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VEGETABLE SEED TREATMENT FOR OKLAHOMA

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Tests Show Vegetable Seed Treatment Pays

This bulletin presents results of tests made to determine the value of chemical treatment of vegetable seeds in Oklahoma. Tests were made on beet, cabbage, cantaloupe, carrot, cucumber, eggplant, lettuce, lima bean, okra, pea, pepper, potato, radish, salsify, edible soybean, spinach, sweet corn, tomato, turnip, and watermelon seed. Recommendations based on these tests may be summarized as follows:

- Chemical seed treatment often results in marked seedling stand increases.

- Chemical seed treatment is especially valuable on spinach, beet, pea, lettuce, carrot, salsify, sweet corn, cucumber, cantaloupe and watermelon seed when environmental conditions following planting are unfavorable for rapid seedling development.

- Although some kinds of seed do not respond as markedly as others to seed treatment, it should be a standard practice on all vegetable seed. Chemicals, properly applied, do not injure seed. Only by treating all vegetable seed can growers obtain the maximum protection afforded by this seedling-emergence insurance.

- Seed treatment chemicals are inexpensive and easy to apply. Most vegetable seed can be treated for approximately one cent per pound. Seeding rates with treated seed should be reduced to avoid getting stands that are too thick.

- Only a few chemicals are needed for effective treatment of all vegetable seed. Arasan, Spergon, Semesan, Cuprocide, and Vasco 4 (zinc oxide) are the chemicals most widely used for vegetable seed treatment. Arasan and Spergon have shown the most outstanding, consistent seedling stand increases. These chemicals are also less poisonous and therefore less dangerous to use.

SEED TREATMENT CHEMICALS ARE POISONOUS. Do not use treated seed for livestock feed or for human food. Avoid breathing the dust or getting it on the skin while treating seed. Treated seed may be saved for later plantings or for planting the following season.

Recommendations for controlling diseases of most vegetables commonly grown in Oklahoma are given in Experiment Station Circular C-117, "Recognition and Control of Vegetable Diseases." Copies are available from county agents, or by writing to the experiment station at Stillwater.

VEGETABLE SEED TREATMENT FOR OKLAHOMA

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The Experiment Station during the past few years has tested many of the chemical dusts used for seed treatment of various vegetable and truck crop seeds.[1] The results are presented in the following pages, together with seed treatment recommendations drawn therefrom. These results have been verified by many investigators in other locations.

PURPOSE OF SEED TREATMENT

Seed when planted in soil are often attacked by microscopic organisms (fungi and bacteria) which are either carried on the seed or live in the soil. One group of these organisms,[2] the parasitic fungi, attack and destroy many of the seed and seedlings of vegetable crops. Poor emergence and poor seedling stands are the result. This is commonly known as damping off.

The extensive losses caused by damping off are not always recognized. Accurate accounts of the number of seed planted and the number of seedlings that come up and live must be made before one is fully aware of them. Percentage stand increases of well over one-hundred percent were found in many of the tests reported later in this bulletin.

Damping off consists of two distinct types of injury. The pre-emergence damping off is the complete rotting of the seed or young seedlings before they emerge from the ground. These losses are usually blamed on poor seed. Post-emergence damping off is more commonly observed. In this type the seedlings emerge from the soil, live for one to several days, then wilt, fall over, and dry up within a short time. Sometimes the seedlings first become a darker green color than normal, and the stems may become watersoaked and glassy in appearance. Seedlings may be attacked and live, although they grow slowly and usually produce a poor crop.

[1] Some of the tests have been in cooperation with a nationwide seed treatment testing program under the auspices of The American Phytopathological Society. Some of the vegetable seed used in the tests was supplied by the Associated Seed Growers, Inc. The seed treatment chemicals were supplied by the respective manufacturers. At the time the cabbage, eggplant, tomato, pepper, salsify, turnip and radish seed treatment tests were conducted, Arasan was not available as a vegetable seed treatment chemical. Arasan is recommended by its manufacturers for use on these crops and from its performance on other vegetable crops in Oklahoma it should prove satisfactory.

[2] In Oklahoma the primamry causes of seedling damping off are *Pythium debaryanum* and *Rhizoctonia solani*. These are parasitic fungi capable of living in the soil and old plant debris throughout the year and are found in almost all soils.

For controlling damping off, the most economical and beneficial method yet found is seed treatment with disinfectant dusts. A thin coating of the proper chemical dust forms a protective wall around the seed and prevents entry of the organisms. Some chemicals give added protection by diffusing into the soil around the seed, and thus retard fungous growth a short distance away from the seed. The protective action of seed treatment chemicals is especially needed when plantings are followed by cold, wet weather.

Seed treatments are inexpensive, easy to apply, and the treatments may be done at any time up to the time of planting the seed. Most seed stores sell some of the seed treatment chemicals, and many of the more progressive seedsmen are now treating their seed prior to selling it to the growers.

