MACHINERY

1945 Sugar Beet Planter Investigations at Fort Collins, Colo.

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The work of the Division of Farm Power and Machinery, U. S. Department of Agriculture and the Colorado Agricultural Experiment Station at Fort ollins, Colo., during the spring of 1945 on sugar beet planter development was planned and carried on with two distinct objectives. One was a study of those characteristics of planters which affect seedling distribution in the field stands; for this work seed furrow openers, press wheels, and other things Avhich affect field germination were kept as nearly constant as possible. The other was a study of those planter characteristics which affect field germination ; in this ease the planter distribution characteristics were kept the same. Improvements in both seedling distribution and field germination were desired.

Seedling Distribution Characteristics of Planters

The plots planted to compare planter distribution were put in on May 3 and 4 and included 45 different plantings with different planters and equipment and different seeding rates. The soil moisture at planting time was excellent and continued to be so throughout the spring. The summarized results are expressed in terms of the percentage of beet seedlings which are singles, a single being a seedling which is single within a. 1-inch length of beet row. This method of evaluation of planter seedling distribution is explained in my accompanying paper entitled "Evaluation of Field Test Data for Comparisons of Sugar Beet Planters."

The data taken from the germination stand counts on this planting were worked up and the percentage of single seedlings have been adjusted for direct comparison as explained in the paper. The percentage of singles was first adjusted to the 35.6 average percent of potential germination and then to the 23.4 average seedling stand per hundred inches, which is the stand for about, a 4 pound per acre seeding rate with 20-inch rows. In most cases the adjustments were small since the variations were not great. The summarized percentages of single seedlings are therefore directly comparable where the seed sixes are the same.

The summarized results from this planting are shown in table 1 and are shown by planters with different equipment and with differ-

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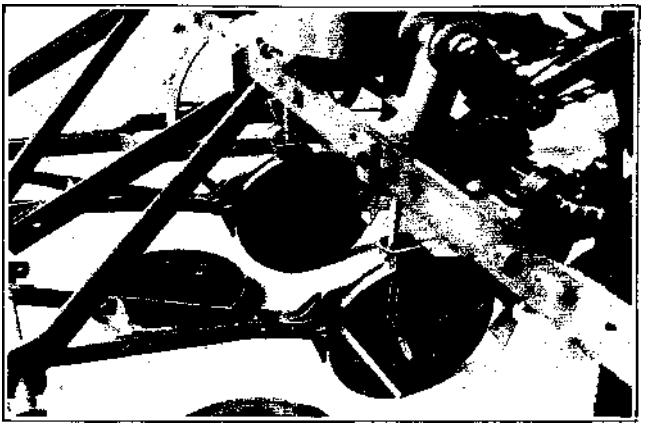

Figure 1.—John Deere No. 55 planter equipped with the small, smooth, straight seed tube in place of the regular, flexible tube on the far opener shown. The nearer opener is equipped with the long, small, smooth, slightly curved tube used in the tests. The dotted lines show the positions of the tubes inside the castings. The nearer opener is also equipped with the scraper bar between the disks which was used for treatment number 18 only.

ent seed as indicated. Briefly the planters are as follows: On the John Deere No. 55 planter the sloppiness had been taken out of the shaft bearings and drives and the opener units had been moved back about 2 inches to place the seed opening in the opener casting directly under the point of seed drop at the seed plate. The opener was the usual double disk opener and the press wheels were the regular type with a slight bevel to the rims, giving comparatively small concavity to the pair of wheels. Seed tubes differed as indicated. The small, straight tubes were of airplane tubing of 5/8 inch O. D. by 9/16 inch I. D. They were flared at the top just under the seed plates to insure all seed dropping into the tubes, and with the openers down in working position the tubes extended just into the disk opener castings so that the lower end of the tubes were slightly below the top edge of the opener disks. Seed dropped straight down these tubes actually dropped into the V between the lower edges of the opener disks and the disks had to turn to lay out the seed in the bottom of the furrow. The long, small curved tube used in this planter was of the same material as the short straight tube but extended about 8 inches lower. It curved back somewhat under the center of the opener disks at its

Table 1.—Summary of data from planter distribution study. Planted 5/3-4/45. Counts 6/2-8/45. (All tests at 2 1/2 m.p.h. except as noted.)

