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THE USE OF DIFFERENT MEDIA AND
CONTAINERS AS A METHOD OF PLANTING
SUGAR BEET SEED

Thesis for the Degree of M. S.
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THE USE OF DIFFERENT MEDIA AND
CONTAINERS AS A METHOD OF PLANTING
SUGAR BEET SEED.

by

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INTRODUCTION

Sugar beet farmers and processors have been adversely affected by a decreasing supply of labor for hand-blocking, thinning and hoeing the crop. No satisfactory method for space planting of sugar beets has as yet been devised. Such space planting would alleviate much of the need for hand labor.

Since the beginning of the industry in Michigan, the need for meeting this problem by machine methods has been recognized. Several attempts at a solution have been made but none to date have proven wholly adequate. If sugar beet seed could be individually packaged in uniform containers prior to planting time, the possibility of space planting by machines might be realized. Further value of such a method might be evidenced in early control of seedling diseases, if the germinating medium were sterile at planting time.

As a consequence, an experiment was begun to determine, first, if sugar beet seed could be packaged in a container filled with a dry germinating medium and, secondly, planted at regular intervals properly spaced in the row, allowed to grow in place to maturity and thus eliminate the necessity of blocking and thinning. Particularly the experiment dealt with:

1. The characteristics of the proper type

of a container.

2. The characteristics of the ideal germinating medium.
3. Germination of beet seed planted in a container of dry germinating medium when compared to planting the seed directly in the soil.
4. Possible protection to the young seedling against black root infection when planted in a sterile germinating medium.

Sugar beet seed might be planted in containers during January or February in a warehouse with precision type machines especially designed to deposit single germ seed pieces in a dry, sterilized germinating medium. At planting time the containers could be set in a vertical position, at proper intervals, the ground firmed around them and a strip of soil about eight inches wide sprayed with a suitable weed killer which would kill existing weeds and prevent the growth of more weeds for at least two months. During this time the beets would have grown sufficiently large to be handled with conventional tools without the aid of hand labor.

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REVIEW OF LITERATURE

The enormous amount of hand labor necessary to produce a crop of sugar beets has long been a noticeable annoyance and a source of study.

It is reported (19) that Napoleon in 1812 awarded premiums to those who were most successful in the advancement of the new enterprise of beet sugar production. He stressed the value of the crop because it provided many hours of profitable employment for the peasants of his domain.

Grant (16) in 1880 relating his experience on a trip to France to investigate sugar beet culture and manufacture of beet sugar reported that because the sugar beet seed is so irregular in size and shape it is necessary to subject it to certain treatments, such as screening and rubbing it between two boards to reduce it to a uniform size to prevent clogging of the planting machine, resulting in long spaces in the lines (rows) without any seed.

In addition to the seeding problems of that day, he discusses a method of using a horse cultivator to cross the rows leaving beet blocks at the corners of squares eighteen inches apart. In modern times we call it cross blocking (17).

West (18) in 1901 says: "I have heard many farmers say that they would raise beets were they sure of help during the time of thinning. Although it seems that the farmer is

doomed to always be compelled to pull his beets by hand, still I believe the time will soon come when this will be done by machinery."

According to Robbins (7) a sugar beet seed as it is known to the trade, is actually a cluster of several seeds, and when a sugar beet seed is planted, from one to six plants may emerge in a single clump.

Segmented seed was introduced in 1941. Roy Bainer (1) thought that by breaking up the clusters of seed mechanically before planting, that some of the work of separating the plants after emergence could be eliminated. His preliminary trials showed that the use of segmented seed reduced the amount of labor needed for blocking and thinning a crop of beets.

The United States Department of Labor (8) recognized that the use of segmented seed reduced the amount of effort needed to block and thin an acre of beets. Consequently in setting a fair and reasonable wage for blocking and thinning an acre of sugar beets, they allowed a reduction in wages of 16.5% from the rate when whole seed was used in planting.

Pelleted seed was introduced in 1941. (9) It was thought that segmented seed containing 75 or 80% single germs could be coated with some inert material, such as feldspar or flyash, fertilizer materials and fungicides and bound together with a water soluble plastic. By

pelleting the seed it would increase by 8 to 10 times its original weight, increase the size by about 20 times and provide a smooth uniform product, about the size of an ordinary smooth coated pea thus permitting the use of a precision type planter to deposit the seeds in the soil at regularly spaced intervals in the row and eliminating the need for hand blocking and thinning.

