EVALUATION OF FIRM SEED IN PENSACOLA BAHIAGRASS (*Paspalum notatum* Flugge) AND BROWNTOP MILLET (*Panicum ramosum* L.)

By

Ramiro Vilela de Andrade

A Thesis
Submitted to the Faculty of
Mississippi State University
In Partial Fulfillment of the Requirements
for the Degree of Master of Science
in the Department of Agronomy

Mississippi State, Mississippi

August, 1977

Evaluation of firm seed in 1977 TS - T.36/77
18398 - 1

EVALUATION OF FIRM SEED IN PENSACOLA BAHIAGRASS (*Paspalum notatum* Flugge) AND BROWNTOP MILLET (*Panicum ramosum* L.)

By

Ramiro Vilela de Andrade

T
36|79

A Thesis
Submitted to the Faculty of
Mississippi State University
In Partial Fulfillment of the Requirements
for the Degree of Master of Science
in the Department of Agronomy

Mississippi State, Mississippi

August, 1977

EMBRAPA
BIBLIOTECA
Sete Lagoas
Centro Nacional Pesquisa Milho e Sorgo

EVALUATION OF FIRM SEED IN PENSACOLA BAHIAGRASS (*Paspalum notatum* Flugge) AND BROWNTOP MILLET (*Panicum ramosum* L.)

By

Ramiro Vilela de Andrade

APPROVED:

Charles E. Vaughan
Professor of Agronomy (Major Professor)

Roy L. Creek
Professor of Agronomy (Head of Department)

Charles E. Smilley
Dean of the College of Agriculture

Marvin J. Lofton
Dean of the Graduate School

August, 1977

DEDICATED

To my wife Vanessa,

and to my parents Nelson and Maria

for their love and understanding.

ACKNOWLEDGMENTS

I wish to express gratitude and deep appreciation to my Major Professor, Dr. Charles E. Vaughan for his professional assistance and guidance during the execution of this study and preparation of this manuscript.

I am grateful to Dr. H. Bunch, and members of the Office of International Programs at Mississippi State University for their valuable assistance in academic and personal affairs.

Appreciation is extended to the Ministry of Agriculture through AGI-PLAN, Brasil, for providing financial support for the realization of this study.

I want to thank Mrs. Euclides Goncalves Martins, Afranio Avelar Marques, Geraldo Tavares, Marcus Eustachio de Andrade and other colleagues and friends for their efforts in convincing and enabling me to come to Mississippi State University.

Thanks are extended to the staff of the Seed Technology Laboratory for their valuable counsel and to my Brasilian friends who shared good times with me at Mississippi State University.

A special thanks to my cousin, Lairton and my sister, Ana Amelia, who took care of my responsibilities during my absence.

And, finally, my deepest gratitude is expressed to my wife, Vanessa, for her help during my laboratory work, typing this manuscript and for her understanding, love, and encouragement.

R. V. A.

ABSTRACT

Ramiro Vilela de Andrade, Master of Science, 1977.

Major: Seed Technology, Department of Agronomy

Title of Thesis: Evaluation of Firm Seed in Pensacola Bahiagrass (Paspalum notatum Flugge) and Browntop Millet (Panicum ramosum L.)

Directed by: Dr. Charles E. Vaughan

Pages in Thesis: 43 Words in Abstract: 298

ABSTRACT

Seeds of Pensacola bahiagrass (Paspalum notatum Flugge) and browntop millet (Panicum ramosum L.) are dormant after harvest and dormancy often persist for several months, or in some cases for a few years. The dormancy of these grasses is characterized by gaseous impermeability and recognized as firm seed.

The general objectives of this study were: (1) to determine the effectiveness and convenience of acid scarification for overcoming seed dormancy in Pensacola bahiagrass and browntop millet, and (2) to evaluate the planting value of firm seed in these crops. The experiment was conducted in both the laboratory and the field.

Ten lots each of bahiagrass and browntop millet seed were evaluated by the standard germination test and by a 20-minute acid scarification treatment.

Bahiagrass seed lots showed an average increase of 17.4% in germination in the laboratory after acid scarification. However, non-treated seed germinated, on the average, higher than acid-scarified seed 38 days after planting.

A 20-minute acid scarification treatment almost overcame dormancy in bahiagrass. At the end of the 28-day germination test period, firm seeds were subjected to the tetrazolium test. Results showed that not all seeds were viable.

Total viability of the seeds was not affected by the acid scarification treatment but the number of abnormal seedlings increased. The acid scarification method shortened the time required for germination by about nine days.

The 20-minute sulfuric acid treatment in browntop millet gave no improvement in the germination percentage. Browntop millet seeds, when treated with sulfuric acid, were more susceptible to fungal attack and as a consequence, there was an increase in the number of abnormal seedlings. The number of abnormal seedlings and degree of fungal attack were closely related to the time of sulfuric acid treatment; as the time increased, abnormality increased.

Based on the results of this study, there appears to be no immediate planting value in the firm seeds of Pensacola bahiagrass or browntop millet.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDIX TABLES

INTRODUCTION

Seed germination of range grasses grown in the United States and other countries has been a serious problem encountered by seed analysts and other interested in grass propagation.

Although some good pastures have been established without special seed treatment, several years are required, and some failures have been experienced (13). The environmental factors associated with dormancy of a seed lot play a dominant role in successful pasture establishment. Whereas environmental factors are difficult to control, man has devoted much effort to overcoming dormancy to hasten germination and obtain better results in both laboratory tests and field plantings.

Browntop millet (Panicum ramosum L.) and Pensacola bahiagrass (Paspalum notatum Flugge) are cultivated grasses in Southeastern United States which are difficult to germinate due to profound dormancy of the seed. Several months after harvest they are often still dormant, showing less than 50 percent germination under standard test conditions. The remaining 50 percent are often viable but dormant (4, 13).

Viability of ungerminated, dormant seed has been determined by using treatments such as removing the covering, alternating temperatures, scarification, heat, soaking in water and chemicals. Among these methods, scarification

with sulfuric acid has been the most successful (12, 13, 30). In spite of the availability of these methods, results found in laboratories usually do not show the same response in the field (41).

The purpose of this study was to compare the speed of germination and total germination in both laboratory and field tests of acid-scarified and non-scarified seed of Pensacola bahiagrass and browntop millet seed. From this study the planting value of firm seed was determined.

LITERATURE REVIEW

In many plants, seeds do not germinate under favorable conditions of moisture, aeration, temperature and light without special treatment at the end of the specified germination test period (37, 41). Such seeds are dormant and require special treatment for germination to occur.

Firm seed is a type of dormancy found in many grasses. The mechanism of dormancy is due to the impermeability of the covering to gaseous exchange. In this type of dormancy the seeds cannot absorb sufficient amounts of water for germination to take place (41). Pensacola bahiagrass seed and browntop millet seed have this type of dormancy. Methods of overcoming seed dormancy are varied, and generally depend on the partidular type of dormancy involved (15).

Presoaking seed in water is one of the simplest methods used. Wenger (44) soaking buffalo grass seed in tap water for two to four days followed by drying at room temperature increased germination from 7.0% to 43.6%. Gaber et al. (25) reported that germination of sweet sorghum seed was increased by soaking the seed in distilled water for 12 to 24 hours at 30 C. In contrast, Burton (12) found that a water soaking treatment for 24 hours had no effect on germination of bahiagrass seed.

Using a prechill treatment, Hyde et al. (31) found that embryo dormancy in Genista tinctoria seed may be overcome by a 60-90 day prechill period at 5 C.

Rogler (40) increased germination by soaking two-year old Indian rice grass seed in water at temperatures slightly above freezing for 40 days. Maximum germination was obtained in the same species by Emal and Conrad (21) by storing seeds for seven months under room conditions and then chilling them for four weeks prior to germination.

Research has shown that germination in dormant grass seed can be improved by removing the hulls of the seed. Akamine (2) improved germination of several Hawaiian grasses by breaking the pericarp. Andersen (3) and Ray et al. (38) greatly increased germination of Paspalum notatum and Paspalum dilatatum by removing the lemma and palea. Croiser and Cullinan (16), however, reported that the removal of the glumes alone did not produce high percentages of germination in some strains of Paspalum. He supported the idea that the alternating temperature--15 C for 8 hours in daylight and 35 C for 16 hours in the dark--is the most important factor influencing germination of some Paspalum species.

