

SEEDING MECHANISMS FOR TRASH-COVER FARMING

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INTRODUCTION

A search for seeding machines that would function adequately in a trash-cover farming program involving the use of subsurface cultivators and disc machines accompanied the change from plowed to plowless tillage on the prairies. The one-way-disc and discer seeders have been used successfully in the drier areas for a once-over tillage and seeding operation. Some attempts have been made to use subsurface cultivators for combined tillage and seeding. Hoe- and lister-type drills have been adapted recently for seeding through trash on fallow and stubble land.

Semi-deep-furrow, single-disc, or deep-furrow drills proved satisfactory for seeding winter wheat in the Pacific Northwest region of the United States. Double-disc drills were less useful in these studies because of difficulties in penetrating heavy mulch (1, 7). In the Great Central Plains areas of the United States studies showed that hoe drills were better adapted for seeding winter wheat (2, 3) but disc drills were satisfactory for seeding spring wheat on fallow where it was less essential to leave as much residue on the surface after seeding (2). In an 11-year study in Saskatchewan the one-way disc seeder proved better for seeding stubble land than the double-disc drill used on seed-beds prepared by either a mold-board plow or a cultivator (4). In later studies on fallow the drill was superior to the one-way and the discer seeder (5). This was attributed to large variations in seed placement by one-way disc and discer seeders when used on rough, uneven seed-beds. Subsequently it was reported (6) that, if fallows were cultivated to leave an even surface, results from the discer seeder equalled those from the double-disc drill.

Results of field studies, undertaken to determine the adaptability of basic seeding machines to trash-cover farming in southern Alberta, are presented in this paper.

MACHINES AND METHODS

The following basic types of seeding mechanisms were used:—

1. A double-disc press drill (7-inch spacing), representing a surface-type seeder.

2. A 6-foot one-way disc equipped with a seeder box and a Vee-wheel-type packer, representing a surface-type combine seeder.
3. A blade seeder consisting of an 8-foot wide-blade cultivator equipped with a seeder box, representing a subsurface-type combine seeder. Seed was moved pneumatically from a manifold under the seed cups through a 1-inch tube harness that distributed the seed under the two 4-foot sweeps to give 8-inch-spaced rows. A flat disc-type packer and a rotary-hoe-type treader were used in different tests to pack behind the blade seeder.
4. A stubble-mulch drill equipped with 2-inch wide hoe openers arranged in three ranks, 16 inches between and 27 inches within the ranks, to provide a 9-inch-spaced row, representing a semi-deep-furrow drill. The unit had 18 inches vertical clearance from the frame to the bottom of the openers and was equipped with V-rimmed, solid packer wheels.
5. A shovel press drill equipped with 8-inch lister shovel-openers arranged in two ranks, 18 inches between and 28 inches within the ranks, to provide a 14-inch-spaced row representing the deep-furrow type of drill. The drill had 15 inches vertical clearance and was equipped with dual spoke-type packer wheels.

Trials were conducted for three years with spring wheat on stubble land at Pincher Creek, Claresholm, and Lomond to determine the adaptability of the semi-deep-furrow drill and the blade seeder to the climate and soils of various areas in southern Alberta. The method of seeding used by

the farmer at each location was included in the trials for comparative purposes.

A factorial study involving four methods of preparing stubble land for spring wheat and four seeders was carried out at Lethbridge. Trash cover was measured prior to preparing the seed beds during the last seven of the nine years of the study.

A series of trials were conducted at Lethbridge with spring wheat on fallow and stubble to supplement the factorial study. The semi-deep-furrow drill, the double-disc drill, and the blade seeder were used.

Winter wheat was seeded on trash-covered fallow for 11 years. The seeders used were the double-disc drill, the semi-deep-furrow drill, the deep-furrow drill, and the blade seeder with a disc packer.