McGuffy (10) found that germination of pelleted seed was reduced by 15% and pelletting delayed germination 1.2 days. He observed that pelleted seed did not germinate as well as uncoated or ordinary seed, particularly under adverse conditions. Pelleted seed has not been adopted on a very wide scale because planters did not deposit the seed uniformly.

Transplanting the sugar beets has been proposed from time to time by many workers. Dionne (11) reviewing the work up to 1935 concluded transplanting might be practical if a short root could be developed on the transplants. The results of his work indicate that yields can be increased 4 to 5 tons per acre, but that it is difficult to maintain good shaped roots and mechanical transplanters are not adapted to handling sugar beet transplants.

Sugar beet roots grow approximately 6 times the length of the height of the top in the first 42 days of growth (12).

Seedling Diseases

Coons, Kotila and Bochstahler (2) found that seedling diseases commonly called black root are the major factors responsible for poor stands of sugar beets. Among the organisms causing black root, only Phoma Beta is known to be seed borne. Control of seedling diseases in the humid area by direct (seed treatment) measures is questionable:- at least so far it is not a reliable control. Indirect measures such as proper crop sequence and fertilizer application show the most promise of meeting this problem, but such a program is gigantic and necessarily a very long time approach. Adequate initial stands of sugar beets are of paramount importance if mechanization is ever to be an accomplished fact.

Soil and Seed Bed Affect Emergence of Sugar Beets

Yoder (13) lists the following soil factors as directly influencing the growth of sugar beets:

1. Soil-water supply
2. Soil-air supply
3. Soil-heat relations
4. Plant nutrient supply
5. Depth of root bed and
6. Presence or absence of injurious substances

McBirney (14) discussing the general problem of

securing a stand of beets in relation to planter development concludes that:- "The wide variation in field emergence on hundred inch counts with even the best types of planters 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. Further work to obtain improved and more uniform emergence should include studies of seed bed preparation in addition to that on planting equipment."

Baver (15) emphasizes the importance of soil structure in relation to germination and plant growth as follows:- "It is known that plants require nutrients, water, and air for growth. The amount of nutrients in the soil is usually taken as an index of fertility. The air and water relationships are dependent upon structure. The growth of plant roots and the germination of seeds require favorable conditions for respiration. If there is a limited supply of oxygen within the soil as a result of poor structural conditions, respiration processes are hindered; germination and growth are retarded. These facts indicate that abundant nutrients in the soil do not insure good crop production. The investigations of numerous workers emphasize that insufficient attention has been given to providing a favorable environment for the germination of seeds and growth of crops."

Therefore we must approach the problem of securing good stands of sugar beets by providing a proper place for

the sugar beet seedling to germinate and grow for the first few weeks of its growth.

METHOD OF PROCEDURE

Materials

The present experiment was started in the winter of 1950, by preparing four types of containers, made from paper, for holding the germinating medium and the seed.

The first container may be described as a two ply tube of chipboard which was impregnated with paraffin to make it relatively stable and water resistant. The second was made from a two ply chipboard tube. The third type was made from two ply 50 pound Kraft paper. The fourth type was made from two ply absorbent paper (towel tissues). All tubes were one-half inch in diameter, two inches in length. The ends were closed by three different methods; namely, (1) plugged with cotton linters, (2) stuck together with water soluble glue, and (3) closed with an ordinary desk type paper stapling machine.

Four types of germinating material, sand, loam, clay, muck and vermiculite were used to fill the tubes. The soil samples were all screened to remove stone and all large pieces of dirt to facilitate filling the tubes. The soil was then placed in a steam chamber at the Michigan Sugar Company laboratory and subjected to 40 pounds live steam

pressure for 2 hours for sterilization, after which it was dried in an oven for 30 hours. Distilled water was then added to bring the moisture content of the soil up to 10%.

The planting tubes were filled half full with the germinating medium, a seed was placed in the tube and filling completed. After filling, the tubes were closed by the various methods previously described. The seed was of the same commercial grade used for planting the 1950 crop in the Lansing area. (Table 1.)