Fendal and Carter (22) found oxygen utilization by intact, relatively dormant, green needlegrass seed (Stipa viridula) was limited by the presence of the lemma and palea. Removal of these structures facilitated an immediate and increased oxygen utilization. However, the possible relation of these structures to the cause of dormancy in green needlegrass seed is not known.

Dry heat treatment has been used as an aid in increasing germination in many grasses. Hodgson (30) found a significant increase in percentage germination of Pensacola bahiagrass seed by using a heat treatment of 50 to 60 C for

two to four days. In this respect the results are comparable to those obtained by Born and Corns (9) with seed of tartary buckwheat using a heat treatment for three days at 70 to 80 C. Predrying Japanese millet seed at 35 C for seven days gave Happer (28) the best germination results of all treatments applied. Rincker (39) found that a dry heat treatment at 105 C for 4 minutes in alfalfa and red clover reduced the number of the hard seed 81 percent and 60 percent, respectively, and the germination percentage was increased by the same amount. Burton (14) placed pearl millet seed in running water and also exposed them to dry heat from 60 to 90 C for 1 to 72 hours. Germination of non-dormant seed was improved. In contrast, germination of partially dormant seed was decreased by using this treatment.

Several workers have shown the effectiveness of chemicals in breaking seed dormancy in many families of plants. The Rules for Testing Seed (6) specifies the use of a diluted solution of KNO_3 for this purpose.

Andersen (4) obtained high germination values in some millet species by moistening the substra with 0.2% KNO_3 solution prior to incubation at alternating temperatures. However, problems due to fungal attach (Helminthosporium and Fusarium) had a significantly greater influence on germination than did dormancy. Two cultivars of Kentucky bluegrass were studied by Maguire (32) using KNO_3 solution as a moistening agent. He found that KNO_3 significantly increased germination of the Newport cultivar, but had no effect on the germination of the Cougar cultivar. In further studies (33), he found that KNO_3 did not overcome dormancy per se but acted in conjuction with dormancy-breaking

treatments such as light and alternating temperatures to increase the germination rate. However, KNO_3 had no effect on germinating Florida pusley seed in the absence of light (37).

Several other chemicals have been reported to be effective in breaking seed dormancy. Ashiru (5) reported that kinetin, thiourea and thiourea dioxide were very effective in inducing germination of cola seed (Cola nitida). High concentration of thiourea dioxide (5,000 ppm) showed pronounced toxicity on fresh cola seed but was effective in breaking dormancy and hastening germination in stored seeds.

Emal and Conard (21) induced germination of Indiangrass seed by soaking them in a sodium hypochlorite solution followed by exposure to daylight. Germination in darkness after soaking had no effect on the final germination percentage. Seeds that failed to germinate in the dark did not respond to daylight treatment. Seeds that failed to germinate under the sodium hypochlorite solution treatment were later tested with tetrazolium and most of them were still viable but dormant.

Soaking seed in a 1% 2-chloroethanol plus 0.5% sodium hypochlorite solution for 1 hour gave excellent results on breaking dormancy in pearl millet (14). However, treatments such as sulfuric acid, sodium hypochlorite and hydrogen peroxide reduced the germination in one or more genotypes of pearl millet seed when used at the apparent average optimum concentration and exposure time.

A considerable number of investigators have concentrated their efforts on the action of gibberellin on germination, especially as a substitute for light in the germination process (17, 25, 42, 43). It is known that gibberellin is a natural hormone synthesized within plants and not only plays a very important role in the plant but also exerts a strong influence on germination (8, 34).

Burton (14) improved germination of pearl millet seed by using a potassium salt of gibberellic acid for 1 hour and a concentration of 1,000 ppm. However, the action of this salt was slower than sodium hypochlorite. Similar results were obtained by Emal and Conard (21) on Indiangrass seed with concentrations of 500, 1,000 and 1,500 ppm of gibberellic acid. They reported that gibberellic acid was effective in both light and dark, but a higher germination was obtained with light. Gibberellin at 250 ppm had no effect on the percentage of germination of Florida pusley seeds in the presence of light but at 1,000 ppm, improved its germination (37). The rate of germination increased with increasing concentrations of gibberellin and at 1,000 ppm twice the number of seeds germinated as did the control. However, gibberellin treatment at 1,000 ppm concentrations had no effect on breaking dormancy of buckwheat seed although the germination of partially after-ripened seed was increased with this substance (9).

A voluminous literature review has been reported concerning the application of sulfuric acid (acid scarification) as an effective treatment to break dormancy, especially in grass seeds (7, 10, 11, 27). This method is, however, considered somewhat difficult to handle on a commercial scale (34).

Harrington (29) using concentrated sulfuric acid for 2 to 3 minutes, significantly improved the germination of Johnsongrass seed. Treatments longer than 3 minutes, however, reduced germination. Similar results were obtained by Dawson et al. (18) on green stipagrass seed with concentrated acid scarification for 10 minutes and Akamine (2) on Panicum prolutum seed for 12 minutes. Afanasieve (1) obtained excellent results on redbud seed (Cerecis canadenses L.) by using acid scarification for 30 minutes followed by a prechill treatment. He reported a germination of 96% in eight days against none in the control after 716 days.

Burton (12, 13) working under field conditions, was very successful in increasing the germination of bahiagrass seed with acid scarification using concentrations of 94 and 78 percent. He scarified seed with concentrated sulfuric acid for 10 to 15 minutes and obtained approximately 50% germination, compared with 0.3% germination for untreated seed (12).

He reported that scarification with crude sulfuric acid (78%) for 45 to 60 minutes was as effective as a 10-minute scarification treatment with concentrated sulfuric acid. Acid-scarified seed also produced greater numbers of plants per pound of seed than unscarified seed. With further studies (14) he proved the effectiveness of sulfuric acid on breaking dormancy of pearl millet seed. A 1% solution of 2-cloroethanol (ethylene chlorohydrin), however, gave highest germination percentages on most of the genotypes of pearl millet studied when compared with other treatments.

Emal and Conard (21) treated Indiangrass seed with concentrated sulfuric acid for 10 minutes and obtained a higher germination than with non-treated seed under both light and dark conditions. They stated that acid scarification destroyed the glumes, thereby removing certain light barriers or filters. In contrast with this finding, Williams and Webb (45) reported that an increase in germination of bahiagrass seed after acid scarification was not related to light.

Gaber et al. (25) reported that sulfuric acid and nitric acid were successfully used to promote germination of sweet sorghum seed. However, higher germinations were obtained by scarification with nitric acid than with sulfuric acid. Feng (23) reported that removing the hulls or soaking in concentrated sulfuric acid for 30 minutes almost completely overcame dormancy in bahiagrass seed. She found that the rates of water absorption of dormant and non dormant seed, and acid-treated and non-treated seed were very similar. Thus, she concluded that impermeability to water was not a factor involved in dormancy, but rather some type of restriction on gaseous exchange. Fernandes (24), working with this same species, found that a 30-minute soaking treatment was somewhat detrimental. She obtained best results with a 20-minute sulfuric acid scarification treatment.

Nakamura (35), reported deep dormancy in bahiagrass seed. He also reported that alternating temperature, prechilling, potassium nitrate and concentrated sulfuric acid were all effective in overcoming dormancy in this grass seed. However, a combination of all four treatments was necessary, with seed

of any age, in order to obtain full germination. Gupta (27) also reported that acid scarification alone did not increase germination significantly in crowfoot-grass, but a pretreatment with sulfuric acid followed by gibberellic acid or stratification treatment produced almost complete germination and hastened the germination process. Nearly 80% of the crowfootgrass seed germinated with this process in nine days, while sulfuric acid treatment alone produced only 34% germination in 16 days.

