

Seed Treatment Tests, 1944 and 1945

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A satisfactory stand at thinning time is one of the chief factors in successful beet growing. Therefore, protection against damage by organisms involved in either pre- or post-emergence mortality is very important, and the use of segmented seed on a large scale, resulting in a substantially reduced initial stand, greatly increases the importance of this protection.

A considerable amount of data now available indicate that a major part, or sometimes practically all, of the fungus damage done to the seedling stand may take the form of pre-emergence mortality. It has been shown that certain forms of seed treatments may be effective against this form of disease, and it may also be possible to obtain satisfactory protection against post-emergence mortality by seed treatments. From the practical point of view it would then appear especially important to investigate the possibilities of devising some seed treatment which would be both effective and harmless when used generally in a standardized form.

The seed treatment tests conducted by the Longmont Experiment Station during the 1944 and 1945 seasons consisted of two different series; (1) relatively localized, but of a somewhat complex nature, and (2) comprising fewer treatments and replications but with larger individual plots and designed to reach all factory districts.

Seed and Seed Treatments Used

Segmented seed as furnished the farmers was used, but it was run through a small fanning machine for removal of dust and small particles of trash which otherwise would have interfered with the uniformity of the portions of seed prepared for the individual plots.

The number of treatments and their composition are reported in tables 1 and 2 for test A and in table 3 for test B in 1945. The treatments constituting test B for 1944, which is not reported in detail, were as follows:

1. New Improved (N.I.) cerasan 4 ounces
2. Fume phosphate 12 ounces + N.I. Cerasan 4 ounces
3. Fume phosphate 20 pounds
4. Fume phosphate 20 pounds + N.I. Cerasan 4 ounces
- f>. Yellow Cuproside 12 ounces

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6. Fume phosphate 20 pounds + Yellow Cuprocide 12 ounces
7. Fume phosphate 20 pounds + Yellow Cuprocide 12 ounces
+ N.I. Ceresan 4 ounces
8. Untreated check

Amounts of substances applied are given in terms of pounds or ounces per 100 pounds of seed if not otherwise stated.

In all cases in which it was practical the treatments were applied as dry dust treatments. The applications of 10 pounds or more of fume phosphate were added to the seed immediately following wetting of the seed with an amount of water representing 16 to 18 percent of the weight of air dry seed and phosphate combined. Thorough air drying followed the application.

The nitrogen compounds were applied in aqueous solution. When they were combined with heavy phosphate applications, the same wetting served for attaching the phosphate.

The Dow No. 6 material was in flake form and being water-soluble was applied in the same manner as the nitrogen compounds.

After air drying of seed which had required wetting, any dust treatment called for was applied in the usual manner. Dry dusts, when more than one were to be used, were mixed well before they were applied to the seed.

Test A

Materials and Methods.—In both 1944 and 1945 seasons these test series were conducted directly from the Longmont Experiment Station with all the individual tests located within a radius of 15 miles of the Station. These tests were placed in farmers' fields with the exception of one on the Experiment Station farm in 1944. There were 13 tests laid out and carried through in 1944 and 14 laid out with 11 carried through in 1945.

The test scheme used for the two series A with individual tests comprising 25 treatments, including an untreated check, was a triple lattice design with 2 replicates of each group, or a total of 6 replicates. Each plot consisted of one row, 29 feet in length.

The amount of net seed used per plot was the same within season for either of the two seasons and was calculated to give a potential stand of 270 seedlings per plot in 1944 and 300 seedlings per plot in 1945.

Seedling counts of the entire plot length made at or shortly before the ideal thinning time were the basis for comparison in determining the effectiveness of the various treatments. The test located

at the Experiment Station farm in 1944 was counted twice, with 8 days between counts to determine the extent of post-emergence damping-off.

Results for 1944 The results of test A for 1944 are summarized statistically, on the basis of average plot values in percent of check for the 6 replicates used, in table 1.

