DISCER SEED SPOUT EVALUATION

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INTRODUCTION

The discer is widely used in Western Canada for the seeding of cereal grains. It is capable of performing an adequate seeding operation in both summer fallow and stubble, without prior tillage, contrary to some of the other seeding machines presently in use (1).

The placement of seed in an optimum location in the soil to obtain the best germination, and consequently the highest yield, varies with the type of seeder used (2, 3). From observations of seeded crops, it is evident that discer seeding results in the seed being scattered, whereas drill seeding results in the crop emerging in neat rows. The assumption usually made is that the optimum location for seed is in the furrow bottom, with the furrow bottom being at such a depth that adequate moisture for germination is available.

In an attempt to determine the degree of seed scatter experienced in discer seeding, the effect of seed spout design (shape, size of outlet, etc.) on seed scatter was studied. The study evaluated seed spouts obtained from six major discer manufacturers. In addition, the velocity and trajectory of wheat kernels leaving the seed spouts were determined to ascertain the best location of the spouts with respect to the disc, so that the kernels would be placed in the furrow bottom. The kernel velocities and trajectories, in conjunction with the location of the seed spouts with respect to the disc on production models of six discers, were used to determine the theoretical placement of seed in the furrow bottom.

EQUIPMENT AND PROCEDURES

Effect of Spout Design on Seed Scatter

To determine the degree of seed scatter obtained from the various discer seed spouts, wheat seeds were delivered to the spout by use of the metering mechanism and box of a fertilizer attachment (Figure 1). The metering mechanism was driven by a V-belt coupled to a reducer-gearbox driven by an electric motor. The seed spout was attached to the metering mechanism so that its position and slope could be altered. The degree of seed scatter was determined by collecting the seed delivered in a grid of 1-inch (2.5-cm) square cells, 4 inches (10.2 cm) deep. When conducting a test, an 18-inch (45.7-cm) diam disc was placed in the appropriate position with respect to the seed spout, thus restricting scatter of seed in that direction (Figure 2). Seed was then delivered into the collecting tray cells for a known period of time. The depth of seed in the cells adjacent to the point of delivery was a measure of seed scatter. The amount of seeds contained in each cell was determined by removing the seeds from the cells by a vacuum-cyclone arrangement (Figure 3), emptying the seeds into the graduated cylinder, and obtaining a volumetric measurement. The number of cells containing seed was an indication over how large an area the seed was scattered, and the volume of seed in each cell was a measure of the concentration of seed.

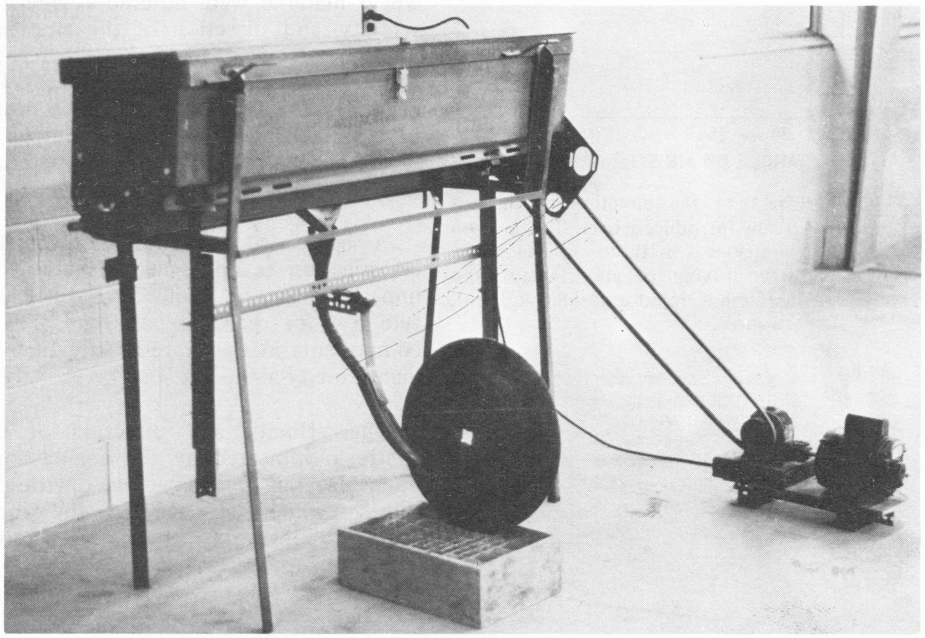

Figure 1. Apparatus to determine seed scatter.