A planting bed was prepared 10 x 10 feet square, 16 inches deep and bound by planks set on edge. The soil used was a mixture of all types of soil high in organic matter from fields which had grown beets in 1949. The soil was packed and then raked so that a fine mulch was left on the upper one-half inch. (Figure 4.) It was allowed to stand in this condition for one week and then raked lightly again before planting.

Planting

The plot was divided into four parts, each being 60 x 60 inches square and planted on May 29, 1950 according to the chart in Figure 2. A row of seed was planted on each side of the plot placing the seeds in a trench 1 inch deep, 11 seeds to the foot which was comparable to the conventional method of drilling 4 pounds of seed per acre in 28 inch rows. Six rows were planted by placing the seed 1 inch deep and

6 inches apart in the row. These 6 rows were used as check rows for comparison with the various container plantings. The planting tubes were then placed in rows 3 inches apart, and spaced 6 inches apart in the row.

In order to insure uniformity in the planting, a piece of wood was turned down in a lathe to $5/8$ inch diameter and a large collar fitted two inches from the end. See Figure 1. The rounded portion was pushed into the soil until the collar rested at the surface of the soil. When it was removed, this left a hole into which the tube could be placed and the top of the tube was level with the ground. The soil was firmed gently about the tube with the fingers.

On May 9th, 11 days after planting, the plot received 1.4 inches of rain. By this time the entire plot had become quite dry. It wasn't until the 25th of May or 27 days after planting that there was sufficient moisture to germinate any of the seed in the plot. See Figure 3.

On June 2nd, Figure 3, more than a month after planting a rain of 2.30 inches occurred. The first beets emerged June 6th, Figure 5, and population counts were started and were taken thereafter on June 10th, June 13th, June 20th, June 27th and July 4th, after which the entire plot was dug up and the roots were all carefully washed and examined for size and shape. Figure 6 and Figure 7.

Table 1.

Germination of seed used for conducting this investigation.
100 seeds used in each of four samples. 14 day test.

	<u>#1</u>	<u>#2</u>	<u>#3</u>	<u>#4</u>
Singles	56	52	52	60
Doubles	32	32	30	28
Triples	1			
Total Sprouts	123	116	112	116
No. Seeds Germinated	89	84	82	88

Figure 1.

A device for gauging the depth of planting the containers.

