AN EVALUATION OF CERTAIN CROPPING SYSTEMS AND SEEDBED PREPARATIONS FOR WHEAT AND THREE SUMMER LEGUMES

By

DALE MONROE FAIN

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Oklahoma State University

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AN EVALUATION OF CERTAIN CROPPING SYSTEMS AND SEEDBED PREPARATIONS FOR WHEAT AND THREE SUMMER LEGUMES

Thesis Approved:

Ralph S. Matlock
Thesis Advisor

Billy B. Tucker

Robert MacVicar
Dean of the Graduate School

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INTRODUCTION

There is currently more interest in tillage practices than ever before. Researchers are trying to find faster, lower cost methods of preparing seedbeds that will increase water intake in the soil and reduce run-off and erosion. Considerable research effort is being expended to determine the best tillage methods for a given area.

Stubble-mulch farming originated in the arid and semi-arid regions of Northwestern United States, but the idea is now being used in the semi-humid regions of Central United States. With stubble-mulch farming, the tillage is done beneath the surface and the residue of the previous crop is left on the surface of the soil. The crop residue, made up of the stubble plus other parts of previous crops, forms a mulch.

Minimum tillage is another type of farming that is now being practiced primarily in the sub-humid and humid regions of Northeastern United States. Minimum tillage is the least amount of tillage necessary to prepare the soil to insure quick germination and a good crop stand.

In the more humid regions of the United States, minimum tillage is generally accomplished by plowing and planting in one operation. Because of the varied rainfall in Oklahoma, this would not always be possible.

A tillage method where crop residue can be left on the soil surface and crops can be planted and cultivated is needed in this region.

The objectives of this study were to evaluate the performance of four crops grown alone and wheat double cropped with three legumes on both the minimum and conventional seedbed.

LITERATURE REVIEW

Research has shown that excessive seedbed preparation can cause soil erosion, soil compaction, and undue loss of soil moisture (2, 15, 21). [1]

Lowdermilk (17) stated that "Leaving crop litter, which is sometimes called stubble-mulch or crop residue, at the ground surface in farming operations is one of the most significant contributions to American agriculture."

Stubble-mulching has become increasingly important in arid and semi-arid regions of the United States where drouth and erosion are always problems. Mathews (18) estimated that the acreage of stubble-mulch fallow in the Northern Great Plains has increased because subsequent yields have been about equal to those after plowed fallow. The stubble-mulch method leaves stubble and trash on the surface to control drifting on soils that are inclined to blow. He further concluded that the nature of the preceding crop and subsequent tillage operation had an influence on the amount of soil blowing.

Zingg (24) concluded that one of the primary functions of stubble-mulching was to decrease the force of the wind on the soil.

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[1] Figures in parenthesis refer to Literature Cited.

Duley and Russel (8) have shown that soil mulched with four tons of straw per acre developed a more desirable granular structure one year after application than soil identically treated, but without mulch. Stephenson and Schuster (23) measured soil aggregation on mulched and bare plots, and after three years found the mulched plots had a more stable structure.

The application of mulch to the soil surface increased the moisture content of the soil according to Alderfer and Merkle (1) and numerous other investigators (4, 6, 8, 10). Ellison (10) indicated that greater infiltration and lower evaporation rates resulted under mulch because soil surface residues tend to receive the direct impact of raindrops, thus lessening splash and providing a roughness obstacle to the flow of water over the surface.

The immediate surface of unmulched plots dries faster than the immediate surface under a mulch for a period following precipitation according to Zingg and Whitfield (25). However, after a period of time the diffusion process of the moisture transferred to the surface may occur at a greater rate or for a longer period of time on mulched than on plowed plots. This may account for the results obtained by workers (6, 7, 11, 21) that found the moisture content of the soil at planting time did not vary much between plowed and stubble-mulched ground.

McCalla (19) reported that both surface and soil organic matter provided soil conditions favorable for the intake of water. Undecomposed residues on the surface afforded protection to the soil by preventing surface sealing.

McCalla and Duley (20) concluded that soil temperatures were reduced considerably by applications of large amounts of crop residues to the soil surface. When the residue from the preceding crop was allowed to remain on the surface, the temperature was reduced slightly but not enough to influence the growth of plants. Larson (15) reported that stubble-mulching in the humid regions of the United States generally reduced yields resulting from the lower soil temperature. This was especially true in the corn belt region where the reduced soil temperature prolonged the emergence and growth of spring planted crops.