Seed spouts from six different discer manufacturers (Figure 4) were evaluated in this manner, determining the degree of seed scatter at spout slopes of 30, 45, and 60 degrees to the horizontal. Due to the curved nature of most of the spouts evaluated, the slope was defined as being the trajectory the seed would take upon leaving the spout, as determined by inserting a straight edge approximately 2 inches (5.1 cm) into the spout opening, resting on the bottom of the spout. The angle the straight edge made with the horizontal was assumed to be the slope of the spout, θ (Figure 5). For this series of tests the spout was kept in a vertical plane with the angle $\alpha = 0$ (i.e., the spout was parallel to the plane of the disc). The spout was located such that the distance from the center of the spout to the edge of the disc was 1 inch (2.5 cm). Another series of tests was also performed with the spout tipped in at 15 degrees to the vertical ($\alpha = 15^\circ$), so as to direct the flow of seed against the disc in an attempt to reduce scattering. The distance A, from the bottom tip of the spout to the top of the cells, was maintained at 5 inches (12.7 cm) for all spouts at all angles. The location of the spout with respect to the

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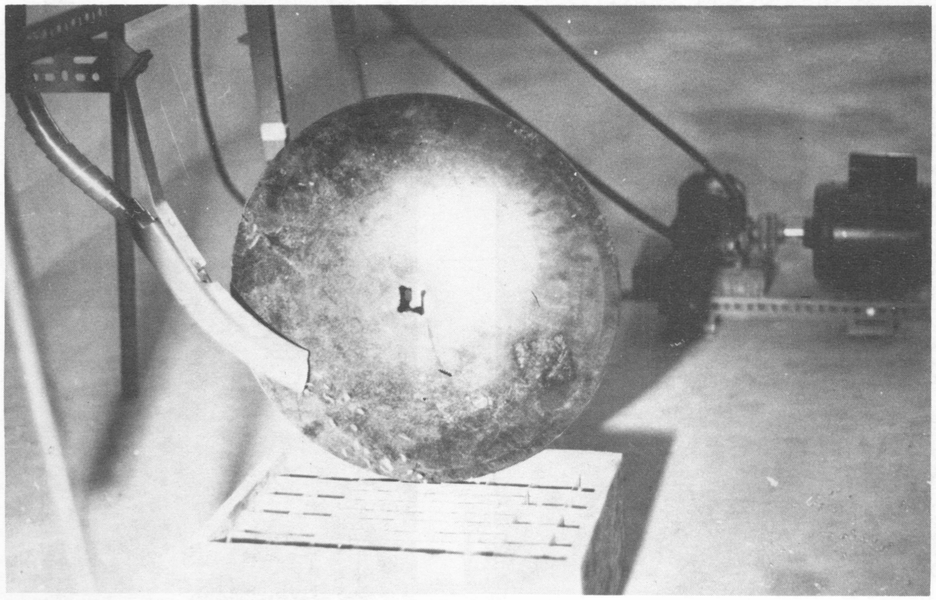

Figure 2. Collecting tray with disc in place.