New Improved Ceresan and Arasan, alone or in combinations, seemed to be leading in effectiveness. The three different amounts of N.T. Ceresan alone averaged very well but did not quite reach the value shown by 12 ounces of Arasan alone. Differences from the check in favor of the latter treatment proved highly significant (LSD 1-percent point) at two locations, and significant (LSD 5-percent point) at one location. N.I. Ceresan together with 12 ounces of fume phosphate was no better than N.I. Ceresan alone. In location VIII 8 ounces of N.I. Ceresan alone may have been an overdose, since the value was significantly lower than the check. The 6-ounce application of N.T. Ceresan alone appeared somewhat superior to both 4 and 8 ounces, while for Arasan the largest application (18 ounces) proved best.

Yellow Cuprocicle alone (12 ounces) was practically equal in effect to the combination of 4 ounces of N.I. Ceresan plus 12 ounces of fume phosphate and also the combination of 12 ounces of yellow cuprocicle with 12 ounces of Arasan.

"1452F", a Du Pont mercurial, averaged slightly better than the check in the amount used (5 ounces).

Dow No. 5 and No. 6 averaged fairly close to the check, and since they have been practically discontinued for beet trials by the manufacturers they are not further discussed here.

Nitrogen, as applied here, never appeared beneficial but was somewhat detrimental on the average and considerably so in a few cases.

Fume phosphate at a relatively low rate in combination with N.T. Ceresan is discussed above. In larger quantities, 10, 30, and 50 pounds of fume phosphate alone consistently proved to be either the poorest treatment or nearly so, and together with the combination nitrogen-N.L Ceresan-fume phosphate averaged the poorest of all the treatments within the entire series. This was not entirely in agreement with the results obtained in the 1943 tests (1)², in which a 10-pound application of fume phosphate resulted in a certain improvement over the check, as the average of tests conducted on six fields, while a significant reduction was noted in one location. The

Table 1.—Average number of seedlings per plot in percentage of untreated check for seed treatment test. Longmont district, 1944.

No.	Treatment per 100 pounds seed ^c	L O C A T I O N													Mean
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	
1.	N. I. Cer. 4 oz.	114	101	108	125*	108	108	107	96	148**	99	87	90	115	107.2
2.	N. I. Cer. 6 oz.	104	105	113	136**	119	105	103	88	151**	91	95	101	134	111.2
3.	N. I. Cer. 8 oz.	102	111	86	137**	107	105	95	85*	129*	97	85	83	101	109.5
4.	Y. Cup. 12 oz.	105	113	116	129*	100	102	106	86	130*	91	100	103	99	105.5
5.	Ara. 12 oz.	113	115	132*	131**	112	105	111	92	125	102	88	107	152**	113.8
6.	F. P. 10 lbs.	71**	77*	75	27**	52**	72**	100	84*	31**	83	82	99	100	72.7
7.	F. P. 30 lbs.	69**	68**	84	21**	47**	56**	85	64**	27**	91	69*	81	81	64.1
8.	F. P. 50 lbs.	71**	56**	84	31**	27**	63**	93	74**	22**	80	57**	71*	73	61.8
9.	N. I. Cer. 4 oz. + F. P. 12 oz.	107	99	108	132**	99	99	111	87	135*	103	109	103	97	106.8
10.	N. I. Cer. 4 oz. + F. P. 10 lbs.	102	113	107	110	94	108	97	84*	106	76*	90	83	94	97.5
11.	N. I. Cer. 4 oz. + F. P. 30 lbs.	94	91	114	103	81	99	90	85*	121	90	90*	76*	83	86.7
12.	N. I. Cer. 4 oz. + F. P. 50 lbs.	93	82	121	127**	78	101	103	92	123	81	75	62**	80	94.5
13.	Ara. 12 oz. + F. P. 10 lbs.	103	107	106	103	102	107	108	84*	126	92	85	91	118	102.5
14.	Ara. 12 oz. + F. P. 30 lbs.	121*	96	98	125*	101	110	92	82*	126	102	80	92	90	101.2
15.	Ara. 12 oz. + F. P. 50 lbs.	113	86	121	131**	107	108	97	84*	148**	72**	71*	87	114	103.0
16.	N. I. Cer. 4 oz. + Y. Cup. 12 oz.	108	107	115	128**	108	111	101	92	157**	98*	87	69*	123	108.0
17.	Ara. 12 oz. + Y. Cup. 12 oz.	102	114	112	98	104	104	116	92	115	54	101	110	122	105.7
18.	Dow No. 5, 5 oz.	90	114	86	92	99*	102	108	77**	88	105	89	96	103	94.0
19.	Dow No. 5, 5 oz.	108	109	98	100	89	98	106	73**	132*	91	82	91	113	100.2
20.	'14324' 5 oz.	119*	117	92	123*	105	91	113	79**	141**	94	97	84	108	102.5
21.	N only*	80*	89	101	85**	99**	91	111	91*	58**	89	80	72*	105	76.3
22.	N + N. I. Cer. 4 oz. ^b	97	100	120	114	87	113	104	84*	100	82	87	84	86	97.2

Table 1. Continued.