The methods of seed-bed preparation used are indicated in the tables accompanying this report. Seed-bed tillage was at a 3- to 4-inch depth except for one treatment in the factorial study. In this treatment the chisel plow, equipped with 2-inch chisels was operated five to six inches deep. The plots were one-twentieth acre in size. Six replicates and a randomized block design were used except that treatments in the factorial study were replicated three times. All seeders were calibrated to provide the same rate of seeding within each trial. Soil zone and texture, and average annual precipitation for the locations of the trials, are given in table I.

RESULTS

Area Adaptation Trials

The results at Pincher Creek, Claresholm, and Lomond are given in table II. The semi-deep-furrow drill, when used on a seed-bed prepared by

TABLE I. LOCATION OF STUDIES

Locality	Soil texture	Soil zone	av. annual pptn. in.
Pincher Creek	clay	Thin Black	20.9
Claresholm	fine sandy loam	Dark Brown	17.8
Lethbridge	loam — silt loam	Dark Brown	16.1
Lomond	clay loam	Brown	12.5

TABLE II. YIELD (BU/AC) OF SPRING WHEAT ON STUBBLE SEEDED WITH VARIOUS SEEDERS AT THREE LOCATIONS

Treatment	av. for 3 years (1952-1954)		
	Pincher Creek	Claresholm	Lomond
1. Farmer's method*	29.8	19.8	14.3
2. Semi-deep-furrow drill on bladed seed-bed	29.0	17.5 ^a	14.8
3. Blade seeder on one-way-disc seed-bed	24.0 ^b	16.0 ^b	13.0 ^a
4. Blade seeder only	25.7 ^b	16.7 ^a	13.9 ^a

*Pincher Creek: double-disc press drill on a cultivated seed-bed; Claresholm: double-disc wheel drill on a cultivated seed-bed; Lomond: discer seeder.

^aSignificantly lower (P = 0.05) than treatment 1 in one year.

^bSignificantly lower (P = 0.05) than treatment 1 in two years.

a wide-blade cultivator, gave results equal to those of the farmer's method at all locations except in one year at Claresholm when heavy stubble and unspread straw swaths, dragged by the openers, caused plugging. Poor plant stands resulted. Inadequate weed control was evident in one year at Pincher Creek but yield differences were not significant statistically. The blade seeder yields were lower than yields obtained by the farmer's method of seeding in one of three years at Lomond (a dry area) and in two of three years at the other locations where rainfall is higher. It was evident that packing was needed to eliminate the loose and, sometimes, lumpy seed-bed left by the blade seeder.

Factorial Study

Yields from the factorial study of four seeding mechanisms used on each of four seed-beds on stubble land at Lethbridge are listed in table III.

The semi-deep-furrow drill provided consistently good yields on all types of seed-beds. In all nine years no other mechanism provided greater yields. However, at no time were yields from plots seeded with this drill statistically different from yields from plots seeded with the one-way-disc seeder used for once-over seeding.

The use of the one-way disc seeder on prepared seed-beds did not significantly increase yields over those from the once-over seeding. Depth of seeding was difficult to control on any deeply cultivated seed-bed, particularly one prepared with the chisel plow, consequently plant stands sometimes were uneven.

Best results with the double-disc press drill were obtained on one-way disced seed beds prepared immediately before seeding, particularly under drought conditions, and on blade-cultivated seed beds on which trash cover was light and weeds were controlled.

Yields from plots seeded with the blade seeder were low when a deeply tilled, rough seed-bed was prepared with the chisel plow, and when the seeder was used for once-over seeding. Depth of seeding was difficult to control, particularly on deeply tilled seed-beds. Annual weeds were inadequately controlled in some years on once-over seeded plots.