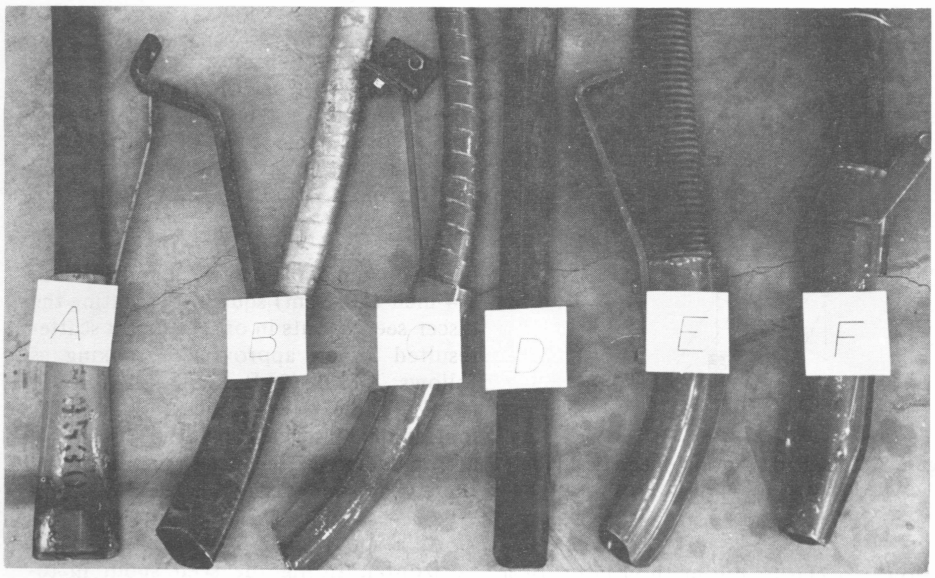

Figure 4. Discer seed spouts evaluated.

disc was such that the distance B, from the spout tip to the center of the disc, was 5 inches (12.7 cm).

Theoretical Location of Seed in the Furrow Bottom

A second laboratory study was undertaken to determine the velocity and trajectory of a wheat seed leaving the spout. Seed velocities and trajectories leaving the seed spouts of the six discer manufacturers were determined by the use of darkroom flash photography. The spout was set up in a dark room in front of a black velvet background, with a ruler to indicate the vertical distance from the spout tip to the ground (Figure 6). A photograph of the seed leaving the spout was obtained using a Minolta SRT 101 camera. The shutter of the camera was held open for the length of time it took the seed to reach the ground. A stroboscope, set at 50 flashes per second, was used to supply the light. Each time a flash of light occurred, the seed was photographed at its particular stage of travel. The distance travelled between flashes could be determined from the ruler (Figure 7). Knowing the distance travelled and the time taken to travel that distance (1/50 of a second), the velocity of seed could be determined. Seed velocities and trajectories were determined for the six discer spouts at spout angles of 45 and 60 degrees to the horizontal. In

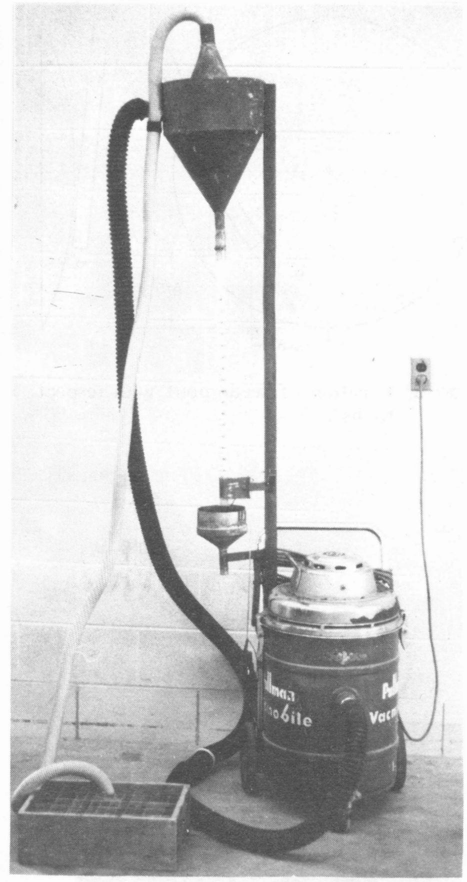

Figure 3. Vacuum-cyclone volumetric measurement apparatus.

addition, the location of the seed spout with respect to the disc on production models of the six discers was obtained to determine the theoretical placing of seed in the furrow bottom.