McCalla (19) showed that the rate of decomposition of crop residues was very important in the development and maintenance of soil structure and the production of available nutrients, especially nitrogen. From similar experiments dealing with nitrogen availability, Larson (15) reported that frequent plowing increased nitrogen uptake. Nitrogen availability was largely related to microbial activity. Microorganisms that favor a cool, moist condition, such as earthworms and nematodes, were frequently more numerous in stubble-mulched soils according to Larson (15). The evidence indicated that mulches on the soil surface favored decomposition products that are inhibitory to plant growth (15).

Larson (15) and other research workers (2, 23, 25) have shown that carbonaceous residues on the surface tend to slow down and tie-up the release of soil nitrates in comparison with residues that were plowed under. Therefore, nitrogen must be added for maximum yields when practicing stubble-mulch farming. Larson (15) stated that potassium appeared to be the only other soil nutrient behaving as nitrogen did above.

McCalla (19) indicated that more available phosphates were concentrated near the surface on stubble-mulched plots than on plowed plots. The additional concentration of available phosphorus should produce faster seedling growth and root development on stubble-mulch soils (19). Other experimenters (1, 21) have indicated that crop residues on the soil surface had little effect on the availability of plant nutrients of secondary importance.

Schaller and Evans (21) stated that soil tilth and aeration were important factors affecting crop yields under mulch tillage but were difficult to measure and evaluate. In general, they varied in importance with soil type, seasonal conditions and tillage technique. Fine-textured soils, soils with poor natural structure, and inferior drainage gave the most trouble; and cool, wet seasons accentuated the aeration problems (21).

The weed problem was greater in the humid than in the dry areas according to Zingg and Whitfield (25). They suggested that chemicals offer possibilities for more weed control in the future.

That surface mulch of plant residue may harbor insects and increase insect damage to the crops is a common criticism, but this has not been so in experiments conducted in the Southern High Plains according to Johnson (14). Zingg and Whitfield (25) summarized data obtained at 16 different locations in the Western United States and concluded that only one location reported insect and plant disease problems attributable directly to subsurface tillage.

Carter and McDole (4) mentioned that a plow with the moldboards removed was the first piece of equipment used in practicing stubble-mulching. Since that time various implements have been used. Jacks et al. (13) reported that implements required for stubble-mulching vary with local conditions, but the most common one used today is the sweep machine. Small sweeps were used first, followed by the large sweeps which have proven to give the best results according to Zingg and Whitfield (25).

The minimum tillage concept of farming has been developed in the more humid areas of the United States for production of crops and conservation of soil and water. With minimum tillage, more rainwater goes in the soil, erosion is reduced, expense and labor are held to a minimum, and weed control is made easier according to Cook et al. (5).

Various experiments have been conducted to determine the effects of minimum tillage in the Eastern States. Bowers and Bateman (2) stated that obtaining a good plant population is the key to successful minimum tillage planting. Any method that provides a seedbed which will promote good germination and stand should produce yields equal to those in conventional planting (2). In the corn belt region, this is done with a moldboard plow alone, or with a moldboard plow with a light smoothing implement attached.

Four basic minimum tillage treatments have been compared with conventional seedbed preparation in the experiments conducted in the corn belt according to Bowers and Bateman (2). These included the plow-plant in one operation, plow and plant using two operations, plow and then plant in the press or tractor wheel, and plow pulling a light tillage tool (e.g. clodbuster, harrow, or rotary hoe section) and then plant. Bowers and Bateman (2) concluded that for each method tested, corn yields were as good as those for the conventional tillage. There was a slight reduction in plant population, but not a significant amount.

Various minimum tillage experiments (2, 15, 16) have been conducted in the midwestern and eastern states in recent years. The results indicated the following: (1) Moisture at planting time was very important in a minimum tillage operation. (2) The first year of minimum tillage is the most difficult in preparing seedbeds. (3) Farmers must determine which minimum tillage technique works best for his own situation.

From experiments comparing minimum tillage and stubble-mulching, Larson et al. (16) made the following pertinent conclusions:

(1) Stubble-mulching is an excellent erosion control practice. It works best on medium and coarse textured soils that are well drained. Various plant nutrients may need to be added, depending on the climate. Also, special machines are needed, but many kinds are now available and stubble-mulching usually reduces cost.

(2) Conventional machinery has been largely used for minimum tillage methods. Some of the disking, harrowing, and cultivating operations are eliminated and cost are reduced. Overworked soil and soil compaction are

avoided. This results in improved soil tilth and reduces erosion. If the moldboard plow is used, planting should be done right after plowing. Minimum tillage systems are best adapted to medium-textured soils where clods break up easily.