Seed treatment chemicals properly applied to seed will increase seedling emergence, resulting in better stands, healthier plants and larger yields. Buy the best seed obtainable, make certain it has been treated or treat it at home, and plant at the proper planting time for your community. Plantings made in a well-drained soil in a well-prepared seed bed on the proper planting date will also result in lower losses from post-emergence damping off.

Seed treatment is not a "cure-all." It will not protect seedlings against insects and diseases attacking plants past the seedling stage. It will bring out the best performance of seed, but is no substitute for poor-quality seed.

SEED TREATMENT METHODS AND COSTS

How to Treat Seed

Small packets of seed may be treated by placing a small quantity of the chemical dust in the packet with the seed and shaking vigorously for a minute or two. Quart or half-gallon jars may be half-filled with seed, the proper amount of chemical added, and the two shaken together for two or three minutes. Gallon buckets with tight lids, or milk cans, may be used for larger quantities of seed. A barrel seed treater may be easily and cheaply made from plans obtained free from the Du Pont Semesan Co., of Wilmington, Delaware. Large seed-treating machines are available for bulk seed treatment by seed producers.

Seed treating containers should not be filled over half-full of seed. Treated seed should have a noticeable covering of the chemical dust on the surface of the seed. With either Arasan or Spergon, it is difficult to get too much chemical on the seed. However, the chemicals should not be wasted.

Apply all chemical dusts at the rates recommended in this bulletin[3] or according to directions on the chemical container. (Read all directions on the chemical containers carefully to avoid mistakes in treating.)

Although chemical dust seed treatment is inexpensive and easy to apply, the best procedure is to ask for and insist on treated seed when buying. Many of the more progressive seedsmen are treating their seed before selling it. If your seedsman does not have treated seed, he probably can get it for you. By asking for and insisting on treated seed, it should only be a short time until most vegetable seed are treated by the seedsmen. Growers are entitled to this service by their seedsmen.

Seed Pelleting

A process of seed treatent known as seed pelleting has received some attention recently. This process consists of treating seed with a sticky, quick-drying plastic to which may be applied large amounts of seed treatment chemicals. The process, when properly done, results in a very uniformly-sized seed, which may be of distinct benefit in obtaining well-spaced plantings of various vegetable crops when the seed are planted with planters. Some results with seed pelleting on lima bean, okra, cucumber, cantaloupe, and watermelon seed are reported in this bulletin. More experimental data are needed before definite seed-pelleting recommendations can be made.

RESULTS OF TESTS

Beets

Beets are especially susceptible to both pre- and post-emergence damping off. Although beet seed are generally planted at excessive seeding rates, the resulting stands frequently are unsatisfactory, often having numerous long skips without plants. Seed treatment is of distinct advantage in improving beet seedling stands.

A greenhouse test, which was conducted under conditions extremely favorable for damping off, showed almost phenomenal stand increases resulting from seed treatment (Table 1). There was also less post-emergence damping off among the seedlings produced from the treated seed. The field test at Stillwater, although conducted under conditions less favorable for damping off, showed marked improvement in stands, resulting from seed treatment. The field test at Bixby may be considered as an average test; equally good results may be expected in most seasons.

[3] Recommended chemicals and rates for the different vegetables are given at the end of the section reporting tests of each vegetable. See table of contents.

BEETS

Table 1.—Effect of seed treatment on stands of beets.

Location of test	Type of test	SOIL CONDITIONS				Stand count of non-treated[1]	PERCENTAGE STAND INCREASES				
		Type	pH	Moisture	Temperature		Arasan .25%	Arasan .5%	Arasan 1.0%	Ceresan	Yellow Cuprocide
Stillwater	Greenhouse	Loam	7.14	Wet	Cool	20	470**	582**	576**	541**	523**
Stillwater	Field	Loam	6.17	Optimum to dry	Cool	47	76**	58**	56**	62**	55**
Bixby	Field	Fine sandy loam	5.14	Optimum	Cool	41	109**	118**	128**	99**	109**

[1] Average of four replications.

** Significant at 1% level.

The experimental results indicate that treatment with any one of the chemicals used would be advantageous.

Recommended seed treatment: Arasan at .5% by weight of seed. (Spergon should not be used on beet or Swiss chard seed.)

Cabbage

Growers of cabbage transplants frequently observe considerable damping off in their beds. Seed treatment will help to prevent or reduce damping-off losses.

Greenhouse tests (Table 2) were conducted under conditions generally favorable for damping off. Seedling stand increases for treatments in cabbage were significant, but Chinese cabbage did not respond to treatment. Cabbage seed treatment is generally recommended to growers of transplants by many experiment station workers.

Recommendations: Spergon or Vasco 4 at .5% by weight of seed. Semesan according to manufacturers' directions.

CABBAGE

Table 2.—Effect of seed treatment on stands of cabbage.