RESULTS AND DISCUSSION

Effect of Spout Design on Seed Scatter

Interpretation of results

The depth of seed contained in each 1-inch (2.5-cm) square cell was measured on a volumetric basis, which for the interpretation of results can be used as an indication of scatter since the volume of seed contained in each cell is proportional to the actual depth of seed. Seed scatter in both the lateral and longitudinal directions resulted. For comparing scatter obtained at different spout angles and scatter between different spouts, two criteria were used:

(1) The percent of the total seed contained in a 4-inch (10.2-cm) square area was calculated.

(2) A rating figure for lateral and longitudinal scatter was determined in the following manner. The column of cells containing the highest total percent of

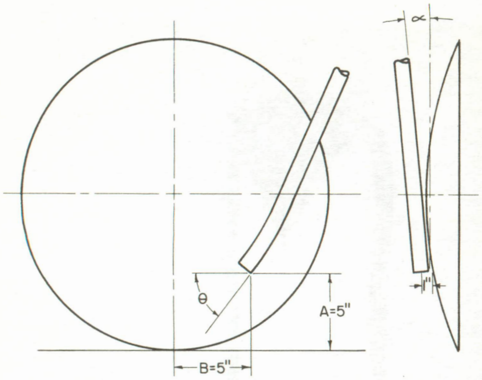

Figure 5. Location of seed spout with respect to disc.

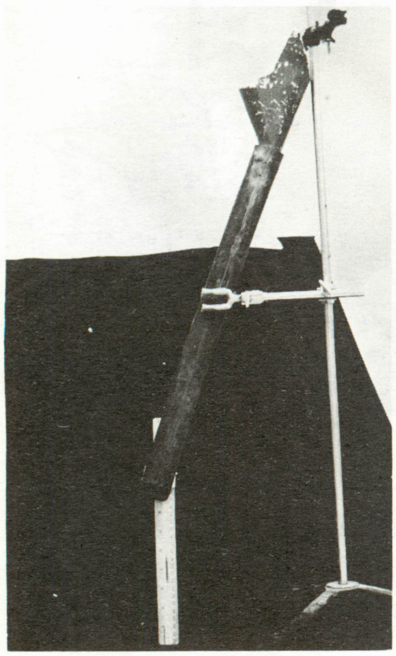

Figure 6. Apparatus for darkroom flash photography.

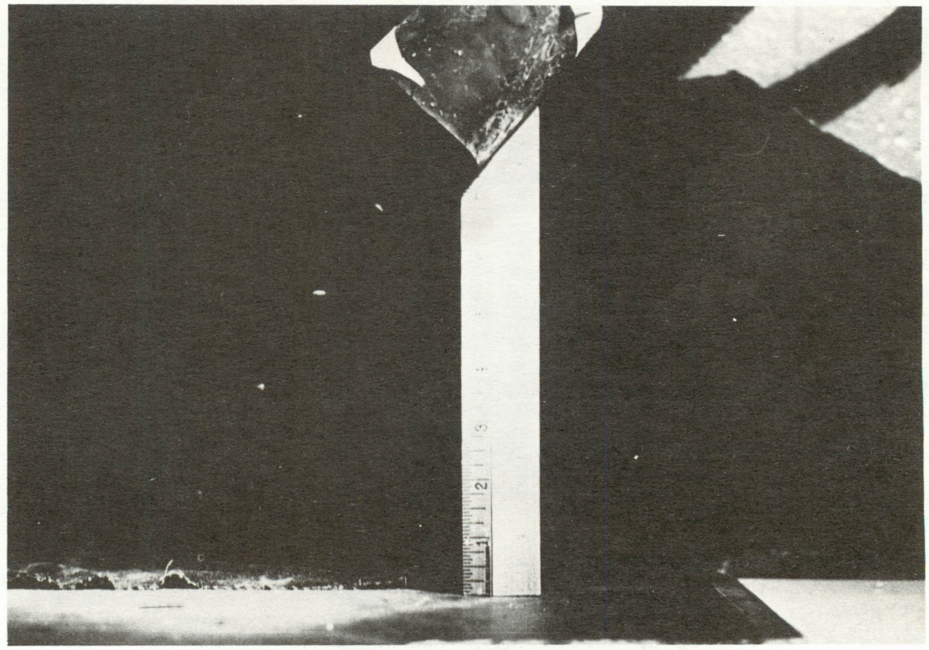

Figure 7. Sample of flash photography to determine velocity and trajectory of the seed.