The conservation of soil moisture and the improvement of soil conditions may lead to a more complete utilization of farming land. The use of double cropping may become more significant to farming operations in the future.

The amount of soil moisture in late June is often a critical factor in the success of planting summer legumes after wheat. The usual practices of preparing the seedbed result in a rapid loss of moisture in the top few inches of soil.

Brim et al. (3) stated that if soil moisture level can be maintained, double cropping will generally produce good yields. From experiments conducted in North Carolina, Brim et al. (3) reported that mulch tillage can be used successfully in obtaining stands of soybeans after wheat, even under adverse weather conditions. The experiments also showed that the late planting of soybeans had very little effect on the final outcome of the crop. The yields for both wheat and summer legumes were as high as when these crops were each grown alone.

Hartwig (12) reported that when practicing double cropping in the Delta region, it is necessary to burn the heavy wheat straw so the soybeans can be cultivated. This practice is not recommended in Oklahoma and more efficient use of chemicals and cultivators that will operate in trashy seedbeds may help remove the necessity for burning straw.

From results obtained on tillage practices in sub-humid regions of Oklahoma, Daniel (6) concluded that cropping systems must be found that will survive during drouths as well as periods of abundant rainfall. Because of variable rainfall, experiments were conducted in Northwestern Oklahoma to compare stubble-mulching with plowing, basin-listing, and one-waying (6). Run-off and erosion were reduced by the practice of stubble-mulching according to Daniel et al. (7). The yields on the stubble-mulch area were equal to those for the other seedbed operations when nitrogen was added, but were lower on the stubble-mulch areas without nitrogen.

Experiments were conducted in North Central Oklahoma in which four methods of primary tillage for winter wheat were compared. The tillage methods were principally the same as those used in Northwestern Oklahoma. Harper (11) surmised from these experiments that plowing gave the best wheat yields in most cases, but that the wheat plots subtilled by sweeps gave significantly higher results than the basin-listed or one-wayed land.

Harper (11) reported that there was a greater tendency for plant nutrients to accumulate in the zero to three inch layer of the subtilled plots than in the plowed plots. He further concluded that there was no appreciable difference in the quantity of moisture for fall planting in the first, second, or third foot of soil on the different tillage areas.

MATERIALS AND METHODS

This study was conducted on the Paradise Agronomy Research Farm near Coyle, Oklahoma. The land area consisted of nine acres of Norge fine sandy loam soil with approximately two percent slope. The data for this study were collected from November 15, 1958 to November 27, 1959.

A randomized block design with three replications for each treatment was used. Each replication contained 16 plots each 53 by 120 feet in size. A 20-foot border between ranges was used to simplify the turning and movement of equipment when preparing and planting the seedbed. Eight of the 16 plots had conventional seedbed preparation and 8 had minimum seedbed preparation. Conventional seedbed preparation in this paper refers to the usual method of plowing, disking, and planting. Minimum seedbed preparation in this paper consists of using a multiple sweep in the fall of 1958 and an 8-foot sweep in 1959 (Figure I). The sweep was designed for subtillage to kill vegetation with minimum disturbance to the surface.

Treatment numbers 4 and 5 were in continuous wheat and planted in the conventional seedbed. Numbers 12 and 13 were also continuous wheat, but planted in a seedbed with minimum tillage. Plots 5 and 13