	Planter and equipment	Seedsize, Rittis	Sprouts per viable seed	Percentage of potential germination*	No. of counts	Percent singles**	Largest gap, Inches
1	JD55 Small, smooth, straight tubes	7-10	1.56	37.5	48	67.72	28.33
2	JD55 Regular, flexible tubes	7-10	1.56	35.5	48	51.56	27.28
3	JD55 Small, straight tubes 3.8 m.p.h.	7-10	1.56	36.2	16	58.36	21.10
4	JD55 Small, straight tubes 5.0 m.p.h.	7-10	1.56	15.9	16	39.92	30.24
5	JD55 Flexible tubes 3.8 m.p.h.	7-10	1.56	36.4	16	58.84	20.05
6	JD65 Flexible tubes 5.0 m.p.h.	7-10	1.56	19.0	16	41.03	25.56
7	JD55 Long, small curved tube	7-10	1.56	36.2	16	56.57	22.70
8	McCD Small, curved tube, 11/64" cell	7-10	1.56	36.0	48	59.41	23.47
9	McCD Regular, flex. tube, 11/64" cell	7-10	1.56	33.8	48	58.58	23.43
10	McCD Regular, flex. tube, 12/64" cell	7-10	1.56	28.9	16	48.12	21.01
11	McCD Small, curved tube, 12/64" cell	7-10	1.56	27.4	16	50.40	30.11
12	JD Experimental planter	7-10	1.56	48.6	48	57.36	23.80
13	Rasmann unit	7-10	1.56	60.4	16	54.83	22.04
14	Ford planter	7-10	1.56	.....	16	36.43	25.84
15	JD55 Small, smooth, straight tubes	7-9	1.49	35.8	48	58.74	24.75
16	JD55 Long, small, curved tubes	7-9	1.49	27.4	48	67.67	25.29
17	JD55 Regular, flexible tubes	7-9	1.49	26.2	48	60.38	28.07
18	JD55 Small, smooth tubes, scraper between disks	7-9	1.49	48.0	16	58.05	18.45
19	JD55 Small, straight tubes, old style round end cut-offs	7-9	1.49	38.6	16	61.11	20.52
20	McCD Regular flexible tubes	7-9	1.49	20.2	16	53.54	20.39
21	JD Experimental planter	7-9	1.49	42.8	16	62.42	16.76
22	Cobbley with G. W. seed	7-9	1.49	37.2	16	53.28	19.27
23	Cobbley with U. I. seed	7-9	1.19	36.1	16	70.46	16.22
24	JD55 Small, straight, tubes, U-I seed	7-9	1.19	25.2	16	76.65	28.24
25	JD55 Small, str. tubes, decort. seed	7-9	1.67	54.3	16	50.95	19.86
26	JD55 Small, str. tubes, decort. seed	9-11	1.90	56.8	16	51.40	23.07
27	JD55 Small, str. tubes, blue pellets	.....	1.21	32.2†	16	70.78	24.52
28	McCD Flexible tubes, screened whole seed	8-11	1.71	53.4	16	54.72	22.06
29	Mervine's single seed planter, whole seed	.....	1.90	31.4	16	47.31	24.75
	Difference for significance 95-percent level						
	Between treatments of 16 counts			12.7		11.46	7.08
	Between treatments of 16 and 48 counts			10.4		9.17	5.78
	Between treatments of 48 counts			7.4		6.41	4.08

*Field germination expressed as percent of potential germination based on seed laboratory germination test and seeding rate.

**Percent of seedlings as singles (single seedling in 1 inch) adjusted to 35.8 average percent of potential germination and to 23.4 average seedling stand.

†Percent of potential germination determined from laboratory germination of base seed before pelleting was 16.0 percent.

lower end so as to drop seed into the opened furrow directly rather than into the V between the disks. The flexible tubes were those regularly supplied with the planters in the past.

The McCormick-Deering planter was the standard No. 40 beet planter with double disk openers. The small, curved tube used with this planter was like that on the John Deere No. 55 as it extended to

the bottom of the opener disks. However, it had a slight bend forward and a lower bend backward to get it down through the opener casting. Seed dropped from it in the opened furrow rather than in the V between the disks.

Plantings shown in lines 12 and 21 were with a John Deere No. 66 experimental, power lift, six-row planter with double disk openers and low seed hoppers mounted directly on the openers. The drives to the seed hoppers were through a front cross shaft, and bevel gears and fore-and-aft shafts. Press wheels on both this planter and on the McCormick-Deering were of the deep concavity type.