23. N + N. I. Cer. 4 oz. + F. P. 30 lbs. ⁶	93	75 ^a	103	42 ^{aa}	31 ^{**}	77 ^{**}	100	73 ^{ab}	58 ^{ab}	80	73 ^a	60 ^{aa}	80	72.7
24. N + Ara. 4 oz. + F. P. 30 lbs. ^b	93	105	94	105	109	98	107	87	115	87	89	90	110	99.2
25. Untreated check	100	100	100	100	100	100	100	100	100	100	100	100	100	100.0
General Mean	93.9	97.7	103.6	101.7	87.8	97.2	102.9	84.8	108.8	90.1	85.9	87.1	103.9	96.2
CV (percentage)	15.49	18.51	25.47	16.83	27.71	15.97	15.29	15.59	22.89	20.84	27.78	24.01	33.23
LSD 5-percent point	17	21	30	20	28	13	18	15	28	21	27	24	39	..
LSD 1-percent point	23	27	40	26	37	23	24	20	38	28	36	32	52	..
Mean No. seedlings per plot	146.0	140.3	100.5	145.0	84.9	165.4	143.0	188.6	98.5	142.3	62.8	97.3	62.6	..

^a and ^{**} Significantly better than check at the 5-percent and 1-percent points, respectively.

^b and ^{aa} Significantly poorer than check at the 5-percent and 1-percent points, respectively.

^c One missing plot value calculated.

^d Nitrogen (N) applied 5-percent on weight of seed in 50-50 mixture of (NH₄)₂SO₄ + NaNO₃ dissolved in water (20 percent on seed), subsequent air drying.

^e Abbreviations used: N. I. Cer.—Cereson, New Improved. Y. Cup.—Yellow Cuproclde. Ara.—Arasan. F. P.—Fume phosphate.

generally reducing effect noted for the heavy phosphate applications was diminished but not altogether offset by the addition of Arasan or N.I. Ceresan, when the comparison was made with these fungicides alone. Combinations of large amount of phosphate with Arasan appeared generally superior to such combinations with N.I. Ceresan. The addition of nitrogen to the heavy phosphate-N.I. Ceresan combination resulted in a material lowering of the average, while this addition to the heavy phosphate-Arasan combination did not appreciably lower the value.

General Observations.—The season of 1944 was characterized by a rather general freedom from seedling disease and this condition no doubt was reflected in the relatively high position of the check and in the fact that in many locations even the better treatments failed to give significant improvements. Very great differences in response to treatments between locations are noted. The results apply almost entirely to pre-emergence mortality, since no damping-off of any consequence was observed after emergence.

Results for 1945.—Chiefly pre-emergence mortality was involved in the reduction of stand by diseases in 1945 also. A summary of the results of test A expressed as mean number of seedlings in percent of check is presented in table 2.

N.I. Ceresan alone was one of the best treatments, and the results were somewhat in favor of the 4-ounce application. The 8-ounce application was significantly poorer than the check in one location (XI).

Two of the Arasan treatments were several points below N.I. Ceresan as used alone. A rise in effect with increased application was consistent through the three treatments. A highly significant reduction was associated with the 6-ounce application in the same location (XI) in which one N.I. Ceresan treatment was highly significantly reduced.

When N.T. Ceresan or Arasan was combined with fume phosphate, there was, as in 1944, an apparent trend in favor of Arasan. Trends relative to dosage were not consistent. The N.I. Ceresan-phosphate combinations averaged short of X.I. Ceresan alone in effect, while the Arasan-fume phosphate combinations averaged better than either Arasan or N.I. Ceresan alone. The combination of 4 ounces of N.I. Ceresan and 12 ounces of fume phosphate averaged lower than either of the N.I. Ceresan treatments.

