THE EFFECT OF CHEMICAL SEED TREATMENTS ON GERMINATION AND EMERGENCE OF TUCSON SIDE-OATS GRAMA BOUTELOUA CURTIPENDULA (MICHX.) TORR.

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TABLE OF CONTENTS

INTRODUCTION

Side-oats grama, Bouteloua curtipendula (Michx.) Torr., is a native, perennial, warm-season, mid-grass of exceptionally wide natural distribution. It is of minor value over much of its natural range but throughout the semi-arid and sub-humid regions of the Great Plains it lends itself readily to domestication(18)[1/]. It is more particularly adapted to the Southern Great Plains. The purest stands are found on the steep, rocky slopes or caliche outcrops and on open, pervious soils, but it is adapted to a wide range of soil conditions. Side-oats grama is considered excellent for soil conservation use.

Tucson side-oats grama is an apomictic type of the native side-oats grama. The original collection of the strain was made by Charles R. Proctor near Douglas, Arizona, in 1935. It differs from most other strains by coming into bloom approximately two weeks earlier and continuing to flower throughout the summer and fall. The forage remains green after cutting and, when sufficient moisture is available, two or three seed crops may be produced. It is similar to other strains of side-oats grama in the production of abundant forage of excellent quality and high palatability.

Tucson side-oats grama winter-killed completely the first year it was tested in the Soil Conservation Service nursery at Lincoln, Nebraska. The bulk lot of Tucson, including several selections, was then tested at the Southern Great Plains Field Station, Woodward, Oklahoma(7). Although some selections were severely injured at Woodward during the winters from 1939 to 1945, other selections exhibited no injury. Because of its desirable agronomic features and its tolerance to extreme summer temperatures, the

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1/ Figures in parenthesis refer to "Literature Cited", page 23.

selections of Tucson side-oats grama which can withstand temperatures of $-11^{\circ}F$ will prove invaluable in revegetating tilled or abandoned land adapted to this species.

The seed supply of Tucson side-oats grama is limited, and, if higher rates of germination and stand can be attained with seed protectants it will render the available supply more effective. Side-oats grama is well adapted to the soil and climatic conditions in Oklahoma, and any information that will lead to improved stands will augment the present revegetation and soil conservation programs.

The primary objective of this experiment was to determine the effects of rates and kinds of fungicides on the germination and emergence of Tucson side-oats grama.

REVIEW OF LITERATURE

In his article published in 1948, Leukel(15) reviewed the effectiveness of all the five chemicals which were used in this investigation. He found Ceresan M to be equal to New Improved Ceresan in effectiveness, but somewhat less vesicant and less toxic. Arasan's outstanding feature is its beneficial effect on emergence due to its action as a seed protectant. Teresan (formerly Thiosan) is a wettable form of Arasan.

Spergon was first used with excellent results as a seed disinfectant for peas and beans. It was later found to be effective for seeds of a number of other crops(14). According to Leukel(14), Phygon may be used both as a spray for foliage diseases and as an effective dust fungicide for seeds of sugar beets, corn, sorghum and peanuts. Dow 9B is recommended by the manufacturer for use on seed of corn, small grains, cotton, sugar beets, peanuts and vegetables(15).

Henry(9), working with flax at Edmonton and Castor, Alberta, Canada in 1941, found that both Ceresan and Spergon improved emergence significantly, with Ceresan being superior to Spergon. Though a greater per cent emergence resulted from seed treatment with Ceresan, he concluded that Spergon also had merit as a seed fungicide.

In a comparison of certain mercurial and non-metallic dusts used for corn seed treatment at Madison, Wisconsin in 1942, Hoppe(8) concluded that Spergon was conspicuous in its inability to inhibit the growth of *Diplodia zeae* Lev.