Seed plates on all three of these planters were 1/8-inch thick and had seed cells drilled 1/.64 inch larger than the largest size of seed used, except for plantings 10 and 31 which had cells 2/64 inch larger than the largest size of seed.

The Rassman planter was a regular Rassmann unit built last year. The Ford planter was an experimental machine under development by Ford-Ferguson. It mounts directly on the rear of a Ford tractor and has horizontal seed plates driven by V-belts from press wheels of about 18 to 20 inches diameter. The openers are combination shovel furrowers and small runners. The Cobbley planter was this year's new Cobbley units mounted directly on John Deere No. 55 double disk openers. The seed tubes curved back slightly between the opener disks just enough to clear the disks and drop the seed in the opened furrow rather than in the V between the disks. Planting 29 was with a unit of Mervine's pick-up cup, single seed planter built several years ago.

Figure 2.—Ford-Ferguson experimental single-seed sugar beet planter under development in 1945.

The table shows seed used, sprouts per viable segment of the seed as determined from seed laboratory germinations, the number of 100 inch counts per planting, and the percent singles. The other two columns will be referred to later. Differences required for significance are shown at the bottoms of the columns.

In summarizing the results of this planting a number of the tabulated results have been combined. In comparing seed tubes, for example, the plantings with 7 to 9 and 7 to 10 seed have been combined. These combined results follow:

Seed tube comparisons	Percent singles
JD No. 55; long, smooth, curved seed tubes	64.9
smooth, straight seed tubes	63.2
regular flexible seed tubes	56.0
Difference for significance (95-percent)	4.6
McC-Drg No. 40; long, smooth, curved tubes	57.2
regular flexible tubes	55.7
Difference for significance	5.6
Planter speed:	
JD No. 55; straight and flexible tubes; 2.5 m.p.h.	59.6
3.8 m.p.h.	55.9
5.0 m.p.h.	47.9
Difference for significance	6.5
The percent singles decreases 2.9 percent for each mile per hour increase of planter speed.	
Seed plate cell size:	
McC-Drg No. 40; plates with 11/64" cells and 7-10 seed	58.9
plates with 12/64" cells and 7-10 seed	49.3
Difference for significance	6.5
Planters—	
With both 7 to 9 and 7 to 10/64" seed	
JD No. 55; 1ong, smooth curved seed tubes	64.9
JD No. 55; regular flexible tubes	56.0
McC-D No. 40; regular flexible tubes	57.1
J.D. experimental, low-hoppered drill	58.9
Difference for significance	5.6
With 7 to 10 seed	
J.D. No. 55; smooth, straight seed tubes	67.7
Rassman planter	54.8
Ford planter	6.4
Difference for significance	9.2
With 7 to 9 seed of two sprout counts	
JD No. 55; small, straight seed tubes	67.7
Cobbley	61.9
Difference for significance	7.9

Seed Size and Sprout Count

An analysis of all of the data where any one planter was tested with seed of two or more sprout counts per viable segment showed that on the average the percent singles decreased 3.0 percent for each increase of .1 in number of sprouts per viable segment.

Some of these results merely substantiate previous results but do give data which definitely show differences to be significant. The results with different planter speeds and with different seed sprout count make it possible to compare planters where different seed or speeds are used. It is rather significant that an increase in seed sprout count of .2 as from 1.2 to 1.4 sprouts per viable segment decreases the percent singles by 6.0 percent, which is nearly as much as the significant increase in percent singles obtained by replacing the flexible seed tubes of a John Deere No. 55 planter with the small straight seed tubes.

It has been suggested that the average size of the largest gap between seedlings in rows planted with different planters be used as a measure of the seedling distribution of the planter. Observations of the largest gap of each seedling stand count made in this study were made and the averages for each planter were adjusted to the average seedling stand. These average largest gap data are shown in the last column of the table and are directly comparable. There are some differences which roughly correspond to differences in percent singles, but in general the differences are not at all significant. The average largest gap for all the planters might be used as a measure of the germination condition of the field, but the percent of field emergence used later in this report seems to be a much better measure of the germination condition of a seed bed.

