

REDUCED TILLAGE FOR MILLET ESTABLISHMENT IN WHEAT STUBBLE

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ABSTRACT

A study was conducted at Carbondale in southern Illinois on an imperfectly drained Stoy silt loam soil (fine-silty, mixed, mesic Aquic Hapludalfs) to determine the feasibility of establishing and producing forage millet in wheat stubble and to evaluate soil moisture regimes. Millet [*Pennisetum americanum* (L) Leche] was planted in wheat stubble in late June using three tillage systems (conventional, minimum and no-till) and three seeding implements (Allis Chalmers No-Till Planter, Brillion Seeder and the International Grain Drill). Adequate and well distributed rainfall was essential for good millet establishment and production. Generally, no-till and minimum tillage systems had higher soil moisture levels than conventional tillage. The no-till planter was the only acceptable seeding implement for minimum and no-till systems under limited surface soil moisture conditions. Under conventional tillage, the grain drill was the most suitable planter. Millet can be successfully established in wheat stubble if the proper seeding implement is used.

INTRODUCTION

There is a need for proper conservation measures to reduce soil erosion and water runoff. Farmers are interested in cultural practices that give the greatest profits and at the same time provide adequate soil and water conservation. The use of reduced tillage systems increases crop residues left on the soil surface which aid soil water recharge and help control water and wind erosion (1).

In the past, conventional tillage was considered necessary. However, the concepts regarding tillage requirements for crop production are changing. With the development of effective non-residual herbicides, the need for conventional tillage is being questioned. It is now possible to spray weeds and have a rapid kill, leaving the seedbed free from any residual herbicide activity.

Farmers are using reduced tillage practices to lessen labor and machinery

costs and to increase yields (3, 5, 8). Fewer trips over the field can result in reduced costs and less damage to the soil structure by compaction.

Reduced tillage systems have been studied extensively for row crops such as corn (*Zea mays* L.) and soybeans (*Glycine max* L.) (2, 4). Soybeans have been seeded with no-till planters in standing wheat (*Triticum aestivum* L.) stubble immediately after harvest to take advantage of firm moist soil (4). Thus, no-till has greatly improved the possibility of double cropping by conserving soil moisture and time. No-till double cropping success is increased by (a) an excellent stand of well-fertilized small grain that controls weeds until it is harvested; (b) early removal of the small grain to increase the chance for maturity and increased yield of the second crop; (c) sufficient moisture; and (d) adequate fertility for the second crop.

No-till seeding of forage legumes and grasses into permanent pasture sod without complete seedbed preparation has been successful (6, 7). Stands of red clover (*Trifolium pratense* L.) and tall fescue (*Festuca arundinacea* Schreb.) have been established in wheat stubble with minimum tillage and no-till practices (5). Forages sown in the late summer in wheat stubble enhance winter cover, thereby providing better protection from soil erosion and water runoff.

The objectives of this study were (a) to determine the feasibility of establishing and producing millet [*Pennisetum americanum* (L.) Leche] in wheat stubble immediately after harvest in the latter part of June; (b) to evaluate different seeding implements and tillage systems; and (c) to assess the effects of selected tillage practices on soil moisture regimes.

MATERIALS AND METHODS

The study was conducted at the Agronomy Research Center at Carbondale in southern Illinois on an imperfectly drained Stoy silt loam soil (fine-silty, mixed, mesic Aquic Hapludalfs) during 1979 and 1980. Soil tests indicated that the pH, phosphorus and potassium levels were high, and thus lime and fertilizer materials were not applied to the experimental sites. A broadcast application of 112 kg/ha/N of ammonium nitrate was made each year with a side dressing of 60 kg/ha/N of ammonium nitrate after the first harvest of millet. Wheat was harvested in late June each year of the study and Paraquat (1,1'-dimethyl-4,4'-bipyridinium dichloride) was sprayed on the wheat stubble at the rate of 0.6 kg/ha active ingredient for weed desiccation. The wheat straw residue was about 3.4 metric tons/ha.

The forage millet was seeded at the rate of 20 kg/ha in late June using three tillage systems and three different seeding implements. The tillage systems consisted of the following: (a) conventional tillage — the land was moldboard plowed to turn under the residue from the wheat crop, and subsequently disked and harrowed; (b) minimum tillage — the preparation of the seedbed consisted of two diskings, (c) no-till-no actual tillage was performed, but soil was disturbed as required in the planting operation. The seeding implements used were the Allis Chalmers No-Till Planter, Brillion Seeder, and the International Harvester Grain Drill for each of the three tillage methods. All of the treatments were replicated four times in a split plot experimental design. The sub-plots were 4 × 8 meters.