In a study of several chemicals including Ceresan M and Spergon in North Dakota, Bretzel(1) noted that disinfectants containing organic mercury increased the percentage of emergence of plants from all grades of barley. The greatest percentage of increase occurred when applied to the seed with the lowest germinating ability. He found that in wheat the percentage of emergence in soil was lower in all tests than the germination between blotters. Hard red spring wheat showed differences ranging from 7 to 14 per cent between blotter germination and emergence in the greenhouse soil. In flax there was a decrease of 18 per cent in emergence in the greenhouse when compared to germination on blotters. Forsyth and Schuster (5) applied Spergon to flax and wheat seed at 5 rates ranging from 0.6 to 3.6 ounces per bushel. Leaf abnormalities were increased in proportion to the amount of Spergon applied. Treated samples of hard red spring wheat planted in unsterilized soil in the greenhouse gave a mean emergence of 2.3 per cent below the mean germination between blotters. Treated amber durham samples gave an increase over blotter tests of 2.4 per cent(5). Similar findings were reported by Greaney and Wallace(6).

Buchholz(2), in South Dakota, included Spergon and Arasan at 3 ounces per bushel in a treatment of grain sorghum seed in trials designed to enable farmers to seed sorghums earlier in the spring and still get suitable stands. Treated seed resulted in higher yields because the stands were better.

Chemical seed treatment of Sudan grass resulted in an average increase of 12 per cent in stand(11). Spergon and Semesan dusts produced the best results while Du Bay 1205 FF and Yellow cuprocide were slightly less beneficial. Du Bay 1205 FF (now Teresan) is a wettable form of Arasan. In one test, an increase in stand of 24 per cent resulted when treated seed were used. Tests conducted with Orchardgrass and Kentucky bluegrass showed no increase in stand when treated seeds were planted.

Workers in Pennsylvania reported that more damping-off occurred in Sudangrass as soil moisture was increased. However, seeds treated with fungicides were protected, even in saturated soil(12). They used New Improved

Ceresan, Semesan, Spergon, Arasan and Yellow Cuprocide. All of the fungicides, with the exception of excessive amounts of New Improved Ceresan, were approximately equal in effectiveness for seed treatment of Sudangrass. Seed treatments trebled stands when seed was planted in infested soils.

In Washington in 1943, Fischer(4) controlled head smut and stripe smut of Canada wild-rye by using New Improved Ceresan and Arasan. New Improved Ceresan proved lethal to seeds and seedlings in overdosages. Thiosan gave excellent smut control and increased the stands. It was not injurious to the seed when applied in large amounts.

The number of seedlings emerging was significantly increased when Phygon and Ceresan M were used on purple straw wheat(16). Seedox and Dow 9B decreased significantly the percentage of emergence in Okla wheat. Miller also reported that non-mercuric organic compounds such as Phygon, Arasan, and Spergon are not recommended for treating seed of small grains. Their failure to control the seed-borne diseases of certain cereals consistently and satisfactorily has been amply demonstrated. He suggested that treatment of clean seed would sometimes pay because of its effective protection against soil-borne pathogens.

In field and greenhouse tests with Spergon, New Improved Ceresan, and Arasan, Schuster(17) concluded that improved stands resulted from each of the seed treatments. Because of seed coat injury due to threshing, chemical seed treatment resulted in much greater increases in stands with machine- than with hand-threshed seed.

Lefebvre and Hollowell(13) summarized the recent work done on seed treatment of forage crops. Seed treatments in numerous experiments conducted over the country since 1936 have not always proved beneficial. When treated legume seed were planted on infested soil the stands were improved over untreated seed by 8 to 145 per cent. The stands were reduced slightly when seed were treated and planted in soil nearly free of the infesting fungus. The greatest increases in stands of Sudangrass were obtained from seed treated with Arasan, Semesan and Spergon. They also report that Arasan, used in excess, is usually not injurious to seed, but that New Improved Ceresan or Ceresan M compounds frequently reduce seed germination when used in amounts greater than those recommended by the manufacturer.

