels on June 22. Ryegrass was almost as good when broadcast seeded on July 1. Hairy vetch was best when band seeded on July 1.

Field bromegrass was superior when broadcast on July 1 giving the highest percentage of ground cover of all treatments in both narrow and wide rows, Figure 2. Domestic ryegrass, however, gave the best average seedings of the experiment, Figure 3. When comparing the two grasses with the two most satisfactory legumes, the grasses gave 83% more ground cover than the two best legumes (red clover and alfalfa) for all dates of seeding and 133% more cover than the two legumes when broadcast seeded on July 1. The grasses broadcast on July 1 gave 98% more cover to the soil than the average of the two best legume seedings (red clover and alfalfa) established by band seeding with press wheels on June 22.

Weed Competition

Weed competition was greatest in the early seedings made on June 10 and decreased progressively when seedings were made on

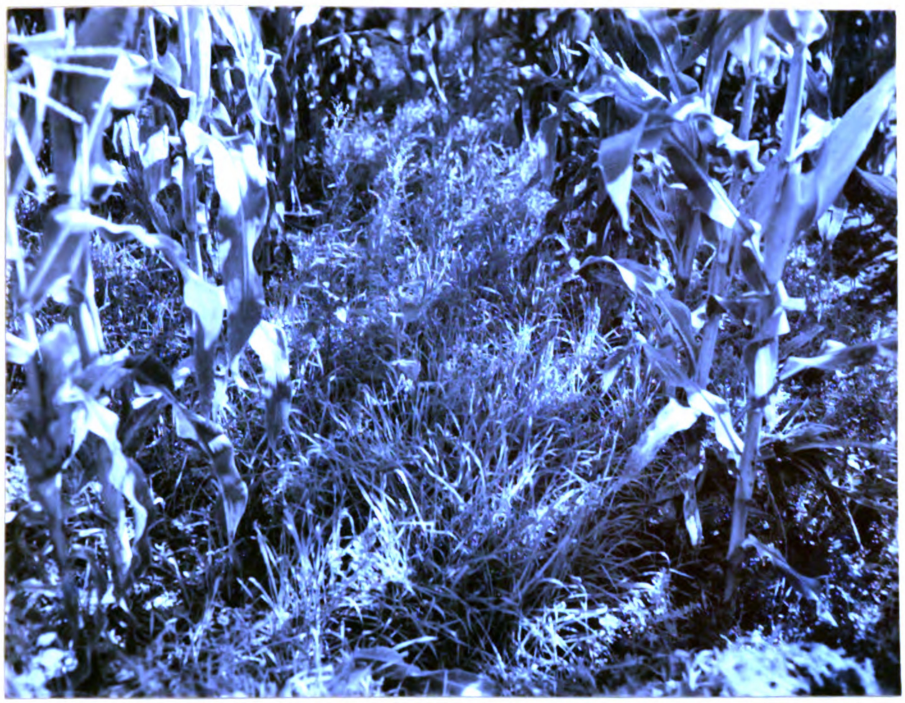

Fig. 2. Field bromegrass broadcast seeded in 56-inch corn rows on July 1. Photographed September 7, 1957.