The millet stands were evaluated visually and rated from 0 to 100 percent. A

rating of 100 percent indicates that there were at least 30 millet plants per square meter and that they were evenly distributed.

The millet was harvested for forage with a portable sickle bar mower. Total herbage fresh weight from each treatment was recorded and sub-samples were taken and oven dried for 24 hours at 90°C to determine the moisture content of the herbage and dry matter yields.

Soil moisture regimes were ascertained by taking soil samples periodically during the growing season in all tillage treatments for comparison. The soil samples were obtained in the plow layer to a depth of 25 cm and placed in aluminum cans immediately after sampling. In the laboratory the samples were weighed, oven dried at a temperature of 105°C for 24 hours, and reweighed to determine soil moisture percentages.

RESULTS AND DISCUSSION

Rainfall before and after planting on June 28, 1979, was adequate for millet germination and establishment (Table 1). The soil moisture regime for the 1979 millet growing season is given in Figure 1. Soil moisture percentages by weight varied 1-4% more in the minimum tillage treatments than for conventional tillage. Probably the two major factors influencing these differences were evapotranspiration rates and soil-water recharge. Average soil moisture was near permanent wilting 8 days after planting for the 25 cm depth. Germination and emergence of the young seedlings were attributed to light showers that occurred during this period. The 5.2 cm rain on July 9, 1979, (Table 1) was sufficient to recharge the plow layer and establish millet successfully. The total rainfall for July (13.1 cm) was only 1 cm less than for August (Table 2). However, the level of soil moisture for August was much higher than for July. This difference may be attributed mainly to rainfall distribution. There were four rainfall events in August with more than 2 cm/rain, whereas, July had only 2 rainfall events with more than 2 cm/rain. With smaller, more frequent rainfalls, a higher percentage of the rainfall was entrapped on the surfaces of the plants. Therefore, the relative percentage of water loss by evaporation was greater.

In 1980, the millet was planted on July 7. Soil moisture was sufficient for germination, emergence and stand establishment when seeds were placed at the proper depth (Table 1). Most of the seeds planted at a shallow depth germinated but then desiccated due to lack of rain for two weeks following planting. Soil moisture was highest for the no-till treatments and lowest for conventional tillage (Figure 2). The differences in soil moisture for the tillage treatments were similar to the 1979 millet growing season. The rainfall for the month of August, 1980 was extremely low and thus the soil moisture was near the permanent wilting point for most of the month. The growth of millet during this period was severely restricted and yields were low.

The two growing seasons varied in the amount and distribution of rainfall (Table 1). During the first growing season, there was ample rainfall and good distribution permitting good millet establishment and production. In contrast, the second growing season had lower rainfall and poor distribution which resulted in lower yields.

Stands were evaluated immediately after the first harvest by counting the

number of millet plants per meter square and their distribution. Acceptable stand ratings were obtained the first year of the study within the minimum and conventional tillage system with the International Grain Drill and the Brillion Seeder (Table 3). Ample late summer rainfall in 1979 resulted in excellent growth and production. Dry matter yields were comparable for minimum or conventional tillage with both the International Grain Drill and the Brillion Seeder.

The second year of the study, the no-till system and the Allis Chalmers No-Till Planter were also evaluated in addition to the other treatments. Very good stands were obtained in conventional tillage with the Allis Chalmers No-Till Planter and the International Grain Drill. However, the use of the Brillion Seeder resulted in poor stand ratings and low yields for all tillage systems. Only the Allis Chalmers No-Till Planter had an acceptable stand rating in the minimum tillage and no-till systems (Figure 3). Low rainfall reduced the amount of soil moisture the second year of the study. The grain drill used on conventional tillage resulted in the highest total dry matter yield of millet; however, the use of the Allis Chalmers No-Till Planter also gave good production. Very low yields in conventional tillage occurred with the Brillion Seeder the second year. As the Brillion Seeder plants at a shallow depth, the millet seedlings desiccated after germination and died due to lack of soil moisture. Although the Brillion Seeder is a valuable implement for establishing forages in the spring or fall when surface soil moisture conditions are more favorable, it may not be suitable for planting in late June after wheat harvest as the surface soil moisture is often inadequate as was the case in 1980.

Acceptable stands and yields of millet occurred only in minimum tillage and no-till systems when the Allis Chalmers No-Till Planter was used. The International Grain Drill was an acceptable seeding implement for planting millet following wheat in the conventional tillage system.