A study of the results of this planting and of our planting experience this spring leads to the following recommendations for planter design to improve seedling distribution characteristics:

1. Use small diameter, straight (or as nearly straight as possible) seed tidies dropping the seed in the bottom of the opened furrow and not into the V between opener disks.
   a. Tubes as small as 9/16 inch inside diameter are satisfactory. Smaller seed tubes with the seed properly guided into the tubes probably are satisfactory but we have no evidence on this.
   b. Seed tubes do not need to be a polished material inside like chrome plate, but care should be taken to determine that small seed tubes are free from spider webs, bugs or other obstructions each time planting is begun.
   c. Seed tubes should be as long as possible, preferably about down to the bottom of the opener disks in lifted position.

d. Have as near a fool proof and streamlined a transition of seed from plate to upper end of seed tubes as possible.

2. Use seed plates with round hole cells beveled up from the bottom with a 10° to 15° included angle reamed.

a. Have cells 1/64 inch larger than the largest size of seed in the range being planted; that is, 11/64 inch cells for 7 to 10 seed and 10/64 inch cells for 7 to 9 seed.

b. Use plates of a thickness not over 1/8 inch for 7 to 9 or 7 to 10 segmented seed.

c. Use plates and false plates with machined surfaces to give true surfaces and a minimum of grinding of seed.

3. Keep planter speed down to not over 2 1/2 miles per hour.

4. Take out all play or back lash in planter drives to the seed plates.

5. Clamp seed hoppers down firmly and be sure the clamping arrangement pulls the hopper down squarely and that the plates run without binding after thc hopper is clamped down.

6. Hopper height—No data which we have obtained or seen indicates that a planter with seed hoppers set. directly on the disck opener castings to reduce the seep drop by a few inches gives any better distribution than one with the hoppers mounted directly on the planter frame as they normally are on the John Deere Xo. 55 planter if suitable small diameter seed tubes are used. Furthermore, the drives to the lower hoppers floating up and down are more elaborate and are likely to provide more allowance for back lash. I would therefore recommend continuing to mount the seed hoppers on the planter frame. Sales pressure may make it desirable to use the hopper mounting on the opener, however.

Study of Germination Characteristics of Planters

The second type of beet planter investigations was that of planter characteristics which affect field germination. Early, mid-season, and late-season plantings were used because weather is generally such a major factor in controlling field germination conditions. The first was planted on April 11 and 12 and soil moisture conditions were apparently ideal for normal planting. The soil had just dried out nicely to plant following a snow of about 12 inches. This planting was followed by another 12-inch snow and other lighter snows and rains so that we could not get into the field again until April 30. Moisture was therefore ample but the temperature was chilly and germination was very slow.

The second was put in on May 12 and 13 on a seed bed which

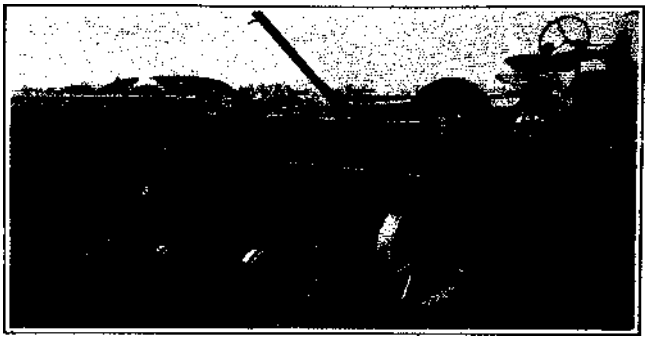

Figure 3.—Putting in planter plots with John Deere No. 55 sugar beet planter equipped Willi special planting equipment—two left openers with furrowers behind disk opener ; right center is regular opener ; right opener with V-rim press wheels.

had good moisture up to about an inch and a half from the surface. This seed bed had been worked up with a duck foot and spike tooth harrow 1o dry it out and give a seed bed with the surface on the dry side. However, rains followed which brought the moisture up to an optimum for germination and in that way did not give the dry planting we desired. The third was put in on June 29 and 30, which was the earliest that our seed bed could be put in a condition where it was definitely on the dry side and we were sure germination would be low with standard planting. There were some light showers on this planting but none ever wet down to the seed and the results were very different with different equipment.

On these germination studies we were concerned only with the percentage of the possible sprouts which actually came up. Germination counts therefore consisted of a count of the number of seedlings per 100 inches. Seeding rates were carefully determined and the potential number of sprouts for each planting was determined from the sprouts per hundred segments obtained in seed laboratory tests, the seed segments per pound, and the seeding rate. Results for each type of planting equipment are shown in tables *2,* 3, and 4 for the three sets of plots as the field germination expressed in percentage of potential germination. The average field germination in Colorado expressed in this manner will usually range from 30 to 50 percent of potential germination.