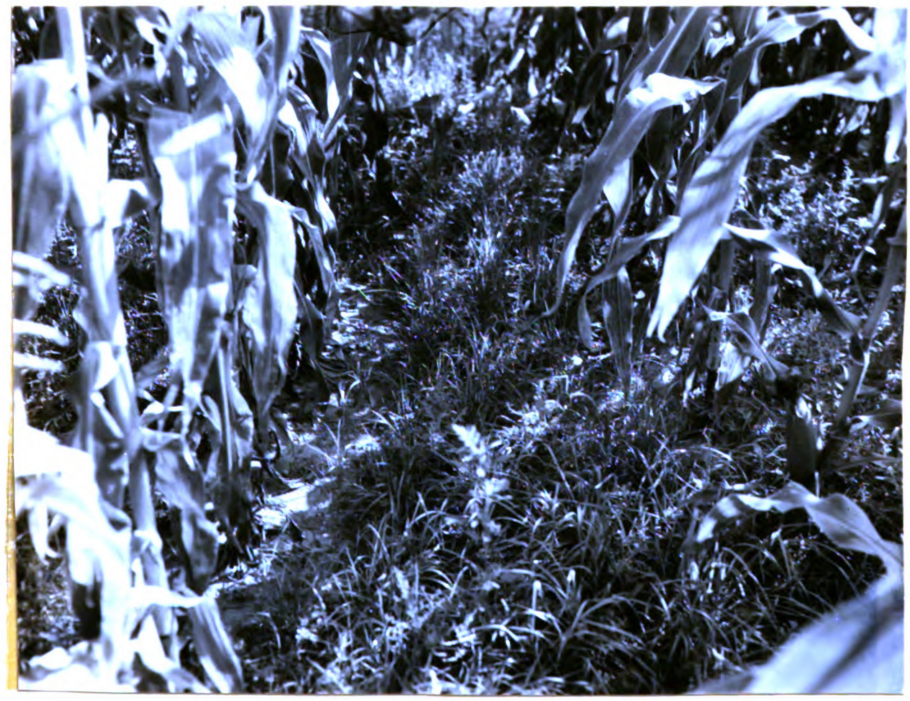

Fig. 3. Domestic ryegrass broadcast seeded in 42-inch corn rows on July 1. Photographed September 7, 1957.

June 22 and July 1, Table 5. Competition from weeds was greater in 56- than in 42-inch corn rows because of the greater amount of moisture and sunlight available to the weeds in the interspaces, Tables 5 and 6. The amount of weeds in alfalfa interseeded on June 10 averaged 830 pounds per acre as compared to 340 pounds when seeded on June 22 and only 100 pounds when seeded on July 1. This weed competition was sufficient to reduce the seedlings of alfalfa seeded on June 10 to 3.5 per square foot, Table 3 and Figure 4. With less weed competition in alfalfa seeded on June 22, the number of alfalfa plants increased to 8.8 plants per square foot, Table 3 and Figure 5. There was very little weed competition in seedings made on July 1, Figure 6. The average density of weeds in all seedings was 68.0 on June 10, 34.3 on June 22, 19.0 where band seeded on July 1, and 17.1 where broadcast seeded on July 1, Table 6, Figures 4, 5 and 6. Since the grasses competed more strongly with the weeds and made more rapid growth than the legumes, there were fewer weeds in the grass seedings than in the legumes.

The average ratings of weeds, ranging from 35.9 to 38.3, were about the same in all treatments where legumes were seeded. Ratings were lower where grasses were interseeded, the ratings for ryegrass and field bromegrass being 30.8 and 27.7, respectively. The more dense cover supplied by the grasses suppressed the weed growth, accounting for 25% more weeds where legumes rather than grasses were seeded.

TABLE 5

AVERAGE DRY WEIGHT OF WEEDS AS AFFECTED BY TIME AND METHOD OF SEEDING AND ROW SPACING OF CORN INTERSEEDED WITH ALFALFA

Row Width, inches	Time and Method of Seeding			Average
	June 10 Band and press wheels	June 22 Band and press wheels	July 1 Band	
	lbs./A.	lbs./A.	lbs./A.	lbs./A.
42	690	270	10	320
56	970	420	200	530
Average	830	340	100	420

