THE EFFECTS OF LOCATION AND STAGE OF MATURITY AT TIME OF HARVEST ON THE GERMINATION OF SWITCHGRASS SEED, *PANICUM VIRGATUM* L.

By

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TABLE OF CONTENTS

Chapter		Page
I.	INTRODUCTION	1
II.	REVIEW OF LITERATURE	2
III.	METHODS AND MATERIALS	5
IV.	RESULTS AND DISCUSSION	9
V.	SUMMARY	20
	LITERATURE CITED	22

LIST OF TABLES

Table		Page
I.	Summary of Locations, Growing Conditions, and Yields of Five Lots of Caddo Switchgrass Seed Produced in 1957.	6
II.	Analysis of Variance on the Germination Capacity of Five Different Lots of Caddo Switchgrass Seed Grown in Oklahoma in 1957.	10
III.	Multiple Range of the Mean Percent Germination Obtained from Eight Germination Tests Within Each of Five Sources of Caddo Switchgrass Seed.	11
IV.	Analysis of Variance on the Germination Capacity of Switchgrass Seed Harvested at Five Stages of Maturity in 1958.	16
V.	The Percent Germination of Five Maturity Stages of Switchgrass Seed Collected in 1958	17

LIST OF FIGURES

Figure | Page

1. Germination of five lots of switchgrass seed tested at 30 day intervals for eight test periods 12

2. Germination of switchgrass seed harvested at weekly intervals from blooming time. 18

INTRODUCTION

Freshly harvested seed of most native and introduced grasses exhibit some degree of seed dormancy. The period of dormancy may vary from a few weeks to many months. Evidence exists which indicates that the geographic location, stage of maturity, and growing conditions are factors affecting the degree of seed dormancy within a given species. The amount of dormancy may vary within and between species and within and between the year the seed is produced.

This study was conducted to see if switchgrass, Panicum virgatum L., seed from five locations in Oklahoma would show differences in degree of dormancy. An attempt also was made to determine the effects of different stages of seed maturity on germination.

REVIEW OF LITERATURE

Relatively few papers have been published dealing specifically with dormancy and germination of switchgrass, Panicum virgatum L., or related Panicum species. The literature cited deals with seed dormancy investigations and germination studies of closely related crops.

The Rules for Testing Seeds (11) [1] specifies alternating temperatures and light for the germination of switchgrass. The need for alternating temperatures was further substantiated by Dunn (5) in a germination study with two varieties of switchgrass. His findings indicated temperature variations within the germination chamber greatly influenced the germination of dormant switchgrass seed.

Crocker (4) listed seven mechanisms by which a delay in germination of seeds is secured when they are placed under ordinary conditions for germination:

> Rudimentary embryos that must mature before germination can begin; complete inhibition of water absorption; mechanical resistance to the expansion of the embryo and seed contents by enclosing structures; encasing structures interfering with oxygen absorption by the embryo; a state of dormancy in the embryo itself or some organ of it; combinations of two or more of these; assumption of secondary dormancy.

Abnormal switchgrass and other grass seedlings were defined by Justice (12) to include those that have no root;

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[1] Figures in parentheses refer to Literature Cited.

a weak, stubby, or spindly root; no plumule; a shortened plumule, extending only one-half the distance up through the coleoptile; a spindly plumule; a shattered longitudinally split plumule with or without splitting of the coleoptile; decayed plumules; various combinations of these abnormal types.

Uniformity trials on germination of freshly harvested Caddo switchgrass seed were conducted in four germinator environments by Ahring, et al. (1). They found significant differences in percent germination between tray levels in three of the four environments tested, indicating the need for replicating seed samples by tray level to obtain a more realistic estimate of the germination capacity of a given seed lot. They further stated that small temperature differences within a germination environment become less important when the most favorable environment is used.

Working with horticultural seeds, Barton (2) found a differential in the degree of dormancy in different seed lots of the same species and in different seeds in the same lot. Harrington (7) reported different lots of Johnsongrass seed varied greatly in the readiness with which they germinated. Poorly germinating lots were more sensitive to temperature conditions within germinators than lots which germinated readily.