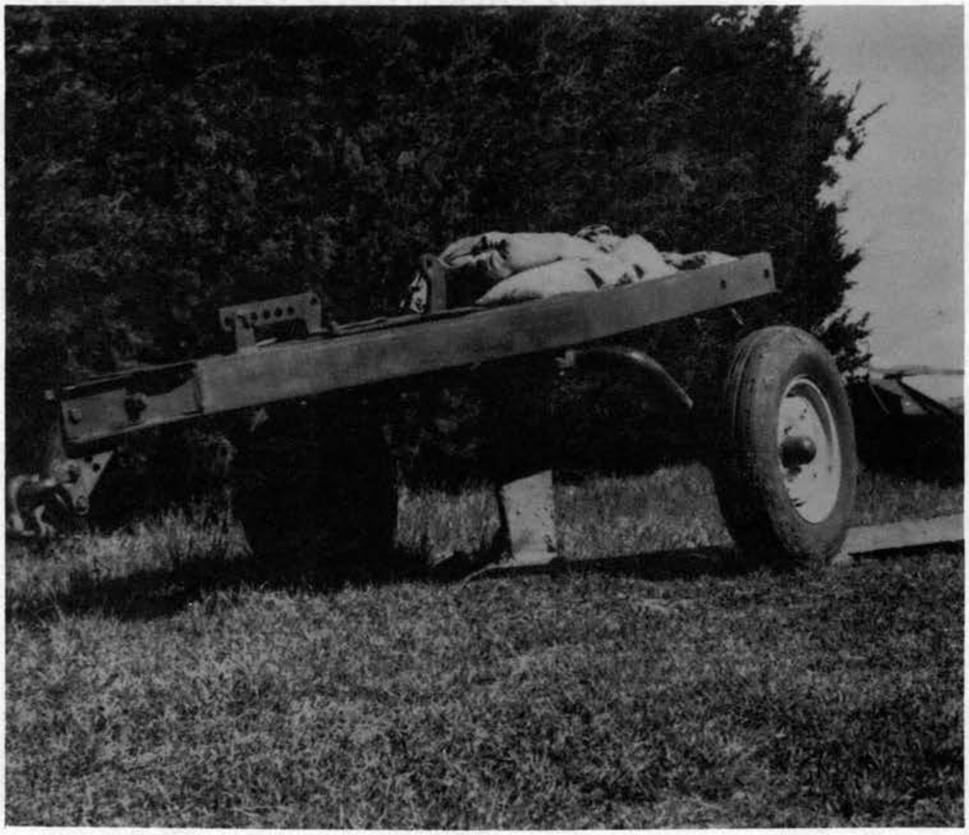

Figure 1. Eight-foot sweep machine used for minimum seedbed preparation in 1959.

received 40 pounds of nitrogen applied as a topdress while 4 and 12 did not. Treatments 1, 2, 3, 9, 10, and 11 were in continuous legumes with 1, 2, and 3 planted on the conventional seedbed and 9, 10, and 11 planted on the minimum tilled seedbed. Treatments 6, 7, 8, and 14, 15, and 16 contain wheat followed by a legume with the former three planted in a conventional seedbed and the latter three in a minimum tilled seedbed.

The dates for the various tillage, seeding, and cultivation operations for each treatment in this study are shown in Table I.

The crops and varieties used in this study include Ponca wheat, Lee soybeans, Brabham cowpeas, and Kiloga mungbeans.

The wheat was seeded with a disk-type grain drill with a 7-inch spacin equipped with a fertilizer attachment. Superphosphate was applied on the six double crop and four continuous wheat treatments at the rate of 300 and 100 pounds per acre, respectively, at seeding time.

On February 25, continuous wheat treatment numbers 5 and 13 were topdressed with 120 pounds of ammonium nitrate per acre. Each of the six summer legume treatment numbers 6, 7, 8, 14, 15, and 16 in the double crop study were sidedressed with 80 pounds of 13-39-0 per acre on August 3.

An application of 2,4-D (2,4-dichlorophenoxy acetic acid) was made on May 2 at the rate of 1/4 pound of amine per acre on the minimum tilled, continuous legume treatment numbers 9, 10, and 11 for control of evening primrose. On May 12, it was estimated that 90 percent of the evening primrose was killed. Dalapon (2,2-dichloropropionic acid) was applied at the rate of 10 pounds per acre to the

FOR EACH TREATMENT FROM NOVEMBER 15, 1958 TO NOVEMBER 27, 1959

KEY		1958				1959					
NO.	TREATMENT	PLOW	SWEEP	DISK	SEEDING	PLOW	SWEEP	DISK	SEEDING	CULT.	R. HOE
CONVENTIONAL SEEDBED PREPARATION											
4	wheat-no nitrogen	11/15		11/15	11/19	11/25 6/23		6/23			7/6
5	wheat-nitrogen	11/15		11/15	11/19	11/25 6/23		6/23			7/6
8	wheat+soybeans	11/15		11/15	11/19	11/25 6/23		6/23	6/22	7/25	7/6
7	wheat+cowpeas	11/15		11/15	11/19	11/25 6/23		6/23	6/22	7/25	7/6
6	wheat+mungbeans	11/15		11/15	11/19	11/25 6/23		6/23	6/22	7/25	7/6
3	continuous soybeans					4/13		5/25 6/9	6/9	6/26	7/6
2	continuous cowpeas					4/13		5/25 6/9	6/9	6/26	7/6
1	continuous mungbeans					4/13		5/25 6/9	6/9	6/25	7/6
MINIMUM SEEDBED PREPARATION											
12	wheat-no nitrogen		11/17		11/19		11/27 6/23				
13	wheat-nitrogen		11/17		11/19		11/27 6/23				
16	wheat+soybeans		11/17		11/19		11/27 6/23		6/23	7/25	
15	wheat+cowpeas		11/17		11/19		11/27 6/23		6/23	7/25	
14	wheat+mungbeans		11/17		11/19		11/27 6/23		7/10* 6/23	7/25	
11	continuous soybeans						11/27 6/8		6/10	6/26	
10	continuous cowpeas						11/27 6/8		6/10	6/26	
9	continuous mungbeans						11/27 6/8		6/10	6/26	