Location of test	Type of test	SOIL CONDITIONS			Stand count from non-treated[1]	PERCENTAGE STAND INCREASES		
		Type	Moisture	Temperature		Spergon	Vasco 4	Semesan
Cabbage								
Still-water	Green-house	Sandy loam	Optimum	Cool	67	34**	28**	25**
Still-water	Green-house	Loam			62		26**	26**
Chinese Cabbage								
Still-water	Green-house	Sandy loam	Optimum	Cool	96	0	−4	−4

[1] Average of four replications. ** Significant at 1% level.

Cantaloupe

Seedling stands of cantaloupes are frequently unsatisfactory due to severe damping-off losses. The seed become subject to attack by many soil-borne organisms when the seed coat softens and swells upon absorbing water. The young seedlings are also quite susceptible to injury.

The field test at Perkins (Table 3) was conducted under very poor testing conditions. The Bixby test, conducted in a warm, moist soil, showed marked stand increases resulting from treatment.

The pelleted seed was seed first treated with a 4 percent solution of methocel to furnish a sticky base, then treated with 10 percent by weight of Arasan. This is twenty times the amount of chemical normally used. The pelleting did not seem to give the seed any added protection against damping-off organisms.

Recommendations: Arasan or Spergon at .5% by weight of seed.

CANTALOUPE

Table 3.—Effect of seed treatment on stands of cantaloupe.

Location of test	Type of test	SOIL CONDITIONS			Stand count from non-treated[1]	PERCENTAGE STAND INCREASES		
		Type	Moisture	Temperature		Arasan .5%	Spergon .5%	Pelleted with 10% Arasan
Perkins	Field	Sandy loam	Dry	Warm	22	6	2	6
Bixby	Field	Fine sandy loam	Optimum	Warm	36	40*	53*	17*

[1] Average of five replications. * Significant at 5% level.

Carrot

Satisfactory stands of carrot seedlings are often extremely difficult to obtain even when the seed are planted at an excessive rate. The young seedlings are delicate and very susceptible to damping-off fungi.

All of the carrot tests were conducted under environmental conditions favorable for damping-off to occur although the conditions were seldom favorable for seedling emergence. The seedling stands obtained from the various treatments (Table 4) although not entirely satisfactory, were much better than the stands from nontreated seed.

Recommendations: Arasan or Spergon at .5% by weight of seed. (Manufacturers of chemicals warn against overdosing carrot seed.)

Cucumber

Cucumber seed and seedlings are especially susceptible to damping-off fungi in cool, moist soils. Even in warm, moist soils the losses are oftentimes excessive.

CARROT

Table 4.—Effect of seed treatment on stand of carrot.

Location of test	Type of test	SOIL CONDITIONS				Stand count from non-treated	PERCENTAGE STAND INCREASES						
		Type	pH	Moisture	Temperature		Arasan .5%	Arasan .75%	Spergon .5%	Spergon .75%	Semesan .42%	Cupro-cide 1.0%	Zinc Oxide 1.0%
Stillwater	Green-house	Sandy loam		Optimum	Cool	60[1]				0	18	17	5
Stillwater	Green-house	Loam	7.14	Wet	Cool	28[2]	49**	80**	32	16	40*	23	33
Stillwater	Field	Loam	6.17	Optimum	Cool	19[2]	44*	60*	40	31	28	26	−12
Bixby	Field	Loam	5.14	Optimum	Cool	17[2]	31	47	3	45	2	33	9

[1] Average of four replications.
[2] Average of five replications.

* Significant at 5% level.
** Significant at 1% level.

CUCUMBER

Table 5.—Effect of seed treatment on stands of cucumber.

Location of Test	Type of test	SOIL CONDITIONS				Stand count from non-treated[1]	PERCENTAGE STAND INCREASES				
		Type	pH	Moisture	Temperature		Arasan	Spergon	N. I.[2] Ceresan	Yellow Cupro-cide	Pelleted + 10% Arasan
Stillwater	Field	Loam	6.17	Optimum	Warm	43	11	1	6	14	
Perkins	Field	Sandy loam		Dry	Warm	49	7	16			8
Bixby	Field	Fine sandy loam		Optimum	Warm	22	162**	135**			152**

[1] Average of five replications.

** Significant at 1% level.

[2] New Improved Ceresan.

In a greenhouse test under conditions favorable for damping off, red copper oxide, zinc oxide, and Semesan gave seedling stand increases of 52%, 55% and 67% respectively. The field tests at Stillwater and Perkins were conducted under poor testing conditions. The Bixby test was conducted under satisfactory testing conditions and here the treatments gave outstanding increases in seedling stands.

The pelleted seed were first treated with 4 percent methocel in water for a sticker base and then treated with 10 percent Arasan by weight of seed. Although the pelleted seed gave results comparable to those treated with Arasan and Spergon, the experimental data are insufficient to support recommendations on pelleting.

Recommendations: Arasan or Spergon at .5% by weight of seed.

Eggplant

Growers of eggplants planted for transplanting sometimes experience losses due to damping-off organisms in the soil. Planting treated seed in a well-drained soil aids in reducing or preventing damping-off losses.