Du Pont "1452F" alone averaged essentially the same as Arasan alone. An improvement with increased dosage was noted, but

Table 2.—Average number of seedlings per plot in percentage of untreated check for seed treatment test. Longmont district, 1945.

No. Treatment per 100 pounds seed ^d	LOCATION											Mean
	I	II	III	IV	V	VI	VII ^e	VIII	IX	X	XI	
1. N. I. Cer. 4 oz.	124*	105	157**	102*	94	104	223*	112**	179**	121	106	129.7
2. N. I. Cer. 6 oz.	117	107	141*	99*	104*	103*	200	142**	164**	100	87*	124.4
3. N. I. Cer. 8 oz.	112	112**	139*	104	108	113**	207	161**	183**	99	80*	126.8
4. Arasan 8 oz.	108	110*	110	103*	114	124**	205	108	117	113	77**	117.2
5. Arasan 12 oz.	117	118**	137*	110*	94	99	182	130**	131*	106	98*	120.5
6. Arasan 18 oz.	106	108	125	98	105	129**	223*	124**	137**	128*	93	126.9
7. "1452F" 4 oz.	122*	108	184**	87	95*	100	138	120**	134*	96	103	116.7
8. "1452F" 6 oz.	120**	103	127	99	111	125**	162	124**	137**	118	92	122.4
9. "1452F" 8 oz.	111	108	141*	85	103	104	272**	122**	130**	106	77**	125.2
10. Y. Cup. 12 oz.	122*	111**	137**	100	110	115**	178	116**	129	99	88*	120.5
11. K-611 12 oz.	106	103	107	89	103	106*	272**	89*	130**	114	73**	119.3
12. 9-B 12 oz.	121*	103	120	105*	93	92**	132	118**	98	96	113	111.0
13. F. P. 20 lbs.	88	89*	44**	83	89	84**	0	58**	89	70**	29**	71.2
14. N. I. Cer. 4 oz. + F. P. 12 oz.	113	119**	122	101	106	104	200	107	155**	116	81*	121.5
15. N. I. Cer. 6 oz. + F. P. 20 lbs.	95	105	146**	93	106	119**	193	128**	167**	97	88*	121.5
16. N. I. Cer. 8 oz. + F. P. 20 lbs.	105	101	138**	98	99	118**	273**	129**	176**	108	91	129.5
17. Ara. 6 oz. + F. P. 20 lbs.	119	106	128	113	116	107*	247*	176**	118	111	86	124.4
18. Ara. 12 oz. + F. P. 20 lbs.	126*	107	121	108	106	126**	202**	141**	133*	125*	99	124.2
19. Ara. 18 oz. + F. P. 20 lbs.	123*	110*	121	109	111	131**	258**	139**	127	102	97	126.8
20. N. I. Cer. 6 oz. + Y. Cup. 8 oz.	112	115**	123	103	94	122**	182	112**	141*	110	93	119.0
21. N. I. Cer. 8 oz. + Y. Cup. 12 oz.	118	113**	146**	102	105	127**	228*	104	139**	110	82*	120.7
22. Ara. 12 oz. + Y. Cup. 8 oz.	129**	106	127	105	115	95	177	116**	137*	108	84	117.6
23. Ara. 12 oz. + Y. Cup. 12 oz.	111	112**	120	98	117	106	115	129**	146**	114	91	114.4
24. "1452F" 6 oz. + Y. Cup. 12 oz.	119	111*	124	109	118	117**	277**	128**	133**	138**	92	125.1
25. Untreated check	100	100	100	100	100*	100	100	100	100	100	100	100.0
General mean	113.9	107.3	127.7	100.0	104.7	109.8	201.4	118.9	141.2	108.2	88.3	120.2
CY (percentage)	16.28	7.95	21.61	15.87	19.17	4.62	45.63	6.75	19.28	17.51	17.91
LSD 5-percent point	21	9	32	No Sig.	No Sig.	6	118	9	31	22	18
LSD 1-percent point	28	11	42	No Sig.	No Sig.	8	156	12	41	29	23
Mean No. seedlings per plot	124.0	256.6	100.2	179.2	129.3	87.4	24.2	36.5	104.6	101.4	143.2

* and ** Significantly better than check at the 5-percent and 1-percent points, respectively.