The equipment used for the three sets of plots was much the same. On the first planting, treatment A was with the John Deere No. 55 used in the distribution study previously described, and the small,

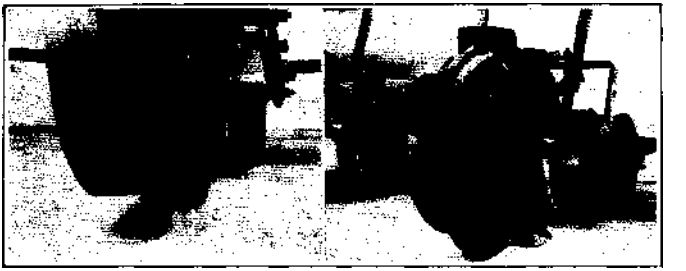

Figure 4.—Disk furrow openers with left disk removed to show small, moist soil, seed covers between disks. On the left is a single side coverer and on the right a double coverer. These coverers were designed to bring in a small amount of moist soil from the bottom of the furrow and cover the seed with it before dry soil fell in, but the devices did not improve germination significantly.

straight seed tubes were used. Depth was controlled in the usual manner with depth bands set in l 1/2 inches from the edges of opener disks, giving 1 he actual planting depth of approximately 1 1/4 inches. On B the planting depth was controlled with the press wheels and was supposed to have been the same as A, but actually was deeper. Plantings C and D were with small, seed coverers which were developed to work between the opener disks and bring in a small amount of moist soil over the seed from the bottom of the opened furrow before dry surface soil fell in on the seed. These coverers were made single to bring in soil from only one side and double to bring soil from both sides. A special double set of V-rim press wheels were used for E in an attempt to obtain better covering and firming of the soil around the seed.

A set of furrowers was made up patterned after those developed by Great Western at Windsor, Colo., to use behind the opener disks. Depth bands were used on the opener disks to give about a 2 1/2 inch depth of planting (bands set 2 1/2 inches from disk edges), and the furrowers behind the disk openers were set to remove about 1 1/2 inches of soil and leave about 1 1/4 inches of soil over the seed. This produced a furrow type planting which was used for F and with the small seed coverers for G and H.

A small stream of water at the rate of about 150 gallons per acre was applied down the seed opener fertilizer spout for I. A similar stream of water was used for K except that it was applied just behind the single small seed coverer. In both cases the press wheels filled the opened furrow, leaving no evidence of the application of water on the seed.

Table 2.—Summary of results, first planter equipment germination study; 7-10 segmented. G. W. No. 92, seed treated with 4 ounces New Improved Ceresan and 12 ounces fume phosphate per 100 pounds seed; planted 4/11 and 12/45 at approximately 4 pounds per acre.

Tmt.	No. of counts	Planter and equipment	Field germination (percent of potential)
A	42	J.D. No. 55; regular with depth bands set to give 1½-inch depth	46.3
B	24	J.D. No. 55; depth controlled with presswheels	27.1
C	20	J.D. No. 55; small, double seed coverers between disks and otherwise same as A	37.6
D	20	J.D. No. 55; small, single seed cover, otherwise same as A	38.3
E	24	J.D. No. 55; with double set of V-rim press wheels	45.4
F	24	J.D. No. 55; Windsor furrowers behind opener	38.5
G	20	J.D. No. 55; Windsor furrowers behind opener and small single seed coverer	43.8
H	19	J.D. No. 55; furrowers behind with small, double seed coverer	35.2
I	24	J.D. No. 55; regular opener with water on seed	43.6
J	24	J.D. No. 55; furrowing shovels ahead of opener	9.6
K	24	J.D. No. 55; with water following single, small seed coverer	43.5
L	20	J.D. No. 55; furrower ahead and small, double seed coverer	28.2
M	20	J.D. No. 55; furrower ahead and small, single seed coverer	23.7
N	20	J.D. No. 55; ridging disks following presswheels and double seed coverers	16.8
O	20	J.D. No. 55; ridging disks following presswheels	10.5
P	24	McC-Drg No. 40; ridging disks following presswheels	16.0
Q	24	McC-Drg No. 40; regular with depth bands set for 1½" depth	54.0
		Difference require for significance (95-percent level)	6.8

Furrowing shovels ahead of the disk openers which acted much like the clod pushers often used in California were used for planting J. The shovels were set to furrow about 1 1/4 to 1 1/2 inches deep, and nomal depth planting was put in in the opened furrow. These same fur-rowers ahead of the openers were used for L and M with the small seed coverers described above. These furrowers as well as those used for F, G, and H are used to get the seed down into moisture when the surface soil is dry. They were used on the early plantings to see if they would be objectionable where there might be excess moisture either at planting time or immediately afterwards.

