THE RELATION OF SEED DENSITY TO THE GERMINATION OF FOUR GRASS SPECIES

By

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James D. Bilbro, Jr.

Stillwater, Oklahoma
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INTRODUCTION

Forage crop breeders are often confronted with the problem of establishing uniform stands in their nurseries. This problem is encountered especially when involving certain of the native and introduced grasses which tend to be low or erratic in germination.

To insure uniform stands in the nursery the breeder usually employs either the greenhouse or the direct field planting method. Either method requires considerable time and labor.

The greenhouse method is perhaps the more laborious and time consuming but it insures a nursery stand of one plant per hill. The usual procedure is to start the seed in a germinator or a flat of soil and later transfer the seedling into individual paper pots. After the seedlings become well established they are transplanted individually into the nursery plots.

The direct field planting method is often impractical or impossible due to a limited supply of seed. The usual procedure is to plant excessive amounts of seed directly in each hill of the nursery plots and later thin to a stand of one plant per hill.

A method which would enable the breeder to fractionate his low germinating seed lots to obtain fractions high in germination would be of considerable value toward saving time and labor. It would permit him to plant directly in the nursery hills at a lower rate, e. g., two seed per hill, and yet be reasonably assured of a uniform

stand. This would eliminate the need for the greenhouse method and reduce the amount of stand thinning of the direct field planting method to a minimum.

The primary objective of this experiment was to determine whether or not a high germinating fraction of seed could be fractionated from a lot of seed low in germination by using specific gravity or controlled-pressure blowing, or both.

REVIEW OF LITERATURE

Many papers have been published concerning germination studies. In spite of this fact, only papers remotely concerned with the problem involved in this study were found.

Abert, Porter and Robbins (1) concluded from their studies on purity and germination of Kentucky bluegrass, Poa pratensis L., that as the blowing pressure of the Iowa air blast separator was increased above a certain pressure, the germination of the sample increased and the purity decreased. Leggatt (3) reports similar results for the same species when blown in an Ottawa seed blower.

A single paper was found that involved the use of specific gravity fractionation. Jones and Mangelsdorf (2) attempted unsuccessfully to separate selfed and crossed seed of corn, Zea mays L., by the use of specific gravity.

MATERIALS AND METHODS

Three experiments were conducted to determine the germination of seed having different densities.

First Experiment

Three-pound samples of smooth brome, Bromus inermis Leyss., sand bluestem, Andropogon hallii Hack., switch grass, Panicum virgatum L. and sand lovegrass, Eragrostis trichodes (Nutt.) Nash were divided by a Dean Gamut precision divider into 64 uniform samples. One sample, selected at random, was used for each series of fractionations and one sample was used as a check.

The seed were fractionated in August of 1952. Sixteen samples of 100 seed each from the check and each different specific gravity fraction of each species were germinated in a Manglesdorf germinator during the fall and winter of the same year. The germination tests were conducted according to the procedures recommended in the Proceedings of the Association of Official Seed Analysts (5).

In preparing the data of the first experiment for analysis two different transformations were made. The square roots of the counts were extracted if they were generally over ten but less than fifty. If the counts were generally less than ten, 0.5 was added to the counts and the square roots were extracted. The results were then analyzed statistically and the "F" test applied as given by Snedecor (4).

As there was a variation of fractionation methods the species will now be considered individually.

Sand Bluestem*

A sample was selected and immersed in a .2% Vel** solution to destroy any hydrophobic film present on the seed. The sample was rinsed for one minute in running tap water and allowed another minute to drain. It was then immersed in 500 ml. of sugar solution, specific gravity 1.295, and allowed to fractionate for five minutes. The floating seed were skimmed off, rinsed in running tap water for one minute and placed between blotters to dry. The sunken seed were caught on a sieve as the solution was poured into another beaker. These seed were rinsed in running tap water, drained and further fractionated in the same manner as before using sugar solutions with specific gravities of 1.315 and 1.335 respectively. The seed that sank in the 1.335 solution were considered as the last fraction.

Smooth Brome

The smooth brome samples were fractionated in water, specific gravity 1.000, and sugar solutions with specific gravities of 1.100 and 1.150 respectively. The previous procedure was used except the seed which sank in the first solution were rinsed and dried before further fractionation and these seed were reimmersed in the Vel solution. The seed were subsequently rinsed, drained and further

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* The seed of the sand bluestem had been processed to remove the lemma and palea.

** Trade name of a neutral alkyl aryl sulfonate detergent.

fractionated for one minute in each solution.

Switch Grass

The switch grass samples were fractionated using the same procedure as was used for sand bluestem except ethyl alcohol, specific gravity 0.875, and a sugar solution, specific gravity 1.145, were used and the seed were allowed to fractionate for 1 minute in each solution.