* replanted due to mechanical error in first planting.

continuous wheat treatment numbers 4, 5, 12, and 13 on July 4 for the control of Johnson grass. It was estimated that 80 percent kill resulted. A rotary-type sprayer equipped with a 20-foot boom and mounted on a Ford tractor was used to apply the herbicides. The spray was applied at the rate of 40 gallons of water per acre, using 30 pounds of pressure.

Wheat was harvested on June 12 and yield was determined by harvesting two drill rows 16-foot long from each plot. These two samples were composited and allowed to dry for two weeks and then threshed. Yields were calculated in bushels per acre.

All summer legumes were planted with a two-row, full floating, double-disc planter which was constructed at Oklahoma State University. This planter was constructed to plant in a trashy seedbed. An accurate spacing and covering of the seed was not obtained in all plots because of mechanical difficulties.

The legumes were planted at the rate of four seeds per foot for the cowpeas and mungbeans and eight seeds per foot for the soybeans.

Very poor emergence was obtained for the mungbeans in the minimum tilled, double cropping study because of mechanical difficulty. These plots were replanted, but emergence was three weeks later than that of the other legumes.

The summer legumes were harvested for forage on September 12 when most of the pods were two-thirds filled and for seed on October 23 when most of the pods had matured. Samples were obtained from two 16-foot sections of each plot to determine the forage and seed yield.

The harvested forage was weighted and then a sample was oven-dried in a forced air oven at 140 degrees Fahrenheit for 48 hours to determine the percentage of dry matter.

Statistical analysis and multiple range tests were calculated as outlined by Snedecor (22) and Duncan (9).

RESULTS AND DISCUSSION

Results are shown for the 16 plots comparing total mean wheat plus legume yields, the mean wheat yields, and mean legume yields from both the conventional and minimum tilled plots. The mean yields of the wheat with and without nitrogen in the conventional and minimum tilled seedbeds are shown. A discussion of observation notes and the forage yield obtained from one replication is presented.

The analysis of variance and multiple range test for total mean seed yields are shown in Tables II and III. The total yields for the wheat plus legumes from the conventional tilled plots ranged from 28.8 to 31.5 bushels per acre. The wheat plus legumes yields were more variable on minimum tilled plots ranging from 21.2 to 30.2 bushels per acre. The mean yields for the wheat plus each of three legumes on conventional tilled, and the wheat plus each of the three legumes on the minimum tilled did not differ significantly at the 1% level and at the 5% level, except that the wheat plus mungbeans on the minimum tilled plot had a significantly lower yield. The replanting and poor stand in the mungbean plots caused this poor yield.

The mean yields for wheat from minimum tillage were consistently 1.5 to 3.5 bushels per acre lower than the conventional tilled, but the

TABLE II

ANALYSIS OF VARIANCE FOR TOTAL YIELD IN BUSHELS PER ACRE FOR WHEAT AND LEGUMES

Source of Variation	D. F.	Sum of squares	Mean square	F Value
Total	47	1684.06		
Replications	2	6.12	3.06	.17
Treatments	15	1129.79	75.32	4.12**
Error	30	548.15	18.27	

** Indicates significance at the 1% level.

C. V. = 9.8%

TABLE III

MULTIPLE RANGE TEST FOR TOTAL WHEAT AND LEGUME YIELDS IN BUSHELS PER ACRE, PARADISE AGRONOMY RESEARCH FARM, 1959.

No.	Treatment [1]	Total Mean Yield	Mean Wheat Yield	Mean Legume Yield	Total Wheat Yield Multiple Range [2] 5%	1%
8	C. T. wheat+soybeans	31.5	18.3	13.2		
16	M. T. wheat+soybeans	30.2	16.8	13.4		
7	C. T. wheat+cowpeas	29.2	19.2	10.0		
6	C. T. wheat+mungbeans	28.8	18.6	10.2		
15	M. T. wheat+cowpeas	26.4	15.7	10.7		
3	C. T. conti-soybeans	22.1				
5	C. T. wheat-nitrogen	22.1				
13	M. T. wheat-nitrogen	22.0				
14	M. T. wheat+mungbeans	21.2	16.3	4.9		
11	M. T. conti-soybeans	20.7				
4	C. T. wheat-no nitrogen	19.9				
12	M. T. wheat-no nitrogen	16.6				
2	C. T. conti-cowpeas	14.7				
10	M. T. conti-cowpeas	14.5				
9	M. T. conti-mungbeans	14.1				
1	C. T. conti-mungbeans	14.0				

[1] C. T. = Conventional Tilled. M. T. = Minimum Tilled.