Howard (9) stated that more than 75% of the wild and cultivated species growing around Columbia, Missouri, produces seed having a distinct period of dormancy. The

rest period is more general and much more persistent among seed of wild plants. Coukos (3), after studying numerous accessions of seeds of Andropogon gerardi Vitman., Andropogon scoparius Michx., and Sorghastrum nutans (L.) Nash., concluded seeds from these species were dormant from 14 to 18 months. He found Bromus inermis Leyss. possessed no dormancy, and Bouteloua curtipendula (Michx.) Torr. was dormant foronly one or two months following harvest. McAlister (10) investigated the viability of seeds of Agropyron cristatum (L.) Gaertn., Agropyron smithii Rydb., Agropyron trachycaulum (Link) Malte., Bromus inermis Leyss., Bromus marginatus Nees., Bromus polyanthus Scribn., and Elymus glaucus Buckl. collected in 1937 in the pre-milk, milk, dough, and mature stages of development. Seeds of Bromus marginatus and Bromus polyanthus collected in pre-milk and milk stages germinated as high as the mature seeds. Dough stage seeds germinated about the same as mature seed in all species. Harlan (6) found that five out of seven barley varieties produced viable seeds as early as six days following pollination under good growing conditions.

Hermann (8) germinated seed of crested wheatgrass, Agropyron cristatum (L.) Gaertn., collected at regular intervals from nine days after anther exsertion until the seed was 50% shattered. The dormant period was shorter in the more mature seed, and the capacity to germinate was higher as maturity increased.

METHODS AND MATERIALS

This study was conducted using the facilities of the Oklahoma Crop Improvement Association seed laboratory located on the Oklahoma State University Campus, Stillwater, Oklahoma.

Two separate germination studies were conducted.

1. The effect of location on seed dormancy.
2. The effect of seed maturity on germination.

Study I

In August, 1957, the growers of certified Caddo switchgrass seed were requested to submit the date of harvest along with their seed sample required by the Oklahoma Crop Improvement Association for seed analysis. The seed was selected for study from the samples received within 15 days after harvest. The study was planned for 12 samples, but only five were received within this time period. Table I gives information concerning each of the five samples.

Samples were drawn from each seed lot and blown with a South Dakota seed blower to remove all blasted and immature seeds. The heavier fraction remaining was examined further by hand to be certain that only apparently sound, well filled seeds were being used.

TABLE I

SUMMARY OF THE LOCATIONS, GROWING CONDITIONS, AND YIELDS OF FIVE LOTS OF CADDO SWITCHGRASS SEED PRODUCED IN 1957

Lot	County in which Located	Year Planted	Row Spacing	Growing Conditions	Date and Method of Harvesting	Lbs. of Seed per Acre	% Purity
1	Dewey	1957	14 in.	very poor, weedy, not uniform in maturing, not irrigated	Oct. 7, 1957, harvested standing at dead ripe stage	40	59.58
2	Canadian	1957	14 in.	good, uniform in maturing, irrigated	Oct. 17, 1957, swathed at heavy dough stage	150	99.77
3	Major	1957	21 in.	good, uniform in maturing, irrigated	Oct. 21, 1957, swathed at heavy dough stage	351	98.59
4	Grant	1957	42 in.	good, not uniform in maturing, not irrigated	Oct. 21, 1957, harvested standing at dead ripe stage	26	97.10
5	Tillman	1957	42 in.	good, uniform in maturing, irrigated	Nov. 3, 1957, swathed at heavy dough stage	74	98.06

The germination test was conducted in a Stults Da-Lite germinator set for 20° - 30° C. alternating environment, 16 hours of darkness at 20° C., and eight hours of light at 30° C. The substratum consisted of blue gray germination blotter paper cut to fit the two and seven-eighths by two and seven-eighths by one and one-eighth inch plastic germination boxes. The substratum in each germination box was moistened with seven ml. of distilled water.

Since other tests have shown considerable variation exists within germinators, only the center of each tray was used. The trays were placed near the top of the germinator with a three inch interval between each tray. The germination test consisted of placing a replicate of 100 seeds of each lot on each of the four germinator tray levels in a randomized block design.

Seed from each seed lot was placed in the germinator on the fifteenth day from harvest. Since all five of the lots tested were harvested at different times, each sample was placed in the germinator on a different date.

Seed was drawn from each lot at 30 day intervals and placed in the germinator. Each seed lot was tested in this manner for an eight month period.

Germination counts were made at seven day intervals for a period of 28 days. At each count normal seedlings were removed and recorded.

Study II

On July 19, 1958, switchgrass plants located on the Agronomy Research Station near Perkins, Oklahoma, were selected for future germination studies. Plants were selected that were shedding pollen, and all branches of each panicle where flowers were not shedding pollen were removed.