MATERIALS AND METHODS

Seed treatment of Tucson side-oats grama was studied at Stillwater, Oklahoma during the winter of 1950-51. Investigations were conducted both in the Manglesdorf Germinator and in the greenhouse. The effects of 5 seed fungicides at 6 rates of treatment on germination and emergence were determined. The seed protectants were:

Ceresan M (Ethyl mercuric-toluene sulfanilide)
Phygon (2, 3, diclor-1, 4-napthoquinone)
Spergon (Tetrachlora-p-benzoquinone)
Arasan (Tetramethylthiuran disulfide)
Dow 9B (Zinc-2, 4, 5-trichlorophenate)

Fifty grams of side-oats grama seed were treated with each of the above 5 chemicals at rates of 0, 2, 4, 8, 16 and 24 ounces per 100 pounds of seed. All of the chemical would not adhere to the seed at the 16 and 24 ounce treatments. In order to maintain uniformity of treatment all of the 5 rates of chemical treatment were treated with one drop of water per gram of seed.

Germinator Tests

Germination tests were run using 100 seeds of each treatment at alternate temperatures of 15^{o}C at night and 30^{o}C during the day(19). The seed were germinated on indented paper blotters 3 by 3 inches in size. The treatments were randomized in the germinator on three trays and each treatment was replicated 4 times. The trays were rotated daily and changed end for end with the top tray being moved to the bottom, middle tray to the top, and bottom tray to the middle.

Each replication in the germinator ran for a period of 8 days. Normal seedlings were counted and removed from the blotters on alternate days beginning with the fourth day. On the eighth day all normal and abnormal seedlings and visibly diseased seed were removed; the seed remaining were considered soft seed. Data from the germinator were analyzed by analysis of variance.

Greenhouse Tests

Emergence tests were run using 100 seed of each treatment planted in flats of unsterilized Yahola fine sandy loam soil. They were covered by sifting 1/16 inch of unsterilized soil over them and adding an additional 1/16 inch of finely ground vermiculite. The flats were watered after seeding by placing them in a vat of water approximately 2 inches deep, allowing the flats to absorb the water slowly from the bottom.

The rates of treatment for 1 chemical were randomized within a flat. The flats were randomized in their respective locations, and on alternate days their positions were changed. The tests were run at temperatures of 20°C at night and 30°C during the day. Normal and diseased seedlings were counted and removed beginning the fourth day and on alternate days thereafter through the eighth day. On the fourteenth day a final count was made of all remaining seedlings. Data resulting from greenhouse tests were treated statistically by analysis of variance.

RESULTS AND DISCUSSION

Ceresan M

Treatment with Ceresan M sharply reduced the number of normal seedlings in germinator tests when applied at 16 and 24-ounce rates. The number of abnormal seedlings was greatly increased as compared to untreated seed. There appeared to be a correlation between the number of soft seed and the number of abnormal seedlings (Tables 1 and 8). Treatment at 2, 4 and 8 ounces reduced the number of normal seedlings slightly. The 16-ounce treatment reduced the number of normal seedlings about 42% and more than doubled the number of soft seed. Treatment at 8, 16 and 24-ounce rates resulted in chemically damaged seedlings. Treatment at 24 ounces resulted in chemically damaged seedlings. Treatment at 24 ounces resulted in a 95% reduction in normal seedlings as compared to untreated seed. The chemically damaged seedlings were short and swollen and did not emerge from the sheath. Ceresan M controlled the seed-borne fungus at all rates of treatment, the chemical damage to the seed more than offset its value as a fungicide for seed-borne diseases.

Ceresan M proved highly significant in increasing the emergence of seedlings in greenhouse trials. Treatment at the 2-ounce rate resulted in over 100% average increase in seedling emergence. The 4-ounce rate of treatment increased total emergence over untreated seed by 300%. The 8 and 16-ounce rate resulted in progressively greater increases in emergence. The 24-ounce rate appeared to be excessive.

Phygon

Phygon proved highly significant in reducing the number of normal seedlings in germinator tests (Tables 2 and 9). At the same time, increases in the number of abnormal seedlings occurred as compared to

Table 1. Average effect of Ceresan M at 6 rates of treatment on the germination and emergence of 100 seed of Tucson side-oats grama.