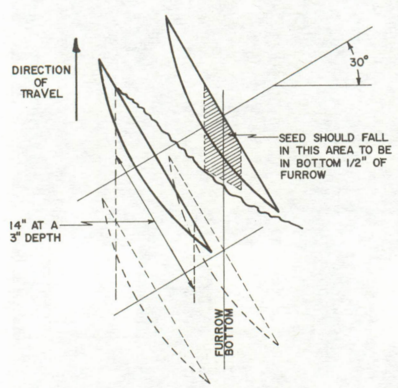

Figure 8. Schematic showing theoretically best location for seed in furrow bottom.

seed was used as the center of seed delivery. The total percent of seed volume contained in the center column was multiplied by 5 (i.e., given a weight of 5) and designated as value "a." The percent volume of seed contained in the two columns of cells directly adjacent to the center were multiplied by 4 and assigned the value "b." The percent of volume contained in the columns of cells adjacent to the "b" cells were multiplied by 3 and designated as value "c," and so on. The rating figure for lateral scatter was then the summation of the individual values (i.e., $a + b + c + \ldots$). A similar rating was obtained for longitudinal scatter. The maximum rating for either lateral or longitudinal scatter would be 500 since the least scatter would place 100% of volume in the center row (i.e., 100 X 5 = 500). An example follows to clarify the method used for a scatter rating.

Example

Shown in the grid (Table I) are the percentages of the total amount of seeds contained in each cell along with the column and row totals with the respective weights attached to each. The summation of the product column or row percentages times the weighting value then result in ratings for lateral and longitudinal seed scatter.

Discussion

For all spouts tested, the amount of seed scatter was reduced as the angle of the spout to the horizontal was increased, with 60 degrees to the horizontal resulting in a minimum amount of seed scatter (Table II). Dimensions obtained from production models of the six discers whose spouts were tested indicated that at a seeding depth of 3 inches (7.6 cm) the angle of the spout to the horizontal varied from 45 to 70 degrees (Table IV).

At a spout angle of 60 degrees and based on the percent of seed contained in a 4-inch (10.2-cm) square area, rating the discer seed spouts in order of least scatter resulted in an approximate ranking as follows: (1) B (2) E (3) D (4) C (5) A (6) F (Table II). Rating numbers for longitudinal and lateral scatter resulted in a somewhat similar ranking, although there were some discrepancies.

At a spout angle of 60 degrees to the horizontal, tilting the seed spout in towards the disc at an angle of 15 degrees to the vertical (i.e., $a = 15°$) did not appear to appreciably reduce the amount of seed scatter except in the case of spout E (Table III).

Seed spout shape appeared to be the factor that determined the amount of seed scatter. The spouts resulting in the maximum amount of seed scatter (A and F) were so shaped as to funnel the wheat kernels into the spout outlet; the spout outlet was smaller than the inlet. The seeds appeared to bounce in a random fashion and left the spout in a similar random fashion, resulting in more severe scattering. Conversely, seed spouts B and E, although each was a different design, were so shaped that the wheat kernels were delivered in a more orderly fashion, resulting in less scatter.

TABLE I SAMPLE CALCULATIONS FOR SEED SCATTER RATING

	% of total vol contained in each cell				Row total (X)	Assigned wt (Y)	Product (X) X (Y)	Designated value
	1.2	2.5	3.0	2.8	9.5	3	28.5	*c*
	2.8	8.6	9.9	8.4	29.7	4	118.8	*b*
	2.2	9.9	12.4	10.0	34.5	5	172.5	*a*
	1.2	5.0	6.8	4.7	17.7	4	70.8	*b*
	0.6	1.6	2.4	2.2	6.8	3	20.4	*c*
		0.6	0.6	0.6	1.8	2	3.6	*d*
Column total (Z)	8.0	28.2	35.1	28.7			414.6 = longitudinal rating	
Assigned weight (Y)	3	4	5	4				
Product (Z) X (Y)	24.0	112.8	175.5	114.8 = 4.27.1 = lateral rating				
Designated value	*c*	*b*	*a*	*b*				

