BEET PLANTER DEVELOPMENT TO IMPROVE SEEDLING EMERGENCE

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The importance of improved and more uniform field emergence of sugar beet seedlings from the seed planted has become increasingly evident as seeding rates have been successively decreased. The reduction of seeding rates during the past several years from around twenty pounds per acre to four or five has been made possible by improvements in the uniformity of seed distribution by planters and the combination of the two, together with processed seed, have enabled great savings in the labor required for beet thinning. Low and eratic percentages of seedling emergence and the accompanying spotty beet stands have become one of the limiting factors in these labor saving developments.

Field emergence in the intermountain area will usually not range over 30 to 50 per cent of the possible seedlings from the seed planted on the better plantings. Often it is considerably less and ranges down to the point where replanting is necessary. Yet one planting which we put in near Fort Collins in 1945, a planting which germinated from moisture in the soil at planting time, averaged nearly 90 percent field emergence. Furthermore the emergence is very erratic. On typical 1946 plantings the percent of field emergence, determined on hundred-inch counts, had the following ranges: 17 to 65; 17 to 44; 5 to 37; 14 to 52; 10 to 64 and 5 to 53. It is evident that either the planting equipment or the seed bed, probably both, needs considerable improvement to give uniform, higher field emergence.

On our 1945 planter plots there were two seed furrow opener modifications which showed particular promise for improving seedling emergence. The first consisted of a bar scraper between the opener disks of an ordinary disk furrow opener to smooth or flatten off the bottom of the furrow slightly above the level of the bottom of the disks. The disks of such an opener are closest together at about normal ground surface and if the soil stood up perfectly a sort of a W shaped furrow bottom would result. The bar scraper flattened this furrow bottom. The other opener was a 1944 Rassmann planter opener which utilizes a small runner opener for the seed furrow between the two disks of a conventional disk opener. These two openers gave a significantly better field emergence indicating, it seemed, that some modification of the bottom of a disk opened seed furrow was necessary.

Our 1946 beet planter studies, consisting of forty different planting equipment set-ups, included the two above mentioned types of openers and several other special openers, some along the same idea, and were chiefly planned to study field emergence characteristics of planters though some seed distribution studies were included. Two nearly identical plantings were made with this equipment to study results under different seed bed conditions. All of the results reported here were put in with 7 to 9/64" segmented seed of high germination and sprout count.

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The first planting was made on April 29 to May 2 and was similar to perhaps 90 percent of the commercial beet plantings in our district this year in that it went into a dry seed bed and didn't come up until rains fell the early part of May. The seed bed was dry down to a 3 1/2" depth and was somewhat loose and contained many small dry clods. No seeds at all germinated until a rainy spell set in on May 5th and 1.08" of rain fell in six days with about equal amounts falling each day. Some rain fell every day or two for the rest of the month bringing the precipitation for the month up to 2.68". The seedlings emerged during this period, but quite slowly as it was rather cool for germination. The ultimate field emergence averaged 43.3%, but differences for different planting equipment, except different depths of planting, tended to be eliminated by having the moisture come this way. There was therefore less variation between counts though a difference of - 5.22% in field germination was needed for significance between different treatments with 20 stand counts each.

The second planting was considerably delayed because of wet weather and was not put in until June 5th and 6th. The seed bed was moist, firm and in excellent condition for planting when this set of plots went in, but several days of drying winds very shortly afterwards dried out the soil somewhat too fast. However fairly good germination resulted from the moisture in the soil. The field emergence averaged 33.1%, significantly lower than on the first planting, and there was a greater variation between hundred inch germination stand counts. A difference of - 7.2% in averages of 20 stand counts was necessary for significance.

The most striking differences in percent of field emergence on these two sets of plots were in different depths of planting. A standard double disk furrow opener was used for the depth of planting comparison. Three nominal planting depths were used, 1", 1 1/2" and 2". That is the depth bands were set in from the disk edges those amounts. Actual planting depths are about 1/4" less than nominal depths as far as could be determined.

The resulting field emergences at the three depths on the two plantings were as follows:

	1st planting	2nd planting
1" depth	50.3%	20.9%
1 1/2" depth	40.4%	35.0%
2" depth	30.9%	36.5%
Difference required for significance	-5.2%	-7.2%

It will be noted on the first planting that field emergence was significantly poorer with each increase in planting depth. Germination resulted from rains following planting and during a relatively cool period and the deeper plantings were too deep. Just the reverse happened on the second planting where the shallow planting was significantly poorer than the other two. Here the drying seed bed left more of the shallow seeds too dry to germinate than on the deeper plantings while with the warm, aerated seed bed, both the 1 1/2 and 2" depth plantings germinated practically the same.