Rate oz/100 lbs	Germinator				Greenhouse		
	Normal Seed-lings	Soft Seed	Abnormal Seed-lings	Visibly Diseased Seed	Normal Seed-lings	Diseased Seed-lings	Total Emer-gence
0	71.0	14.5	6.5	8	9.5	0.0	9.5
2	67.0	23.5	9.5	0	19.0	1.3	20.3
4	69.8	22.5	7.7	0	36.5	1.3	37.8
8	67.5	24.7	7.8	0	51.8	0.0	51.8
16	41.0	30.8	28.2	0	50.8	1.2	52.0
24	3.8	48.5	47.7	0	31.5	0.8	32.3
F value	98.8**						18.9**

** Indicates that the F value exceeds the value required for significance at the 1% level.

Table 2. Average effect of Phygon at 6 rates of treatment on the germination and emergence of 100 seed of Tucson side-oats grama.

Rate oz/100 lbs	Germinator: Normal Seedlings	Germinator: Soft Seed	Germinator: Abnormal Seedlings	Germinator: Visibly Diseased Seed	Greenhouse: Normal Seedlings	Greenhouse: Diseased Seedlings	Greenhouse: Total Emergence
0	71.0	14.5	6.5	8.0	9.5	0.8	10.3
2	64.7	26.0	8.8	0.5	8.8	0.2	9.0
4	61.3	24.7	14.0	0.0	15.0	1.8	16.8
8	33.3	28.3	38.4	0.0	21.5	0.3	21.8
16	10.0	44.5	48.0	0.0	5.8	0.0	5.8
24	4.7	43.3	52.0	0.0	5.8	0.0	5.8
F value	198.1**						11.6**

** Indicates that the F value exceeds the value required for significance at the 1% level.

untreated seed. None of the treatment rates produced increases in the number of normal seedlings, although seed-borne fungus was eliminated by all but the 2-ounce rate of treatment. The 2 and 4-ounce rates reduced the number of normal seedlings by approximately 11%. The 8-ounce rate of treatment reduced the number of normal seedlings 54% as compared to untreated seed. The application of this seed protectant at the 16-ounce rate resulted in over 85% reduction in the number of seed germinating as compared to untreated seed. The number of normal seedlings was reduced approximately 93% by the 24-ounce rate of treatment. The chemically damaged seedlings were contorted and the shoots were split vertically.

Total emergence of seedlings was increased somewhat by 4 and 8-ounce rates of seed treatment in greenhouse trials. The 16 and 24-ounce rates of treatment reduced the emergence of seedlings about 50%. Plants which were contorted at emergence were not counted unless they later grew upright and appeared normal.

Spergon

In the germinator the number of normal seedlings was significantly decreased by most rates of treatment with Spergon (Tables 3 and 10). Treatment at 2 ounces resulted in a decrease of less than 1%. The number of normal seedlings was consistently decreased with increased rates of treatment. The 24-ounce rate of treatment decreased the number of normal seedlings about 10% as compared to untreated seed. The visibly diseased seed were progressively reduced by the 2, 4 and 8-ounce rates of treatment. There was no visibly diseased seed at the two higher rates of treatment.

Highly significant differences occurred in normal seedlings in the greenhouse when seed was treated with Spergon. The 4-ounce rate of

Table 3. Average effect of Spergon at 6 rates of treatment on the germination and emergence of 100 seed of Tucson side-oats grama.

Rate oz/100 lbs	Germinator: Normal Seed-lings	Germinator: Soft Seed	Germinator: Abnormal Seed-lings	Germinator: Visibly Diseased Seed	Greenhouse: Normal Seed-lings	Greenhouse: Diseased Seed-lings	Greenhouse: Total Emer-gence
0	71.0	14.5	6.5	8.0	12.5	0.3	12.8
2	70.8	20.5	7.0	1.7	14.5	1.0	15.5
4	68.5	20.8	9.7	1.0	9.8	0.5	10.3
8	65.5	22.2	11.5	0.8	18.5	1.5	20.0
16	65.2	24.3	10.5	0.0	17.2	1.3	18.5
24	63.8	23.2	13.0	0.0	22.5	2.8	25.3
F value	4.2*						15.6**

* Indicates that the F value exceeds the value required for significance at the 5% level.