Pairs of small Plant Jr. ridging disks of 7-inch diameter were used behind the press wheels for plantings N, O, and P. The ridge which was about 1 1/2 inches high was supposed to hold the moisture for germination and then be removed before the sprouts got up into the ridge. It developed that these ridges had to be removed by the fifth day after planting when germination conditions were favorable so that the ridges could be safely removed without damaging the sprouts.

Figure 5.—Putting in planter plots with McCormick-Deering No. 40 sugar beet planted equipped with furrowing disks on the front of the 1 wo left disk openers and with furrowers behind the openers; on the two right openers.

Plantings P and Q were put in with the McCormick-Deering No. 40 planter with the regular deep concavity press wheels. Planting Q was with the planter operating normally and with depth bands set in $1^{1}/4$ inches from the edges of the disks. The press wheels used on the John Deere No. 55 planter were of the flat-beveled-rim type giving only slight concavity to the pair.

The lettering of treatments is different for the second set of germination study plots but the only differences in equipment used are as follows: For planting X the regular John Deere press wheels used in the furrow planting were replaced with one pair of the V-rim press wheels used for E. Sets of furrowing disks to act as clod pushers or furrowers ahead of the seed furrow openers were used for planting R. Plantings T and V were put in with decorticated seed prepared for us from our base seed by the California Experiment Station at Davis. In one case the seed was planted dry and in the other the seed was presoaked and surface dried for planting.

The results for the first and second set of germination study plots will be discussed together since they were more or less similar because of similar moisture conditions. In general the standard or check plantings were the best and most of the other special plantings had a more or less detrimental effect on germination. On the first

Table 3.—Summary of results, second planter equipment germination study. Planted 5/11 and 12/45 with 7-10 G. W. No. 92 segmented seed treated with 4 ounces New Improved Ceresan and 16 ounces fume phosphate per 100 pounds of seed. Planted at aproximately 4 pounds per acre.

Tmt.	No. of counts	Planter and equipment	Field germination (percent of potential)
A	40	J.D. No. 55; regular with depth bands set for 1½-inch depth	66.5
B	16	J.D. No. 55; depth controlled with press wheels	39.2
C	16	J.D. No. 55; small, double seed coverers	78.5
D	16	J.D. No. 55; small, single seed coverer	66.9
E	16	J.D. No. 55; with double set of V-rim press wheels	67.6
F	16	J.D. No. 55; Windsor type of furrowers behind opener	35.2
X	16	J.D. No. 55; Windsor type of furrowers behind opener and one pair of V-rim press wheels	47.1
V	16	J.D. No. 55; furrowers behind openers with depth controlled by press wheels	44.7
G	16	J.D. No. 55; Windsor type furrowers behind openers and single small coverer	37.0
H	16	J.D. No. 55; Windsor type furrowers behind openers and double small coverers	43.6
I	16	J.D. No. 55; with water on seed	57.8
J	16	J.D. No. 55; with furrowers ahead of openers	25.4
K	16	J.D. No. 55; water following single small seed coverer	62.0
L	16	J.D. No. 55; furrows ahead and small double coverers	21.0
M	16	J.D. No. 55; furrowers ahead and small single coverer	20.6
W	16	J.D. No. 55; furrowers ahead set for shallower planting	49.5
NO	16	J.D. No. 55; small Planet Jr. ridgers following press wheels	63.3
Q	16	McC-Drg: regular with depth bands set for 1¼-inch depth	67.0
P	16	McC-Drg; small Planet Jr. ridgers following press wheels	66.0
R	16	McC-Drg; small furrowing disks ahead of opener disks	22.3
S	16	McC-Drg; furrowers behind openers	32.0
T	16	McC-Drg; 7-9 wet decorticated seed, 1¼ inch depth bands	31.2
U	16	McC-Drg; 7-9 dry decorticated seed, 1¼-inch depth bands	44.5
		Difference required for significance, treatments of 16 counts	9.3
		between treatments of 16 and 40 counts	7.8

planting the differences between Q, A, and B are, I believe, attributable to depth of planting. The shallower planting Q did significantly better and the deeper planting B was significantly poorer than A, probably because of the cold, slow germination weather.