REFERENCES CITED

- Black, A.L. and F.H. Siddoway. 1979. Influence of tillage and wheat straw residue management on soil properties in the Great Plains. *J. Soil and Water Cons.* 34:220-223.
- Jones, J.N., J.E. Moody, G.M. Shear, W.W. Moschler, and J.H. Lillard. 1968. The no-tillage system for corn (*Zea mays* L.). *Agron. J.* 60:17-20.
- Jones, J.N., J.E. Moody, and J.H. Lillard. 1969. Effects of tillage, no-tillage and mulch on soil water and plant growth. *Agron. J.* 61:719-721.
- McKibben, G.E., and M.C. Oldham. 1973. Double cropping soybeans in small grain stubble. *Illinois Research. Ill. Agric. Exp. Sta.* 15(3):10-12.
- Olsen, F.J., J.H. Jones and J.H. Faix. 1978. Forage establishment in wheat stubble. *Agron. J.* 70:969-972.
- Sprague, M.A. 1960. Seedbed preparation and improvement of unplowable pasture using herbicides. *Proc. 8th Int. Grassl. Cong. Reading, England.* p. 264-266.
- Taylor, T.H., J.M. England, R.E. Powell, J.F. Freeman, C.K. Kline, and W.C. Templeton, Jr. 1964. Establishment of legumes in old (*Poa pratensis* L.) sod by use of paraquat and strip-tillage for seedbed preparation. *Proc. 7th Brit. Weed Control Conf.* 2:792-803.
- Triplett, G.B., Jr. and D.M. Van Doren, Jr. 1977. Agriculture without tillage. *Sci. Am.* 236:28-33.

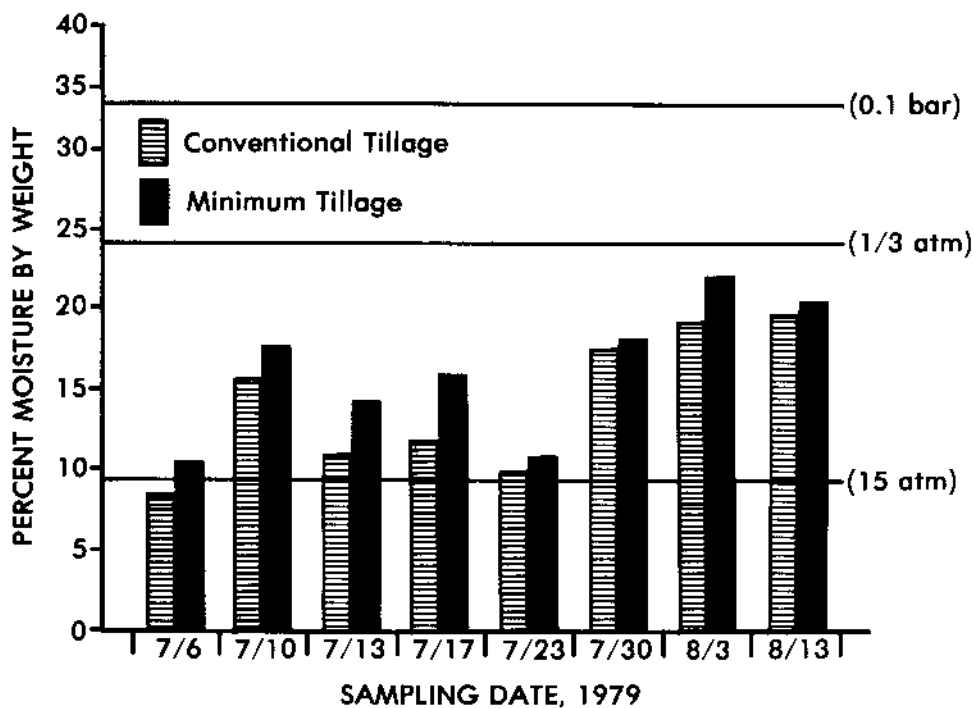


Figure 1. Soil moisture percentages by weight and tensions during the 1979 growing season for conventional and minimum tillage systems.