The Station experimental data are limited but do show seedling stand increases from the seed treatment chemicals used (Table 6). Personal observation and experience indicate that eggplant seed should be treated as a general practice by growers of transplants.

Recommendations: Spergon or Vasco 4 at .5% by weight of seed. Semesan according to manufacturer's directions.

EGGPLANT

Table 6.—Effect of seed treatment on stands of eggplant.

Location of test	Type of test	SOIL CONDITIONS			Stand count from non-treated[1]	PERCENTAGE STAND INCREASES			
		Type	Moisture	Temperature		Spergon	Semesan	Vasco 4	Cuprocide
Stillwater	Greenhouse	Sandy loam	Optimum	Cool	59	12	37*	16	0

[1] Average of five replications. * Significant at 5% level.

Lettuce

The common practice of planting lettuce seed at an excessive rate to get satisfactory stands of lettuce seedlings often fails its purpose. Lettuce seed respond well to seed treatment.

LETTUCE

Table 7.—Effect of seed treatment on stands of lettuce.

Location of test	Type of test	SOIL CONDITIONS				Stand count from non-treated	PERCENTAGE STAND INCREASES				
		Type	pH	Moisture	Temperature		Arasan 2.0%	Spergon 2.0%	Semesan .2%	Zinc Oxide 2.0%	Cupro-cide 2.0%
Stillwater	Greenhouse	Sandy loam		Optimum	Cool	59[1]		27**	32**	24**	36**
Stillwater	Greenhouse	Loam	7.14	Wet	Cool	21[2]	231**	166**	156**	94	194**
Stillwater	Field	Loam	6.17	Optimum	Cool	12[2]	47	42	0	90	15

[2] Average of five replications. [1] Average of four replications. ** Significant at 1% level.

LIMA BEANS

Table 8.—Effect of seed treatment on stands of lima beans.

Location of test	Type of test	SOIL CONDITIONS			Stand count from non-treated	PERCENTAGE STAND INCREASES					
		Type	Moisture	Temperature		Arasan .25%	Spergon .25%	Fermate .25%	PELLETED+ .25% Arasan	2.5% Spergon	5% Spergon
Stillwater	Field	Loam	Optimum	Warm	73[1]		4	8			
Stillwater	Field		Dry	Warm	64[1]	16**	16**				
Perkins	Field	Sandy loam	Dry	Warm	70[2]	9	7		−12	3	3
Bixby	Field	Fine sandy loam	Optimum	Warm	32[2]	124**	108**		99**	87**	105**

[1] Average of five replications. [2] Average of six replications.
** Significant at 1% level.

Results of Oklahoma tests with lettuce are shown in Table 7. Under cool, wet soil conditions, lettuce seed treatment often more than doubles the resulting stand. The results from lettuce seed treatment tests conducted throughout the United States have shown that lettuce responds to seed treatment in approximately one-third of the tests.

Recommendations: Arasan or Spergon at 1% by weight of seed.

Lima Beans

Although lima beans are ordinarily planted in warm soils, losses due to damping-off organisms are commonly experienced. In regions where lima beans are grown extensively, seed treatment is a general practice. The treatments do not injure the seed and often mean the difference between a good stand and a poor stand.

In the lima bean tests (Table 8) seed were pelleted with Arasan and Spergon at different dosages, but the pelleting was not superior to the other treatments under the conditions of these tests. In the Bixby field test the seedling stands were not only doubled but the plants had a much more vigorous appearance, being taller and more robust.

Recommendations: Arasan or Spergon at .25% by weight of seed.

Okra

Satisfactory seedling stands of okra are often difficult to obtain because the seed rot readily in wet soils. Okra is a warm-season crop and should be planted in a well-drained soil.

The seed used in the okra tests were of low viability and the resulting stands (Table 9) were unsatisfactory. However, seed

OKRA

Table 9.—Effect of seed treatment on stands of okra.

Location of test	Type of test	SOIL CONDITIONS			Stand count from non-treated[1]	PERCENTAGE STAND INCREASES		
		Type	Moisture	Temperature		Arasan .5%	Spergon .5%	Pelleted + 10% Arasan
Perkins	Field	Sandy loam	Dry	Warm	31	16	13	21
Bixby	Field	Fine sandy loam	Optimum	Warm	17	46	13	58

[1] Average of four replications.

GARDEN PEAS

Table 10.—Effect of seed treatment on stands of garden peas.

Location of test	Type of test	SOIL CONDITIONS				Stand count from non-treated[1]	PERCENTAGE STAND INCREASES				
		Type	pH	Moisture	Temperature		Arasan		Spergon		Cupro-cide
							1.5 oz.	2.0 oz.	1.5 oz.	2.0 oz.	2.25 oz.
Stillwater	Greenhouse	Sandy clay loam	7.14	Wet	Cool	15	464**	522**	491**	477**	384**
Stillwater	Field	Loam	6.17	Optimum	Cool	89	9*	9*	8*	8*	9*
Stillwater	Field	Loam	6.17	Optimum	Cool	82	17**	14**	15**	18**	13**
Bixby	Field	Fine sandy loam	5.14	Optimum	Cool	57	54**	64**	61**	61**	55**

[1] Average of five replications. * Significant at 5% level. ** Significant at 1% level.