[2] Any two means paralleled by the same line are not significantly different.

difference was not significant. The continuous legume yields for the soybean, cowpea, and mungbean treatments ranged from 14.0 to 22.1 bushels per acre, but did not differ significantly at the 1% level.

Mean wheat yields ranged from 15.7 to 22.1 bushels per acre (Table V). The continuous wheat plots with nitrogen added averaged 3.8 bushels per acre or 17% more than the continuous wheat with no nitrogen added. When nitrogen was added, the conventional and minimum tilled continuous wheat yields were 22.0 and 22.1 bushels per acre. When no nitrogen was added, however, the conventional tilled plots were higher than the minimum tilled plots. Conventional tilled continuous wheat with no nitrogen averaged 3.3 or 17% more than the minimum tilled continuous wheat. This was a significant difference at the 1% level. These results agree with those obtained by Larson (15). The mean yield from the 10 treatments with wheat differed significantly with the primary difference between the conventional and minimum tilled plots without 40 pounds of nitrogen (Table V). Analysis of variance and multiple range test for mean wheat yields are shown in Tables IV and V.

The soybeans averaged 6.8 to 7.3 bushels per acre more than the mungbeans and cowpeas (Table VII). The soybeans were significantly higher in yield at the 1% level than the cowpeas and mungbeans. The mean yield of cowpeas, mungbeans, and soybeans in the continuous legume and double crop study did not differ significantly between the minimum and conventional tilled plots for each legume, except for the replanted mungbean minimum tilled plots which had a poor stand. Analysis of variance and

TABLE IV

ANALYSIS OF VARIANCE FOR WHEAT YIELDS IN BUSHELS PER ACRE, PARADISE AGRONOMY RESEARCH FARM, 1959.

Source of Variation	D.F.	Sum of squares	Mean square	F Value
Total	29	169.27		
Replications	2	6.16	3.08	2.54
Treatments	9	141.28	15.70	12.97**
Error	18	21.83	1.21	

** Indicates significance at the 1% level.

C.V. = 5.9%

TABLE V

MULTIPLE RANGE TEST FOR MEAN WHEAT YIELD IN BUSHELS PER ACRE, PARADISE AGRONOMY RESEARCH FARM, 1959.

No.	Treatment [1]	Mean Yield	Multiple 5%					Range [2] 1%				
5	C. T. wheat-nitrogen	22.1	│					│				
13	M. T. wheat-nitrogen	22.0	│					│				
4	C. T. wheat-no nitrogen	19.9		│				│	│			
7	C. T. wheat-cowpeas	19.2		│	│				│	│		
6	C. T. wheat-mungbeans	18.6		│	│	│			│	│	│	
8	C. T. wheat-soybeans	18.3		│	│	│			│	│	│	
16	M. T. wheat-soybeans	16.8			│	│	│			│	│	│
12	M. T. wheat-no nitrogen	16.6				│	│			│	│	│
14	M. T. wheat-mungbeans	16.3					│				│	│
15	M. T. wheat-cowpeas	15.7					│					│

[1] C. T. = Conventional Tilled. M. T. = Minimum Tilled.

[2] Any two means paralleled by the same line are not significantly different.

multiple range test for mean legume yields are shown in Tables VI and VII.

Johnson grass was noted on almost all plots in July. It was especially bad on plots 4, 5, 12, and 13 where continuous wheat was grown. More pigweed plants were observed in treatments of 14 and 15 and the continuous wheat plots than in the other plots, but some occurred on most all plots. The conventional tilled plots were rotary hoed and cultivated, whereas the minimum tilled plots were only cultivated. Dalapon was sprayed on the continuous wheat plots in July to control Johnson grass. Because of the toxic effect of Dalapon on legumes, cultivation and hoeing were used on the rest of the plots.

Rainfall in 1959 probably caused weeds to be a bigger problem than might be expected in drier years. The amount of rainfall by 10-day intervals is shown in Appendix Table I. These data show that 14 out of 26 ten-day intervals between wheat planting and harvest had less than 0.5 inches of rainfall. The rainfall was favorable for summer legumes, but 7 out of 18 ten-day intervals between May 31 and November 26 had less than 0.5 inches of rainfall.