Starting one week after bloom, the tagged plants were harvested by hand at seven day intervals for a period of six weeks. The seed were allowed to cure until 15 days after the last sample was harvested and were then hand-threshed.

Samples from each stage of maturity were drawn and placed in the germinator using the same procedure as described for Study I except that all samples were placed in the germinator on the same date. Three germination tests were conducted with a 45 day interval between each test.

RESULTS AND DISCUSSION

Study I

The multiple range test, Table II, shows that the germination capacities of the five lots of Caddo switchgrass seed differ greatly. The mean germination ranged from 42.8% to 76.8%. While lot 3 was statistically different from lots 2 and 5, the practical difference was small with only 4.4% difference in the mean germination of lots 2 and 3. Both lot 1 and lot 4 differed from one another and all other lots tested.

This germination study shows a marked difference in the dormancy pattern of the seed sources studied. Three distinct dormancy patterns were observed, Table III and Figure 1. Lots 1 and 4, 2 and 3, and 5 could be grouped according to the period of time required before each reached the germination capacity. The germination of lot 5 was suppressed for a shorter period of time than any of the other lots tested. There was no significant change in the germination of this lot of seed 45 days after harvest. Lots 2 and 3 showed effects of dormancy for 75 days after harvest. Lots 1 and 4 were erratic in germination and were dormant for at least 105 and 135 days, respectively, and may have contained substantial amounts of dormant seed at the conclusion of the test.

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TABLE II

ANALYSIS OF VARIANCE ON THE GERMINATION CAPACITY OF FIVE DIFFERENT LOTS OF CADDO SWITCHGRASS SEED GROWN IN OKLAHOMA IN 1957

A.O.V. Source	D.F.	S.S.	M.S.	F.
Total	159	79,512		
Treatments	39	76,244	1,954.97	70.95*
Lots	4	29,025	7,256.25	263.33*
Time	7	37,504	5,357.71	194.43*
LxT	28	9,715	346.96	12.59*
Replications	3	44	14.67	
Error	117	3,224	27.56	

Multiple Range Test of Lots

Lots	1	4	3	2	5
Mean	42.8	56.0	72.3	76.7	76.8

Multiple Range Test of Time

Time	1	2	3	4	7	8	5	6
Mean	26.8	57.6	69.7	71.3	72.4	73.5	73.7	74.6

*Significance at 1% level

Note: Any two means underscored by the same line are not significantly different at the 5% level.

TABLE III

MULTIPLE RANGE OF THE MEAN PERCENT GERMINATION OBTAINED FROM EIGHT GERMINATION TESTS WITHIN EACH OF FIVE SOURCES OF CADDO SWITCHGRASS SEED

				Lot 1				
Test	2	1	3	7	8	4	6	5
Mean	22.3	30.8	42.5	43.8	48.3	49.5	51.0	54.0
				Lot 2				
Test	1	2	7	5	3	4	6	8
Mean	21.3	60.3	84.8	88.5	88.8	88.8	90.3	91.3
				Lot 3				
Test	1	2	4	3	6	5	7	8
Mean	41.0	64.5	74.8	76.3	78.3	79.8	81.3	83.0
				Lot 4				
Test	1	2	3	4	8	5	7	6
Mean	23.3	55.3	57.8	57.8	60.0	60.3	66.5	67.5
				Lot 5				
Test	1	3	8	2	4	7	5	6
Mean	17.5	83.3	85.0	85.5	85.8	85.8	86.0	86.0

Note: Any two means underscored by the same line are not significantly different at the 5% level.

