EFFECT OF CHEMICAL SEED TREATMENTS ON THE GERMINATION OF FOUR NATIVE GRASS SPECIES

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By

MILTON H. SUMMEROUR

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Mississippi State College

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THESIS AND ABSTRACT APPROVED:

Roy A. Chessmore
Thesis Adviser

Melvin D. Jones
Faculty Representative

D. C. McIntosh
Dean of the Graduate School

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Milton H. Summerour

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TABLE OF CONTENTS

LIST OF TABLES

INTRODUCTION

Big bluestem, Andropogon gerardi (furcatus) Muhl., little bluestem, Andropogon scoparius Michx., side-oats grama, Bouteloua curtipendula (Michx.) Torr., and switchgrass, Panicum virgatum L. are native perennial bunch grasses that are prevalent over an exceptionally wide area for a long period of time, and have proved indespensible in the prairies and great plains (5)[1] during recent years. All 4 species are considered excellent for soil conservation use. They are warm-season grasses that depend principally on seed for reproduction.

An adequate stand of native grasses is hard to maintain unless good range management is practiced. An abundant seed crop is not produced every year, and sometimes weather conditions prevent the successful establishment of a stand. Therefore, a more efficient use of available seed is highly desirable. Domestication and cultivation of native grasses necessitate a knowledge of the beneficial effect of various seed treatments.

Little work has been done on the chemical treatment of native grass seed to control seed and soil borne organisms, although similar studies have been conducted with other crops. Should the treatments increase the germination and stand of these grasses they will be of great value in the reseeding program that is underway.

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[1] Figures in parentheses refer to "Literature Cited," p. 21.

The primary objective of this investigation was to determine the effect of 6 chemical disinfectants on germination and stand of native grasses.

REVIEW OF LITERATURE

Lefebvre and Hollowell (11), in their resume of previous work on chemical seed treatment, state that good seed may show a greater response to proper treatment than poor seed. Treated seed of grasses and small seed legumes have not consistently given better results than untreated seed, and disinfectants used in excess of amounts prescribed by the manufacturers were wasted.

Whitehead (20), in Oklahoma, reported that Arasan would increase the germination on poor samples of legume seed but not on good samples.

Later, Vlitos and Preston (18), working in Oklahoma with Arasan, Ceresan M, Dow 9B, Phygon and Spergon, asserted that all but Spergon increased germination of field legumes when planted in the greenhouse. They considered the greenhouse much more reliable than regular field plantings for testing chemical seed treatments.

According to Fisher (6), some commercial seed treatments were found to be of negligible value when used on 12 native grasses, while others increased germination and stand from 300 to 400 per cent. Cuprocide, Fermacide, Copper Carbonate and Basic Coper Sulfate were not effective in smut control or stand improvement. Ceresan and New Improved Ceresan were best at controlling head smut and improving the stand.

When Spergon was used by Miller (15), increases in yield amounted to 36% in 3 varieties of seed corn, 66% in peanuts, 33% in lima beans, and 45% in sorghum. He also reported that

Spergon completely eliminated smut and was non-toxic to handlers; and, that Phygon could be used as a foliage spray as well as a seed protectant.

Greenhouse experiments on chemical seed treatment of forage grasses and legumes by Kritlow (10) indicated that Sudangrass stands were improved 12%, while the treatment of orchardgrass and bluegrass resulted in no increase.

Leaf distortions from chemical seed treatments were noted by Forsyth and Schuster (7) in their experiment with flax. This distortion was soon overcome, and differences in germination and seedling response were attributed to a majority of the seed being cracked or scratched.

Smut of millet and kernel smut of sorghum were effectively controlled by use of fungicides in experiments conducted by Melchers (14).

Seed laboratory germination tests in New York by Crosier and Others (4) disclosed that spread of disease from contaminated seed to healthy seed may be prevented with the use of New Improved Ceresan highly diluted with French talc or water.

Chemical Seed treatments were tested in the greenhouse on a comparative basis and analyzed statistically in New York by McCallan (13). He decided that only pre-emergence was affected by chemical treatments.

In his review of work done previous to 1948, Leukel (12) concluded that treatments are important when cold and damp weather occur after planting. He found no deleterious effects by using mixtures of several chemicals, but stated that treatment was often advantageous to the germination of seed that had been stored.