Chisel plowing five to six inches deep sometimes resulted in lower yields than those obtained on other types of seed-beds. Except when the semi-deep-furrow drill was used, deep tillage

TABLE III. YIELD (BU/AC) OF SPRING WHEAT SEEDED ON STUBBLE LAND BY VARIOUS METHODS AT LETHBRIDGE (AVERAGED FOR 9 YEARS, 1951-1959)

Seeder	Seed-bed preparation				av.
	Cultivated 3 to 5 days before seeding				
	chisel plow	one-way disc	blade cult.	once-over seeding*	
Double-disc press	20.8	20.2	21.5	22.8	21.3
Semi-deep-furrow	22.5	22.5	22.7	23.2	22.7
One-way disc and packer	21.2	23.1	22.1	22.5	22.2
Blade seeder and packer	20.3	22.2	21.8	18.7	20.7
Av.	21.2	22.0	22.0	21.8	

L.S.D. (P = 0.05): drills = 0.8 bu; drills x seed-beds = 1.5 bu.

*One-way disc followed by the double-disc press drill; blade cultivator followed by the semi-deep-furrow drill; one-way disc and blade seeders used as combine seeders.

TABLE IV. AVERAGE YIELD (BU/AC) OF SPRING WHEAT SEEDED ON FALLOW AND ON STUBBLE LAND BY SEVERAL METHODS AT LETHBRIDGE

Treatment	on fallow		on stubble	
	1953-1956	1958-1961	1953-1956	1958-1961
1. Blade cultivator and semi-deep-furrow drill	30.1	28.4	18.8	15.6
2. Blade cultivator and double-disc press drill	—	26.9 ^a	—	15.0 ^a
3. Blade seeder	28.8 ^a	24.6 ^c	15.2 ^c	12.9 ^b
4. Blade seeder and disc packer	29.0 ^a	26.9 ^a	15.2 ^b	12.8 ^b
5. Blade seeder and treader	29.2 ^a	—	15.5 ^b	—

Significance at P = 0.05 compared with treatment 1:

^aLower in one year; ^blower in two years; ^clower in three years.

frequently hindered seeding operations. Weed control was sometimes inadequate on chisel plowed plots seeded with the double-disc press drill.

The quantity of trash measured prior to seed-bed preparation varied from 1,500 to 4,000 pounds per acre. Stubble height varied from 6 inches to about 15 inches. In four to seven years quantities exceeded 3,000 pounds. The blade seeder and the one-way disc seeder operated with little or no difficulty in all quantities of trash. The double-disc openers frequently failed to place seed properly when used on seed-beds with more than 2,000 pounds of surface trash per acre. The hoe openers on the semi-deep-furrow drill operated satisfactorily in most quantities of trash. However, trash was dragged by the hoe openers when cover was 3,000 pounds or more and stubble and straw length was 12 inches or longer, particularly on an unusually loose seed-bed.

Supplementary Studies

Yields obtained from supplementary trials on stubble and fallow land from 1953 to 1961 are given in table IV.

For the first 4 years of the study two types of packers were used with the blade seeder to improve weed control and seed-bed tilth. Results from the blade seeder nearly equalled those from the semi-deep-furrow drill on fallow but not on stubble. Seed-bed tilth appeared to be improved on both fallow and stubble, but inadequate weed control and difficulties in maintaining a proper depth of seeding were still evident. From 1958 to 1961, yields from the double-disc press drill were lower in one year in four on fallow than those from the semi-deep furrow drill and in one year in three on stubble, when both seeders were used on a blade cultivated seed-bed. Lower yields were more frequent than this when the blade seeder was used on fallow without a packer and on stubble either with or without the packer.

The wide-blade cultivator and the heavy-duty cultivator with a rod-weeder attachment were used to prepare trash-covered fallow for seeding from 1962 to 1964, inclusive. The semi-deep-furrow drill and the double-disc press drill were used on each seed-bed. Yield differences averaging 0.2 bushel were obtained for seed-beds and for drills.

Stubble land was prepared with the wide-blade cultivator and with the one-way disc from 1962 to 1964, inclusive. The semi-deep-furrow drill and the double-disc drill were used on each seed-bed. In 1962 the yield from the one-way seed bed was 11.6 bushels as compared with 9.3 from the bladed seed bed. The one-way disc controlled existing annual weeds better than the blade, and the difference in weed control probably influenced the yields of these crops, which were grown under drought conditions. Drills did not influence yield. In the other two years yields were not significantly different.

