A Press-Wheel Study To Improve Beet Seedling Emergence

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THE SUCCESS OF spring mechanization depends to a large extent upon the germination of a high percentage of the seed pieces placed in the soil and the emergence of a uniform stand of beet seedlings. With precision planting and reduced seeding rates all irregularities in field emergence are much more apparent than they were when heavy-seeding rates were used. Under ideal germinating conditions and with precision planters now available it would be quite possible to plant to a final stand eliminating entirely the necessity for any kind of thinning. If it were possible to produce ideal germinating conditions in the field, or to recognize the proper combination of equipment necessary, the problem of getting good emergence would be greatly simplified. Assuming that the essential elements necessary to produce a germinating condition are fairly well understood, the mechanics of producing optimum results under a variety of field conditions will require a great deal more study and experimentation.

To obtain as much information as possible on both the field conditions and the combinations of planter equipment necessary, the Colorado Agricultural Experiment Station, The U. S. Department of Agriculture, and the Beet Sugar Development Foundation have cooperated on some rather large-scale tests. In 1946, plantings with 8 types of press wheels were made in 8 different fields over a territory 600 miles wide in the Rocky Mountain area. In 1947, twenty-four different combinations of press wheels and other devices were used at only one location but with two plantings, on May 22 and August 8.

Weather conditions at planting time throughout the Rocky Mountain area in 1946 were universally dry. Seedbeds varied from fine-textured surfaces to cloddy; and from light sandy soils to heavy clay loam. In all cases the surface soil was too dry to germinate seed for a depth of from 1½ to 3 inches with plenty of moisture in the subsoil below. The earliest planting was made March 20 in dry surface soil and remained in dry soil for 5 weeks without rain or irrigation. Some plantings were made after rains had fallen, but the surface moisture was lost due to the necessity of working the field to kill weeds before planting. Without exception, the 1946 experiments were planted in dry soil which remained dry from a few days to 5 weeks after planting.

In 1947, the press-wheel test was planted at Fort Collins on May 22 in a moist firm seedbed and on May 23 a heavy rain fell on the plots. For the summer planting on August 8, the field was irrigated before planting

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and again after planting to overcome some of the effects of the hot weather. This planting was to serve the dual purpose of a press-wheel study and to provide beets of a proper size for thinning demonstrations at a later date.

Examination of table 1 will show that some of the devices which showed greatest promise in 1946 are at the bottom of the list in 1947. At first this seems to be very confusing and some early predictions had to be rescinded. Close analysis of all the facts will show that the principles involved are not at fault, but that the mechanical means of obtaining the desired soil and seed relationship must be different for different field conditions. To produce a germinating condition there must be a firm contact between the seed and moist soil surrounding the seed. In 1946, the dry surface soil responded to one type of mechanical equipment while the moist soil in 1947 required a different treatment to produce a firm soil around the seed.

Table 1.—Press-wheel emergence study.

Treatment	1947 Percentage comparison combining May and August plantings. Check = 100	1946 Percentage comparison of six replicated tests. Check = 100
1. Olsen-Beck with ¾" protruding sprockets (2 sprockets each ¼" thick)	136	---
2. Blunt sprocket with flat press wheels—teeth ¾" deep with the diameter of the root circle lying ⅜" above the surface of the press wheels	123	---
3. Wedge press wheels 10" diameter 1½" thick—22½° included angle	123	115
4. Sharp sprocket between deep concave press wheels—teeth ¾" deep with the diameter of the root circle lying 3/16" below the inside edge of the press wheel	118	---
5. 10" x 1½" double-rubber press wheels	118	117
6. 16" x 3½" single-rubber press wheel with light chain dragged behind	116	
7. 3" diameter press wheel in front of opener with standard press wheel behind	115	135
8. Olsen-Beck with two 3/16" thick sprockets between press wheels—outside diameter of sprocket flush with surface of press wheel	115	---
9. Blunt sprocket between standard press wheels—root diameter flush with inside edge of press wheel	114	---
10. English press wheel 5" wide	114	---
11. 10" x 1¾" single-rubber press wheel with chain dragged behind	113	---
12. English press wheel with smoother between discs (smoother failed and was removed)	110	---
13. 1¼" deep furrow firmer in front of opener with standard press wheels behind)	108	---
14. Smoother between discs with standard concave press wheels	108	---
15. Plain flat press wheels—9" diameter	106	134
16. 14" Sishc press wheel (3 abreast)—1½" apart—teeth 1¼" deep	101	---
17. Standard check. Plain deep concave press wheel (John Deere)	100	100
18. Cast iron beveled face press wheel. I.H.C.	94	---
19. 10" x 1½" flat steel press wheel with scraper (Bakersfield type)	92	---
20. 10" x 1½" flat steel wheel with scraper removed	89	---
21. 18" diameter Sishc wheel arranged 2 in front and 1 behind	82	154
22. 14" diameter Sishc wheel arranged 2 in front and 1 behind	80	---
23. Standard concave press wheels reversed—spaced ¾" apart	*	---
24. 16" x 3½" single-rubber press wheel with scraper in front, dragging chain behind	*	---
25. Western land roller wheels	Not tested	109
26. Standard I.H.C. press wheels	Not tested	125