Sand Lovegrass

The sand lovegrass samples were fractionated by using a South Dakota seed blower.

To insure uniform speed during the fractionation procedure, the blower was allowed to run for five minutes before the fractionations were started. The blower tube was then removed and a sample poured onto the blower screen. The blower tube was replaced and the air flow valve was opened to a reading of 46. The blower was started and allowed to run for six minutes. The blower tube was removed and the seed from the blower trays were removed and packaged. The blower tube was replaced and the blowing operation repeated at air flow valve readings of 59 and 64 respectively, with the seed being removed from the trays and packaged following each blowing. After the final blowing the seed remaining on the blower screen were packaged as the last fraction.

Second Experiment

This experiment was conducted in March, 1953 to further substantiate the findings of the first experiment and to also attempt to obtain more desirable germination results from the switch grass and

sand bluestem fractions by modifying their respective procedures.

The seed used for this experiment, with the exception of switch grass, were selected from the fractionated seed not used for germination in the first experiment.

Four samples of 100 seed each from the check and each fraction of each species were germinated in this experiment. The seed were placed upon two layers of blotter in covered petri dishes and germinated in a Stults germinator which was operated at alternating temperatures of 20 and 30 degrees centigrade.

The final counts for smooth brome and sand lovegrass were made after 14 days. The final counts for switch grass and sand bluestem were made after 28 days.

The data were transformed and analyzed in the manner of the first experiment.

Sand Bluestem

In the first experiment the seed for germination were selected at random and many of them contained no embryos. In this experiment only seed having embryos were used as an attempt to obtain more desirable germination results.

The procedure was further modified by combining the seed of the 1.315 and 1.335 specific gravity fractions into one fraction before selecting the seed for germination.

Smooth Brome

The combining of the specific gravity fractions 1.100 and 1.150 into one fraction for the germination study was the only modification of the smooth brome procedure.

Switch Grass

A sample was selected from the seed stock of the first experiment. The sample was fractionated in the manner of the first experiment except for using water, specific gravity 1.000, and a sugar solution, specific gravity 1.200.

Sand Lovegrass

The only modification of the sand love procedure was the combining of the fractions obtained by blowing at air flow valve readings of 46 and 54 before the seed for germination were selected.

Third Experiment

The objective of this experiment was to determine what results could be obtained by specific gravity fractionation of an average germinating sample of smooth brome.

The smooth brome used for this experiment was from a different source than that used for the first experiment.

One pound of seed was divided into 32 uniform samples by using a Dean Gamut precision divider. One sample was selected for fractionation and another sample was selected for use as a check.

The seed were fractionated in the same manner as the seed of the first experiment except water, specific gravity 1.000, and a sugar solution, specific gravity 1.150, were used.

The seed were germinated as follows: A sloping, 18 by 32 inch piece of galvanized metal was covered with two layers of blotter and 16 golden fleece scouring pads. Upon these pads four samples of 100 seed each were germinated from the check and each fraction. The seed

were kept moist by dripping warm tap water at five locations along the high side of the metal piece.

The final count was made after 14 days and the results analyzed statistically. The "F" test was applied as given by Snedecor (4).

RESULTS AND DISCUSSION

Sand Bluestem

The results of the first experiment (Table 1) were highly variable due to the presence of seed without embryos. The average germination of the heaviest fraction, 5.25%, when compared with the lightest fraction, average germination of 33.56%, indicates that seed having no embryos have a higher specific gravity than those containing embryos.

The results of the second experiment (Table 1) indicated no significant difference between the fractions. This may have been due to biasing the experiment by selecting each seed individually instead of selecting the seed at random.

Smooth Brome

The results of the first experiment (Table 2) indicated a highly significant difference between fractions. The check had the lowest average germination but also had more mold than any of the fractions. The fractions had been washed while being fractionated and this may account for the lesser amounts of mold present on them. The lightest fraction had an average germination of 4.13% and the heaviest fraction had an average germination of 15.25%. The average germination of the other two fractions fell between these percentages.

The second experiment results (Table 2) were comparable to those of the first experiment. The check was again the lowest in germination. The lightest fraction had an average germination of 6.00% and

Table 1.--- The average germination of sand bluestem seed of different specific gravities.

Specific Gravity	Germination Per cent[1]	
	1st Expt.	2nd Expt.
Check	32.13	39.00
0.000-1.295	33.56	33.50
1.295-1.315	43.25	-----
1.295-1.335	-----	31.75
1.315-1.335	33.63	-----
1.335 and heavier	5.25	37.00
F Value	196.43**	3.14

[1] Average of sixteen samples of 100 seed each and four samples of 100 seed each for the first and second experiments respectively.