MATERIALS AND METHODS

Ten lots of Pensacola bahiagrass seed and 10 lots of browntop millet seed were obtained from the Wax Company, Amory, Mississippi and Ring Around Products, Inc., Montgomery, Alabama. The seed were produced and harvested in 1975.

The seed were stored at room temperature in the Mississippi Seed Technology Laboratory until May, 1976. The samples were mechanically subdivided with a Gamet precision divider into smaller sub-lots for use during the experiment. These sub-lots were cleaned with a South Dakota seed blower to remove empty florets and trash material. The seed were then stored in an atmosphere of 10 C and 50% relative humidity. Seeds were taken from this controlled environment as needed for the experiment.

All germination procedures were conducted in accordance with the "Rules for Testing Seed" (6). Four replications of 100 seeds each were counted by hand to obtain an exact number of seeds and to provide only full seeds for the tests. The seeds were germinated on three layers of filter paper in petri dishes.

Pensacola bahiagrass seed were germinated in an alternating temperature (20 - 35 C) and germination counts were made at 7, 14, 21 and 28 days after planting. Browntop millet seed were also germinated in an alternating temperature (20 - 30 C) and germination counts were made at 4 and 14 days after

planting. Germination and firm seed were evaluated two times during the experiment.

At the end of the prescribed period for germination, the ungerminated seeds were pressed with a metal spatula. In the first experiment seeds that resisted the pressure method were considered "firm seed", reported and added to the germination percentage (germination plus firm seed). Firm seed from the second experiment were determined in the same manner as described in the first experiment for bahiagrass seed, followed by the application of the tetrazolium test to evaluate viability. A percentage of firm, viable seed was also determined and added to the germination percentage to determine the total viability of each lot.

Sulfuric Acid Treatment:

Fernandes (23) determined that the best acid scarification treatment for bahiagrass seed was obtained by soaking the seed for 20 minutes in concentrated sulfuric acid. Based on these results, both Pensacola bahiagrass and browntop millet seeds were soaked in 25 cc of concentrated sulfuric acid for 20 minutes. A glass stirring rod was used so that all seeds would be quickly immersed. At the end of the treatment, the seeds were poured into a 100 ml beaker containing a small screen wire mesh and washed in running tap water for 2 minutes. The seeds were then enclosed in cheese cloth and tied with a rubber band, and dipped into a large beaker of water for an additional 10 minutes to remove all trace of acid. The bag containing the seeds was then opened and the treated

seeds were spread on germination towels and dried for approximately 1 hour. The seeds were then placed in the germination tests. The time between acid scarification and planting never exceeded 1 week.

Tetrazolium Test Procedures:

Bahiagrass seeds from the second experiment which resisted the pressure method previously described were considered "firm seed". These seeds were bisected longitudinally through the embryo. One half of each seed was placed in a 100 ml beaker containing 0.5% tetrazolium solution (2, 3, 5 triphenyl tetrazolium chloride). After soaking 6 hours at room temperature the seeds were washed several times in cool water to drain off the tetrazolium solution. Enough water was retained after the final washing to completely cover the seeds. The containers with seed were placed in a refrigerator and were removed as needed for tetrazolium interpretation.

The interpretation procedures were in accordance with the specifications in the Tetrazolium Test for Seed Viability (20) and the Tetrazolium Testing Handbook (26). For accuracy in interpretation, a magnifying lens was used.

Thus, the percentage of firm, viable seed determined by the tetrazolium test previously described was added to the germination percentage to determine the total viability of each lot.

Preconditioning is normally necessary as the first step in tetrazolium evaluation of these seeds. However, it was not necessary to precondition these seed as they absorbed sufficient amounts of water during the germination test.

Field Emergence:

A field plot was selected on the Plant Science Farm at Mississippi State University. Three weeks before planting the area was thoroughly cultivated and fumigated with Vapam (32.7% active ingredients) at a dosage rate of 140 cc per square meter dilluted in water. At planting time, the plot was re-cultivated to facilitate the escape of gases which may have remained in the soil.

For each crop, a randomized complete block design was used with twenty treatments (10 lots of acid-treated and 10 non-treated) and four replications. One hundred seeds per treatment in each replication were planted, 1 centimeter deep and spaced approximately 1 centimeter apart in the row to facilitate counting. Rows were spaced 12 centimeters apart.

Seedling emergence counts were made 9, 14, 19, 24, 28 and 38 days after planting on Pensacola bahiagrass and 9, 14, 19 and 28 days on browntop millet. To avoid the possibility of counting a tiller and to obtain accurate results, the last count was made by digging up all plants.

In view of the poor germination percentage obtained with the sulfuric acid treatment in both laboratory and field tests with seeds of browntop millet, another experiment was set up to determine the optimum period of time for the sulfuric acid treatment. This experiment consisted of treating the two lots of browntop millet seed which showed the highest degree of dormancy in the preliminary experiments with sulfuric acid for 0.0 (control), 1.0, 2.5, 5.0, 7.5, 10.0, 12.5, 15.0 minutes. The scarification procedure was the same as previously described.

RESULTS AND DISCUSSION

The objectives of this experiment were: (1) to evaluate acid scarification as a method for overcoming seed dormancy in Pensacola bahiagrass and browntop millet; and (2) to determine the planting value of firm seed in these crops.

Pensacola Bahiagrass Seed:

Results as shown in Table 1 and Figure 1 indicate an increase in the rate of germination after sulfuric acid scarification in both laboratory and field tests. The first count germination in the laboratory (seven days after planting) indicated 75.2% of the acid scarified seed germinated compared with only 8.2% germination of unscarified seed. At the end of 28 days, however, the difference between acid-scarified and unscarified seeds was small, 17.4% in favor of the acid scarification method.

Early field emergence (after 14 days) was similar to the laboratory results. Acid-scarified seed germinated much faster than non-scarified seed. An emergence value of 45.4% was obtained with acid scarification nine days after planting compared with 0.1% germination of unscarified seed. The difference in favor of acid-scarified seed gradually diminished; 28 days after planting, the values were approximately equal. After 38 days, non-scarified seed germinated 6.4% more than acid-scarified seed. This difference in germination between

Table 1. Mean germination and emergence percentages of acid-treated and non-treated Pensacola bahiagrass seed.

Test Treatment		Days After Planting							
		7	9	14	19	21	24	28	38
Laboratory	Acid-treated	75.2		83.1		84.4		84.6	
	Non-treated	8.2		50.6		62.0		67.2	
Field	Acid-treated		45.4	57.8	61.4		61.5	62.3	62.9
	Non-treated		0.1	13.6	41.9		50.6	60.0	69.3