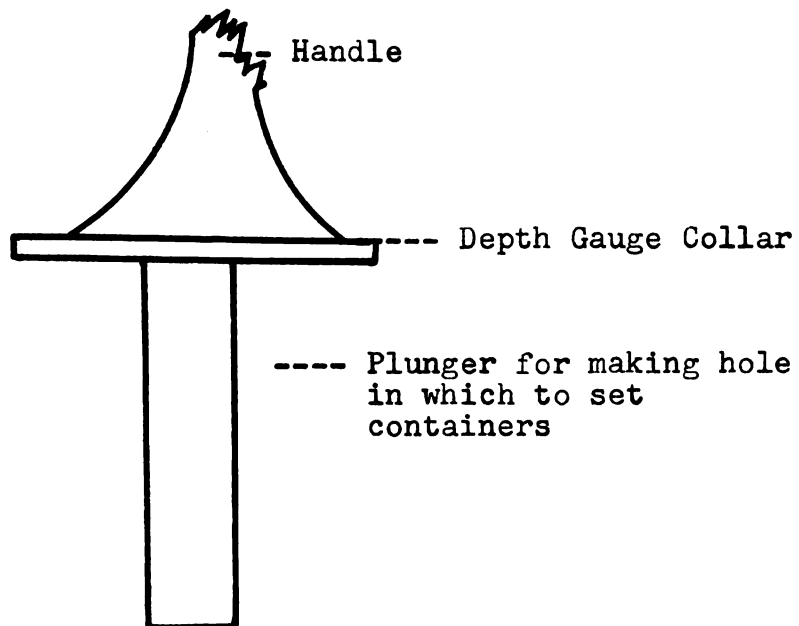
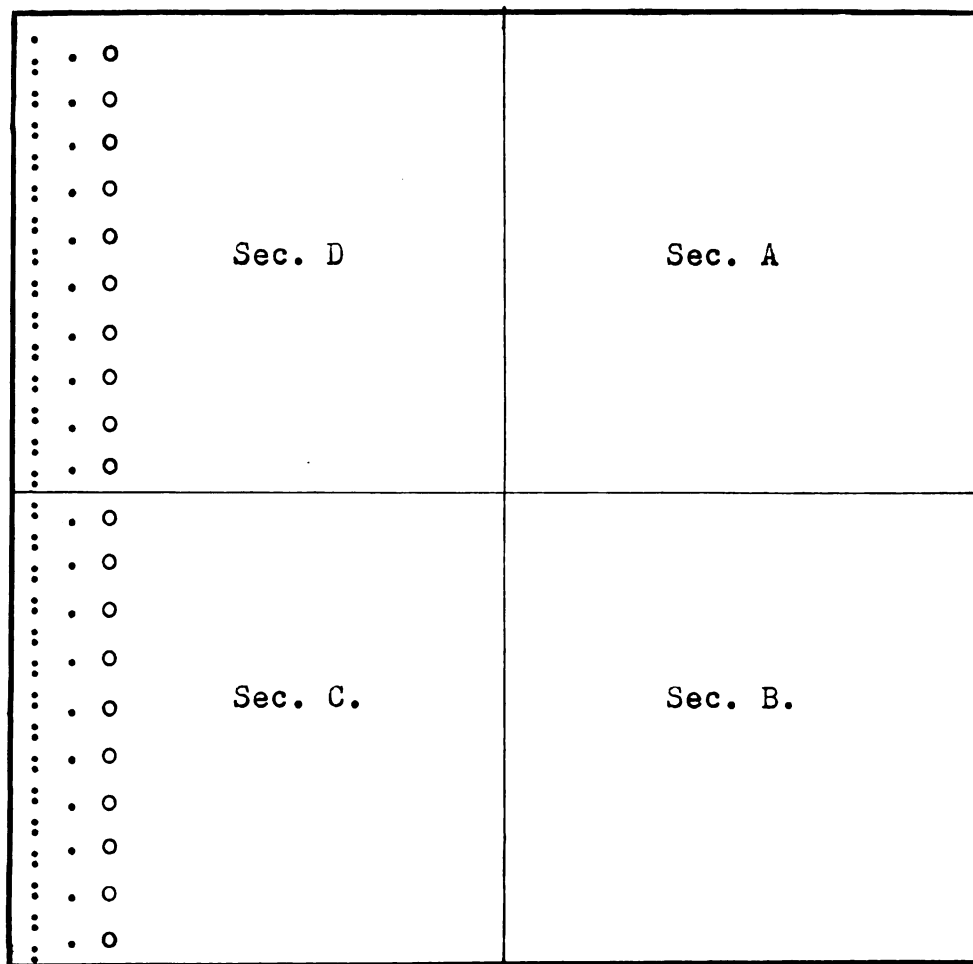


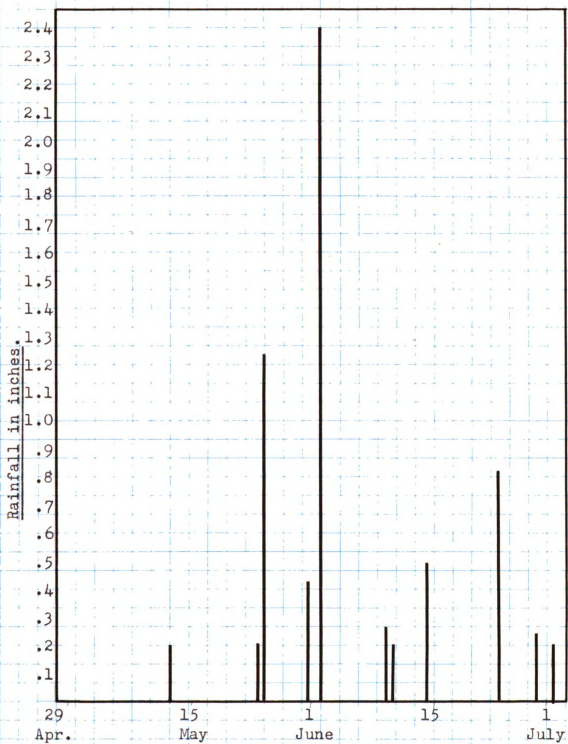
Figure 2.