** Indicates that the F value exceeds the value required for significance at the 1% level.

treatment resulted in fewer normal seedlings than untreated seed, while more normal seedlings occurred at all other rates of treatment. Spergon delayed emergence in the greenhouse. Results from the first replication (Table 10) indicated that Spergon would prove highly effective as a seed protectant, but variation between replications was highly significant and the fourth replication, planted only 3 weeks after the first, resulted in an average germination for all treatments of 66% less than that for untreated seed. The seed was treated January 17, and the toxic affect became noticeable for the first time in plantings made in the greenhouse February 17. Spergon apparently is toxic to seed of Tucson side-oats grama at all rates, but the toxicity does not become noticeable until approximately 4 weeks after treatment.

Arasan

No significant differences occurred in normal seedlings when Arasan was used as a seed treatment in germinator tests. However, all rates except that of 4 ounces slightly reduced the number of normal seedlings. The number of soft seed was increased an average of 66% by seed treatment; however, the number of soft seed could not be correlated with rate of treatment (Tables 4 and 11). The visibly diseased seed were reduced from an average of 8% in the untreated seed to .03% for treated seed.

Increases in total emergence in the greenhouse was highly significant at the 4, 8, 16 and 24-ounce treatments. The number of seedlings was apparently correlated with the rate of treatment through the 16-ounce rate. The 16-ounce rate resulted in the highest total germination with the 24-ounce rate proving to be almost as effective. These two rates of treatment resulted in an average increase of 400% in germination over untreated seed. Arasan proved highly effective as a seed protectant in

Table 4. Average effect of Arasan at 6 rates of treatment on the germination and emergence of 100 seed of Tucson side-oats grama.

Rate	Germinator				Greenhouse		
oz/100 lbs	Normal Seedlings	Soft Seed	Abnormal Seedlings	Visibly Diseased Seed	Normal Seedlings	Diseased Seedlings	Total Emergence
0	71.0	14.5	6.5	8.0	11.3	0.5	11.8
2	66.0	24.3	9.0	0.7	10.5	0.8	11.3
4	73.5	20.5	5.5	0.5	15.8	4.2	20.0
8	68.7	23.0	8.3	0.0	30.7	3.8	34.5
16	63.2	25.0	11.8	0.0	60.0	2.5	62.5
24	66.0	25.2	8.5	0.3	54.8	1.0	55.8
F value	2.3						38.9**

** Indicates that the F value exceeds the value required for significance at the 1% level.

Table 5. Average effect of Dow 9B at 6 rates of treatment on the germination and emergence of 100 seed of Tucson side-oats grama.

Rate oz/100 lbs	Germinator: Normal Seedlings	Germinator: Soft Seed	Germinator: Abnormal Seedlings	Germinator: Visibly Diseased Seed	Greenhouse: Normal Seedlings	Greenhouse: Diseased Seedlings	Greenhouse: Total Emergence
0	71.0	14.5	6.5	8.0	8.5	0.5	9.0
2	70.5	17.0	5.2	7.3	5.0	0.0	5.0
4	67.0	21.5	7.3	4.2	3.5	0.0	3.5
8	68.7	20.0	8.0	3.3	6.5	0.0	6.5
16	60.0	30.8	8.7	0.5	4.7	0.3	5.0
24	61.8	30.0	8.0	0.2	7.7	0.3	8.0
F value	3.9*						2.1

* Indicates that the F value exceeds the value required for significance at the 5% level.

greenhouse trials.

Dow 9B

Significant differences in the number of normal seedlings occurred in samples treated with Dow 9B in the germinator (Tables 5 and 12). All rates of treatment resulted in fewer normal seedlings. Dow 9B conspicuously failed to completely control the growth of mold at rates as high as 24 ounces per hundred pounds of seed. All rates of treatment resulted in a greater number of soft seed and all rates of treatment above the 2-ounce rate resulted in an increase in abnormal seedlings.

Treatment with Dow 9B at all rates resulted in reduced total emergence in the greenhouse. This is the only chemical used in the seed treatment that did not have some rate of treatment which proved superior to the check in greenhouse trials. The 24-ounce rate of treatment approached the percentage of emergence for seed not treated.