*August planting only. Significantly better than the check.
Difference required for significance at the 5 percent level (19:1 odds) for 1947 = 12.5.
Difference required for significance at the 5 percent level (19:1 odds) for 1946 = 18.5.

The 18-inch Sishc press-wheel unit consisting of 5 sprocket-like wheels and weighing 165 pounds per unit gave consistently higher emergence in the dry seedbeds where there was insufficient surface moisture for immediate germination. The same arrangement used with abundant surface moisture was disappointing. The projections on the rim of the wheels packed the moist soil around the seed as the projections came down, but as the wheel rolled forward the moist soil stuck to the teeth and loosened the seedbed as they came up. Other types of press wheels such as the two 10-inch x 1½-inch rubber wheels and the 10-inch x 1½-inch wedge wheels were not significantly better than the check under the dry-soil condition, but they were significantly better when the soil was moist.

The first 11 treatments listed in table 1 were significantly better than the check in 1947, with treatment 12 about on the border line of significance. Treatments 23 and 24 were replicated, but at only one planting date, August 8, and in this one test they were found to be significantly better than the check plot. Treatments 21 and 22 were definitely poorer than the check in 1947 and number 19 was about on the border line of significance.

In the 1946 test the standard press wheels which were used as the check method was at the bottom of the list from the standpoint of emergence. The large Sishc press-wheel arrangement, the plain flat-press wheels 9 inches in diameter and the small press wheel in front of the opener were all decidedly better than the check. The Western Land Roller wheels, used as press wheels, the wedge press wheels, and the double-rubber press wheels did not show a significant improvement. For some reason the standard International press wheel showed considerable improvement over the standard John Deere wheels and they are very nearly the same size and shape.

The most consistent improvement was shown in 1947 by the addition of some kind of toothed projections between the two halves of the conventional type of press wheel with both the deep concave and relatively flat wheels. The length of the projection beyond the rim of the wheel evidently made some difference, but it would seem quite possible that if the projections were extended too far the same kind of action might be encountered as with the Sishc wheel. With the equipment used, the two parts of the conventional press wheel acted as a depth gage for the various toothed wheels. This type of equipment was not included in the 1946 test so the data cannot be taken as conclusive, however, the first year's results are encouraging enough to warrant further investigation of this type of equipment.

One other type of press wheel, which looked very good in the field, was a copy of an English planter. This was made of two circular steel plates 12 inches in diameter and 5 inches wide with heavy bicycle-wheel spokes running between the two plates forming a squirrel-cage arrangement. Inside the cage and rolling freely on the inside of the bicycle spokes was a piece of triple-strength tubing with a diameter a little less than half the diameter of the side plates. The differences with this device were significant and the action in the soil was very good. More tests should be made with it.

With only 1 or 2 years' data on the various types of equipment it would be dangerous to try to make any predictions or to draw any definite conclusions. One thing which seems to be evident in both tests is that the deep concave press wheel, which is standard equipment on some planters, is not as good as some of the other types of press wheels. Anything that can be done to increase the unit pressure on the soil in the immediate vicinity of the seed is good if the device does not tear up the seedbed as it moves on down the row. In general, a device which leaves a rough surface directly over the row, stands a better chance of preventing crust formation than one which leaves a smooth packed surface or glazed surface. Any device or combination which will leave the seed encased in firmly packed moist soil in any field condition would, of course, be the ultimate goal in planter design. It will be necessary to repeat tests of the devices now available over a number of years, adding any new ideas that come up until some definite trend is established, before any recommendations can be made.

The factors influencing field results are many and varied. Among these factors are soil moisture, the amount of humus in the soil, size of soil particles which may vary from dust to clods an inch or more in diameter, temperature of the soil, and many others. Continued investigation of equipment design and field conditions will surely reveal at least a partial solution to the emergence problem.

Any improvement in general cultural practice will do a great deal to improve seedling emergence and to advance spring mechanization in general. Greater benefits from light-seeding rates could be realized now if it were not for the weed-control problem. With perfect weed control the time will come when beets will be planted to a final stand like other farm crops and no hand work will be required for thinning