GARDEN PEAS

Table 11.—Effect of seed treatment on vigor and strength of pea seedlings.

Location of test	Type of test	SOIL CONDITIONS				Strong plant count from non-treated[1]	PERCENTAGE STRONG PLANT INCREASE				
		Type	pH	Moisture	Temper-ature		Arasan		Spergon		Cupro-cide
							1.5 oz.	2.0 oz.	1.5 oz.	2.0 oz.	2.25 oz.
Stillwater	Greenhouse	Sandy clay loam	7.14	Wet	Cool	3	1227**	1887**	1267**	1773**	1787**
Stillwater	Field	Loam	6.17	Optimum	Cool	78	15**	17**	13**	14**	17**
Stillwater	Field	Loam	6.17	Optimum	Cool	72	24**	24**	26**	29**	24**
Bixby	Field	Fine sandy loam	5.14	Optimum	Cool	37	122**	139**	134**	137**	128**

[1] Average of five replications. ** Significant at 1% level.

treatment was observed to increase seedling stands by 40 to 50 percent or more.

Pelleting appeared to be more satisfactory with okra seed than with any of the other seed on which it was tested. The results on okra seed warrant further investigation.

Recommendations: Arasan or Spergon at .5% by weight of seed.

Peas

Peas normally are planted in cold, wet soils—conditions which are very favorable for seed rotting and seedling damping off. Seedling stands are often unsatisfactory and the surviving seedlings do not grow as expected. Garden peas show marked benefits from seed treatment.

The seedling stand increases resulting from treatment were pronounced especially under conditions adverse for seed germination (Table 10). There was also a second beneficial effect—plants produced from treated seed are much more vigorous and robust than plants produced from nontreated seed (Table 11).

Recommendations: Spergon or Arasan at .2% by weight of seed, or at 2 oz. per bushel.

Pepper

Growers of pepper plants for transplants sometimes experience losses due to damping-off pathogens present in their soils. Planting treated pepper seed in well-drained soil aids in preventing or reducing such losses.

Although the greenhouse test reported in Table 12 was conducted under conditions generally favorable for seedling emergence, the more effective chemicals increased seedling emergence 10 percent or more. Pepper seed treatment is a general recommendation.

PEPPER

Table 12.—Effect of seed treatment on stands of pepper.

Location of test	Type of test	SOIL CONDITIONS			Stand count from non-treated[1]	PERCENTAGE STAND INCREASES			
		Type	Moisture	Temperature		Spergon	Semesan	Cupro-cide	Vasco 4
Still-water	Green-house	Sandy loam	Opti-mum	Cool	81	10	5	19	4

[1] Average of five replications.

Recommendations: Spergon or Cuprocide at .5% by weight of seed. Semesan according to manufacturer's directions.

Potato

Potato seed pieces are often subject to considerable rotting under Oklahoma conditions before emergence of the seedlings. In many of the major potato-growing regions of the United States, potato seed piece treatment is a standard practice. The Oklahoma Station conducted one extensive seed treatment test with potatoes on the experimental farm near Perkins. The potato tubers used for seed were of the Bliss Triumph variety, grown and certified in North Dakota in 1942.

POTATO

Table 13.—Effect of seed treatment data on seedling stand, Rhizoctonia disease index, green weight per plant and yield of tubers of potatoes.

	Type of data and treatment	Mean seedling stand	Rhizoctonia index	Mean weight per plant in grams	YIELD[1]			
					Total	No. 1	No. 2	Culls
Mean data of nontreated[1]		41	.40	53	26	17	7	2
Percentage stand increase	Semesan Bel	5	−36	51**	8	−12	57*	32
	Yellow oxide of mercury	5	−13	8	4	− 6	29*	8
	Spergon	12*	−28	42**	27*	18*	43*	22
	Fermate	7	− 9	6	−4	−18	29	13
	Cold formalin	0	−31	34*	4	− 6	29	14
	Bichloride of mercury	12*	−21	30	23*	23*	29	7
	Thiosan	7	−15	21	8	0	29	17

[1] Mean of five replications; yield data in pounds per plot.
* Significant at 5% level. ** Significant at 1% level.

The data (Table 13) indicate that potato seed treatment may be beneficial in increasing stands of healthier, more vigorous plants which in turn results in increased yields. It is noteworthy that seedlings grown from treated seed pieces were heavier and were less diseased by Rhizoctonia than seedlings produced by nontreated seed pieces.

In a second test, using Oklahoma-grown, fall-crop seed of the Bliss Triumph variety, the benefits from seed treatment were not so marked.

Recommendations: See Mimeographed Circular 36 for methods of liquid treatment.