Notes were taken on the germination of seed obtained from various treatments in the factorial and the supplementary studies with spring wheat. Because of relatively dry conditions at seeding time germination was earlier and emergence of plants more uniform in six of 14 years on stubble land plots seeded with the semi-deep-furrow drill than on plots seeded with the double-disc press drill. In three of the six years differences were relatively small. In the other three years initial emergence was estimated to be 90 to 100 percent on furrow seeding and 25 to 80 percent on double-disc-drill seeding. Rain that fell subsequent to initial plant emergence germinated the remaining seeds. In one year stand differences appeared to be a factor

contributing to yield differences. On fallow land germination differences favored the furrow seeding in two of 14 years. In one of these years stand differences probably influenced yield.

The degree of control of annual and winter annual weeds obtained by various tillage and seeding practices was rated visually in all studies. Ratings on blade-cultivator — semi-deep-furrow-drill plots ranged from 80 to 100 percent and were generally equivalent to those on plots seeded with the one-way disc (once-over seeding on stubble). Ratings for the blade-cultivator—double-disc-drill plots, the blade-seeder plots (once-over seeding), and the chisel-plow — double-disc-press-drill plots ranged from 60 to 100 percent.

Winter Wheat Studies

Yields from summer-fallow plots seeded to winter wheat are listed in table V. The results in 1956 and 1960 were influenced by a variable infestation of winter annual weeds that

the blade seeder. Subsequent stooling of plants compensated stand differences and yields were not influenced significantly. Yields from plots seeded with the deep-furrow drill and with the semi-deep-furrow drill were essentially equal in these studies.

DISCUSSION

The blade seeder provided results generally equivalent to those from other seeders when used on a prepared seed-bed provided that depth of seeding was carefully controlled and a packer was used. When used as a once-over seeder it occasionally failed to control annual weeds. This difficulty was encountered when seeding into soil having a high moisture content, particularly if cool, rainy weather occurred a day or two after seeding. Uniformly shallow seed placement was difficult to obtain during once-over seeding. A coarse open seed bed often resulted when the seeder was used in soils that formed clods readily. Packers helped overcome this difficulty. In its

TABLE V. YIELD (BU/AC) OF WINTER WHEAT ON FALLOW AT LETHBRIDGE, 1952-1962*

Seeder	1954	1956	1957	1958	1959	1960	1961	11-yr. av.
Deep furrow	27.5	14.7	34.3	32.5	38.9	19.0	18.9	28.3
Semi-deep-furrow	29.5	20.8	34.2	31.3	38.4	19.4	20.0	29.3
Double-disc press	27.7	15.1	33.5	31.2	35.6	23.2	16.4	28.0
Blade seeder	24.8	11.5	32.6	30.2	35.1	20.0	16.1	26.8
L.S.D. (P = 0.05)	2.1	4.6	1.2	0.8	2.4	1.3	1.2	

*Data for years in which differences were not statistically significant are omitted from the body of the table but are included in the 11-year averages. Seed-beds were prepared with the wide-blade cultivator and/or, the rod weeder.

showed no relationship to methods of seeding. Yields from plots seeded with the blade seeder were generally lower than those from plots seeded with other mechanisms. Furrow seeding gave significantly better yields than double-disc-press-drill seeding in 1959 and 1961. In the winter of 1958-1959 drifting soil damaged plants on plots seeded with the double-disc drill and the blade seeder but not on plots seeded with the semi-deep- and deep-furrow drills. The soil ridge left by the furrow drills protected the plants. In the fall of 1960 plots were seeded under drought conditions. Plant stands on the double-disc-drill plots were less than 50 percent of those on furrow-seeded plots. Stooling of plants in the spring of 1961 partly compensated for the difference in stands. These occurrences probably influenced yields in 1959 and 1961. During the winter of 1951-1952 stands winter-killed by 8 and 17 percent on furrow-seeded plots and 30 and 57 percent on plots seeded with the double-disc drill and

present stage of development the wide-blade cultivator has limited usefulness as a combine seeder for cereal crops in only the drier areas.