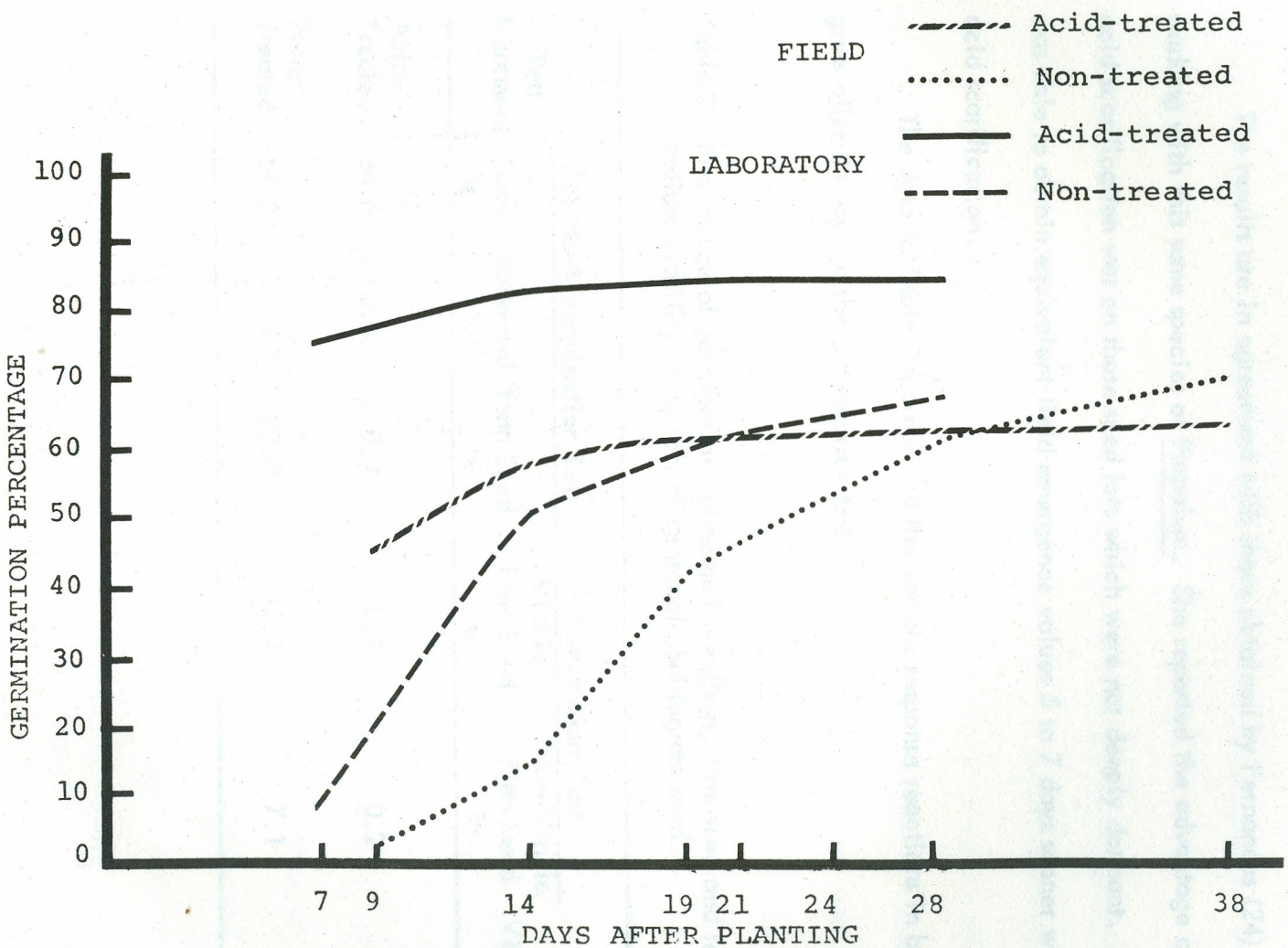

Figure 1. Germination percentages of acid-treated and non-treated Pensacola bahiagrass seed.

acid-scarified and non-scarified seed is within the tolerance prescribed in the Rules for Testing Seeds.

The results are in agreement with those obtained by Fernandes (24) working with this same species of Paspalum. She reported the advantage of acid scarification was on those seed lots which were not deeply dormant. She was able to obtain equivalent field emergence values 5 to 7 days sooner with acid scarification.

The data in Table 2 summarized the various response reactions in bahiagrass after 28 days in the germination test.

Table 2. Percentage of germination, abnormal seedlings, firm seed and tetrazolium viability of 10 lots of Pensacola Bahiagrass seed.

Test Treatment	Standard Germination Test			Tetrazolium Test		Total Viability %
	Germ. %	Abnormal %	Firm Seed %	Viable Firm Seed %	Non-Viable Firm Seed %	
Acid-Treated	84.6	3.6	0.4	0.2	0.2	84.8
Non-Treated	67.2	2.1	22.8	15.7	7.1	82.9

The average firm seed content after 28 days was 22.8% in untreated seeds and 0.4% in acid-treated seed. The tetrazolium test with these firm seeds indicated 70% of the untreated seed and 50% of the acid-scarified seed were still viable.

The total vaiability of the seed lots was not affected by the acid scarification method, although its use increased the number of abnormal seedlings.

Comparisons between laboratory and field emergence values of acid-scarified and unscarified bahiagrass seed are summarized in Figure 2. Seed that were scarified with acid germinated 22% less in the field than in the laboratory. However, untreated seed gave a higher germination in the field (6.4% higher) than in the laboratory, but these values were within tolerance.

The literature has reported the use of sulfuric acid being detrimental to seeds that were dormancy free, even though the application was made at the optimum rate and time. Afanasiev (1) reported the use of sulfuric acid scarification to be detrimental to seeds of Cercis canadensis. Similar results were reported by Andersen (3) in some Paspalum species and by Currey et al. (17) in smutgrass (Sporobolis poiretii). This damaging effect of acid scarification may explain why field emergence was lower than germination in the laboratory. An increasing number of abnormal seedlings in acid-treated seed lots indicate that acid scarification injured some seed which probably were not dormant.

Browntop Millet:

The data shown in Table 3 and Figure 3 summarizes the germination and field emergence of acid-scarified and unscarified browntop millet seed in both

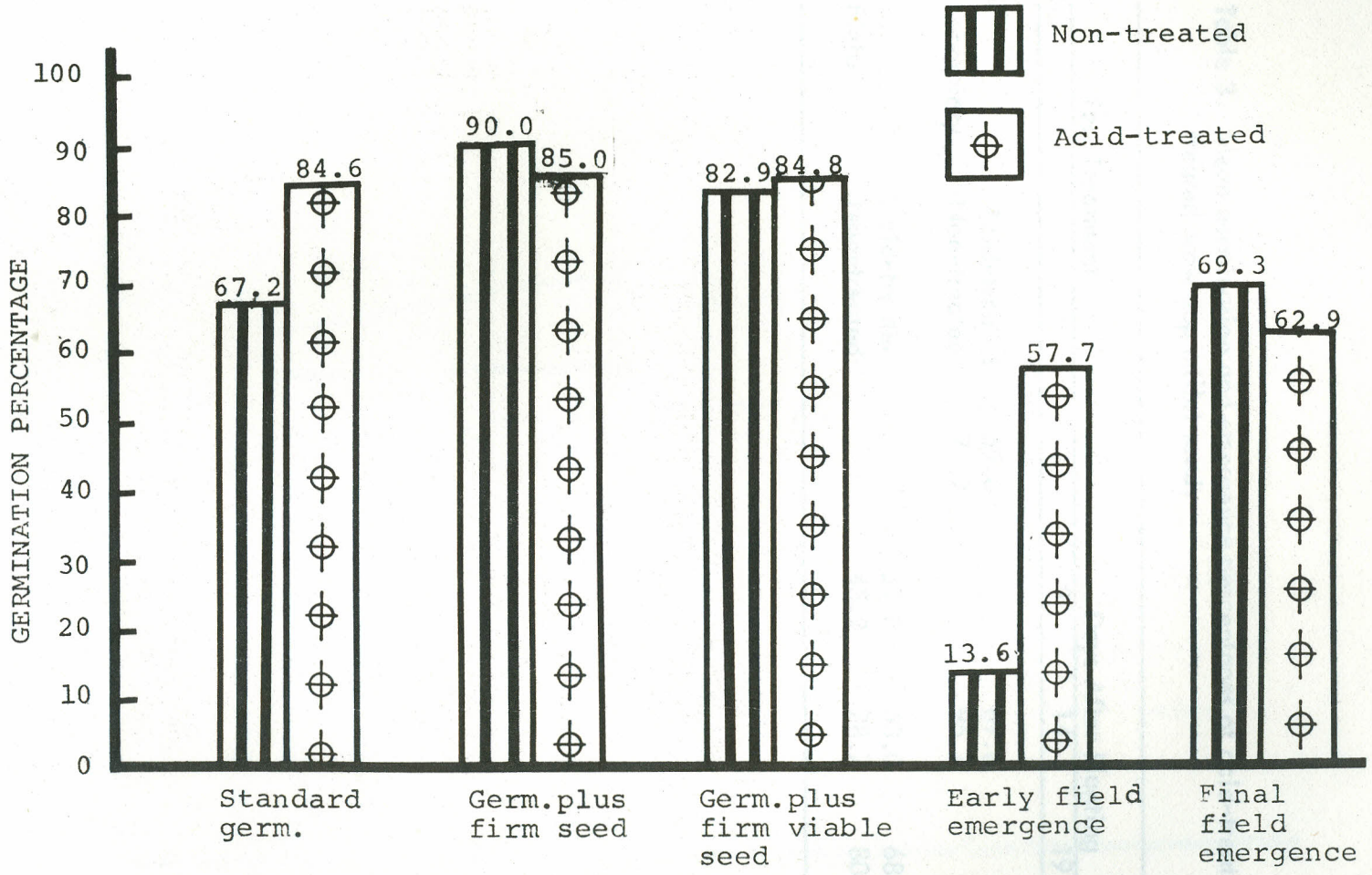

Figure 2. Comparison of laboratory germination and field emergence of acid treated and non treated Pensacola bahiagrass seed.