These results emphasize the need to very carefully keep planting depths the same for different planting equipment being compared for field emergence. Differences in percent of field emergence obtained with different types of planting equipment may be the result of slightly different planting depths rather than actual differences between equipment as will be pointed out later.

The summarized results of the seedling emergence portion of the 1946 beet planter studies are shown in the following table. The average percent of field emergence obtained on each planting with each type of equipment is shown together with a reference number and the number of counts which are averaged. This latter number is included so that the proper difference required for significance, shown at the bottom of the table, can be used.

The planter used as a check had John Deere regular disk furrow openers with depth bands set in 1 1/2" from edge of disks and with bevel rim press wheels set with the usual space of about 3/4" between them. The pressure rod was set in the middle hole of its three possible positions and as much pressure was put on the four planter openers as possible without getting over 4 or 5% planter drive wheel slippage. The field emergence with this opener unit, as shown on reference line 1 of the table, was 43.1% on the first planting and 31.3% on the second.

The use of the bar scraper between the disks, which had shown promise in 1945, produced no significant improvement over the check planting as shown in line 2. In fact there was a tendency to be poorer on the first planting but not significantly so. A device made up and tried in 1945 for bringing in moist soil from the bottom of the furrow to initially cover the seed was tested again this year. In 1945 no significant improvement was obtained with this device, but this past spring it gave a very significant increase in field emergence on the more or less normal second planting as shown in line 3, but no improvement on the dry seed bed of the first planting. Both this small seed coverer and the bar scraper between disks were used together and, as shown in line 4, gave significant improvement on both plantings though only barely so on the first planting.

A new Rassmann single seed planting unit which was practically the same as the one showing promise in 1945, as far as furrow opener was concerned, did not show improved field emergence in 1946 as shown in line 5. In fact it was practically the same as the check on the first planting, but for some reason was significantly poorer on the second planting. The older Rassmann unit used in 1945 was also tested again, but though its results were practically the same as those with the 1946 unit listed on line 5, its results are not included in the table as a different sized seed had to be used in it.

Another style of disk opener with small runner or shoe between the disks which was made by Rassmann in 1935 was also included in the tests. It gave significantly better emergence on the second planting, but practically the same as the check on the first planting as shown in line 6. With this opener the seeding mechanism was the regular John Deere can and a flexible ribbon seed tube was used.

A special shoe or runner was made to use between the disks of a regular disk opener. With this opener it was necessary to drop the seed down the fertilizer spout of the disk casting as the shoe was attached at that point. It was necessary to use a flexible seed tube, but for seed distribution studies

not reported here, shorter draw bars and a small straight, smooth seed tube was used for comparison. The field emergence with this unit was very little different from the check planting as shown in line 7.

Another modification of the regular disk opener which was made and tested consisted of a small shoe on the lower end of a straight seed tube which ran down the fertilizer spout of the opener casting. The bottom of the narrow shoe merely divided the small ridge of soil left between the disks and flattened it off. The emergence data with it is tabulated on line 8. There was very little difference between it and the check on planting one, but for some reason or another it was very significantly lower on the second planting. Something must have gone wrong on that test for it isn't greatly different from some of the other equipment tested, but no observations, notes or data indicate what it was. The rate of seeding was normal.

Both the John Deere and McCormick-Deering beet planters now being built are equipped with deep concavity press wheels which can either be set close together or as usually set are separated about 3/4". Line 9 shows the emergence data obtained with a regular disk opener equipped with deep concavity press wheels set separated in place of the bevel rim press wheels used on all of the previous equipment. The field emergence tended to be lower but not quite significantly so. Later in the report a further more complete comparison of the results with different press wheels will be made.

Comparative tests between runner and disk openers were also included in the plots. The next three pieces of equipment listed in the table, lines 10 to 12, are runner openers. First in line 10 is a regular John Deere No. 55 planter runner opener with deep concavity press wheels and the regular flexible seed tube used with this opener. Next in line 11 is the same runner opener but with bevel rim press wheels. Line 12 gives the data on an old No. 8 John Deere planter runner opener mounted in the No. 55 planter draw irons and used with bevel rim press wheels. This runner makes a narrower seed furrow which is felt by some to be better. The data shows a tendency for the bevel rim press wheels to be better, This becomes a significant difference on the second planting, line 12, where the slight advantage of the narrower runner is added to that of the press wheels.