The furrow plantings of both sets of plots were very significantly poorer than the regular planting. This was largely the result of going in poorly and poor covering of the seed. None of these furrow plantings went in well or covered well where the surface soil was moist and the subsurface soil was moist and firm. The planting with furrowers ahead of the openers went in particularly poorly because ribbons of moist soil came up around the outer edges of the opener disks and in dropping off left a rough surface and not enough pressure could be put on the press wheels to cover the seed. It seemed that this type of planting should be used only when necessary to get the seed down into moisture. Then, too, these rows were harder to thin

Table 4.-Summary of results, third planter equipment germination study. Planted 0/29 and 30/45 at 4 pounds per acre with 7-10 segmented G. W. No. 92 seed treated with 4 ounces New Improved Coresan and 12 ounces fume phosphate per 100 pounds of seed except as noted.

Plt'g.	Planter and equipment	Field germination (percent of potential)
B & 1	J.D. No. 55; regular opener with bands at 1½-inch depth	6.6
D	J.D. No. 55; small double seed coverers between disks	8.1
E	J.D. No. 55; small single seed coverer between disks	9.4
C	J.D. No. 55; double set of V-rim press wheels	11.2
H	J.D. No. 55; regular opener with bands at 2-inch depth	31.1
J	J.D. No. 55; regular with bands at 1¼-inch depth and IHC press wheels	7.6
A	J.D. No. 55; Windsor type furrowers behind openers, bands at 2¾-inch depth	47.6
N	J.D. No. 55; furrowing shovels or cind pushers ahead of openers	47.6
F	J.D. No. 55; stream of water following small single seed coverer	9.9
G	J.D. No. 55; stream of water following directly on seed	16.5
K_1	J.D. No. 55; large ridgers (2½-inch ridges); ridges removed	8.4
K_2	J.D. No. 55; large ridgers (2½-inch ridges); ridges left	1.4
L_1	J.D. No. 55; small ridgers (1½-inch ridges); ridges removed	4.7
L_2	J.D. No. 55; small ridgers (1½-inch ridges); ridges left	2.2
M	J.D. No. 55; regular openers, bands at 1¼-inch, 8-11 whole seed in 12/64-inch cells at 3.61 pounds per acre	2.5
O	J.D. No. 55; regular opener, 7-9 dry decorticated seed	2.0
P	J.D. No. 55; regular opener, 7-9 wet decorticated seed	4.7
Q	McC-D No. 40; furrowing shovels behind openers, bands at 2¾ inches	28.5
R	McC-D No. 40; furrowing disks ahead of openers	22.2
S	McC D No. 40; regular openers with bands at 1¼-inch depth	6.3
T_1	McC-D No. 40; small ridgers (1½-inch ridges); ridges removed	2.0
T_2	McC-D No. 40; small ridgers (1½-inch ridges); ridges left	1.0
U & V	J.D. Experimental planter	7.6
W	J.D. low hoppered No. 55, bands at 2 inch depth	18.4
X	J.D. low hoppered No. 55, bands at 1¼-inch depth	2.0
	Difference required for significance (95 percent)	4.9

than normally planted rows because it was hard to get the hoe down into the furrow.

On the first set of plots the ridged plantings could not be uncovered because the field was too wet to work for 38 days after planting and by then the sprouts were up into the ridges. These plantings were therefore very poor. On the second set of plots the ridges were removed in 5 days after planting and these plantings were practically identical in germination with the rows planted normally.

In general the small seed coverers did no good and sometimes reduced germination. The V-rim press wheels gave results about the same as regular planting except that when used in furrow planting as for X in the second set of plots, they produced better seed covering

Figure 6.- Equipment used for putting in the covered or ridged row. sugar beet, plantings. The two left openers have the largre ridging disks and the two right the smaller disks. Ridges must be removed by about the fourth dav after planting- before the sprouts get up into the ridges.

and increased germination. Water on the seed seemed to depress germination slightly on both sets of plots but not significantly so. For some reason the germination of both wet and dry decorticated seed on the second set of plots was significantly different and significantly below the regular plantings with segmented seed.