Radish

Even though radish seed generally germinate rapidly and produce strong seedlings following planting, there are sometimes losses due to damping off, especially when environmental conditions following planting are such that the seed cannot germinate readily and emerge.

RADISH

Table 14.—Effect of seed treatment on stands of radish.

Location of test	Type of test	SOIL CONDITIONS			Stand count from non-treated[1]	PERCENTAGE STAND INCREASES		
		Type	Moisture	Temperature		Spergon	Semesan	Vasco 4
Still-water	Green-house	Sandy loam	Optimum	Cool	96	3	0	−8

[1] Average of four replications.

The data from a greenhouse test performed under conditions that were rather favorable for seedling emergence do not show outstanding increases resulting from the seed treatment (Table 14). Nevertheless, radish seed should be treated as a general practice. Seed treatment of any kind of seed is inexpensive seedling-emergence insurance.

Recommendations: Spergon at .5% by weight of seed.

Salsify

It is frequently difficult to obtain satisfactory seedling stands of salsify. Damping-off losses are high.

SALSIFY

Table 15.—Effect of seed treatment on stands of salsify.

Location of test	Type of test	SOIL CONDITIONS			Stand count from non-treated[1]	PERCENTAGE STAND INCREASES			
		Type	Moisture	Temperature		Spergon	Semesan	Cupro-cide	Vasco 4
Still-water	Green-house	Sandy loam	Optimum	Cool	79	20*	6	18*	18*

[1] Average of six replications. * Significant at 5% level.

Greenhouse test data (Table 15) show seedling stand increases of 18 to 20 percent for the more effective chemicals. These increases are due largely to control of pre-emergence damping off. It has also been observed that many salsify seedlings are lost from an infection of the seedling leaves by the fungus *Pythium debaryanum*. Losses from this cause were

extremely high in the seedlings produced from nontreated seed in the above test. Various chemical seed treatments reduced the amount of infection as shown in Table 16.

SALSIFY

Table 16.—Effect of seed treatment data in reducing seedling leaf infection by Pythium debaryanum.

Location of test	Type of test	SOIL CONDITIONS			Leaf infection[1] of non-treated[2]	PERCENTAGE REDUCTION OF LEAF INFECTION			
		Type	Moisture	Temperature		Spergon	Semesan	Cuprocide	Vasco 4
Still-water	Greenhouse	Sandy loam	Optimum	Cool	65	94**	28**	72**	48**

[1] Seedling leaves infected by *Pythium debaryanum.*
[2] Average of six replications.
** Significant at 1% level.

Spergon seed treatment was outstanding both in increasing initial seedling stands and in preventing fungous infection of seedling leaves.

Recommendations: Spergon, Cuprocide, or Vasco 4 at .5% by weight of seed.

Soybeans (edible)

In general edible soybeans do not show marked benefits from chemical seed treatment. However, under special adverse conditions, such as cold, wet weather following planting, seed treatment may mean the difference between a good and poor seedling stand.

In each season of the tests, the soil conditions following planting were unfavorable for damping-off and seed-rotting losses. However, the various treatments resulted in seedling

SOYBEAN (EDIBLE)

Table 17.—Effect of seed treatment on stands of soybean.

Location of test	Type of test	SOIL CONDITIONS				Stand count from non-treated[1]	PERCENTAGE STAND INCREASES			
		Type	pH	Moisture	Temperature		Fermate .16%	Semesan Jr. .16%	Spergon .16%	Arasan .10%
Still-water	Field	Sandy loam	Alkaline	Dry	Warm	77	10*	1	12*	16**
Still-water	Field	Loam	6.17	Optimum	Warm	88	5		6	6

[1] Average of five replications.
* Significant at 5% level.
** Significant at 1% level.

stand increases of from 5 to 16 percent (Table 17). Soybean seed treatment will often be beneficial. Seed may be inoculated with legume nodule bacteria immediately before treatment with the chemical dust and planting.

Recommendations: Arasan or Spergon at .2% by weight of seed.

Spinach

Spinach seed treatment tests have been conducted in most of the spinach-growing regions of the United States and very striking increases in both seedling stands and yields have been reported for various treatments. Extensive spring and fall spinach seed treatment tests have been conducted in Oklahoma.[4]

Both greenhouse and field plantings made in the spring season at Stillwater have resulted in marked seedling stand increases (Table 18). The results are especially striking wherever planting is followed by cold, wet weather, as in the Stillwater field test of 1943. A spring planting at Bixby in 1944 showed seedling stands more than doubled by the better chemicals.

Fall plantings of spinach also show very noteworthy seedling stand increases resulting from treatments. In a seed lot showing 54 percent laboratory germination planted at Bixby in the fall of 1944 at different seeding rates, it was observed that at equivalent rates seedling stands were generally doubled by either Spergon or Arasan treatments and that yields were generally increased by 50 percent or more. The most economical and satisfactory rate of planting appeared to be 8.5 pounds of seed per acre. At this rate the plants from non-treated seed yielded at the rate of 7,144 pounds of cut spinach per acre, whereas the plants from Arasan-treated seed yielded at the rate of 10,332 pounds of cut spinach per acre. This is an increase in yield of approximately 50 percent.