Results of seed treatment experiments in the Manglesdorf germinator revealed several phenomena. With the exception of the 4-ounce rate of treatment with Arasan, the number of normal seedlings was decreased by all chemicals at all rates of application as compared with untreated seed (Table 6). Ceresan M and Phygon produced a characteristic type of damage to the seedlings at 8, 16 and 24-ounce rates. In every instance the number of soft seed was greater in treated than in untreated seed. The increase in number of soft seed was somewhat proportional to the rate of treatment. The greatest number of soft seed was found in the 24-ounce rate of treatment with Ceresan M and Phygon.

Untreated seed in the germinator resulted in more visible disease than any rate or type of seed treatment; however, more normal seedlings resulted when no chemical was applied. The results indicate that the

Table 6. Average effect of 6 rates of application of 5 fungicides on total germination in the germinator.

Rate oz/100 lbs	Ceresan M	Phygon	Spergon	Arasan	Dow 9B
0	71.0	71.0	71.0	71.0	71.0
2	67.0	64.8	70.8	66.0	70.5
4	69.8	61.3	68.5	73.5	67.0
8	67.5	33.3	65.5	68.5	68.8
16	41.0	10.0	65.3	63.3	60.0
24	3.8	4.8	63.8	66.0	61.8

Table 7. Average effect of 6 rates of application of 5 fungicides on total emergence in the greenhouse.

Rate oz/100 lbs	Ceresan M	Phygon	Spergon	Arasan	Dow 9B
0	9.5	10.3	13.3	11.8	9.0
2	20.3	9.0	15.5	11.8	5.0
4	37.8	16.8	10.3	20.0	3.5
8	51.8	21.8	20.0	34.5	6.5
16	52.0	5.8	18.5	62.5	5.0
24	32.3	5.8	25.3	55.8	8.0

control of seed-borne fungus contributes nothing toward increasing the number of normal seedlings in germinator tests. Chemical damage was evidenced by soft seed. There are apparently no hard seed in Tucson side-oats grama.

With the exception of Spergon, all chemicals gave similar results between replications in greenhouse trials. The average total emergence for all rates of treatment with Spergon was reduced by 87% from the first replication to the fourth replication in the greenhouse. No correlation was apparent between the amount of post-emergence "damping off" and the kind or rate of seed treatment.

Results with Ceresan M and Arasan in the greenhouse indicate that great increases in emergence of seedlings from seed treated with either chemical can be expected. Total emergence was increased by Phygon and Spergon. Dow 9B reduced total emergence at all rates of treatment.

Results of seed treatment in greenhouse trials were quite different from those obtained in the germinator. This may be due to such factors as the dilution effect of the soil on the concentration of chemical adhering to the seed coat, increases in soil diseases, and the variations in temperature and soil moisture. The dilution effect in the soil may make it practical to use higher rates of application for field planting than are indicated as optimum in the germinator tests.

SUMMARY AND CONCLUSIONS

Investigations were conducted to determine the effects of different chemicals and rates of application on the germination and emergence of side-oats grama, Bouteloua curtipendula (Michx.) Torr.. The seed protectants used were Ceresan M, Phygon, Spergon, Arasan and Dow 9B at rates of 2, 4, 8, 16 and 24 ounces per 100 pounds of seed. The investigations were conducted in a Manglesdorf germinator and in the greenhouse at Stillwater, Oklahoma, in 1950-51.

Ceresan M treatment resulted in reduced germination at all rates. The 16 and 24-ounce rates in the germinator rendered practically all seed inviable. All rates of treatment increased the total emergence in the greenhouse. Treatment at rates of 8 and 16 ounces increased emergence an average of 400%.

Phygon delayed and decreased germination in the germinator. The 24-ounce rate, like Ceresan M, rendered practically all seed inviable. Total emergence of seedlings was increased somewhat by 4 and 8-ounce rates of seed treatment in greenhouse trials. All other rates of treatment reduced total emergence.

Spergon decreased germination at all rates in the germinator. Treatment with this seed protectant resulted in increased emergence in the greenhouse at rates other than 4 ounces. These increases were neither large nor consistant.