The seed bed on the third set of germination study plots was distinctly on the dry side as shown by the very low field germination of the regular plantings. Some new equipment or treatments were used on this set of plots which were not used on the first two sets. Planting H is similar to B and I which are regular except that for II the depth bands were set in 2 inches from the disk edges. Larger ridging disks were used for K_1 and K_2 than those previously used and used on this set of plots for L_1 and L_2, T_1 and T_2. These larger disks replaced the press wheels and made ridges 2 1/2 inches high. They were adapted by Great Western at Windsor in an attempt to bring up moist soil over the planted row. The John Deere experimental low-hoppered drill was used for U and V, and a special low hoppered John Deere No. 55 drill built up at Windsor was used for W and X.

The only very good germination stands on this planting were obtained with the furrow planting. Both the furrowers ahead of the openers and behind were equally good and both plantings went in in nice shape. The planting with depth bands set for 2 inch depth

(actual planting depth approximately 1¾ inches) was very much better than that with bands set for 1½ inch depth (actual depth approximately 1¼ inches), showing that the shallower planting hardly got into moisture. Water directly on the seed increased the germination percentage significantly and the V-rim press wheels improved germination but not significantly so. The furrow plantings and the 2 inch depth of planting were the only ones which would produce a satisfactory thinned stand in this set of plots.

The percentage of field emergence was worked out for the seedling distribution study plots and is shown in column three of table 1. It contains some interesting results. The John Deere No. 66 experimental planter gave significantly better germination. This might have been because the planter was heavier and more pressure could be put on the press wheels. The seed bed was on the firm side and considerable press wheel pressure was needed to cover the seed. This was shown by the fact that not enough pressure could be put on the Mcormick-Deering planter deep-concavity press wheels to cover the seed well and the germinations with this planter were usually significantly lower.

Another thing of particular interest was the high germination with the Rassmann unit. This unit used a double disk opener with a small secondary runner opener in the bottom of the opened furrow. Planting 18 with a small scraper between the disks to flatten off the bottom of the furrow opened by the disk opener was also significantly better than regular planting. Apparently something should be done to the bottom of the opened furrow to smooth or flatten it to improve field germination.

The germination of the pelleted seed was very low when based on the germination of the base seed used for pelleting. However, when field germination is based on seed laboratory germination tests the percentage field germination on this planting was not much lower than the regular plantings, though the number of seedlings was low. The germination of the decorticated seed was very significantly higher than for the segmented seed planting on this set of plots, which is a reversal of results from those in the second set of germination study plots. Wet and dry decorticated seed here were practically the same.

This matter of field emergence is now probably more important in its bearing on mechanized thinning than further improvements in seedling distribution. It is a problem to which we intend to give increased attention.

A study of the data obtained in the planter germination investigations and our experience this past spring prompts the following sug-

gestions, particularly for Colorado conditions, for improving the percentage of field emergence, though they are not listed in any order of importance:

1. Use more pressure on press wheels, particularly on firm seed beds. Care must be taken not to overdo this because the planter weight will be largely carried on the press wheels and slippage will be excessive.

2. Loosen up the surface of firm seed beds by surface harrowing prior to planting. Tins also is effective in control of early weeds which come in fields where planting is delayed by rains or snows.

3. Use deep concavity press wheels with considerable pressure for loose seed beds.

4. For firm seed beds use shallow concavity press wheels or set deep concavity press wheels close together and be sure the seed is well and firmly covered.

(5). Level, scrape, or smooth out the bottom of the seed furrow before dropping seed. Considerable experimental work should be done to develop suitable equipment to do this.

(6). Use shallower depths for early plantings when germination is slow and moisture may be excessive.

7. Use deeper plantings for later plantings when soil is likely to be dry and germination is rapid.

8. Use furrow planting only when necessary to get the seed into moisture. The furrow planting with furrowers behind the disk openers usually goes in better and the depth can be more accurately controlled than with furrowers ahead of the seed furrow openers.

9. Our plantings have not shown the ridged planting to be of any benefit. However, for late plantings or for irrigating up or in weedy conditions where removal of ridges would assist in weed control, the ridged planting probably would be desirable. It should be used only where one has assurance that the ridges can be removed in lime to avoid damage to sprouting seedlings.