A planting at Bixby in the fall of 1945 showed results very similar to those of 1944. Seedling stands were more than doubled as a result of either Spergon or Arasan treatment in most instances and yields of cut spinach were increased as a result of the better emergence.

Spinach seed show the most striking response to seed treatment of any crop thus far tested. Certainly, in large commercial plantings where seed treatment is combined with the

[4] In cooperation with Horticulture Department at Oklahoma Vegetable Research Station at Bixby.

SPINACH

Table 18.—Effect of seed treatment on stands of spinach.

Location of test	Type of test	SOIL CONDITIONS			Temperature	Stand count of non-treated	PERCENTAGE STAND INCREASES				Mean yield of non-treated	PERCENTAGE YIELD INCREASE	
		Type	pH	Moisture			Spergon	Arasan	Fermate	Zinc Oxide		Arasan	Spergon
Stillwater 1942	Greenhouse	Sandy loam		Optimum	Cool	58[1]	14**			14**			
Stillwater 1943	Field	Loam	6.2	Optimum	Cool	15[2]		239**	236**	284**			
Stillwater 1944	Greenhouse	Sandy clay loam	7.1	Wet	Cool	53[2]		32**	31**	38**			
Stillwater 1944	Field	Loam	6.2	Optimum	Cool	57[2]		4	7	16			
Bixby 1944	Field	Fine sandy loam	5.1	Optimum	Cool	28[2]		111**	51**	107**			
Bixby 1944	Field	Fine sandy loam		Optimum	Cool								
	4.3 lbs. seed per acre					8[2]	100**	100**			5	60**	30*
	5.5 lbs. seed per acre					16[2]	63**	−23**			6	33**	50**
	8.5 lbs. seed per acre					17[2]	88**	100**			8	50**	38**
	11.5 lbs. seed per acre					27[2]	82**	56**			8	50**	50**
Bixby 1945	Field	Fine sandy loam		Optimum	Cool								
	5.5 lbs. seed per acre					25[1]	132**	120**			1.0	12	31
	7.0 lbs. seed per acre					25[1]	160**	92**			.9	0	51**
	8.5 lbs. seed per acre					33[1]	142**	55**			.9	61**	98**
	11.5 lbs. seed per acre					66[1]	68**	52**			1 3	43**	51**

[1] Average of six replications.
[2] Average of five replications.
** Significant at 1% level.

proper rate of seeding, seed treatment is very beneficial. Large yield increases may be expected at a negligible cost.

Recommendations: Arasan or Spergon at .5% by weight of seed.

ADJUSTMENT OF SPINACH PLANTING RATES

All tests reported in this bulletin except the spinach-yield tests were planted at the rate of 100 seed per plot or row. The spinach yield tests at Bixby in 1944 and 1945 were planted with weighed lots of seed in a Planet Jr. planter using plates with numbered holes. The heaviest rate of each treatment was planted through a No. 15 plate hole. The numbers of seed planted per linear foot were then calculated from the total number of linear feet planted to a treatment and the weight of seed used in that treatment. These data are presented in Table 19.

SPINACH RATE OF PLANTING

Table 19.—Numbers of spinach seed planted per linear foot at Bixby in 1944 and 1945.

Treatment	Planter plate hole number	Rate of planting pounds /acre	NUMBERS OF SEED PER LINEAR FOOT	
			1944	1945
Spergon	15	13.4	13.3	12.6
	13	11.0	11.7	9.7
	11	8.1	8.0	7.7
	10	6.2	5.3	6.8
Arasan	15	10.5	10.6	9.7
	13	7.4	7.4	6.8
	11	5.3	4.5	5.8
	10	3.9	3.7	3.9
Nontreated	15	11.0	10.6	
	13	8.5	8.1	
	11	5.6	5.4	
	10	4.5	4.3	

At equal rates of flowing through the planter plate holes the various treatments should have been planted at approximately the same number of seed per linear foot. That was clearly not the case. Spergon-treated seed were flowing more rapidly than nontreated seed, and nontreated seed were flowing more rapidly than Arasan-treated seed.

A simple laboratory test was made to study the differences in seed flowing for the different treatment. Two-hundred-gram samples of each of the treated spinach seed lots were

permitted to flow through a large funnel. The time of flowing for each sample was determined by a stop watch. The means for ten trials of each of the different treatments were: Spergon—4.78 seconds; nontreated—4.98 seconds; and Arasan—5.14 seconds.

Thus there is evidence that seed flow is slightly faster in Spergon-treated seed and slightly slower in Arasan-treated seed than in non-treated seed. Seeding rates in planters should be adjusted to reduce these differences. The percentage germination for the seed lot being planted must also be considered.