Spergon treated seed should be planted immediately or in no case later than 4 weeks after disinfecting according to work done by Hobbs (8) at Oklahoma.

Wheeler (19), states that no adequate treatment for soil and seed borne diseases causing damping-off has been discovered.

Preliminary studies conducted in Wisconsin by Allison and Torrie (1) indicated that treatment of seed to improve the germination and survival of several forage legumes was not economically feasible.

Greenhouse and germinator results proved quite inconsistent according to Bretzel (2) at North Dakota. He listed the necessary requirements of a good chemical when used for seed treatment.

The evolution of seed disinfectants, according to Chester (3), has signified a change from inorganic oxides and salts to heavy metals (Mercuric chloride, copper sulfate, copper carbonate, and zinc and copper oxides) and formaldahyde to the mercuric dusts and non-metallic compounds.

Horsfall (9) noted that completely sterlizing the soil often lowered germination, and that any chemical soil disinfectant which was strong enough to kill damping-off organisms would also kill the seed.

MATERIALS AND METHODS

Studies of the effect of 6 chemical seed disinfectants on the germination and emergence of 4 native grasses were conducted at the Oklahoma Agricultural and Mechanical College, Stillwater, Oklahoma, in 1950 and 1951.

These investigations included big bluestem, little bluestem, side-oats grama, and switchgrass. The chemical seed protectants used were:

Arasan (Tetramethylthiuram disulfide)
Ceresan M (Ethyl mercuric-p-toulene sulfanilide)
Copper Carbonate (Copper carbonate)
Dow 9B (Zinc-2, 4, 5-trichlorophenate)
Phygon (2, 3, dichlor-1, 4-napthoquinone)
Spergon (Tetrachloro-p-benzoiquinone)

These chemicals were applied as a dust to 30-gram samples of each grass species at the rate of 4 ounces per 100 pound of seed. The seed and protectants were thoroughly shaken in a well corked, 500 cc Erlenmeyer flask. No difficulty was encountered in making the dust adhere to the seed coat.

Seed of the 1949 crop was furnished by the Forage Crops Division of the Oklahoma A. & M. College Agronomy Department. All of these seed except switchgrass had been processed to remove glumes, lemma and palea. Broken and damaged seed were removed when the count was made in preparation for germinator and greenhouse plantings.

An analysis of variance was made of all the data, and the "f" test was applied as given by Snedecor (16).

Germinator Tests

Normal germinating procedures were used since the objective was to determine the effects of different chemical seed treatments on the 4 native grasses. These tests were started on July 20, 1950 and were completed on September 4, 1950.

One hundred seed of each sample were tested in a Mangelsdorf germinator at a temperature of approximately 30° C. The seed was germinated on indented paper blotters 3-inches square. Each sample was replicated 3 times, and each replication was observed for a 14-day period. The treatments, randomized in the germinator on 4 trays, were changed end for end and rotated daily with the top tray being moved to the bottom and the other trays moved up.

Normal seedlings were counted and removed on the fourth day and continued on alternate days for two weeks (17). Diseased seed, which were too deteriorated to germinate, were removed to prevent them from distorting the count.

Greenhouse Tests

A replication was composed of one flat containing the 7 treatments for each species. Each row was planted with 100 seed in a very shallow furrow, approximately 1/4 inch deep, with enough soil sifted on to cover the seed. Fertile, unsterilized Kirkland sandy loam soil from the college agronomy farm was used in these experiments. Flats were watered with a fine sprinkler and were covered with two plies of coarse burlap. Water was added when the topsoil became dry.

A randomized block design, as suggested by McCallan (13), was used. The treatments were randomized within each flat, and the flats were alternated in location every day. The temperature was kept at approximately 20° C during the nights and at 30° C during the days. Stand counts were taken for 21 days (17) to allow ample time for the germination of slower seed. These experiments were conducted from November 1, 1950 to March 31, 1951.