A diagram of plot lay out.



1 2 3

1. Edge row seed spaced 11 seeds per foot of row
 2. Seed spaced 6 inches apart planted 1 inch deep
 3. Seed containers spaced 6 inches apart
- Sec. A. Planted to Chipboard with paraffin series
- Sec. B. Planted to chipboard series
- Sec. C. Planted to towel tissue series
- Sec. D. Planted to Kraft paper series



Daily precipitation

1950

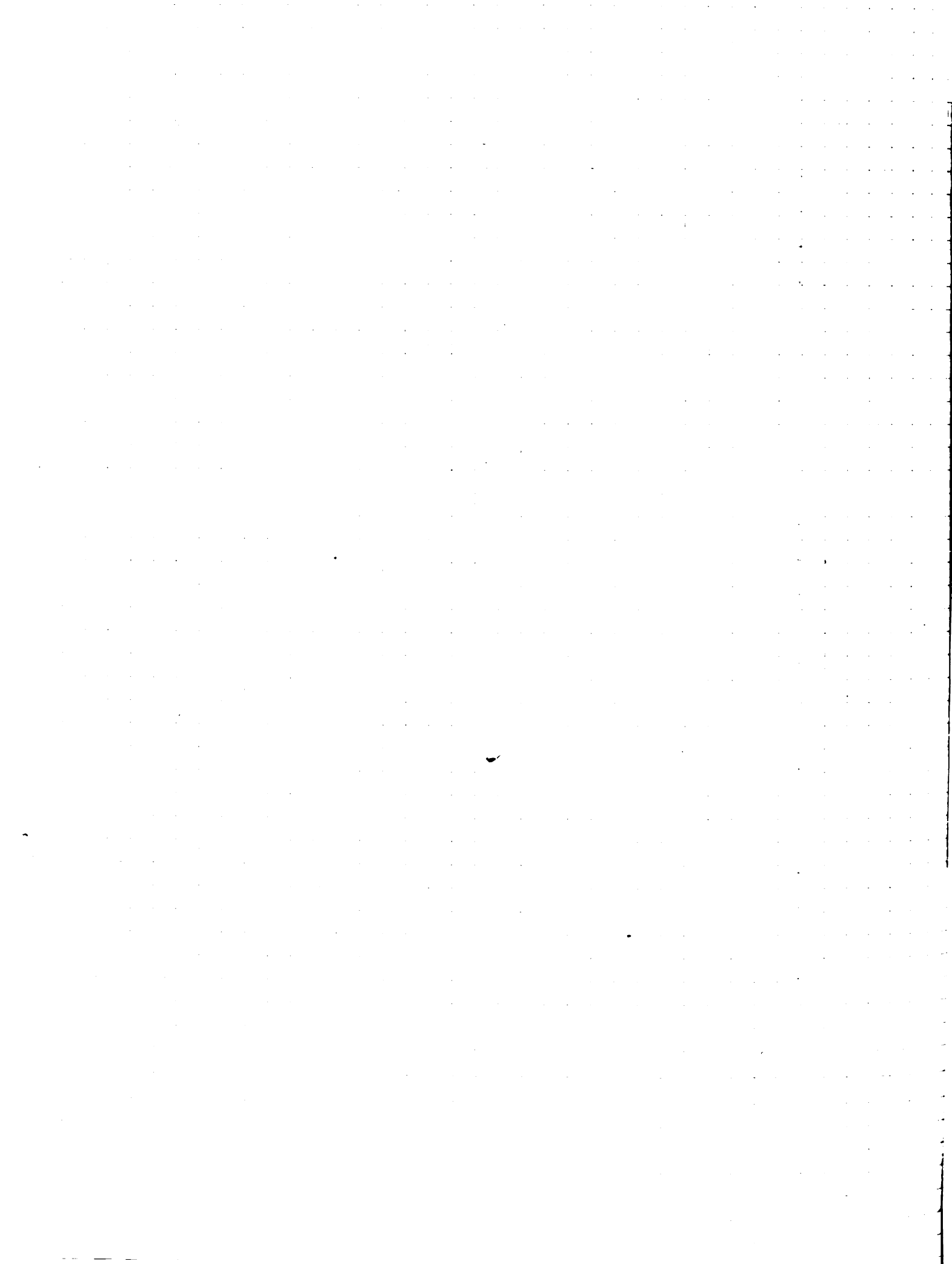


Figure 4.