* and ** Significantly poorer than check at the 5-percent and 1-percent points, respectively.

* One missing plot value calculated.

* Two missing plot values calculated.

* Five replications.

Abbreviations used: N. I. Cer.—Cerana, New Improved.
Y. Cup.—Yellow Cuproclad
Ara.—Arasan
F. P.—Fume phosphate

the 8-ounce application resulted in a highly significant reduction in location XI, referred to for similar performances of X.T. Ceresan and Arasan. "1452F" with Yellow Cuprocide in treatment 24 ranked the highest of all treatments in this series.

Yellow Cuprocide 12 ounces fell well in line with treatment 14 (4 ounces Ceresan and 12 ounces fume phosphate) and with the general mean of all treatments.

Dow Company products K-611 and 9-B (copper and zinc salts, respectively, of 2, 4, 5 trichlorophenol) were used in 12-ounce applications. Significant differences from the check for both increases and reductions were noted in the results obtained. K-611 averaged the higher of these but performed perhaps more irregularly than 9-B.

Again, as in 1944, very great differences existed between locations in their response to treatments.

Test B

Materials and Methods.—In each factory district three separate fields were chosen in which seedling disease was considered reasonably likely to occur. One test was placed on each of these fields. Each test included seven different treatments together with one untreated check, or eight treatments in all, and these were replicated three times in randomized arrangement using one-row plots. A different randomization was used for each of the three fields. For each treatment the results for pre-thinning seedling counts made on S strips (1944) or 10 strips (1945) of row of 100 inches length per plot served as a basis for calculation of the stand obtained per unit of seed. The figure representing the total count for the three replications was divided by the weight of seed (grams or fractions of a pound) reported used, and the values thus obtained were converted into percentages of the check. Of these tests 35 were completed in 1944 and 40 in 1945. In 1944, however, the data obtained appeared very erratic and were not considered as warranting statistical analysis, while for the 1945 data significant differences were obtained between treatments from 16 fields distributed on 11 factory districts.

Results for 1944.—Although the test was not analyzed statistically, the following facts are presented as a matter of record: Treatment 2, a combination of 12 ounces of fume phosphate and 4 ounces of X.I. Ceresan, averaged the highest (112.8), followed by treatment 3, Yellow Cuprocide 12 ounces (106.0). Treatment 3, fume phosphate 20 pounds, averaged the lowest (85.6). When the fume phosphate was buffered by N.I. Ceresan (treatments 4 and 7) the average stand differed but little from the check or from N.I. Ceresan alone (treatment 1); when buffered by Yellow Cuprocide (treatment 6),

Table 3.—Seedling stand obtained per unit of seed in percentage of check. All-factory seed treatment test. 1045.

No.	Treatment per 100 lb. seed ^b	Greeley	Windsor	Longmont	Longmont	Brighton	Brighton	F. Lupton
		3	3	1*	3	3	3	1
1.	F. P. 12 oz. + Cer. 4 oz.	104	130*	97	110	87	121**	78**
2.	N. I. Cer. 6 oz.	79 ^o	122*	110	87	73	117*	67**
3.	F. P. 20 lbs. + N. I. Cer. 4 oz.	Lost	142*	130	127**	123	138**	84 ^o
4.	Y. Cup. 12 oz.	118*	122*	146*	112	58 ^o	152**	84 ^o
5.	"1452B" 6 oz.	90	116	115	96	39 ^o	112	78**
6.	N. I. Cer. 4 oz. + Y. Cup. 12 oz.	111	131 ⁴	100**	102	112	119*	70**
7.	Arauan 12 oz.	114	127*	267**	126**	113	126**	80*
8.	Check	100	100	100	100	100	100	100
General Mean		102.3	124.1	145.1	108.8	88.1	121.0	81.6
CV (percentage)		0.46	0.53	0.62	7.33	21.92	7.15	8.83
LSD 5-percent point		17	21	34	14	34	15	13
LSD 1-percent point		24	Not sig.	50	19	47	21	18