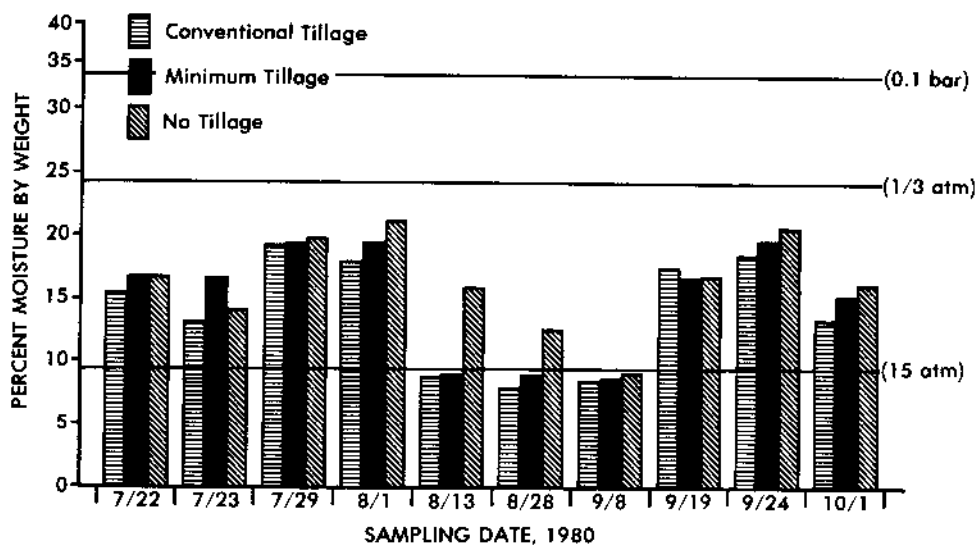


Figure 2. Soil moisture percentages by weight and tensions during the 1980 growing season for conventional, minimum tillage and no-tillage systems.



Figure 3. Millet establishment in wheat stubble with a no-till planter.

Table 1. Rainfall from June-Sept. 1979 and 1980 at Carbondale, IL.

1979		Rainfall	1980		Rainfall
		-cm-			-cm-
June	3	0.3	June	3	0.6
	7	2.5		7	0.1
	8	1.4		8	0.3
	23	3.9		23	3.4
	24	<u>0.7</u>		24	2.5
		8.8	29	<u>7.9</u>	14.8
July	2	0.5	July	1	1.5
	4	0.2		7	3.4
	6	0.3		22	1.3
	7	0.2		28	<u>3.6</u>
	9	5.2			9.8
	10	0.3			
	12	0.1	Aug.	2	0.3
	16	1.1		15	1.9
	24	0.6		19	0.6
	25	0.2		28	<u>0.2</u>
	26	0.6			3.0
	27	0.6			
	28	2.9	Sept.	2	0.1
31	<u>0.3</u>	4		0.1	
		6		1.4	
		17		4.6	
		13.1	22	<u>2.5</u>	8.7
Aug.	1	2.3			
	2	0.5			
	10	0.7			
	11	2.3			
	15	2.4			
	24	0.8			
	28	0.1			
	29	1.4			
30	<u>3.6</u>				
		14.1			
Sept.	21	2.7			
	22	<u>0.8</u>			
		3.5			

Table 2. Monthly mean maximum and minimum temperature and rainfall from June - Sept. 1979 and 1980 at Carbondale, IL.

Month	1979			1980		
	Temperature		Rainfall	Temperature		Rainfall
Max	Min	Max		Min		
	----°C----		cm	----°C----		cm
June	30.1	15.1	8.8	31.4	15.7	14.8
July	30.8	19.2	13.1	35.1	21.1	9.8
Aug.	30.6	26.1	14.1	34.9	20.9	3.0
Sept.	27.5	11.6	3.5	30.5	16.6	8.7

Table 3. Effects of tillage systems and seeding implements on stand ratings and dry matter yields of millet during 1979 (Planted June 28).

Seeding Implements	Stand Ratings†	Dry Matter Yields
	%	metric tons/ha
	<u>Minimum Tillage</u>	
Grain Drill	86 a*	16.8 a
Brillion Seeder	80 a	13.7 a
	<u>Conventional Tillage</u>	
Grain Drill	86 a	16.0 a
Brillion Seeder	85 a	14.0 a

†Stand ratings were evaluated visually and rated from 0 to 100% based on 30 millet plants per meter square and their distribution.

*Means in the same column with the same letter are not significantly different at the 5% probability level.

Table 4. Effects of tillage systems and seeding implements on stand ratings and dry matter yields of millet during 1980 (Planted July 7).

Seeding Implements	Stand Ratings†	Dry Matter Yields
	%	metric tons/ha
	<u>No-Till</u>	
A.C. No-Till	66 bc*	6.9 b
Grain Drill	10 c	0.9 c
Brillion Seeder	8 e	0.9 e
	<u>Minimum Tillage</u>	
A.C. No-Till	85 ab	6.6 b
Grain Drill	51 cd	4.6 c
Brillion Seeder	43 d	3.5 cd
	<u>Conventional Tillage</u>	
A.C. No-Till	94 a	7.1 b
Grain Drill	98 a	8.7 a
Brillion Seeder	33 d	2.4 d

†Stand ratings were evaluated visually and rated from 0 to 100% based on 30 millet plants per meter square and their distribution.

*Means in the same column with the same letter are not significantly different at the 5% probability level.