RESULTS AND DISCUSSION

Big Bluestem

The effect of chemical seed treatments on the number of normal seedlings of big bluestem in the germinator showed a highly significant difference between treatments (Table 1). Ceresan M seemed to be the most detrimental and inconsistent. It apparently was too strong for big bluestem as shown by the plants in one replication which germinated late and failed to develop into normal seedlings. The three replications of Ceresan M yielded 25, 57 and 0 normal seedlings (Table 6). In no other case were differences in replications of the same treatment outstanding. The average germination with Ceresan M was 27.3% as compared with 64.7% in the check. Phygon gave consistently low germination. Spergon and Arasan increased the number of normal seedlings approximately 15% above the check.

Ceresan M ranked highest with 72.7 hard and diseased seed and abnormal seedlings; Spergon was low with 26.0 while the check produced 35.3. Although one replication of Ceresan M produced 100 hard and diseased seed and abnormal seedlings this was not entirely responsible for the high average as both of the other Ceresan M replications were also much greater than the check.

The inconsistency in effect of each treatment on germination in the greenhouse as compared with the normal seedlings in the germinator is noticeable. Arasan, which ranked second

Table 1.--Effect of six chemical treatments on the germination and emergence of 100 big bluestem seed.

Treatment	Germinator		Greenhouse		
	Normal Seedlings	Hard and diseased seed and Abnormal Seedlings	Normal Seedlings	Diseased Seedlings	Total Emergence
Check	64.7	35.3	27.7	3.6	31.3
Arasan	72.7	27.3	11.3	7.6	18.9
Ceresan M	27.3	72.7	13.0	1.0	14.0
Copper Carbonate	55.0	45.0	13.3	3.3	16.6
Dow 9B	51.0	49.0	21.3	0.3	21.6
Phygon	36.7	63.3	16.0	6.3	22.3
Spergon	74.0	26.0	15.6	2.3	18.0
F Value	6.76**				1.44

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

highest in the number of normal seedlings produced in the germinator was lowest in the greenhouse, while Spergon treated seed dropped from first in normal seedlings in the germinator to fourth place in the greenhouse. The check with 27.7 normal seedlings exceeded any chemical treatment. Dow 9B was second with a total of 21.3.

Arasan and Phygon treatments resulted in approximately 50% increase in diseased seedlings above untreated seed in the greenhouse. Dow 9B was lowest in diseased seedlings with an average of 0.3. The remaining chemicals ranked below the check.

Tests in the greenhouse indicate no significant differences among the various treatments on total emergence. Ceresan M was not as lethal as it had been in the germinator. The check was 31.3% was higher in total emergence than any of the chemical treatments which ranged from 14% to 22.3%.

Little Bluestem

Normal seedlings of little bluestem in the germinator ranged from 25.0% with Phygon to 40.3% with Ceresan M (Table 2). These treatments are significantly different at the 5% level. Ceresan M was consistently high in germination in all replications. Phygon gave low germination in all replications with a trend toward lower germination as the age of the seed under treatment increased. Seed borne diseases were very evident when the seed was treated with Arasan, Copper Carbonate and Dow 9B.

Table 2.--Effect of six chemical treatments on the germination and emergence of 100 little bluestem seed.

Treatment	Germinator		Greenhouse		
	Normal Seedlings	Hard and diseased Seed and Abnormal Seedlings	Normal Seedlings	Diseased Seedlings	Total Emergence
Check	32.3	67.7	26.3	2.3	28.6
Arasan	34.3	65.7	17.3	7.7	25.0
Ceresan M	40.3	59.7	22.0	0.7	22.7
Copper Carbonate	32.0	68.0	22.0	3.0	25.0
Dow 9B	33.0	67.0	22.7	1.0	23.7
Phygon	25.0	75.0	21.3	4.0	25.3
Spergon	34.7	65.3	18.0	1.6	19.6
F Value	4.50**				2.79

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

The highest number of hard and diseased seed and abnormal seedlings was produced by Phygon with 75.0 and the lowest by Ceresan M with 5.97. The check produced 67.7 hard and diseased seed and abnormal seedlings. Arasan, Copper Carbonate, Dow 9B and Spergon were near the check.

Normal seedlings in the greenhouse ranged from 17.3 with Arasan to 26.3 in the check. Spergon with 18.0 was next to the lowest in normal seedlings. The remaining treatments were intermediate between Arasan and the check.