TABLE 6

EFFECT OF TIME AND METHOD OF SEEDING AND ROW SPACING ON WEED COMPETITION IN CORN INTERSEEDED WITH VARIOUS SPECIES

Species	Row Width in Inches	Time and Method of Seeding				Average
		June 10 Band and press wheels	June 22 Band and press wheels	July 1 Band	July 1 Broadcast	
Alfalfa	42	69.2	27.5	7.8	8.2	28.2
	56	66.0	44.0	34.2	31.2	43.8
	Ave.	67.6	35.8	21.0	19.8	36.0
Red Clover	42	66.0	26.8	9.2	10.2	28.0
	56	73.0	48.8	23.8	29.2	43.7
	Ave.	69.5	37.8	16.5	19.8	35.9
Sweet Clover	42	62.2	28.8	9.2	7.8	27.0
	56	72.2	51.5	38.8	26.8	47.3
	Ave.	62.7	40.1	24.0	17.2	37.1
Hairy Vetch	42	73.0	31.8	5.8	8.2	29.7
	56	85.2	35.2	27.5	25.2	43.3
	Ave.	79.1	33.5	16.6	16.8	36.5
Annual Ryegrass	42	58.8	18.5	6.8	6.8	22.7
	56	66.2	36.2	29.2	23.8	38.9
	Ave.	62.5	27.4	18.0	15.2	30.8
Field Bromegrass	42	52.8	20.8	8.0	4.8	21.6
	56	64.8	35.2	21.0	14.2	33.8
	Ave.	58.7	28.0	14.5	9.5	27.7
None - (control)	42	66.2	26.2	8.8	12.0	28.3
	56	76.8	48.8	36.2	31.2	48.2
	Ave.	71.5	37.5	22.5	21.6	38.3
Average	42	64.0	25.8	7.9	8.3	26.5
	56	72.0	42.8	30.1	25.9	42.7
	Ave.	68.0	34.3	19.0	17.1	34.6

Ratings from 0 to 100 were made the last of September, 100 most severe.

Ratings: Poor 0-- 20 Fair 21 - 40 Good 41 - 60
Very Good 61 - 80 Excellent 81 - 100

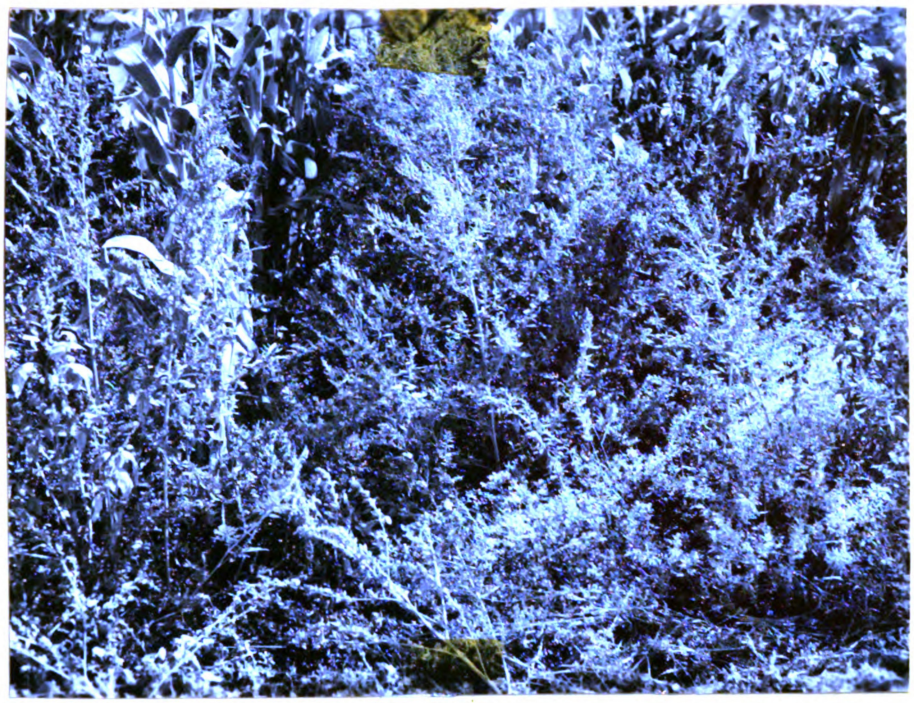

Fig. 4. Alfalfa band seeded with press wheels in 56-inch corn rows on June 10. Photographed September 7, 1957.