Table 3.—Continued

Stirling	Brush	Ft. Morgan	Ft. Morgan	Gettag	Gettag	Bayard	Bayard	Mintcare	Mean
2	2	2	2	1	3	1	3	3	
140**	118*	108	94	100	145**	122*	157*	99	113.2*
124**	97	123*	96	105	126	107	116	103	104.1
160**	110	100	80 ^o	94	107	118*	86	110	113.9 ^o
182**	97	117*	103	115	68 ^o	119*	106	104	103.3*
134**	103	128*	85*	80	106**	111	103	101	105.6
135**	113*	110*	100	122	108**	124*	97	102	120.9*
138**	121*	119*	107	99	143**	110	113	104**	123.9*
100	100	100	100	100	100	100	100	100	100.0
132.9	108.3	114.3	96.0	101.9	128.0	113.9	109.8	110.4	111.7
6.83	8.27	7.80	7.06	12.71	13.61	7.27	12.21	6.64	2.03
16	16	16	13	28	30	15	24	13	11.2
22	Not sig.	Not sig.	19	Not sig.	42	Not sig.	33	18	--

* and ** Significantly better than check at the 5-percent and 1-percent points, respectively.

^o and ^{oo} Significantly poorer than check at the 5-percent and 1-percent points, respectively.

^a Two replications. All other locations three replications.

^b Abbreviations used:

N. I. Cer.—Ceresan, New Improved

Y. Cup.—Yellow Cuproicide

P. P.—Fume phosphate

some improvement was indicated but the value of the check was not reached.

Results for 1945.—The results of the seedling counts from the 16 locations yielding statistically significant differences between treatments (5-percent and 1-percent points) are presented in table 3.

As in test A, striking differences in response to treatments were found between different locations. In the Fort Lupton test all applications proved either significantly or highly significantly poorer than the check, and in some other locations several treatments ranked very low, sometimes, significantly so. At the same time it is true that the general mean of all treatments was considerably higher than the value for the check and that five of the seven treatments used averaged at least significantly better than the check. These facts would seem to indicate presence of disease and benefit from the treatments generally.

Fume phosphate 12 ounces and N.I. Ceresan 4 ounces (treatment 1) averaged slightly better than the general mean and much higher than the check.

N.I. Ceresan 6 ounces (treatment 2) averaged second lowest aside from the check and thus much poorer than the same treatment in test A, especially in 1945.

Fume phosphate 20 pounds and 6 ounces of N.I. Ceresan (treatment 3) at least equalled treatment 1 on the average.

Yellow Cuprocide 12 ounces alone (treatment 4) ranked lower than treatments 1 and 3 but was considerably better than the check.

"1452F" 6 ounces (treatment 5) averaged lowest and not significantly better than the check.

X.T. Ceresan 4 ounces and Yellow Cuprocide 12 ounces (treatment 6) ranked second best, significantly better than any of the treatments preceding.

Arasan alone 12 ounces (treatment 7) proved to be the best treatment in the series.

Summary

1. Two series of tests with seed treatments against seedling diseases in sugar beets were conducted.
2. Very great variations in the effectiveness of various treatments were found to exist between individual fields.
3. In spite of these variations it was observed that the treat-

ments commercially designated N.I. Ceresan and Arasan rather consistently ranked among the very best, while "1452F" and Cuproside ranked very high, alone or in combinations, with less consistency.

4.. Applications of large amounts fume phosphate alone to the seed consistently resulted in reduced seedling counts, while in some instances mixtures of large amounts of fume phosphate and fungicides approached or compared favorably with those fungicides alone in effectiveness.

5. Nitrogen, as used in the test, whether alone or in combination, appeared detrimental in many cases and in no cases statistically beneficial.

6. It is indicated that it will be very difficult to design a universally superior treatment, perhaps because of natural factors out of our control. However, the fact that the top ranking treatments as identified where they have been most effective, and barring some instances of possible overdosage, still in a general way are found associated with the higher or highest seedling counts in locations where treatments prove to be not needed or ineffective, or perhaps detrimental, indicates that it may be possible to approach the goal of a generalized seed treatment to a rather satisfactory degree.

Literature Cited

1. Isaksson, A. and Brewbaker, IT. E. Seed Treatment Tests, 1943. Proc. Amer. Soc. Sug. Beet Tech. Regional Meeting, Eastern Slope and Intermountain 5-9. 1944.