Table 3. Mean germination and emergence percentages of acid-treated and non-treated browntop millet seed.

Test Treatment		Days After Planting				
		4	9	14	19	28
Laboratory	Acid-treated	69.0		69.8		
	Non-treated	75.7		85.7		
Field	Acid-treated		61.8	63.0	68.2	66.3
	Non-treated		45.2	78.7	80.2	81.7

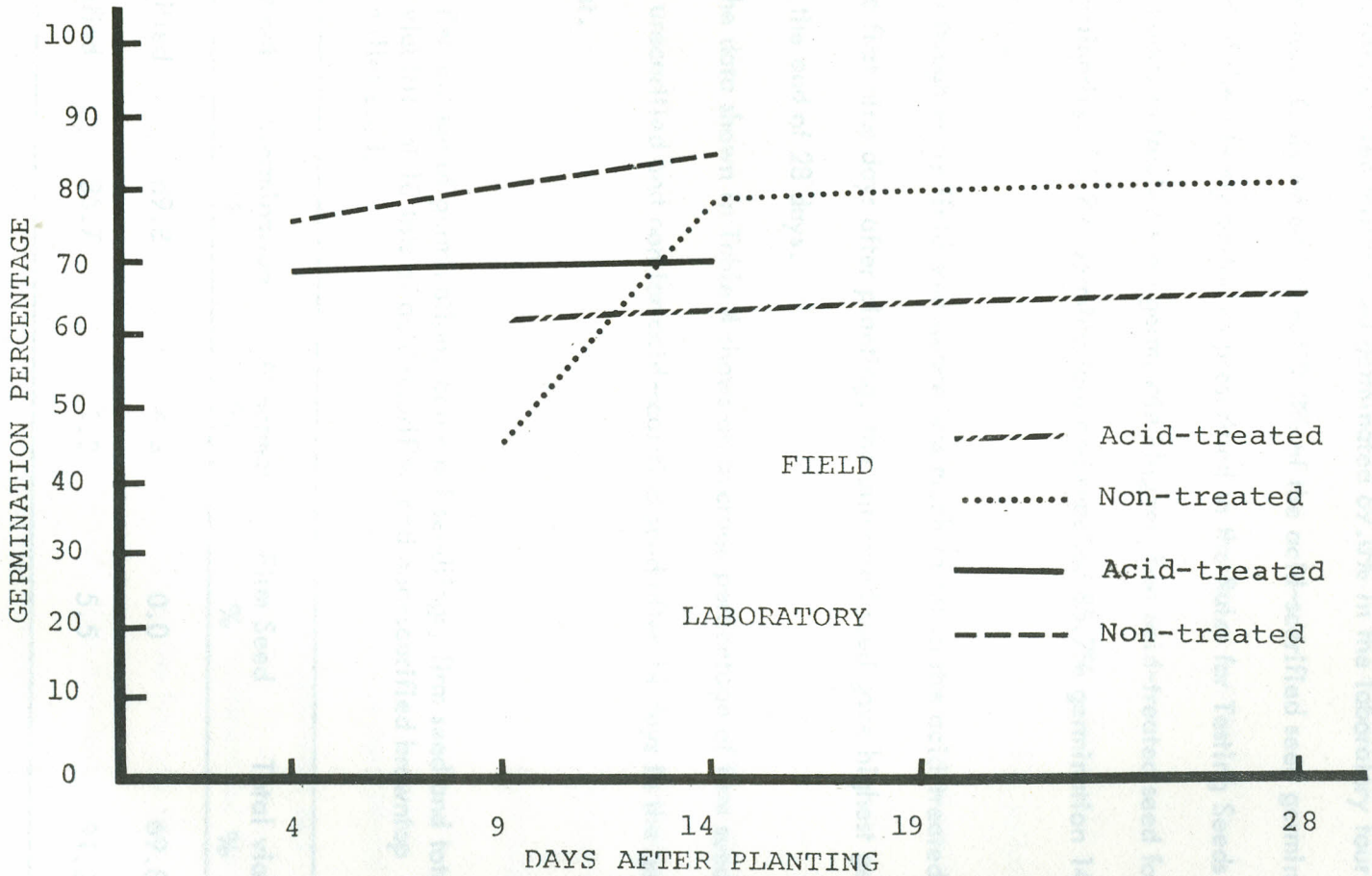

Figure 3. Germination percentage of acid-treated and non-treated browntop millet seed.

laboratory and field tests.

Acid-scarified millet seed germinated 69.0% in the laboratory four days after planting. Only an additional 0.8% of the acid-scarified seed germinated at the end of the 14-day period as prescribed in the Rules for Testing Seeds. On the other hand, untreated seed germinated higher than acid-treated seed four days after planting (75.7% germination) and reached 85.7% germination 14 days after planting.

Although early field emergence was much faster in the acid-treated seed during the first nine days after planting, the untreated seed gave highest germination at the end of 28 days.

The data shown in Table 4 shows an average percentage of firm seed of 5.5% for unscarified and non for acid-scarified seed after 14 days in the germination test.

Table 4. Percentage of germination, abnormal seedlings, firm seed and total viability of 10 lots of acid-scarified and non-scarified browntop millet seed.

Test treatment	Germination %	Abnormal %	Firm Seed %	Total viability %
Acid-scarified	69.8	4.3	0.0	69.8
Non-scarified	85.7	1.0	5.5	91.2

There was a four-fold increase in the number of abnormal seedlings with the acid-scarification treatment when compared to non-scarified seed. Also, the viability of seed was reduced with acid-scarification.

All lots of browntop millet were slightly dormant, except lot no. 2 which showed 20% dormancy. See Appendix Table 9.

Figure 4 shows the comparison of standard germination with field emergence in acid scarified and non-scarified browntop millet seed. The sulfuric acid treatment reduced germination approximately 16% in both the laboratory and field tests.

It was observed that seedlings of sulfuric acid-scarified seeds were more susceptible to fungal attach and less vigorous. The observations are in accordance with those reported by Andersen (4). She found serious fungal problems in germination of browntop millet and cattail millet. She reported greater problems with Helminthosporium and Fusarium on germination of cattail millet than with dormancy per se.

It was evident that 20 minutes of acid scarification was detrimental to seeds of browntop millet. Based on these results, another experiment was organized to determine the optimum time of sulfuric acid-treatment for these seeds. A range of one to 15 minutes was established and the two lots that showed the highest firm seed percentage were tested. The data shown in Table 5 indicated no improvement in germination in these two lots due to acid scarification.