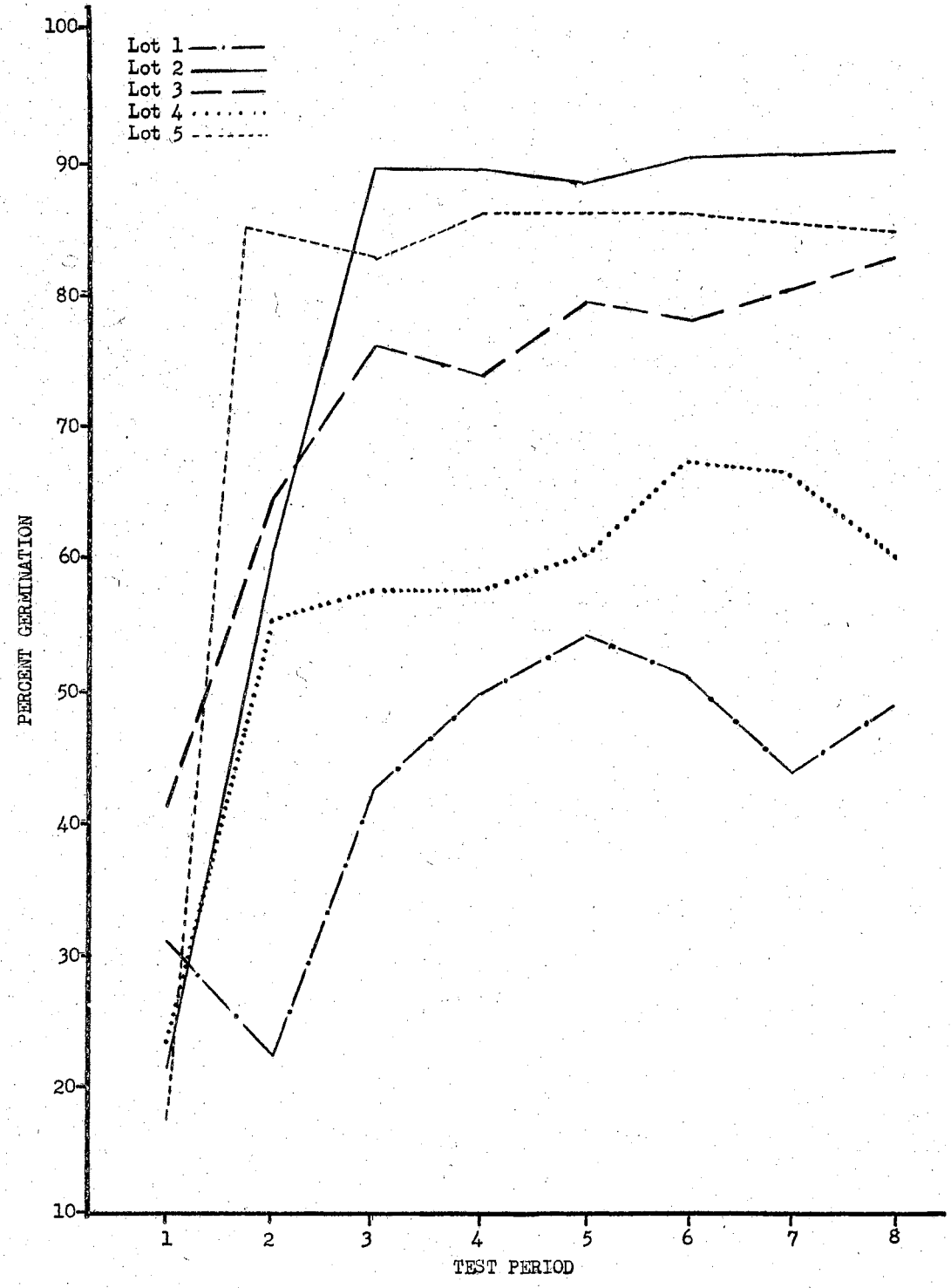

Figure 1. Germination of five lots of switchgrass seed tested at 30 day intervals for eight test periods.

Assuming the maximum germinating capacity of the seed would be reached by the eighth test, the failure of each seed lot to reach its maximum germination was attributed to dormant seed. Each lot was tested at an equal number of days from harvest which indicates a factor, or factors, other than age of the seed, influenced the degree of dormancy found in these seeds.

The environment in which these seed lots were produced was studied to see if there was a correlation between germination and environmental conditions (Table I). Lots 2, 3, and 5, which were very close in mean germination, differed from lots 1 and 4 in available moisture during the growing season and stage of maturity at time of harvesting. Since the rainfall in Oklahoma during the summer of 1957 was above average, moisture might not have been a contributing factor. Each seed grower was asked the stage of maturity of his seed at the time it was harvested. The stage of maturity shown in Table I is the opinion of the seed grower. Lots 1 and 4 definitely had the appearance of seed allowed to fully mature before being harvested. Some seed growers have observed that seed harvested directly with a combine usually gives a lower germination test in the laboratory than seed harvested from a windrow, or bound and threshed from the shock. This study tends to confirm these observations.

The variances for treatments, lots, time, and the interaction of lot and time were highly significant (Table

II). Since other germination studies have shown significance between replications, it is assumed that the germinator design used in this study was effective in reducing this variation.

It appears from this study that age of seed is not the sole contributing factor to seed dormancy in Caddo switchgrass. The stage of maturity at harvest apparently influenced the germinating capacity and the degree of dormancy within each seed lot.