Preparing the planting plot

Figure 5.



First beets emerged June 6th

Figure 6.



General view digging plot July 4th

Figure 7.



Size and shape were carefully observed

Figure 8.



Left - restricted growth in paraffin chip-
board series.

Right - normal growth in towel tissue series.

Figure 9.



Left - injured by staples.

Center - completely severed by staples.

Right - normal growth in towel tissue series.

Figure 10.



A normal shaped sugar beet root washed
clean of dirt in the towel tissue series.

Table 2. - Paraffined chipboard.

Number of plants per ten tubes														
Date of reading		6/6	6/10	6/13	6/20	6/27	7/4	Root Shape*		Size #				
Filler	Closure	N. Abn. L M S												
Check Ave.		8.3	14	13.8	11.8	9.6	5.8	5.5	.3	1.6	.5	3.6		
Sand	Cotton	0	0	0	0	0	0	0	0	0	0	0	0	0
Loam	"	0	0	0	2	2	2	0	2	0	0	2		
Clay	"	0	0	0	0	0	1	0	1	0	0	1		
Muck	"	0	0	0	0	0	3	0	3	0	0	3		
Vermic.	"	0	0	0	0	0	1	0	1	0	0	1		
Sand	Glued	0	0	0	0	0	0	0	0	0	0	0		
Loam	"	0	0	0	0	0	0	0	0	0	0	0		
Clay	"	0	0	0	0	0	0	0	0	0	0	0		
Muck	"	0	0	0	0	0	4	0	4	0	0	4		
Vermic.	"	0	0	0	0	0	0	0	0	0	0	0		

Table 2. (con't.)

Number of plants per ten tubes										
Date of reading	6/6	6/10	6/13	6/20	6/27	7/4	Root Shape*	Size #		
Filler	Closure						N.	Abn.	L	M S
Sand	Stapled	0	0	0	0	0	0	0	0	0
Loam	"	0	0	0	0	1	0	1	0	1
Clay	"	0	0	0	0	1	0	1	0	1
Muck	"	0	0	0	0	2	0	2	0	2
Vermic.	"	0	0	0	0	2	0	2	0	2

* N - Normal shape

L - Large

Abn - Abnormal shape

M - Medium

S - Small

Table 3. - Plain chipboard

Number of plants per ten tubes										
Date of reading		6/6	6/10	6/13	6/20	6/27	7/4	Root Shape*		Size #
Filler	Closure	N. Abn. L M S								
Check Ave.		8.3	14	13.8	11.8	9.6	5.8	5.5	.3	1.6 .5 3.6
Sand	Cotton	0	0	0	0	0	0	0	0	0 0 0
Loam	"	0	7	13	11	9	7	6	1	3 0 4
Clay	"	1	4	7	7	5	5	5	0	0 0 5
Muck	"	0	0	2	3	2	2	2	0	0 1 1
Vermic.	"	0	1	4	5	4	4	4	0	0 2 2
Sand	Glued	0	0	0	1	2	1	0	1	0 0 1
Loam	"	0	1	6	5	5	5	5	0	2 0 3
Clay	"	0	3	6	6	7	7	7	0	2 1 4
Muck	"	0	1	3	2	2	2	0	2	0 0 2
Vermic.	"	0	0	2	1	1	1	0	1	0 0 1

Table 3. (con't.)

Number of plants per ten tubes										
Date of reading	6/6	6/10	6/13	6/20	6/27	7/4	Root Shape*	Size #		
Filler	Closure		N.					Abn.	L	M S
Sand	Stapled	0	0	1	1	2	0	0	0	0 0
Loam	"	0	2	9	9	6	4	0	2	0 2
Clay	"	0	5	10	6	5	5	2	3	4 0 1
Muck	"	0	5	15	14	9	5	2	3	1 2 2
Vermic.	"	0	5	10	8	6	3	2	1	0 2 1

* N - Normal shape

L - Large

Abn - Abnormal shape

M - Medium

S - Small

Table 4. - Kraft paper.