Sweet Corn

Sweet corn seed generally shows consistent seedling stand increases from treatment. In seasons when corn planting is followed by cool, wet weather, the increases are more striking.

Under adverse environmental conditions at Perkins and Bixby, sweet corn seedling stands were almost doubled by the better treatments (Table 20). Overdosage with the mercurial chemicals (Semesan Jr. and Barbak-C) sometimes results in injury. In the case of Arasan and Spergon there is not much choice between the two dosages used. The lower dosage is the more economical and is generally as satisfactory.

Tests conducted throughout the United States show much the same results and also show that stronger, more vigorous seedlings result from treatment.

Recommendations: Arasan or Spergon at .17% by weight of seed, or 1.5 ounces per bushel.

SWEET CORN

Table 20.—Effect of seed treatment on stands of sweet corn.

Location of test	Type of test	SOIL CONDITIONS				Stand count from non-treated[1]	PERCENTAGE STAND INCREASES							
							Arasan		Spergon		Semesan Jr.		Barbak-C	
		Type	pH	Moisture	Temperature		1.5 oz.	3.0 oz.	1.5 oz.	3.0 oz.	1.5 oz.	3.0 oz.	1.5 oz.	3.0 oz.
Stillwater	Field	Loam	6.8	Optimum	Cool	77	5	6	5	2	6			
Stillwater	Field	Loam	6.2	Optimum	Cool	48	33**	34**	20*	30**	10	12	0	0
Perkins	Field	Sandy loam	5.1	Optimum	Cool	31	86**	96**	54**	59**	24*	10	10	30**
Bixby	Field	Fine Sandy loam	5.1	Optimum	Cool	31	98**	112**	39**	68**	20	6	4	34**

[1] Average of five replications. * Significant at 5% level. ** Significant at 1% level.

Tomato

Growers of tomato plants for transplanting often experience severe losses due to pre- and post-emergence damping off. One of the methods found effective for preventing or reducing such losses is seed treatment.

TOMATO

Table 21.—Effect of seed treatment on stands of tomato.

Location of test	Type of test	SOIL CONDITIONS			Stand count from non-treated[1]	PERCENTAGE STAND INCREASES			
		Type	Moisture	Temperature		Spergon	Semesan	Cuprocide	Vasco 4
Still-water	Greenhouse	Sandy loam	Optimum	Warm	85	0	5	9	−14
Still-water	Greenhouse	Loam			63		5	5	8

[1] Average of four replications.

Although Station experimental data are limited and do not indicate much benefit from treatment (Table 21), personal observation and wide experience with seed treatment testing lead to a general recommendation that tomato-transplant growers should treat their seed before planting.

Recommendations: Cuprocide at .5% by weight of seed. Semesan according to manufacturer's directions.

Turnip

Turnip seed are much like radish seed in that they germinate readily and usually produce good seedling stands. However, under adverse conditions of cool, wet weather following planting, seed treatment aids in obtaining more satisfactory stands.

In a greenhouse test under favorable soil conditions for damping off, seed treatments increased seedling stands 20 percent more (Table 22). In general such increases might be ex-

TURNIP

Table 22.—Effect of seed treatment on stands of turnip.

Location of test	Type of test	SOIL CONDITIONS			Stand count from non-treated[1]	PERCENTAGE STAND INCREASES		
		Type	Moisture	Temperature		Spergon	Semesan	Vasco 4
Still-water	Greenhouse	Sandy loam	Wet	Cool	67	22*	22*	21*

[1] Average of four replications. * Significant at 5% level.

pected of fall plantings when the soil is becoming cooler and there is an abundance of moisture.

Recommendations: Spergon or Vasco 4 at .5% by weight of seed. Semesan according to manufacturer's directions.

Watermelon

Watermelon growers frequently fail to obtain good seedling stands or they find it necessary to plant many seeds per hill and then thin to a desirable stand after emergence. Watermelon seed treatment is a general recommendation.

WATERMELON

Table 23.—Effect of seed treatment on stands of watermelon.

Location of test	Type of test	SOIL CONDITIONS			Stand count from non-treated	PERCENTAGE STAND INCREASES		
		Type	Moisture	Temperature		Arasan .25%	Spergon .25%	Pelleted +10% Arasan
Perkins	Field	Sandy loam	Dry	Warm	56[1]	−4	−15	−28
Bixby	Field	Fine sandy loam	Optimum	Warm	25[2]	71*	85**	72*

[1] Average of seven replications.
[2] Average of eight replications.
* Significant at 5% level.
** Significant at 1% level.

The test at Bixby was carried on under conditions quite favorable for seed treatment testing and seed treatment resulted in much better seedling stands than in the case of nontreated seed (Table 23). In the test at Perkins, the soil was dry and warm and there was no rain following planting for three weeks or more. Only enough moisture was present in the soil to permit scanty germination. In addition, the planting was severely damaged by field mice eating the seed. Pelleting of watermelon seed did not seem to be advantageous.

Recommendations: Arasan or Spergon at .25% by weight of seed.

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