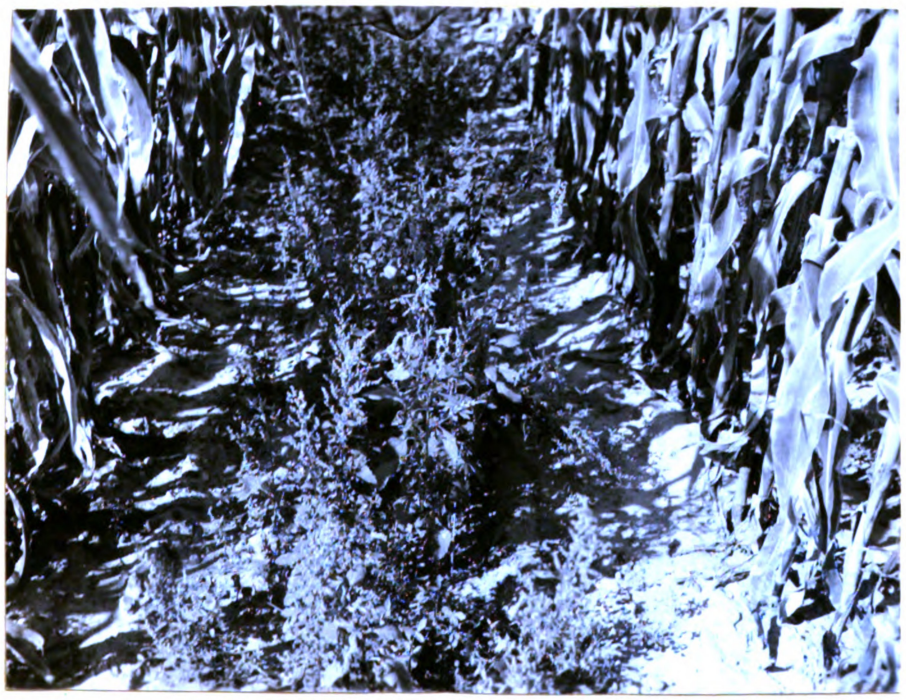

Fig. 5. Alfalfa band seeded with press wheels in 56-inch corn rows on June 22. Photographed September 7, 1957.

Fig. 6. Alfalfa band seeded without press wheels in 42-inch corn rows on July 1. Photographed September 7, 1957.

DISCUSSION

This experiment showed that corn in 56-inch rows yielded less than corn in 42-inch rows as previously reported by Pendleton et al. (6), Stringfield and Haynes (9), and Tesar (11). The 40% decrease, however, is greater than generally reported because of poor distribution and low rainfall during periods of the 1957 cropping season and low water-holding capacity of the soil. This is in agreement with the work of Stringfield and Haynes (9) who report that dry weather affected corn yields more when rows were wider than 50 inches.

Peterson (7), Schaller and Larsen (8), Tesar (11), and others have found that seedings of legumes in corn in wide rows were better than seedings made in narrow rows. Tesar (11) also found that with increasing distance from the corn row, the number of seedlings per square foot increased. This was also generally true in this experiment except when the seedings were subject to severe weed competition. Alfalfa seemed to suffer more from weed competition than did red clover. Red clover was also the only species that did better in the narrow than in the wide corn rows. This may be explained by the recent work of Gist and Mott (2). They found that at 1200 foot candles of light (F. C.), the top growth of red clover slightly exceeded the top growth of alfalfa and that the difference was in favor of red clover at lower light intensities. They found that at the low light intensity of 200 F.C.,

the weight of the tops of red clover was twice that of alfalfa and the weight of the roots was 50% greater than that of alfalfa. High temperatures at high light intensities affected the red clover more than the alfalfa. It is probable that the combination of higher temperature and higher light intensity in the wide corn rows did not provide as favorable a condition for growth of the red clover as the narrow corn rows.

Sweet clover stands were generally poor in all plots. It is not known why sweet clover did not establish well. Stringfield and Haynes (9) report good stands of sweet clover in 63-inch corn row spaces band seeded during the dry June of 1952 near Wooster, Ohio. It is probable that the sweet clover weevil may have severely injured the young seedlings which subsequently died.