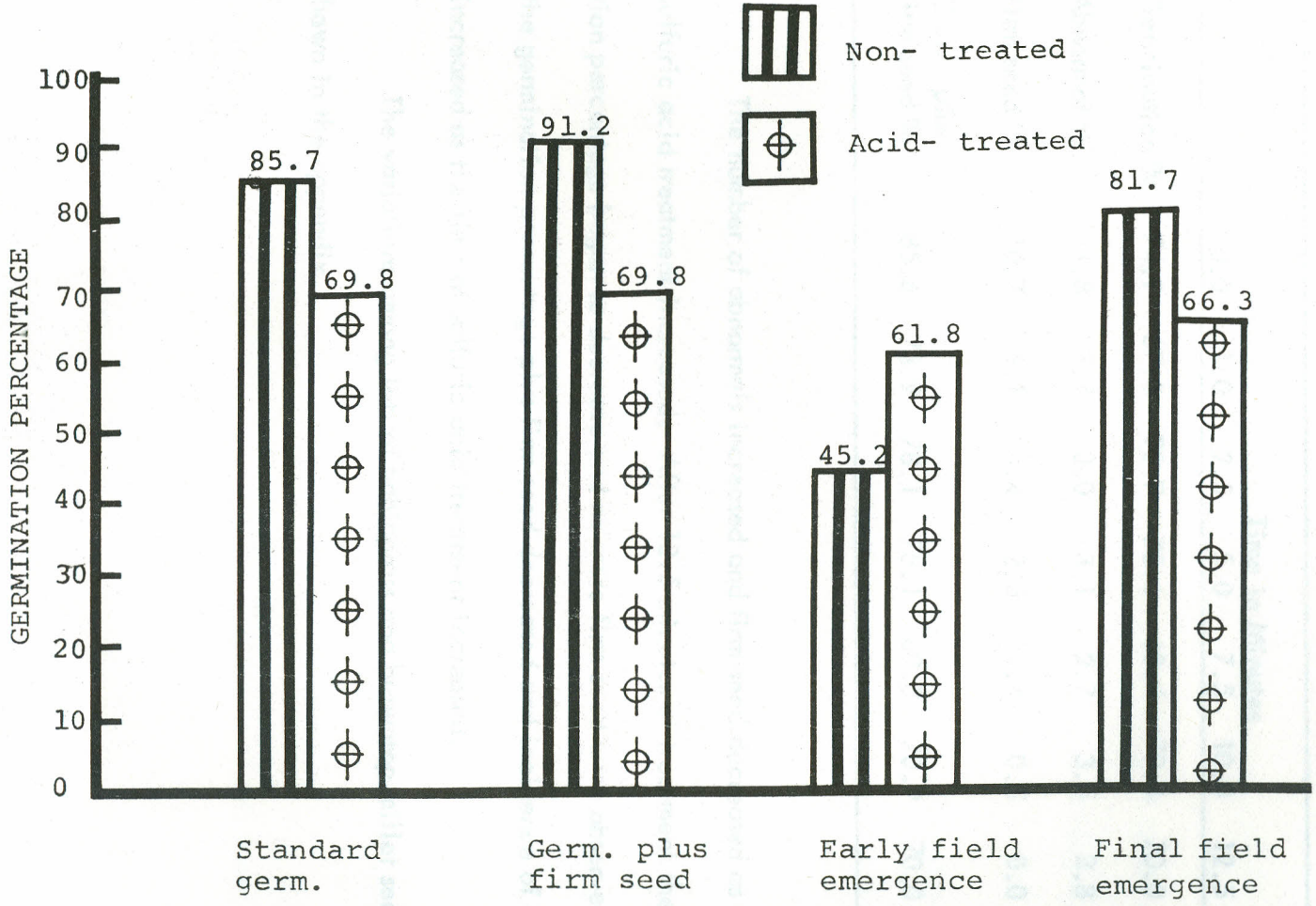

Figure 4. Comparison of laboratory germination and field emergence of acid-treated and non-treated browntop millet seed.

Table 5. Effect of sulfuric acid scarification on germination of two lots of browntop millet seed.

	Time in Minutes							
	0.0	1.0	2.5	5.0	7.5	10.0	12.5	15.0
Germination %	74.9	67.8	73.7	75.6	68.4	70.4	70.0	65.2
Abnormal %	1.8	3.7	3.0	3.1	2.7	3.5	3.8	4.4
Firm seed %	10.7	6.1	4.4	2.5	1.4	0.5	0.0	0.0
Germ. plus firm seed %	85.6	73.9	78.1	78.1	69.8	70.9	70.0	65.2

The number of abnormals increased and firm seed decreased as the time of sulfuric acid treatment increased. After 12.5 minutes of treatment the germination percentage began to decrease and no more firm seed were observed. Also, the germination percentage plus firm seed decreased and incidence of fungi increased as the time of sulfuric acid treatment increased.

The variations among lots of bahiagrass and browntop millet seed are shown in the appendix.

SUMMARY AND CONCLUSIONS

The purpose of this study was to determine the effect of acid scarification treatments upon the planting value of firm seed in Pensacola bahiagrass and browntop millet.

Ten lots of bahiagrass seed and ten lots of browntop millet seed were tested in accordance with the specifications in the Rules for Testing Seed (6). A 20-minute acid scarification treatment with concentrated sulfuric acid was used for both species.

Germination and firm seed were evaluated twice during the experiment. At the end of the prescribed test period, the percentage of firm seed (dormant viable seed) was added to the germination percentage to determine the total viability for each seed lot.

Following the laboratory study a field experiment was also conducted to determine the planting value of firm seed.

The principal conclusions derived from the results of this study are as follows:

Pensacola Bahiagrass Seed:

Bahiagrass seed showed an increase in the germination percentage in the laboratory of 17.4% with an acid scarification treatment, but not in the field

planting. Non-treated seed germinated 6.4% higher in the field, 38 days after planting. Early seedling emergence was also increased by acid scarification. In general, acid-scarified seed emerged nine days earlier than non-treated seed in the field.

A 20-minute acid scarification treatment almost completely overcame dormancy in this seed. The application of the tetrazolium test to seeds which did not germinate after the prescribed 28-day period indicated that most of these seeds were still viable (70% for un-scarified seed and 50% for acid-scarified seed).

Total viability of the seed in each lot was not affected by the acid scarification treatment but the number of the abnormals increased.

Browntop Millet Seed:

Sulfuric acid scarification did not improve germination in browntop millet seed. A 20-minute sulfuric acid scarification treatment was detrimental to these seeds. The number of abnormal seedlings was greatly increased and the seedlings were severely attacked by fungal organisms following the acid scarification treatment.

In the second experiment, the application of sulfuric acid for 1 to 15 minutes resulted in no improvement in germination of browntop millet seed. As the time of sulfuric acid scarification increased the number of abnormals and the incidence of fungal activity also increased.

The use of sulfuric acid in scarification did not improve final germination of Pensacola bahiagrass and browntop millet seed lots which showed slight to moderate dormancy. However, further studies are necessary for seed lots of these species which are deeply dormant.

Based on the results of this study, there appears to be no immediate planting value in the firm seeds of Pensacola bahiagrass or browntop millet.

APPENDIX

Appendix Table 1. Field emergence of sulfuric acid-treated and non-treated Pensacola bahiagrass seed.

	Acid-Treated (20 min.)						Non-Treated					
	Days after Planting						Days after Planting					
Lot No.	9	14	19	24	28	38	9	14	19	24	28	38
1	47	60	65	65	65	67	0	13	51	59	68	79
2	47	64	69	69	70	71	0	12	37	49	59	70
3	54	66	69	69	71	71	1	12	44	57	60	76
4	52	61	63	63	64	64	0	11	40	49	61	69
5	40	53	59	60	60	61	0	9	31	42	54	63
6	48	61	62	62	64	65	0	15	46	52	62	72
7	47	60	63	63	63	64	0	15	46	51	60	67
8	49	64	70	70	71	71	0	19	46	55	65	73
9	33	41	44	44	44	44	0	18	41	47	56	61
10	37	48	50	50	51	51	0	12	37	45	55	63
Average	45.4	57.8	61.4	61.5	62.3	62.9	0.1	13.6	41.9	50.6	60.0	69.3

Appendix Table 2. Germination of sulfuric acid-treated and non-treated Pensacola bahiagrass seed.

	Acid-Treated				Non-Treated			
	Days after Planting				Days after Planting			
Lot No.	7	14	21	28	7	14	21	28
1	87	92	92	92	9	51	64	70
2	77	87	89	90	6	48	60	68
3	77	91	91	91	8	40	53	60
4	78	90	92	92	10	51	64	69
5	70	79	82	83	5	39	53	62
6	81	86	87	87	12	61	69	73
7	76	83	84	84	6	45	59	66
8	81	86	88	88	10	63	74	77
9	65	69	70	70	9	57	64	65
10	60	68	69	69	7	51	60	62
Average	75.2	83.1	84.4	84.6	8.2	50.6	62.0	67.2

Appendix Table 3. Percentage of germination, abnormal seedlings, firm seed and tetrazolium viability of 10 lots of Pensacola bahiagrass seed.