Arasan slightly decreased the number of normal seedlings in the germinator at rates other than 4 ounces per 100 pounds of seed treated, but increased total emergence approximately 400% above untreated seed when applied at 16 and 24 ounces in the greenhouse. All rates of treatment resulted in increased emergence in the greenhouse.

Dow 9B decreased germination in the germinator and total emergence in the greenhouse. Dow 9B conspicuously failed to inhibit the growth of seed mold.

All chemicals increased the number of soft, non-viable seed at all rates of treatment. There was apparently no hard seed in Tucson side-oats grama.

Rates of seed treatment may be profitably increased in field seedings over those rates indicated as optimum by Manglesdorf germinator tests.

Results of this investigation indicate that Ceresan M and Arasan are highly effective in increasing total emergence of Tucson side-oats grama in unsterilized soil. Spergon and Phygon may be effective in increasing stands. Seed treated with Spergon should be planted immediately or in no case later than 4 weeks after treating.

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APPENDIX

Table 8. Effect of Ceresan M at 6 rates of treatment on the germination and emergence of 100 seed of Tucson side-oats grama.

Rate oz/100 lbs	Repli-cation	Germinator				Greenhouse		
		Normal Seed-lings	Soft Seed	Abnormal Seed-lings	Visibly Diseased Seed	Normal Seed-lings	Diseased Seed-lings	Total Emer-gence
0	1	70	13	6	11	15	0	15
	2	67	17	5	11	9	0	9
	3	73	13	8	6	9	0	9
	4	74	15	7	4	5	0	5
2	1	75	14	11	0	30	0	30
	2	58	32	10	0	24	2	26
	3	63	26	11	0	11	0	11
	4	72	22	6	0	11	3	14
4	1	72	13	9	0	29	3	32
	2	62	32	6	0	49	0	49
	3	70	20	10	0	29	2	31
	4	75	19	6	0	39	0	39
8	1	71	18	11	0	48	0	48
	2	69	27	4	0	59	0	59
	3	68	29	3	0	49	0	49
	4	67	25	8	0	51	0	51
16	1	30	36	34	0	45	0	45
	2	47	27	26	0	56	1	57
	3	43	27	30	0	51	4	55
	4	44	33	23	0	51	0	51
24	1	1	52	47	0	39	0	39
	2	5	45	50	0	35	2	37
	3	2	50	48	0	41	1	42
	4	7	47	46	0	11	0	11

Table 9. Effect of Phygon at 6 rates of treatment on the germination and emergence of 100 seed of Tucson side-oats grama.

Rate oz/100 lbs	Repli-cation	Germinator				Greenhouse		
		Normal Seed-lings	Soft Seed	Abnormal Seed-lings	Visibly Diseased Seed	Normal Seed-lings	Diseased Seed-lings	Total Emer-gence
0	1	70	13	6	11	11	3	14
	2	67	17	5	11	8	0	8
	3	73	13	8	6	9	0	9
	4	74	15	7	4	10	0	10
2	1	64	29	6	1	17	1	18
	2	56	34	10	0	8	0	8
	3	68	21	10	1	3	0	3
	4	71	20	9	0	7	0	7
4	1	65	18	17	0	15	7	22
	2	57	29	14	0	18	0	18
	3	58	25	17	0	11	0	11
	4	65	27	8	0	16	0	16
8	1	27	22	50	1	17	1	18
	2	38	35	27	0	24	0	24
	3	27	25	48	0	24	0	24
	4	41	31	28	0	21	0	21
16	1	10	42	48	0	7	0	7
	2	3	45	52	0	2	0	2
	3	10	40	50	0	7	0	7
	4	17	41	42	0	7	0	7
24	1	2	39	59	0	3	0	3
	2	5	48	47	0	7	0	7
	3	3	38	59	0	6	0	6
	4	9	48	43	0	7	0	7

Table 10. Effect of Spergon at 6 rates of treatment on the germination and emergence of 100 seed of Tucson side-oats grama.