Number of plants per ten tubes									
<u>Date of reading</u>	<u>6/6</u>	<u>6/10</u>	<u>6/13</u>	<u>6/20</u>	<u>6/27</u>	<u>7/4</u>	<u>Root shape*</u>	<u>Size #</u>	
<u>Filler</u>	<u>Closure</u>		<u>N.</u>					<u>Abn.</u>	<u>L M S</u>
Check Ave.	8.3	14	13.8	11.8	9.6	5.8	5.5	.3	1.6 .5 3.6
Sand	Cotton	0	0	2	3	2	0	2	0 0 2
Loam	"	1	3	5	6	6	5	1	1 2 2
Clay	"	0	1	2	3	1	1	0	0 1 0
Muck	"	0	1	2	0	0	0	0	0 0 0
Vermic.	"	0	0	1	2	1	1	0	0 1 0
Sand	Glued	0	0	0	0	1	1	0	0 0 1
Loam	"	0	4	6	7	5	5	0	2 0 3
Muck	"	0	3	2	2	2	2	0	0 1 1
Vermic.	"	0	9	4	3	2	2	0	0 2 0

Table 4. (con't.)

Number of plants per ten tubes									
Date of reading	6/6	6/10	6/13	6/20	6/27	7/4	Root shape*	Size #	
Filler	Closure		N.					Abn.	L M S
Sand	Stapled	0	10	10	3	3	1	0	1 0 0 1
Loam	"	0	8	8	7	6	5	4	1 0 2 3
Clay	"	0	9	4	5	5	4	2	1 0 3
Muck	"	0	6	3	5	5	2	1	1 0 1 1
Vermic.	"	0	7	10	11	12	12	5	7 0 3 0

* N - Normal shape

L - Large

Abn - Abnormal shape

M - Medium

S - Small

Table 6. - Total plants regardless of type container or closure.

When Filler was	6/6	6/10	6/13	6/20	6/27	7/4	% of Total	Total Possible
Sand	2	29	40	34	35	22	18.2	120
Loam	7	47	79	74	69	57	47.5	120
Clay	3	39	61	50	46	42	35.0	120
Muck	4	27	56	57	45	41	34.2	120
Vermic.	2	28	50	50	46	40	33.3	120
Check Row	50	84	83	71	58	35	58.3	60

Table 7. - Total plants regardless of filler
or closure.

When Container was	6/6	6/10	6/13	6/20	6/27	7/4	% of Total	Total Possible
Paraffin Chipboard	0	0	0	2	2	17	11.3	150
Chipboard	1	34	86	79	65	51	34.0	150
Kraft	1	66	58	55	59	45	30.0	150
Towel Tissue	16	70	140	129	115	89	66.1	150
Check Rows	50	84	83	71	58	35	58.3	60

Table 8. - Total plants regardless of type of container or filler.

When Closure was	6/6	6/10	6/13	6/20	6/27	7/4	% of Total	Total Possible
Cotton	10	43	76	83	75	66	33.0	200
Glued	1	47	71	60	58	55	27.5	200
Stapled	7	80	139	123	108	81	40.5	200
Check	50	84	83	71	58	35	58.3	60

Table 9. - Total Plants

When Closure was	Normal	Abnormal
Cotton	53	13
Glued	45	10
Stapled	47	34
Check	33	2

Table 10. - Total Plants

When Container was	Normal	Abnormal
Paraffin Chipboard	0	17
Chipboard	39	12
Kraft	30	15
Towel	76	13

DISCUSSION

Tables 2, 3, 4 and 5 offer a detailed compilation of the results of the experiment.

It was obvious that when beets were planted in water resistant containers that germination was almost completely halted and only after the moisture entered from the top, did a few of the seeds germinate. A few plants finally produced a few leaves, but the roots were completely confined in the container at the end of the experiment.

The containers made of paraffined chipboard were very stable, which made them easy to fill, handle, store and plant but, growth was practically prevented.