	Non-Treated Seed						Acid-Treated Seed					
	Standard Germ. Test			TZ Test			Standard Germ. Test			TZ Test		
Lot No.	Germ %	Abnor-mal %	Firm seed %	Viable firm seed %	Non viable firm seed %	Total viability %	Germ %	Abnor-mal %	Firm seed %	Viable firm seed %	Non viable firm seed %	Total viability %
1	70	1.5	22.4	17.8	4.6	87.8	92	0.6	0.4	0.0	0.4	92.0
2	68	1.8	25.4	18.0	7.4	86.0	90	2.2	0.5	0.3	0.2	90.3
3	60	0.9	31.2	25.5	5.7	85.5	91	2.1	0.0	0.0	0.0	91.0
4	69	0.8	22.5	16.0	6.5	85.0	92	2.4	0.1	0.0	0.1	92.0
5	62	2.8	30.5	18.5	12.0	80.5	83	4.1	1.0	0.5	0.5	83.5
6	73	2.9	23.4	13.0	10.0	86.0	87	2.9	0.4	0.3	0.1	87.3
7	66	4.1	17.7	13.5	4.2	79.5	84	2.6	0.0	0.0	0.0	84.0
8	77	2.6	17.2	10.5	6.7	87.5	88	2.8	0.0	0.0	0.0	88.0
9	65	1.6	17.4	12.0	5.4	77.0	70	5.9	0.6	0.0	0.6	70.0
10	62	2.3	24.5	14.0	10.5	76.0	69	10.4	0.9	0.4	0.5	69.4
Average	67.2	2.1	22.8	15.7	7.1	82.9	84.6	3.6	0.4	0.2	0.2	84.8

Appendix Table 4. Comparison of standard germination and field emergence of acid-treated and non-treated Pensacola bahiagrass seed.

Acid-Treated Seed						Non-Treated Seed					
Lot No.	Germ %	Germ plus firm seed %	Germ plus firm viable seed %	Early field emergence % (14 days)	Final field emergence % (38 days)	Lot No.	Germ %	Germ plus firm seed %	Germ plus firm viable seed %	Early field emergence % (14 days)	Final field emergence % 38 days)
1	92	92.4	92.0	60	67	1	70	92.4	87.8	13	79
2	90	90.5	90.3	64	71	2	68	93.4	86.0	12	70
3	91	91.0	91.0	66	71	3	60	91.2	85.5	12	76
4	92	92.1	92.0	61	64	4	69	91.5	85.0	11	69
5	83	84.0	83.5	53	61	5	62	92.5	80.5	9	63
6	87	87.4	87.3	61	65	6	73	96.4	86.0	15	72
7	84	84.0	84.0	60	64	7	66	83.7	79.5	15	67
8	88	88.0	88.0	64	71	8	77	94.2	87.5	19	73
9	70	70.6	70.0	41	44	9	65	82.4	77.0	18	61
10	69	69.9	69.4	48	51	10	62	86.5	76.0	12	63
Average	84.6	85.0	84.8	57.8	62.9	Average	67.2	90.0	82.9	13.6	69.3

Appendix Table 5. Effect of sulfuric acid-treatment on germination percentage of two lots of Browntop millet seed

Lot No. 1								
Time in Minutes	0.0	1.0	2.5	5.0	7.5	10.0	12.5	15.0
Germination %	82.5	75.5	77.3	80.8	75.3	74.0	72.0	69.0
Abnormal %	1.5	4.3	2.0	2.3	1.3	4.0	4.5	4.5
Firm Seed %	3.0	1.8	1.5	1.0	0.8	0.0	0.0	0.0
Total Viability %	85.5	77.3	78.8	81.8	76.1	74.0	72.0	69.0
Lot No. 2								
Time in Minutes	0.0	1.0	2.5	5.0	7.5	10.0	12.5	15.0
Germination %	67.3	60.0	70.0	70.3	61.5	66.8	68.0	61.3
Abnormal %	2.0	3.0	4.0	3.8	4.0	3.0	3.0	4.3
Firm Seed %	18.3	10.3	7.3	4.0	2.0	1.0	0.0	0.0
Total Viability %	85.6	70.3	77.3	74.3	63.5	67.8	68.0	61.3
Average								
Time in Minutes	0.0	1.0	2.5	5.0	7.5	10.0	12.5	15.0
Germination %	74.9	67.8	73.7	75.6	68.4	70.4	70.0	65.2
Abnormal %	1.8	3.7	3.0	3.1	2.7	3.5	3.8	4.4
Firm Seed %	10.7	6.1	4.4	2.5	1.4	0.5	0.0	0.0
Total Viability %	85.6	73.9	78.1	78.1	69.8	70.9	70.0	65.2

Appendix Table 6. Field emergence of sulfuric acid-treated and non-treated Browntop millet seed.

	Acid-Treated (20 min.)				Non-Treated			
	Days after Planting				Days after Planting			
Lot No.	9	14	19	28	9	14	19	28
1	65	68	68	68	35	84	84	85
2	58	61	63	65	35	60	63	66
3	61	61	64	65	53	83	84	85
4	63	64	66	67	39	79	79	80
5	68	69	70	71	58	78	79	80
6	57	55	59	59	43	84	86	87
7	63	66	68	69	42	79	82	84
8	66	67	70	72	48	88	89	90
9	55	55	57	58	47	73	74	76
10	62	64	67	69	52	79	82	84
Average	61.8	63.0	65.2	66.3	45.2	78.7	80.2	81.7

Appendix Table 7. Germination of acid-treated and non-treated Browntop millet seed.

Lot No.	Acid-Treated Seed Germination Rate % Days after Planting		Non-Treated Seed Germination Rate % Days after Planting	
	4	14	4	14
1	66	67	79	89
2	57	60	53	71
3	71	72	78	90
4	68	68	72	83
5	80	80	83	88
6	48	48	75	87
7	71	72	76	86
8	79	79	85	90
9	75	76	78	87
10	75	76	78	86
Average	69.0	69.8	75.7	85.7

Appendix Table 8. Comparison of standard germination and field emergence of acid-treated and non-treated Browntop millet seed.

Non-Treated Seed					Treated Seed				
Lot No.	Germ %	Germ plus firm seed %	Early field emergence % (9 days)	Final field emergence % (28 days)	Lot No.	Germ %	Germ plus firm seed %	Early field emergence % (9 days)	Final field emergence % (28 days)
1	89	95.3	35	85	1	67	67	65	68
2	71	91.0	35	66	2	60	60	58	65
3	90	95.8	53	85	3	72	72.3	61	65
4	83	89.3	39	80	4	68	68	63	67
5	88	91.5	58	80	5	80	80	68	71
6	87	91.0	43	87	6	48	48	57	59
7	86	88.0	42	84	7	72	72	63	69
8	90	92.0	48	90	8	79	79	66	72
9	87	87.8	47	76	9	76	76	55	58
10	86	91.8	52	84	10	76	76	62	69
Average	85.7	91.2	45.2	81.7	Average	69.8	69.8	61.8	66.3

Appendix Table 9. Percentage of germination, abnormal seedlings, firm seed and total viability of 10 lots of acid treated and non treated Browntop millet seed.

	Acid-Treated Seed				Non-Treated Seed			
	Germination Test				Standard Germination Test			
Lot No.	Germ %	Abnormal %	Firm seed %	Total viability %	Germ %	Abnormal %	Firm seed %	Total viability %
1	67	4.8	0.0	67.0	89	1.3	6.3	95.3
2	60	4.8	0.0	60.0	71	1.0	20.0	91.0
3	72	4.5	0.3	72.3	90	0.5	5.8	95.8
4	68	4.0	0.0	68.0	83	1.3	4.8	87.8
5	80	5.0	0.0	80.0	88	1.5	3.5	91.5
6	48	4.5	0.0	48.0	87	0.8	4.0	91.0
7	72	3.5	0.0	72.0	86	0.8	2.0	88.0
8	79	3.5	0.0	79.0	90	1.2	2.0	92.0
9	76	4.3	0.0	76.0	87	0.6	0.8	87.8
10	76	3.3	0.0	76.0	86	0.5	5.8	91.8
Average	69.8	4.3	0.0	69.8	85.7	1.0	5.5	91.2

BIBLIOGRAPHY

1. Afanasiev, M. 1944. A study of dormancy and germination of seed Cercis canadensis. J. of Agr. Res. 69: 405-420.

2. Akamine, E. 1944. Germination of Hawaiian range grass seeds. Hawaii Agr. Exp. Sta. Tech. Bul. 2.

3. Andersen, A. M. 1953. The effect of the glumes of Paspalum notatum Flugge on germination. Proc. Assoc. Off. Seed Anal. 43: 93-100.