Rate oz/100 lbs	Replication	Germinator: Normal Seedlings	Germinator: Soft Seed	Germinator: Abnormal Seedlings	Germinator: Visibly Diseased Seed	Greenhouse: Normal Seedlings	Greenhouse: Diseased Seedlings	Greenhouse: Total Emergence
0	1	70	13	6	11	13	2	15
	2	67	17	5	11	12	0	12
	3	73	13	8	6	10	0	10
	4	74	15	7	4	15	1	16
2	1	68	24	4	4	37	4	41
	2	69	20	10	1	7	0	7
	3	72	19	9	0	10	0	10
	4	74	19	5	2	4	0	4
4	1	68	19	12	1	21	2	23
	2	65	26	7	2	7	0	7
	3	71	16	13	0	8	0	8
	4	70	22	7	1	3	0	3
8	1	68	18	12	2	48	4	52
	2	67	24	9	0	10	0	10
	3	62	25	12	1	13	0	13
	4	65	22	13	0	3	2	5
16	1	65	26	9	0	40	3	43
	2	64	20	16	0	12	2	14
	3	63	29	8	0	11	0	11
	4	69	22	9	0	6	0	6
24	1	65	23	12	0	34	11	45
	2	56	31	13	0	22	0	22
	3	69	17	14	0	26	0	26
	4	65	22	13	0	8	0	8

Table 11. Effect of Arasan at 6 rates of treatment on the germination and emergence of 100 seed of Tucson side-oats grama.

Rate oz/100 lbs	Replication	Germinator: Normal Seedlings	Germinator: Soft Seed	Germinator: Abnormal Seedlings	Germinator: Visibly Diseased Seed	Greenhouse: Normal Seedlings	Greenhouse: Diseased Seedlings	Greenhouse: Total Emergence
0	1	70	13	6	11	13	2	15
	2	67	17	5	11	6	0	6
	3	73	13	8	6	10	0	10
	4	74	15	7	4	16	0	16
2	1	67	19	13	1	14	2	16
	2	61	29	9	1	11	1	12
	3	73	19	7	1	11	0	11
	4	63	30	7	0	6	0	6
4	1	74	21	4	1	19	10	29
	2	68	21	10	1	10	4	14
	3	70	23	7	0	19	0	19
	4	82	17	1	0	15	3	18
8	1	70	24	6	0	23	6	29
	2	66	25	9	0	44	7	51
	3	71	18	11	0	24	0	24
	4	68	25	7	0	32	2	34
16	1	70	23	7	0	65	4	69
	2	53	37	10	0	69	0	69
	3	58	23	19	0	51	2	53
	4	72	17	11	0	55	4	59
24	1	64	29	7	0	54	1	55
	2	66	23	10	1	48	3	51
	3	71	23	6	0	53	0	53
	4	63	26	11	0	64	0	64

Table 12. Effect of Dow 9B at 6 rates of treatment on the germination and emergence of 100 seed of Tucson side-oats grama.

Rate oz/100 lbs	Replication	Germinator: Normal Seedlings	Germinator: Soft Seed	Germinator: Abnormal Seedlings	Germinator: Visibly Diseased Seed	Greenhouse: Normal Seedlings	Greenhouse: Diseased Seedlings	Greenhouse: Total Emergence
0	1	70	13	6	11	11	1	12
	2	67	17	5	11	5	0	5
	3	73	13	8	6	10	0	10
	4	74	15	7	4	8	1	9
2	1	78	11	2	9	6	0	6
	2	69	17	6	8	2	0	2
	3	65	23	5	7	7	0	7
	4	70	17	8	5	5	0	5
4	1	67	21	6	6	2	0	2
	2	68	16	10	6	2	0	2
	3	71	22	7	0	7	0	7
	4	62	27	6	5	3	0	3
8	1	75	15	7	3	4	0	4
	2	61	24	7	8	12	0	12
	3	65	20	13	2	8	0	8
	4	74	21	5	0	2	0	2
16	1	65	24	10	1	4	0	4
	2	61	30	9	0	3	0	3
	3	53	41	6	0	5	0	5
	4	61	28	10	1	7	1	8
24	1	66	26	8	0	9	0	9
	2	56	36	8	0	5	0	5
	3	67	26	7	0	9	0	9
	4	58	32	9	1	8	1	9

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