The double-disc drill gave good results when used on stubble seed-beds prepared by the blade cultivator provided weeds were controlled and trash did not interfere with seed placement. Seeding with the disc drill immediately after tillage with the one-way disc was better than seeding a few days after tillage when drought was a factor. Results from the double-disc drill did not always equal those from other methods. Germination of seed was often uneven, particularly on stubble. Results from the double-disc drill on fallow were generally equivalent to those from the semi-deep-furrow drill. Trash in quantities exceeding about 2,000 pounds per acre interfered with seed placement by the disc openers, particularly on a loose seed-bed.

These studies confirm work done elsewhere (4), and indicate that the

one-way disc seeder is as effective as other seeders on stubble land. Its usefulness on fallow has also been pointed out (5, 6). No significant increase in yield resulted from preparing the seed bed in advance of seeding where the only weeds were annuals and winter annuals. If tillage is done before seeding with the one-way disc seeder, a deeply worked, rough seed-bed must be avoided.

The semi-deep-furrow drill used in these studies was essentially a stubble-mulch drill that formed moderate furrows. The drill was as useful as the one-way-disc seeder for seeding stubble land. The tilling action of the openers supplemented the tillage provided by the wide-blade cultivator, and the control of existing annual weeds generally equalled that obtained when the one-way disc was used for once-over seeding. The furrowing action of the openers facilitated seed placement into moist soil and thus provided earlier and more uniform stands than were obtained with the double-disc drill when the seed-bed was drier. This was apparently a factor that influenced yield in one year each on fallow and stubble. Under conditions drier than at Lethbridge this would probably occur more frequently. The semi-deep-furrow drill operated successfully through trash in quantities of up to 4,000 pounds per acre provided that stubble and straw length did not exceed about 12 inches and that the trash was dry and uniformly spread. These factors have enabled the semi-deep-furrow drill to perform adequately on widely different types of seed-beds and over a wide range of soil and climatic conditions.

The deep-furrow drill and the semi-deep-furrow drill occasionally provided better results with winter wheat on fallow than the double-disc drill when drought influenced germination of seed and when soil drifted. The deep-furrow drill seems to offer no real advantage over the semi-deep-furrow drill under conditions similar to those at Lethbridge.

SUMMARY

Results of a 14-year field study of the use of some basic machines for seeding wheat on fallow and stubble land in southern Alberta are reported.

The wide-blade cultivator, in its present stage of development, has limited usefulness as a combine seeder for cereal crops in only the relatively dry areas. It is less useful than the one-way disc-type combine seeder.

The one-way disc-type seeder, when used for once-over seeding of stubble land, provided results equivalent to those from other methods of seeding where existing weeds were annuals or winter annuals and where trash quantities did not exceed about 4,000 pounds per acre.

The double-disc press drill gave results equivalent to those of other methods for seeding fallow land having a relatively light trash cover. Results were sometimes inferior when the drill was used to seed stubble fields having trash quantities exceeding about 2,000 pounds or when drought conditions existed at time of seeding stubble or fallow land.

The stubble-mulch drill (in this study a semi-deep-furrow drill) performed adequately on widely different types of seed-beds including those prepared with the wide-blade cultivator. Results equalled those from the one-way disc seeder on stubble land having up to 4,000 pounds of trash cover per acre and generally equalled those of the double-disc press drill on fallow. The furrow-seeding principle occasionally provided results superior to those of the double-disc press drill when severe drought conditions existed at time of seeding.

The deep-furrow, the semi-deep-furrow, and the double-disc press drill generally provided equal results when used for seeding winter wheat on fallow land. Under drought conditions at seeding time the furrow seeders were occasionally superior to the double-disc press drill but there was no advantage in using the deep-furrow drill in preference to the semi-deep-furrow drill.

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... RUNOFF FREQUENCY

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A maximum amount of runoff does not necessarily occur from a maximum amount of precipitation. Consequently, further studies should be made to determine the various inherent factors that affect watershed yield.

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