4. _____. 1958. A preliminary study of dromancy in browntop and cattail millets. Proc. Assoc. Off. Seed Anal. 48: 85-92.

5. Ashiru, G. A. 1969. Effect of kinetin, thiourea and thiourea dioxide, light and heat on seed germination and seedling growth of kola (Cola nitida [Ventenant] Schott and Endlicher). Am. Soc. Hor. Sci. J. 94: 429-432.

6. Association of Official Seed Analyst. 1970. Rules for testing seeds. Proc. Assoc. Off. Seed Anal. 60(2).

7. Beaty, E. T. and J. D. Powell. 1968. Pensacola Bahia: The grass that came to stay. Georgia Agr. Res. 10(2): 8-9.

8. Black, M. 1970. Seed germination and dormancy. Sci. Prog. 58: 379-393.

9. Born, W. H. V. and W. G. Corns. 1958. Studies on seed dormancy, plant development, and chemical control of tartary buckwheat (Fagopyrum tartaricum [L.] Gaertn). J. Pl. Sci. 38(3): 357-366.

10. Bryan, W. E. 1918. Hastening the germination of Bermuda grass seed by the sulfuric acid treatment. J. Am. Soc. Agron. 10: 279-281.

11. Burns, E. R. 1959. Effect of acid scarification on lupine seed impermeability. Plant Phys. 34(2): 107-108.

12. Burton, G. W. 1939. Scarification studies on Southern grass seeds. J. Am. Soc. Agron. 31: 179-187.

13. _____. 1940. The establishment of Bahiagrass (Paspalum notatum Flugge). J. Am. Soc. Agron. 32: 545-549.

14. _____. 1969. Breaking dormancy in seeds of pearl millet, Pennisetum typhoides. Crop Sci. 9: 659-664.

15. Crocker, W. 1916. Mechanism of dormancy in seed. Am. J. Botany 3: 99-120.

16. Croiser, W. and B. Cullinan. 1941. Some observations in the germination of grass seed. Proc. Assoc. Off. Seed Anal. 33: 69-82.

17. Currey, W. L., R. Parrado and D. W. Jones. 1973. Seed characteristics of smutgrass (Sporobolis poiretii). Soil and Crop Sci. of Florida Proc. 32: 53-54.

18. Dawson, M. D., and D. H. Heinrichs. 1952. The effect of various seed techniques to overcome dormancy in stipagrass seed. Sci. and Agric. 32: 266-271.

19. Delouche, J. C. 1961. Effect of gibberelin and light on germination of centipedegrass seed (Eremochloa ophiuroides). Proc. Assoc. Off. Seed Anal. 51: 147-150.

20. _____, T. W. Still, M. Raspet, and M. Lienhard. 1962. The tetrazolium test for seed viability. Mississippi Agricultural Experiment Station, State College, Mississippi. Bull. 51.

21. Emal, J. G. and E. C. Conard. 1973. Seed dormancy and germination in Indiangrass as affected by Light, Chilling, and certain chemical treatments. Agron. J. 65(3): 383-385.

22. Fendall, R. K. and J. F. Carter. 1965. New-seed dormancy of green needlegrass (Stipa viridula. Trin.). Influence of the lemma and palea on germination, water absorption and oxygen uptake. Crop Sci. (5): 533-536.

23. Feng, J. G. 1974. Seed dormancy in Johnson grass, Argentine bahiagrass and Pensacola bahiagrass. Thesis (M.S.), Mississippi State University, Mississippi.

24. Fernandes, G. M. B. 1976. Methods for overcoming seed dormancy in Pensacola bahiagrass (Paspalum notatum Flugge). Thesis (M. S.) Mississippi State University, Mississippi State, Mississippi.

25. Gaber, S. D., F. H. Abdalla and M. T. Mahdy. 1974. Treatments affecting dormancy in sweet sorghum seed. Proc. Int. Seed Test. Assoc. Bul. No. 1, Nov. 305-316.

26. Grabe, D. F. 1970. Tetrazolium Testing Handbook for Agricultural Seeds. Assoc. Off. Seed Anal. Contribution to the Handbook on Seed Testing no. 29.

27. Gupta, K. C. 1973. Factors influencing dormancy in seeds of crowfoot-grass. Biochem. Phys. Pflanzen (Bpp), Bd. 164: 582-587.

28. Happer, L. W. 1970. Dormancy in Japanese millet (Echinochcoa crusgallivar frumentacea [Roxb.] Wight) seed. Proc. Assoc. Off. Seed Anal. 60: 132-136.

29. Harrington, G. T. 1918. Germination and viability of Johnson grass seed. Proc. Assoc. Off. Seed Anal. 6: 24-48.

30. Hodgson, H. J. 1949. Effect of heat and acid scarification on germination of seed of bahiagrass, Paspalum notatum, Flugge. Agron. J. 41: 531-533.

31. Hyde, L. C., J. Troll and J. M. Zak. 1972. Breaking seed dormancy in Genista tinctoria. L. Proc. Assoc. Off. Seed Anal. 62: 155-158.

32. Maguire, J. D. 1970. Role of KNO_3 in germination of Kentucky Bluegrass Seed. Proc. Assoc. Off. Seed Anal. 60: 219-225.

33. _____, K. M. Steen. 1971. Effects of potassium nitrate on germination and respiration of dormant and non-dormant Kentucky bluegrass (Poa pratensis L.) seed. Crop. Sci. 11: 48-50.

34. Mathews, D. 1947. Observation on methods of increasing the germination of Panicum anceps MIchx. and Paspalum notatum Flugge. J. Am. Soc. Agron. 39: 439-442.

35. Nakamura, S. 1962. Germination of grass seeds. Proc. Int. Seed Test. Assoc. 27(3): 710-729.

36. Nikolaeva, M. G. 1969. Physiology of deep dormancy in seed. Printed by IPST Press Binding: Wiener Bindery, Jerusalem Isreal.

37. Paul, K. B., J. L. Crayton, and P. K. Biswas. 1976. Germination of Florida pusley seeds. II. Effects of germination stimulating chemicals. Weed Sci. 24: 349-352.

38. Ray, C. B. and R. T. Stewart. 1937. Germination of seed from certain species of Paspalum. J. Am. Soc. Agron. 29: 548-54.

39. Rincker, C. M. 1954. Effect of heat on impermeable seeds of Alfalfa, Sweet Clover, and Red Clover. Agron. J. 46: 247-250.

40. Rogler, G. A. 1961. Relation of seed dormancy of Indian ricegrass (Orysopsis hymenoides), (Roem. & Schult), (Ricker) to age and treatment. Agron. J. 52: 470-472.

41. Toole, E. H., S. B. Hendricks, H. A. Borthwick, and V. K. Toole. 1956. Physiology of seed dormancy. Ann. Rev. of Plant Phy. 7: 299-324.

42. Vegis, A. 1964. Dormancy in higher plants. Ann. Rev. of Plant Phy. 15: 185-224.

43. Wareing, P. F. and P. F. Saunders. 1971. Hormones and dormancy. Ann. Rev. of Plant Phy. 22: 261-288.

44. Wenger, L. E. 1941. Soaking buffalograss seed to improve its germination. J. Am. Soc. Agron. 33: 135-141.

45. Williams, R. C. and B. C. Webb. 1958. Seed moisture relationships and germination behavior of acid scarified bahiagrass seed. Agron. J. 50: 235-237.