The greatest number of diseased seedlings was found in the Arasan treatments and the lowest count of 0.7 in Ceresan M. Dow 9B was next to the lowest in number of diseased seedlings and Phygon was second from highest. As with big bluestem, Arasan and Phygon treatments resulted in an increase of diseased seedlings.

Total emergence of little bluestem averaged nearly as much in the greenhouse as the production of normal seedlings in the germinator. No significant difference was shown between treatments. All chemical treatments resulted in lower total emergence than no treatment.

Side-oats Grama

The number of normal seedlings of side-oats grama was unusually high for all treatments in the germinator (Table 3). The largest reduction in normal seedlings resulted from treatment with Phygon which was 8 below the check. However, no significant differences were found among the treatments.

Table 3.--Effect of six chemical treatments on the germination and emergence of 100 side-oats grama seed.

Treatment	Germinator		Greenhouse		
	Normal Seedlings	Hard and Diseased Seed and Abnormal Seedlings	Normal Seedlings	Diseased Seedlings	Total Emergence
Check	86.3	12.7	17.7	0.7	18.4
Arasan	85.0	15.0	33.7	2.0	35.7
Ceresan M	83.7	16.3	43.7	0.3	44.0
Copper Carbonate	86.0	14.0	28.3	0.3	28.6
Dow 9B	86.3	13.7	27.6	0.0	27.6
Phygon	78.3	21.7	18.0	1.6	19.6
Spergon	85.0	15.0	25.0	1.0	26.0
F Value	1.44				2.50

Phygon had the highest number of hard and diseased seed and abnormal seedlings in the germinator while Dow 9B and the check were lowest. There was a range of only 13.7 to 21.7 with Ceresan M second highest.

A large reduction in the number of normal seedlings in the greenhouse compared with the normal seedlings in the germinator is quite evident. Only one treatment, Ceresan M, noticeably increased the number of normal seedlings in the greenhouse (Table 3). Diseased seedlings ran very low ranging from 0.0 with Dow 9B to 2.0 with Arasan. Total emergence of side-oats grama ranged from 18.4 for untreated seed to a high of 44.0% when Ceresan M was used. All chemical treatments increased total emergence over the check. Phygon treatment resulted in a very slight increase over the untreated seed. There were no significant differences between treatments.

Switchgrass

Switchgrass is the only species of the group tested that retains its palea and lemma after processing. This may account for the lack of visible seed borne organisms in the germinator (Table 4). Averages of normal seedlings in the germinator ranged from 57.7 with Dow 9B to 68.0 when Ceresan M was used. These differences, however, were not significant. The seed cover seemed to prevent any retarding effect from Ceresan M treatment which showed an increase of 10.9% over no treatment in the number of normal seedlings.

Ceresan M produced 32.0 hard and diseased seed and abnormal seedlings which was the lowest while Dow 9B ranked highest with 42.3 dead seed. The check produced 38.7.

Table 4.--Effect of six chemical treatments on germination and emergence of 100 switchgrass seed.

Treatment	Germinator		Greenhouse		
	Normal Seedlings	Hard and Diseased seed and Abnormal Seedlings	Normal Seedlings	Diseased Seedlings	Total Emergence
Check	61.3	38.7	42.3	10.0	52.3
Arasan	64.7	35.3	44.6	2.6	47.2
Ceresan M	68.0	32.0	50.0	1.6	51.6
Copper Carbonate	61.3	38.7	49.7	3.6	53.3
Dow 9B	57.7	42.3	46.0	0.3	46.3
Phygon	59.0	41.0	54.3	1.3	55.6
Spergon	61.0	39.0	57.3	0.6	57.9
F Value	-0.45				1.44

The number of normal seedlings produced in the greenhouse was considerably lower than the number produced in the germinator. Spergon was high in the greenhouse with 57.3, and the check was low with 42.3 normal seedlings.

All chemical treatments reduced the number of diseased seedlings in the greenhouse. The check ranked first with 10.0, Copper Carbonate produced 3.6, and all other treatments had less than 3.0 diseased seedlings.

Spergon, Phygon and Copper Carbonate resulted in slight increases in total emergence over that of the check, but these increases were not significant.

The average effect of the 6 chemical seed treatments on the 4 species of native grasses in the germinator as reflected by the number of normal seedlings is shown in Table 5. As an average over all treatments the species differed significantly in the number of normal seedlings produced. The average of normal seedlings for each treatment over all species reveals that Phygon was low with 49.7 and Arasan high with 64.1. The check was near the midpoint. These differences are not significant.