TABLE II SUMMARY OF RESULTS OF SEED SCATTER FROM VARIOUS DISCER SPOUTS

Spout identification	Angle (°) of spout with horizontal	Longitudinal rating	Lateral rating	% of seed contained in 4-inch square area
A	30	391	414	84.5
A	45	413	404	85.9
A	60	390	410	86.8
B	30	414	445	90.2
B	45	418	442	90.5
B	60	423	443	97.1
C	30	381	424	76.7
C	45	400	430	91.4
C	60	415	427	92.0
D	30	409	440	93.2
D	45	398	442	87.7
D	60	421	453	93.3
E	30	415	428	91.1
E	45	427	445	92.7
E	60	435	440	95.1
F	30	323	410	59.5
F	45	339	416	63.9
F	60	403	430	86.2

Theoretical Location of Seed in the Furrow Bottom

Seed spout location with respect to the disc

The seed spout location with respect to the disc at a seeding depth of 3 inches (7.6 cm) was obtained from production models of the six discers (Table IV). The seed spouts in the plane of the disc were either positioned or shaped (angle *a*, Figure 5) so that the edge of the spout nearly touched the back of the disc. This enabled seed to be delivered as close to the disc as possible and still not have the spout actually touching the disc. All discers were equipped with 20-inch (50.8-cm) discs with disc concavity varying between 2 inches (5.1 cm) and 2-1/2 inches (6.4 cm).

Seed velocity and trajectory

Seed velocity and trajectory in conjunction with the location of the seed spout with respect to the disc can be used to determine, theoretically, where each discer would place seed in the furrow bottom. In order for seed to fall into the bottom 1/2 inch (1.3 cm) of the furrow, seed should be placed in the cross-hatched area shown in Figure 8. Photographs obtained by the use of darkroom flash photography for an individual wheat kernel leaving each seed spout yielded sufficient information to determine kernel velocity and trajectory (Figure 7). This information in conjunction with the location of the spout with respect to the disc could then be used to determine the theoretical positioning of the seed in the furrow bottom in the direction of travel (Table V). Lateral positioning of the kernel, however, could not be determined. To allow the maximum amount of lateral scatter and still place seed in the bottom 1/2 inch (1.3 cm) of furrow, delivery should theoretically occur at a location 3 inches (7.6 cm) behind the disc center (Figure 8).

The theoretical location of seed in the furrow bottom in the direction of travel was dependent upon the angle of the seed spout with the horizontal. A spout angle of 45 degrees would result in seed being located in the furrow bottom behind disc center for all six discers, whereas at a spout angle of 60 degrees, some discers would locate seed ahead of disc center (Table V). Also shown are the actual spout angles as obtained from production models of each discer at a seeding depth of 3 inches (7.6 cm). To compare the theoretical location of seed in the furrow bottom with respect to disc center for the six discers, the seed location associated with the spout angle (45 or 60 degrees) closest to the actual spout angle was used. On this basis, the theoretical kernel location for seed spouts A and B occurred slightly ahead of disc center, whereas seed spout F located seed slightly behind disc center. Only seed spouts C and D located kernels near the theoretically widest furrow bottom opening.

Delivery from all discer seed spouts resulted in a significant amount of both lateral and longitudinal scatter. Also, preferred area for locating seed in the bottom 1/2 inch (1.3 cm) of the furrow (Figure 8) is located largely behind the disc center. Therefore, it would be desirable to have seed spouts so located with respect to the disc that seed be delivered behind disc center.

CONCLUSIONS

For all six discer spouts evaluated, the least amount of seed scatter occurred at a spout angle of 60 degrees to the horizontal. Tilting the spout in towards the disc at 15 degrees did not result in an appreciable amount of reduction in seed scatter. Seed spout shape appeared to be the major factor determining the degree of seed scatter. Spouts that funnelled the seed (i.e., a larger inlet than outlet) imparted a random bounce to the seed within the seed spout, which resulted in a similar random bouncing of the seed leaving the spout and consequently more seed scatter.