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

Table 2.— The average germination of smooth brome seed of different specific gravities.

Specific Gravity	Germination Per cent[1]		
	1st Expt.	2nd Expt.	3rd Expt.
Check	2.56	2.00	69.75
0.000-1.000	4.13	6.00	48.75
1.000-1.100	11.56	———	———
1.000-1.150	———	12.25	82.50
1.100-1.150	13.75	———	———
1.150 and heavier	15.25	18.50	82.75
F Value	64.71**	36.76**	17.60**

[1] Average of sixteen samples of 100 seed each for the first experiment and four samples of 100 seed each for the second and third experiments.

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

the heaviest fraction had an average germination of 18.50%.

The third experiment results (Table 2) gave much higher germination percentages. The heaviest fraction was the highest in average germination, having an average of 82.75%. The lightest fraction was lowest in germination with an average of 48.75%. The check had an average germination of 69.75% and the next to heaviest fraction had an average of 82.50%.

Switch Grass

The results of both experiments (Table 3) indicated highly significant differences between fractions.

The first experiment results indicated that immersion of the seed in ethyl alcohol lowered the germination. The heaviest fraction had an average germination of 9.63% as compared with 17.50% for the check.

In the second experiment, in which no alcohol was used, the heaviest fraction had an average germination of 24.00% as compared with 14.00% for the check.

Sand Lovegrass

The first experiment results (Table 4) indicated a highly significant difference between fractions. The fraction obtained by blowing at an air flow valve reading of 64 was the highest in average germination followed closely by the heaviest fraction. Their average germinations being 18.25% and 18.19% respectively. The lightest fraction had the lowest average germination with 9.31%. The check had an average germination of 17.63% and the fraction obtained by blowing at a reading of 59 had an average germination of 16.56%.

Table 3.-- The average germination of switch grass seed of different specific gravities.

First Experiment	
Specific Gravity	Germination Per cent[1]
Check	17.50
0.000-0.875	0.94
0.875-1.145	8.13
1.145 and heavier	9.63
F Value	97.52**

Second Experiment	
Specific Gravity	Germination Per cent[1]
Check	14.00
0.000-1.000	5.00
1.000-1.200	23.75
1.200 and heavier	24.00
F Value	60.43**

[1] Average of sixteen samples of 100 seed each and four samples of 100 seed each for the first and second experiments respectively.

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

Table 4.-- The average germination of sand lovegrass seed obtained by blowing at different air flow valve readings.

Air Flow Valve Reading	Germination Per cent[1]	
	1st Expt.	2nd Expt.
Check	17.63	11.00
46	9.31	5.75
54	16.56	-----
54-69	-----	8.25
69	18.25	-----
Remaining after final blowing	18.19	9.25
F Value	34.18**	3.71*

[1] Average of sixteen samples of 100 seed each and four samples of 100 seed each for the first and second experiments respectively.

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

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

The results of the second experiment (Table 4) indicated a significant difference between fractions. The check had the highest average germination with 11.00% as compared with 9.25% for the heaviest fraction. The lightest fraction and the fraction obtained by blowing at a valve reading of 59 had average germinations of 5.75% and 8.25% respectively.

Conclusions

Generally the results of the germination tests indicate that seed density is related to germination. Except in the case of sand bluestem, the heavier fractions had higher average germination percentages than did the lighter fractions. The results further indicate that specific gravity fractionation of smooth brome and switch grass may be of some value for obtaining more desirable planting seed from lots of seed low in germination.

However, on the basis of the results of these experiments, specific gravity fractionation and controlled-pressure blowing cannot be generally recommended as methods for obtaining high germinating fractions of seed from seed lots low in germination.

SUMMARY

Three experiments were conducted at Stillwater, Oklahoma in 1952 and 1953 to determine the relation of seed density to germination of four grass species. Two of these experiments involved sand bluestem, smooth brome, switch grass and sand lovegrass. The third experiment involved only smooth brome.

Samples of sand bluestem, smooth brome and switch grass were fractionated using solutions of different specific gravities. The sand lovegrass samples were fractionated by using a South Dakota seed blower.

Seed from a check and each specific gravity fraction of each species were germinated and the results analyzed.

The results of the first experiment with sand bluestem were highly variable due to the presence of seed having no embryos. The heaviest fraction of seed had the lowest average germination, indicating that seed without embryos have a higher specific gravity than seed with embryos. The results of the second experiment indicated no significant difference between the fractions.

The results of the first two experiments with smooth brome indicated a highly significant difference between fractions. In both experiments the checks had the lowest average germinations and the heaviest fractions the highest. The results of the third experiment indicated a highly significant difference also. The heaviest fraction was again

the highest in germination. However, the lightest fraction was lowest in germination instead of the check.