There was no significant difference among the mean percentages of dry matter for the forage of the summer legumes (Appendix Table III). Though no statistical analysis was made for the pounds of dry matter per acre, it was interesting to note that a slight increase in forage was found on the conventional tilled continuous legume plots.

TABLE VI

ANALYSIS OF VARIANCE FOR SUMMER LEGUME YIELDS
IN BUSHELS PER ACRE,
PARADISE AGRONOMY RESEARCH FARM, 1959.

Source of Variation	D. F.	Sum of squares	Mean square	F Value
Total	35	733.13		
Replications	2	8.22	4.11	3.80
Treatments	11	701.20	63.74	59.02**
Error	22	23.71	1.08	

** Indicates significance at the 1% level.

C. V. = 7.7%

TABLE VII

MULTIPLE RANGE TEST FOR SUMMER LEGUMES YIELD IN BUSHELS PER ACRE, PARADISE AGRONOMY RESEARCH FARM, 1959.

No.	Treatment /1	Mean Yield	Multiple 5%	Range /2 1%
3	C. T. conti-soybeans	22.1		
11	M. T. conti-soybeans	20.8		
2	C. T. conti-cowpeas	14.7		
10	M. T. conti-cowpeas	14.5		
9	M. T. conti-mungbeans	14.1		
1	C. T. conti-mungbeans	14.0		
16	M. T. wheat-soybeans	13.4		
8	C. T. wheat-soybeans	13.2		
15	M. T. wheat-cowpeas	10.7		
6	C. T. wheat-mungbeans	10.2		
7	C. T. wheat-cowpeas	10.0		
14	M. T. wheat-mungbeans	4.9		

/1 C. T. = Conventional Tilled. M. T. = Minimum Tilled

/2 Any two means paralleled by the same line are not significantly different.

SUMMARY AND CONCLUSIONS

This study involved the evaluation of certain cropping systems and seedbed preparations for wheat and three summer legumes at the Paradise Agronomy Research Farm between November, 1958 and November, 1959.

The objectives of the study were to compare the performance of wheat and three legume crops used in a double cropping system with a single crop in both a clean and minimum tilled seedbed grown on a Norge fine sandy loam soil.

Wheat was sown in November, 1958 on all plots except the continuous legume plots. The continuous summer legumes were planted in early June. All wheat plots were harvested in late June, 1959. In early July, 1959, summer legumes were planted on double crop treatments 6, 7, 8, 14, 15, and 16. Seed yields for summer legumes were obtained during October, 1959. Ponca wheat was seeded at the rate of one bushel per acre on all plots except the continuous legume plots on November 28, 1959.

The mean total yields obtained from the 16 treatments ranged from 14.0 to 31.5 bushels per acre. The total mean yields of wheat plus legume were 5.2 to 17.5 bushels higher than the wheat, soybean, cowpea, and mungbean crops grown alone, except for the wheat plus mungbean on the minimum tilled plot where a poor stand was obtained for the mungbeans. The wheat plus legumes mean yields were more variable on the minimum tilled than for the conventional tilled plots. However, the means were not significant at the 1% level and the 5% level except for the yield of the wheat plus mungbeans on the minimum tilled plots. The continuous wheat and continuous legumes mean yields ranged from 14.0 to 22.1 bushels per acre.

Wheat yields ranged from 15.7 to 22.1 bushels per acre. When 40 pounds of nitrogen was added as a topdress, the yields of the minimum and conventional tilled plots were the same. With no nitrogen, the conventional tilled continuous wheat averaged 3.3 bushels per acre or 17% more than the minimum tilled continuous wheat.

The legumes mean yields ranged from 4.9 to 22.1 bushels per acre. The yield of the mungbeans and cowpeas did not differ appreciably, but the soybeans averaged a significant 6.8 to 7.3 bushels more per acre than the mungbeans and cowpeas. Where stand was not a problem, the yield of the three legumes on both the continuous legumes and the double crop plots did not differ significantly between the minimum and conventional tilled plots.

Pigweed and Johnson grass population was higher on the continuous wheat plots than the double crop or continuous legume plots.

There was no significant difference for the mean percentages of dry matter for the summer legumes.

Though good yields were obtained for the summer legumes, it was interesting to note that 7 out of 18 ten-day intervals between May 31 and November 26 had less than 0.5 inches of rainfall.