Containers made from chipboard were very stable in structure, were easily filled, handled and stored and were more water absorptive than the paraffined chipboard. Although this type of container allowed more rapid penetration of soil moisture and consequently more rapid germination than the very water resistant paraffined chipboard, it apparently interfered with plant growth. Table 7.

Containers made from Kraft paper were stable in structure, easily filled, lighter and less bulky to store than chipboard containers. The paper was tough and even though fairly water absorptive, the soil moisture did not penetrate as readily as towel tissue. For all practical purposes, it would compare favorably with chipboard, both producing fewer plants than the check.

Towel tissue, the most water absorptive type container used, interfered the least with germination, although it was much slower than the check. However by the 13th of June all plantings except the paraffined chipboard reached their maximum germination, and at the end of the period of growth there was a 66% stand where towel tissue was used, compared to 58.3% in the check.

The towel tissue series was more than twice as good as any other treatment and appreciably better than the check.

On the 13th of June, the two outside rows of beets drilled at the 4 pound rate of seeding had become so infected with blackroot and so spindly that they were falling over the check rows. They had to be removed at this time, so as not to interfere with the growth of the check rows. It is interesting to note that this was only one week after emergence and these beets had already reached the stage where thinning was necessary. This condition was similar to what often happens in the commercial field when labor is not available or weather does not permit thinning.

In contrast the plants spaced 6 inches apart in the check rows were sturdy, were not suffering from crowding, but blackroot was beginning to show up and by the end of the test the checks were reduced in stand by 58%. However the plants in the towel tissue containers were reduced by only 36%, in the Kraft containers by only 32%, in the

chipboard containers by only 40%. This would indicate that the sterile column of soil in which the seed was planted protected the plant against a serious attack by blackroot.

The method of closing the tubes, Table 8, gave some very interesting figures for study and produced some odd effects on the beet roots.

All of the plants produced in the paraffined chipboard containers regardless of the way they were closed, were abnormal in root growth.

There was a higher percentage of germination and a more rapid germination when the tubes were closed with a paper staple, but the tap roots grew through the staple and were either pinched severely or in some cases completely severed, Figure 9. Forty-two percent of all the tap roots were abnormal in shape at the end of the experiment, Table 9. Therefore closing the tubes with paper staples must be considered to be damaging to the root.

When the tubes were stuck together with glue or plugged with cotton, the abnormal plants amounted to only 18% and 20%, respectively. The abnormal plants in the checks amounted to 5.7%.

The type of material used as a germinating medium influenced the immediate germination and the livability of the plants as shown by Table 6. Sand was the least desirable type of germinating medium. Clay, muck and vermiculite media appeared better than sand and nearly

alike in results. However loam was appreciably better than any other type of germinating medium used, giving less delay in germination and showing a greater percentage of living plants at the conclusion of the test. There was much less loss from blackroot in all of the treatments than in the check. The vermiculite showed the least percentage loss from maximum number emerged to completion of the test, but the total germination was not nearly as good as the containers filled with loam.

Root shape was not influenced by the type of germinating material used, nor the type of container except in the case of paraffined chipboard in which all were abnormal, Table 10.

SUMMARY

The season of 1950 was far from ideal for germination of beet seed. During May the weather was cool and dry for most of the period.

Planting seeds in a dry germinating medium was given a rigid test under these conditions.

Germination was visibly slower in the treated rows (planted in containers). From this experiment it would appear that the germination of beet seed may be delayed as much as 3 or 4 days when planted in containers with dry germinating medium, in comparison to seed planted directly in the soil.

Sterilized soil planted in a column about a seed offers some protection to the germinating seed and young plant from the attacks of blackroot.

Loam soil was the best type of germinating medium used in this test.

The results of this experiment seemed to indicate that if seed is to be planted in this manner that the containers must be as water absorptive as possible and yet tough enough to be handled, when filling and planting. Towel tissue paper containers proved to be stable enough to handle, when filled with soil, and were planted as easily as heavier type containers. Germination was most rapid when seed was planted in towel tissue containers with loam soil as a germinating medium and when the tubes were closed with paper staples. Paper staples however interfered with the proper development of the tap root.

Pre-packaging and space planting of sugar beet seed in small containers appears to be a feasible technique provided efficient machines for packaging and planting were developed.

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