The average over all treatments revealed a significant difference in total emergence among species in the greenhouse. There was no significant difference in total emergence for each treatment over all species.

Table 5.--Effect of six chemical treatments at 4-ounces per 100 pounds of seed on the germination and emergence of four native grasses.

a. Germinator

Treatment	Average Normal Seedlings				
	Big Bluestem	Little Bluestem	Side-oats Grama	Switchgrass	Average
Check	64.7	32.3	86.3	61.3	60.6
Arasan	72.7	34.3	85.0	64.7	64.1
Ceresan M	27.3	40.3	83.7	68.0	54.8
Copper Carbonate	55.0	32.0	86.0	61.3	58.5
Dow 9B	51.0	33.0	79.6	57.7	54.3
Phygon	36.7	25.0	78.3	59.0	49.7
Spergon	74.0	34.7	85.0	61.0	63.6

b. Greenhouse

Treatment	Average Total Emergence				
	Big Bluestem	Little Bluestem	Side-oats Grama	Switchgrass	Average
Check	31.3	28.6	18.4	52.3	32.6
Arasan	18.9	25.0	35.7	47.2	31.7
Ceresan M	14.0	22.7	44.0	51.6	33.1
Copper Carbonate	16.6	25.0	28.6	53.3	30.8
Dow 9B	21.6	23.3	27.6	46.3	29.7
Phygon	22.3	25.3	19.6	55.6	30.7
Spergon	18.0	19.6	26.0	58.3	30.5

SUMMARY

Studies were conducted at Stillwater, Oklahoma in 1950 and 1951 to determine the effect of six seed disinfectants on the germination and emergence of four native grass species--big bluestem, little bluestem, side-oats grama and switchgrass. The seed protectants, Arasan, Ceresan M, Copper Carbonate, Dow 9B, Phygon and Spergon were used at the rate of 4 ounces per 100 pounds of seed. A check was used as basis for comparison of results. Tests were conducted in a Mangelsdorf germinator and in the greenhouse. The treatments were randomized in three replications.

The production of normal seedlings of big bluestem was increased by treatment with Arasan and Spergon but was retarded and reduced by Ceresan M and Phygon in the germinator. All chemical treatments reduced total emergence of big bluestem in the greenhouse.

Ceresan M produced the greatest increase in the number of normal seedlings of little bluestem in the germinator. Phygon treatment resulted in a sharp reduction in normal seedlings. Seed borne diseases were very evident when little bluestem was treated with Arasan, Copper Carbonate, Dow 9B, and check. Total emergence of little bluestem in the greenhouse was reduced by all chemical treatments. Normal seedlings of side-oats grama varied from extremely high in the germinator to extremely low in the greenhouse. No significant differences in treatments were found in the germinator. All chemical treatments increased total emergence of side-oats grama in the greenhouse, but there were no significant differences.

The percent of germination of switchgrass ran relatively high in both the germinator and greenhouse with no significant differences among the treatments. There was a noticeable absence of seed borne diseases in the germinator. However, in the greenhouse, the untreated check had almost three times as many diseased seedlings as the highest chemical treatment. Seed treatment gave no significant increases in total emergence of switchgrass.

There appeared to be a definite interaction between species of grasses and chemical treatments (Table 5). Results were not consistent using a standard rate of application of chemical seed protectants. Unless other rates of application will produce greater increases in germination and emergence of seed of these native grasses, the use of chemical seed protectants cannot be generally recommended.

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A P P E N D I X

Table 6.--Effect of six chemical treatments on germination and emergence per replication of 100 big bluestem seed.