Stands of vetch were not quite as good as those of alfalfa or red clover. Vetch produced the best stands when seeded on July 1 by the banding method. Actually the seed was planted about 3/4-inch deep on all dates. This may have been more favorable for its emergence with subsequent early July rains than earlier seedings followed by less rain. Seeding vetch 3/4-inch deep on July 1 was probably superior to broadcasting on this date because the large round seed of vetch would logically be favored by soil coverage during germination.

It is probable that better stands of grasses resulted from broadcasting rather than by band seeding on July 1, because of possible excessive coverage in the latter case, brought about by the early July rains. Moist conditions prevailing in early

July were very favorable for establishing grasses by broadcasting on the surface.

The average ratings of the different species interseeded in corn at both row widths showed that the grasses resulted in better seedings, when measured in percent of ground cover, than did the legumes. Field bromegrass seeded broadcast on July 1 resulted in the best cover of all treatments although domestic ryegrass resulted in the best average cover of all species in both row widths.

The fact that field bromegrass resulted in the best stands when broadcast on July 1 and resulted in a poorer stand when band seeded on July 1 than the stand resulting from ryegrass may indicate that field bromegrass is a more desirable grass for broadcast (surface) seeding than ryegrass. Wide rows gave the best seedings of grass but good seedings were obtained in narrow rows. It appears that either field bromegrass or domestic ryegrass broadcast on July 1 between narrow corn rows, immediately after the last cultivation on the freshly cultivated soil should result in the establishment of a good over-winter cover crop (if subsequent rainfall is adequate) without the risk of greatly reducing corn yields. Admittedly, the heavy rains in July, 1957, were favorable for establishing seedlings by the broadcast method. Without this appreciable rainfall in other years, seedings by broadcasting in July might be inferior to a method in which the seed was compacted in the soil at the same or earlier date of seeding when moisture conditions are usually more favorable for germination and establistment.

If alfalfa or red clover is used as a cover crop, this experiment indicates they should be band seeded with press wheels about June 22. June 10 would probably be a more favorable date of seeding legumes if it were not for greater weed competition when seeded at that date.

SUMMARY AND CONCLUSIONS

Alfalfa, red clover, sweet clover, hairy vetch, domestic ryegrass, and field bromegrass were interseeded in 42- and 56-inch corn rows by band seeding with press wheels on June 10 and 22, band seeding without press wheels on July 1, and broadcast seeding on July 1. The seedings were evaluated as a winter cover crop by ratings of 0 to 100 made in late September.

1. Corn yields were significantly lower in the 56- than in the 42-inch corn rows. Legume and grass seedings were generally better in the 56-inch corn rows except red clover which gave better stands in the 42-inch corn rows.

2. Grasses gave 83% more cover than legumes for all dates of seeding and 133% more cover than legumes when broadcast on July 1.

3. Field bromegrass broadcast on July 1 gave the best seedings of all treatments although domestic ryegrass gave the best average seedings of the experiment. Good grass stands were obtained in narrow corn rows.

4. Alfalfa, red clover, and domestic ryegrass seedings were best when seeded on June 22; ryegrass was almost as good when broadcast on July 1. Field bromegrass and domestic ryegrass averaged 98% more cover when broadcast on July 1 than did the best average seedings of alfalfa and red clover band seeded with press wheels on June 22.

5. The weights of weeds in alfalfa interseeded on June 10 and 22 were 730 and 230% greater, respectively, than when seedings were made on July 1. Weeds were suppressed by the rapid dense growth of field bromegrass and domestic ryegrass, accounting for 25% more weeds in the legume than in the grass seedings.

6. With increasing distance from the corn row, seedings became stronger especially at the later dates of seedings because of less weed competition.

7. In view of the good grass stands obtained in narrow rows by broadcast seeding on July 1 and the reduction in corn yields in 56-inch rows, it can be concluded that broadcast seedings of domestic ryegrass or field bromegrass in narrow-row corn immediately after the last cultivation should provide a stand satisfactory for a good cover crop if moisture conditions are favorable after seeding.

8. Limited results of this one year's experiment indicate that field bromegrass may be superior to domestic ryegrass as a cover crop between normally-spaced corn.

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