Cobbley seeding units were used on two different openers. One was a regular John Deere disk opener and logically should not be and wasn't significantly different from the check as shown in line 13. Differences in seed damage by the two types of seeding mechanisms, if there was any appreciable difference, would account for differences in field emergence. The other Cobbley unit was in a Lindeman Plant-trol seeding unit which uses a small round bottom shoe or runner opener very much like that used by a Planet Jr. seeder. The field emergence with the Plant-trol unit, as shown in line 14, was significantly better on the second planting but no different on the first.

A type of planting referred to as furrow planting has occasionally in the past shown improved field emergence, particularly on dry surface seed beds where there was moisture somewhat deeper. The equipment used for this planting is a disk opener with depth bands set in 2 3/4" from the edge of the disks to give deep planting. The disks are followed by a furrower set to run about 1 1/4" below the ground surface, thus leaving about 1 1/4 to 1 1/2" of soil

over the seed, and followed by regular bevel rim press wheels. This opener as shown in line 15, gave a slightly better, but not significantly better, emergence on the first planting, but gave a very much poorer emergence on the second planting. This bore out our last years' experience in that where this type of planting is used on a moist seed bed, it goes in poorly and the field emergence is low.

Lines 16 and 17 give the data on regular McCormick-Deering disk and runner openers with their regular deep concavity press wheels. The data in lines 16 and 17 are comparable with that in lines 9 and 10 which are for disk and runner openers with the same type press wheels. The McCormick-Deering runner openers were probably running slightly deeper than the disk openers which would account for lower emergence on the first planting and higher on the second. A quarter inch deeper would account for the larger difference on the second planting.

Seedling Emergence Results on Beet Planter Tests

Ref. No.	Planting Equipment	No. of Counts	% Emergence 1st. Pltg.	% Emergence 2nd. Pltg.
1	JD disk opener 1 1/2" depth, bevel rim press wheels	120	43.1	31.3
2	JD disk opener with bar scraper between disks	20	40.2	32.3
3	JD disk opener with moist soil seed coverer	20	44.3	41.1
4	JD disk opener with bar scraper and seed coverer	20	47.4	40.2
5	1946 Rassmann unit (runner between disks)	20	43.6	22.3
6	1935 Rassmann opener (runner between disks)	20	42.2	40.4
7	JD disk opener with runner between disks	40	44.9	33.9
8	JD disk opener with small shoe on seed tube	20	44.9	17.5
9	JD disk opener with deep concavity press wheels	20	39.5	29.3
10	JD runner opener with deep concavity press wheels	20	39.9	33.5
11	JD runner opener with bevel rim press wheels	20	41.7	36.3
12	JD #8 runner opener with bevel rim press wheels	20	43.4	37.7
13	Cobbley seeding unit on J. D. disk opener	20	41.5	31.8
14	Cobbley unit on Lindeman Plant-trol unit	20	42.2	39.6
15	JD disk opener equipped for furrow planting	20	46.7	15.0
16	McCD disk opener with deep concavity press wheels	80	41.9	29.7*
17	McCD runner opener with deep concavity press wheels ***	60	38.1	35.1*
	Difference required for significance, 16 and 17		±3.0	±3.2
	Differences required for significance			
	20 and 20 counts		±5.2	±7.2
	20 and 60 counts		±4.3	±5.9
	20 and 120 counts		±4.0	±5.5

* 100 counts

*** Probably running slightly deeper than 15 thereby at least partially accounting for difference.

Some of the data in the table has been combined where equipment is the same to make further comparisons. For example lines 1 and 9 can be combined and paired with that from lines 11 and 10 to get a better comparison between disk and runner openers. The results are as follows:

	1st. planting	2nd. planting
Disk openers	41.3	30.3
Runner openers	40.8	34.9
Difference for significance (40counts)	±3.7	±5.1

The combined data shows practically no difference between the disk and runner openers on the first planting and not quite a significant difference on the second. The difference on the second planting again could be the result of a quarter of an inch greater depth of planting with the runner.