Study II

Switchgrass panicles that were shedding pollen were tagged July 19, 1957. Starting one week from pollination, a number of plants were harvested at seven day intervals for six weeks. The seed harvested one week from bloom had to be discarded since approximately 95% of the spikelets blasted and the remaining seeds were so immature that it was impossible to separate the pure seed with any degree of accuracy. At two weeks from bloom the spikelets were filled enough to readily distinguish the pure seed.

The seed harvested at two and three weeks from bloom was very light. Four weeks from bloom appeared to be the most ideal harvesting stage. Seed taken at this stage of maturity were well filled with a bright lemma and palea, and only a few seed had shattered. At five weeks from bloom the seed was shattering, and over 50% had shattered at six weeks

from bloom. The seed could have been mechanically harvested from the standing plant at five weeks from bloom. The seed taken at five and six weeks from bloom had a dark lemma and palea.

Table IV shows the third stage of maturity, four weeks from bloom, to have the highest germination capacity. The analysis of variance was highly significant for treatment, maturity stage, time, and interaction of maturity stage and time. Replications were not significant which substantiates conclusions drawn in Study I concerning the germinator design. Data for the three germination intervals also are presented in Figure II.

The fourth stage of maturity probably would have germinated above 80% and the fifth stage above 90% if some of the seed had not been infested with Helminthosporium fungus. The fungus spread from the infested seed to all the seed in close proximity during the germination test. Only a few replications were affected, but the germination was lowered considerably in each instance (Table V). Since seed harvested at all stages of maturity were treated identically, the seed became infested with the fungus spores after the first three stages were harvested or, if infested at an earlier date, the spores were dead or dormant in the early stages of maturity.

TABLE IV

ANALYSIS OF VARIANCE ON THE GERMINATION CAPACITY OF SWITCHGRASS SEED HARVESTED AT FIVE STAGES OF MATURITY IN 1958

A.O.V. Source	D.F.	S.S.	M.S.	F.
Total	59	31,115		
Treatments	14	30,496	2,178.30	301.29*
Maturity stage	4	9,660	2,415.00	334.16*
Time	2	16,794	8,397.00	1,147.71*
MxT	8	4,042	505.25	69.88*
Replications	3	315	15.00	2.07
Error	42	304	7.23	

Multiple Range Test of Maturity Stage

Maturity Stage	1	2	5	4	3
Mean	36.8	58.5	65.6	69.3	72.0

Multiple Range Test of Time

Time	1	2	3
Mean	36.9	70.3	74.2

*Significance at 1% level

Note: Any two means underscored by the same line are not significantly different at the 5% level.

TABLE V

THE PERCENT GERMINATION OF FIVE MATURITY STAGES OF SWITCHGRASS SEED COLLECTED IN 1958

Stage	Time from Bloom	Test	Replication 1	2	3	4	Mean
1	2 weeks	1	28	16	10	6	15.0
		2	33	37	59	42	42.8
		3	52	54	46	58	52.5
2	3 weeks	1	50	38	38	38	41.0
		2	68	66	64	68	66.5
		3	80	66	60	66	68.0
3	4 weeks	1	46	44	58	46	48.5
		2	82	82	84	86	83.5
		3	84	86	84	82	84.0
4	5 weeks	1	60	52	50	42	51.0
		2	74*	88	84	62*	77.0
		3	82	64*	88	86	80.0
5	6 weeks	1	42	36	20*	18*	29.0
		2	82*	72*	90	82*	81.5
		3	80*	94	98	74*	86.5

*denotes seed were badly infested with Helminthosporium fungus.