The delivery from all seed spouts resulted in appreciable amounts of both lateral and longitudinal scatter. Therefore, theoretically, seed should be delivered to the largest available area of furrow opening. This was determined to be 2-3 inches (5.1-7.6 cm) behind disc center. Analysis of the velocity and trajectory of an individual wheat kernel leaving the seed spouts, along with seed spout location with respect to the disc obtained from production models of the six discers, indicated that only two of the discers located seed in the theoretically desirable location (i.e., behind disc center in the furrow bottom).

SUMMARY

Discer seeding results in significant scatter of the seeds that are delivered by the seed spouts. This study undertook an evaluation of six seed spouts, taken from discers of the major discer manufacturers, in an attempt to determine the effects of spout design on seed scatter. In addition, the velocity and trajectory of an individual wheat kernel leaving the six seed spouts was obtained. This, in conjunction with the spout location with respect to the disc, made it possible to determine the placement of seed in the furrow bottom with respect to disc center on each discer. The placement of seed for each discer was then compared to the theoretically preferred location.

Spout shape was found to be the factor that appeared to contribute most to seed scatter. A seed spout that funnelled the seed imparted a random bounce to the seed, which resulted in increased seed scatter. Only two of the discers placed seed near the theoretically preferred location in the furrow bottom.

TABLE III SUMMARY OF RESULTS OF SEED SCATTER FOR SEED SPOUTS TIPPED IN TOWARDS THE DISC AT 15 DEGREES

Spout identification	Angle (°) of spout with horizontal	Angle (°) of spout with respect to disc (angle α)	Longitudinal rating	Lateral rating	% of seed contained in 4-inch square area
A	60	15	373	430	84.6
A	60	0	390	410	86.8
B	60	15	427	435	95.7
B	60	0	423	443	97.1
C	60	15	401	440	93.0
C	60	0	417	430	92.0
D	60	15	378	423	89.1
D	60	0	421	453	93.3
E	60	15	452	452	99.9
E	60	0	435	440	95.1
F	60	15	336	403	72.6
F	60	0	403	430	86.2

TABLE IV DIMENSIONS TO INDICATE SEED SPOUT LOCATION WITH RESPECT TO THE DISC AS OBTAINED FROM PRODUCTION MODELS OF THE DISCERS AT A SEEDING DEPTH OF 3 INCHES

Spout identification	Vertical distance† A – inches	Horizontal distance B – inches	Angle with horizontal θ – degrees
A	8-1/4	4-1/8	70
B	6-3/4	3-1/8	60
C	7-3/4	2-1/2	55
D	7	2-1/8	65
E	7	3	45
F	6-1/4	4-3/8	50

† Refer to Figure 5 for a clarification of stated dimensions.

TABLE V THEORETICAL LOCATION OF SEED IN THE FURROW BOTTOM

Spout identification	Spout angle (°) with horizontal on test apparatus	Distance (inches) seed drops in furrow behind spout tip	Distance (inches) from spout tip to center of disc	Position of seed† in furrow bottom with respect to disc centers – inches	Actual spout angle (°) with horizontal on production model of discer
A	45	5.00	4.125	−1.88	80
A	60	3.55	4.125	0.58‡	
B	45	3.78	3.125	−0.66	60
B	60	2.74	3.125	0.39‡	
C	45	8.27	2.50	−5.77	55
C	60	5.81	2.50	−3.31‡	
D	45	5.63	2.125	−3.51	65
D	60	4.00	2.125	−1.88‡	
E	45	4.09	3	−1.09‡	45
E	60	2.87	3	0.13	
F	45	4.82	4.375	−0.46‡	50
F	60	3.42	4.375	0.96	

† Negative values indicate that seed is located in furrow bottom behind disc center.

‡ Indicates seed location most closely represented by actual seed spout angle.

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