A similar further comparison between bevel rim and deep concavity press wheels can also be made by combining the data in lines 1 and 11 and pairing with that in 9 and 10 as follows:

	1st. plantg.	2nd. plantg.	Average
Bevel rim press wheels	42.8	33.8	38.3
Deep concavity press wheels	39.7	31.4	35.6
Difference for significance (40 and 80 counts)	±3.7	±5.1	±3.1

The difference is not significant in any case, but the tendency is consistent. In general the deep concavity press wheels tend to ride on their rims on a firm seed bed and do not obtain as good seed covering as the bevel rim press wheels. The covering of seed and resulting field emergence could very probably be improved by setting the deep concavity press wheels close together. Unfortunately no test was made with the press wheels so set as this came to our attention after the plantings were made in.

A special set of press wheels was built up for us by International Harvester and tests were included on these plantings. These press wheels consisted of two pair of heavy, solid cast iron wheels with sharp, steeply beveled rims and mounted in staggered pairs so that one wheel of each set came between the two wheels of the other set. The set weighed seventy pounds. Several different comparable equipment set-ups were tested with and without these special press wheels and the combined data gives a good comparison with the regular press wheels. The combined data is as follows:

	1st planting	2nd planting
Regular deep concavity press wheels on disk and runner openers	37.5	31.8
4 V press wheels on disk and runner openers	41.1	37.9
Difference necessary for significance	±3.7	±5.1

The special press wheels produced an improvement in field emergence which was nearly significant on the first planting and was entirely so on the second. The wheels cut in badly and caused some difficulty on the first planting because the seed bed was so dry and somewhat loose. In fact all pressure spring pressure had to be removed to get them to work at all. They worked fine on the second planting with a moist seed bed, but probably should have been of somewhat larger diameter to work under all conditions apt to be encountered.

To summarize briefly, in general the differences between field emergence obtained with all of the planting equipment were not significant on the first planting. Ample moisture for germination and the settling effect of the repeated rains tended to wipe out any differences which might have existed. However, depth of planting on the first planting had a very significant effect on field emergence thus substantiating previous experience. Early plantings which will probably receive plenty of moisture for germination and which will probably have to germinate in cool weather should be planted shallower, probably about 1" deep. The opposite condition usually exists on later plantings where the seed bed dries out rather rapidly and deeper plantings of 1 1/2" and even up to 2" in some cases, have a higher percentage of field emergence.

On the second planting which was typical of a mid- or late-season planting in a good, moist seed bed, significant improvement in emergence was obtained with the moist soil seed coverer and with some of the more or less round or blunt bottom small runners or shoes between the disks. The narrow runner opener tended to show improvement but this might have been because of slightly deeper planting as the depth of planting is harder to control and determine with a runner opener. The special heavy, sharp rim press wheels were significantly better than the deep concavity press wheels where the seed bed was moist and firm enough so that the special wheels would work properly. The bevel rim press wheels tended to be better than the deep concavity press wheels when the latter were set about 3/4" apart as they usually are set.

The wide variation in field emergence on hundred inch counts with even the best types of openers on what are apparently good seed beds seems to indicate that our seed beds are too variable and not as good as they should be. We know from grease-board tests that the variation in seed drop in hundred inch runs is not great and that the extreme variation in emergence must result from some other cause. Further work to obtain improved and more uniform emergence should include studies of seed beds and bed preparation in addition to that on planting equipment.

Appendix

Examples of average field emergence of sugar beet seedlings under various conditions near Fort Collins, Colorado in 1945.

	Percent Emergence
Dry, fairly loose surface, firm sub surface seed bed, moderately fine but with numerous small clods 1/2" to 1" diameter, moisture at approximately 2" depth, late June planting with disk opener planters with depth bands set for 1 1/2" depth.	7
Same conditions except with depth bands set for 2" depth.	25
Same conditions but with furrow planting. (Seed planted 2 1/2" deep and 1 1/4" of soil removed with furrowing shovel).	48
Same conditions at 1 1/2" depth with seedlings irrigated up.	73
Fall plowing, left rough all winter, worked up in spring after about three inches of rainfall in March and April using double disk, spike tooth harrow and double floating with Eversman lever just before planting, planted May 9 with disk opener planter at 1 1/2" depth, some cloudy weather and light sprinkles after planting which kept soil from drying too fast, but no moisture soaked in or no crust formed.	90
Previous years' sugar beet ground, deeply disked in spring after good moisture from snows and rains, double floated and harrowed, planted with disk opener planter at 1 1/2" depth as follows:	
Planted in good moisture on 4/11/45 followed by .88" moisture from snow, then good germination weather.	46
Planted in good moisture on 5/3/45 followed by good germination weather.	36
Planted on freshly harrowed seed bed which was somewhat loose and dry on the surface but moist below on 5/11/45 followed by light rains and good germination weather.	66