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APPENDIX

APPENDIX TABLE I

RAINFALL AT PARADISE, OKLAHOMA,
JANUARY 1, 1958 TO DECEMBER 31, 1959

	1958	1959
Jan. 1-10	-	-
Jan. 11-20	1.70	.11
Jan. 21-31	.03	.64
Jan. 31-Feb. 9	.38	.63
Feb. 10-19	.26	-
Feb. 20-Mar. 1	.22	-
Mar. 2-11	1.76	.06
Mar. 12-21	.99	2.35
Mar. 22-31	1.91	.61
Apr. 1-10	.30	1.17
Apr. 11-20	2.31	1.85
Apr. 21-30	.19	-
May 1-10	.46	2.97
May 11-20	.39	-
May 21-31	.11	2.51
May 31-June 9	.38	1.23
June 10-19	2.99	.03
June 20-29	3.73	1.36
June 30-July 9	.36	1.65
July 10-19	1.16	3.25
July 20-29	2.16	5.40
July 30-Aug. 8	.39	.68
Aug. 9-18	2.03	-
Aug. 19-28	2.97	-
Aug. 29-Sept. 7	-	4.21
Sept. 8-17	2.57	-
Sept. 18-27	.13	5.14
Sept. 28-Oct. 7	.08	11.12
Oct. 8-17	.63	1.15
Oct. 18-27	.05	-
Oct. 28-Nov. 6	-	1.24
Nov. 7-16	.14	-
Nov. 17-26	.28	-
Nov. 27-Dec. 6	.38	-
Dec. 7-16	.35	.37
Dec. 17-26	-	1.90
Dec. 27-31	.37	.18
TOTAL	32.16	52.15

APPENDIX TABLE II

AVERAGE HEIGHT IN INCHES AT HARVEST

Key No.	Treatment [1]	Wheat	Legumes
4	C. T. wheat-no nitrogen	31	
5	C. T. wheat-nitrogen	35	
8	C. T. wheat-soybeans	30	26
7	C. T. wheat-cowpeas	31	21
6	C. T. wheat-mungbeans	30	20
3	C. T. continuous soybeans		30
2	C. T. continuous cowpeas		24
1	C. T. continuous mungbeans		23
12	M. T. wheat-no nitrogen	28	
13	M. T. wheat-nitrogen	34	
16	M. T. wheat-soybeans	29	22
15	M. T. wheat-cowpeas	27	21
14	M. T. wheat-mungbeans	27	16
11	M. T. continuous soybeans		28
10	M. T. continuous cowpeas		22
9	M. T. continuous mungbeans		23

[1] C. T. = Conventional Tilled. M. T. = Minimum Tilled.

APPENDIX TABLE III

PERCENT DRY MATTER AND MEAN POUNDS OF DRY MATTER PER ACRE FOR SUMMER LEGUMES

Key No.	Treatment /1	Percent Dry Matter	Pounds Dry Matter /2 Per Acre
1	C. T. conti-mungbeans	26.4	1705
2	C. T. conti-cowpeas	26.8	2277
3	C. T. conti-soybeans	27.4	2436
6	C. T. wheat-mungbeans	25.7	1687
7	C. T. wheat-cowpeas	26.3	2047
8	C. T. wheat-soybeans	26.5	2123
9	M. T. conti-mungbeans	27.1	1669
10	M. T. conti-cowpeas	26.3	2025
11	M. T. conti-soybeans	26.9	2012
14	M. T. wheat-mungbeans	24.8	1197
15	M. T. wheat-cowpeas	25.7	1921
16	M. T. wheat-soybeans	26.3	1913

/1 C. T. = Conventional Tilled. M. T. = Minimum Tilled.

/2 Yields from one replication. No statistical analysis.

VITA

Dale M. Fain

Candidate for the Degree of

Master of Science

Thesis: AN EVALUATION OF CERTAIN CROPPING SYSTEMS AND SEEDBED PREPARATIONS FOR WHEAT AND THREE SUMMER LEGUMES

Major Field: Agronomy (Field Crops)

Biographical:

Personal data: Born July 25, 1937 near Snyder, Oklahoma, the son of Jim (deceased) and Jessie Lee Fain.

Education: Attended elementary school and graduated from Snyder High School, Snyder, Oklahoma in 1955. Undergraduate work at Cameron State Agricultural College, Lawton, Oklahoma, 1955-1957; Oklahoma State University, 1957-1959. Graduate study at Oklahoma State University, 1959-1960.

Experience: Born and reared on a farm; worked for Agronomy Department at Oklahoma State University, 1957-1958.

Member of: Agronomy Club and Scabbard and Blade.

Date of Final Examination: May, 1960