Treatment	Replication	Germinator: Normal Seedlings	Germinator: Hard and Diseased Seed and Abnormal Seedlings	Greenhouse: Normal Seedlings	Greenhouse: Diseased Seedlings	Greenhouse: Total Emergence
Check	1	79	21	15	3	18
	2	61	39	37	7	44
	3	54	46	31	1	32
Arasan	1	76	24	9	4	13
	2	70	30	9	12	21
	3	72	28	15	7	22
Ceresan M	1	25	75	10	0	10
	2	57	43	17	1	18
	3	0	100	12	2	14
Copper Carbonate	1	63	37	14	6	20
	2	58	42	11	1	12
	3	44	56	15	3	18
Dow 9B	1	68	32	24	0	24
	2	46	54	16	1	17
	3	39	61	24	0	24
Phygon	1	42	58	9	5	14
	2	39	61	20	9	29
	3	29	71	19	5	24
Spergon	1	83	17	7	5	12
	2	67	33	23	1	24
	3	72	28	17	1	18

Table 7.--Effect of six chemical treatments on the germination and emergence per replication of 100 little bluestem seed.

Treatment	Replication	Germinator: Normal Seedlings	Germinator: Hard and Diseased Seed and Abnormal Seedlings	Greenhouse: Normal Seedlings	Greenhouse: Diseased Seedlings	Greenhouse: Total Emergence
Check	1	33	77	37	0	37
	2	36	64	21	5	26
	3	28	72	21	2	23
Arasan	1	39	61	21	5	26
	2	36	64	12	11	23
	3	28	72	19	7	26
Ceresan M	1	38	62	30	1	31
	2	46	54	12	1	13
	3	37	63	24	0	24
Copper Carbonate	1	38	62	19	3	22
	2	32	68	22	6	28
	3	26	74	25	0	25
Dow 9B	1	37	63	36	1	37
	2	37	63	16	2	18
	3	25	75	16	0	16
Phygon	1	34	66	16	1	17
	2	25	75	18	7	25
	3	16	84	30	4	34
Spergon	1	43	57	22	2	24
	2	38	62	13	1	14
	3	23	77	19	2	21

Table 8.--Effect of six chemical treatments on germination and emergence per replication of 100 side-oats grama seed.

Treatment	Repli-cation	Germinator		Greenhouse		
		Normal Seedlings	Hard and Diseased Seed and Abnormal Seedlings	Normal Seedlings	Diseased Seedlings	Total Emergence
Check	1	92	8	22	0	22
	2	84	16	18	0	18
	3	83	17	13	2	15
Arasan	1	91	9	53	0	53
	2	85	15	19	5	24
	3	79	21	29	1	30
Ceresan M	1	81	19	40	0	40
	2	86	14	61	1	62
	3	84	16	30	0	30
Copper Carbonate	1	92	8	28	1	29
	2	87	13	33	0	33
	3	79	21	24	0	24
Dow 9B	1	76	24	31	0	31
	2	83	17	27	0	27
	3	80	20	25	0	25
Phygon	1	85	15	11	3	14
	2	78	22	26	0	26
	3	72	28	17	2	19
Spergon	1	87	13	46	0	46
	2	92	8	22	0	22
	3	76	24	7	3	10

Table 9.--Effect of six chemical treatments on germination and emergence per replication of 100 switchgrass seed.

Treatment	Replication	Germinator: Normal Seedlings	Germinator: Hard and Diseased Seed and Abnormal Seedlings	Greenhouse: Normal Seedlings	Greenhouse: Diseased Seedlings	Greenhouse: Total Emergence
Check	1	47	53	42	9	51
	2	68	32	39	8	47
	3	69	31	46	13	59
Arasan	1	57	43	60	3	63
	2	69	31	36	2	38
	3	68	32	38	3	41
Ceresan M	1	60	40	63	0	63
	2	77	23	34	5	39
	3	67	33	53	0	53
Copper Carbonate	1	50	50	64	5	69
	2	68	32	42	2	44
	3	66	44	43	4	47
Dow 9B	1	50	50	58	1	59
	2	56	44	33	0	33
	3	67	33	47	0	47
Phygon	1	55	45	61	0	61
	2	66	34	54	0	54
	3	56	44	48	4	52
Spergon	1	64	36	70	0	70
	2	43	57	47	2	49
	3	76	24	56	0	56

TYPIST PAGE

THESIS TITLE: EFFECT OF CHEMICAL SEED TREATMENTS ON THE GERMINATION OF FOUR NATIVE GRASS SPECIES

NAME OF AUTHOR: MILTON H. SUMMEROUR

THESIS ADVISER: ROY A. CHESSMORE

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NAME OF TYPIST: Betty Stewart Massey