The results of the first experiment with switch grass indicated that germination was lowered by using ethyl alcohol as one of the specific gravity solutions. The check was the highest in germination followed by the heaviest fraction. In the second experiment, the heaviest fraction was the highest in germination and the lightest fraction the lowest.

The results of the first experiment with sand lovegrass indicated a highly significant difference between fractions. The next to heaviest fraction was slightly higher in germination than the heaviest. The lightest fraction was the lowest in germination. The results of the second experiment indicated a significant difference between fractions. The check was the highest in germination and the lightest fraction the lowest.

The results of these experiments indicate that specific gravity fractionation and controlled-pressure blowing can not be generally recommended as methods of obtaining high germinating fractions of seed from seed lots low in germination.

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APPENDIX

Table 5.— The germination per 100 seed sample of sand bluestem seed of different specific gravities.

First Experiment

	Check	Specific Gravity			
		0.000 to 1.295	1.295 to 1.315	1.315 to 1.335	1.335 and heavier
Sample					
1	32	34	32	33	7
2	37	35	46	26	4
3	31	45	40	26	6
4	32	37	45	32	5
5	34	30	51	36	4
6	32	34	44	43	1
7	36	33	51	34	2
8	26	37	47	42	2
9	38	34	34	35	9
10	30	23	35	27	9
11	30	31	48	33	8
12	33	37	36	22	9
13	39	34	44	34	3
14	28	30	48	45	5
15	31	31	48	32	5
16	25	33	43	38	5

Second Experiment

	Check	Specific Gravity		
		0.000 to 1.295	1.295 to 1.335	1.335 and heavier
Sample				
1	38	30	27	38
2	42	42	36	35
3	38	31	30	36
4	38	31	34	39

Table 6.-- The germination per 100 seed sample of smooth brome seed of different specific gravities.

First Experiment

	Check	Specific Gravity			
		0.000 to 1.000	1.000 to 1.100	1.100 to 1.150	1.150 and heavier
Sample					
1	3	6	19	17	25
2	4	8	14	17	22
3	4	8	9	17	18
4	2	7	14	19	15
5	3	3	11	9	12
6	3	2	7	12	13
7	4	2	11	11	9
8	3	2	10	11	8
9	2	3	8	18	10
10	3	3	10	16	11
11	1	3	7	12	12
12	1	1	8	14	11
13	2	8	14	15	20
14	1	4	14	11	20
15	3	4	14	10	19
16	2	2	15	11	19

Second Experiment

	Check	Specific Gravity		
		0.000 to 1.000	1.000 to 1.150	1.150 and heavier
Sample				
1	2	9	11	19
2	3	5	10	20
3	2	4	11	13
4	1	6	17	22

Third Experiment

Sample				
1	71	54	87	89
2	80	45	87	90
3	56	52	83	78
4	72	44	73	74

Table 7.-- The germination per 100 seed sample of switch grass seed of different specific gravities.

First Experiment

	Check	Specific Gravity		
		0.000 to 0.875	0.875 to 1.145	1.145 and heavier
Sample				
1	13	0	4	9
2	24	0	6	7
3	18	2	7	6
4	25	1	8	6
5	29	1	6	8
6	17	0	5	12
7	15	2	6	13
8	19	0	8	12
9	21	2	14	16
10	17	2	9	14
11	16	1	9	13
12	17	0	12	15
13	13	2	11	7
14	11	0	7	5
15	14	1	4	10
16	11	1	14	11

Second Experiment

	Check	Specific Gravity		
		0.000 to 1.000	1.000 to 1.200	1.200 and heavier
Sample				
1	14	7	22	20
2	15	4	21	24
3	14	5	22	23
4	13	4	30	29

Table 8.-- The germination per 100 seed sample of sand lovegrass seed obtained by blowing at different air flow valve readings.

First Experiment

	Check	Valve Reading 44	54	69	seed remaining on screen
Sample					
1	13	7	13	19	17
2	19	11	15	24	17
3	21	7	17	17	18
4	20	5	13	20	19
5	20	10	14	14	21
6	12	13	16	14	14
7	18	11	11	15	16
8	20	13	15	20	19
9	12	10	19	25	20
10	19	5	21	19	19
11	20	10	20	20	19
12	17	9	16	21	21
13	15	9	18	15	18
14	18	11	20	16	17
15	19	11	19	16	19
16	19	7	18	17	18

Second Experiment

	Check	Valve Reading 44	69	seed remaining on screen
Sample				
1	9	5	7	11
2	12	7	10	8
3	7	7	8	7
4	16	4	8	11

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