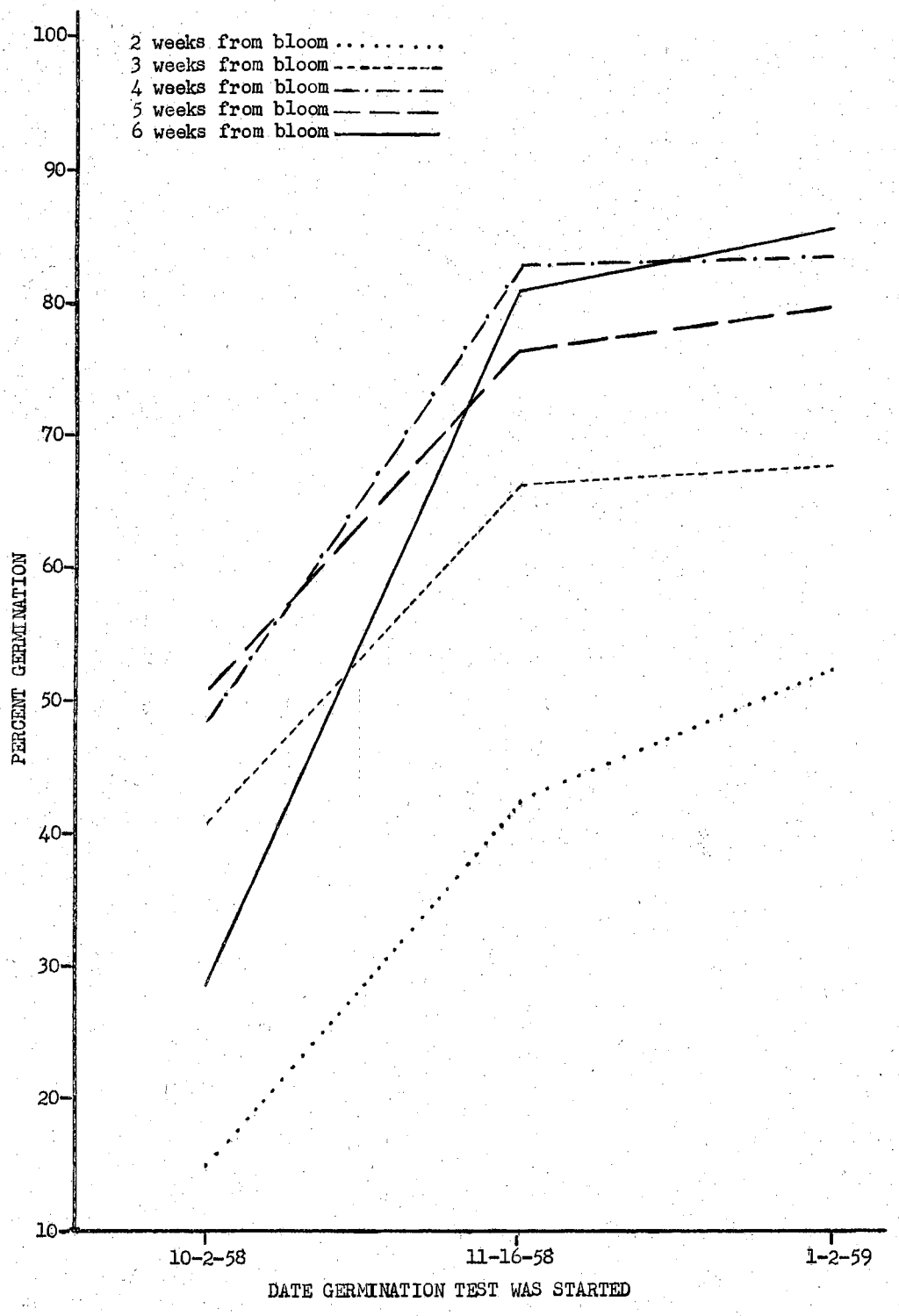

Figure 2. Germination of switchgrass seed harvested at weekly intervals from blooming time and tested for three test periods.

It was planned originally to have at least five germination tests on each maturity stage, but when the last stage was harvested it had shattered until there was only enough seed for three tests. The first germination test was started 15 days after the last seed sample was collected.

Switchgrass seed harvested at two weeks from bloom showed a higher percent of dormancy than any of the other maturity stages. This is even more significant considering this seed was cured 28 days longer than the fifth maturity stage. Seed harvested at stages two through five showed no significant difference between the second and third germination tests, but there was enough variation contributed by stage 1 for a statistical difference when all stages are considered collectively (Tables IV and V).

SUMMARY

In 1957, a germination study was conducted on Caddo switchgrass seed grown at five different locations in Oklahoma. The experiment was designed to determine the degree of dormancy in seeds grown under varying conditions.

The germinator design consisted of placing each of four replications on a different tray level with only the center portion of the tray and the upper one-third of the germination chamber utilized. There was no significant difference between replications in this study. Since replications are frequently significantly different in germination studies, it would seem that this design was an improvement over those commonly used.

Seed of the same age, but grown under varied conditions, had different dormancy patterns. The dormant period was longer and the germination capacity lower in the two lots of seed that were more mature at time of harvesting. Seed acquired from Dewey County was dormant for 105 days and had an average germination of 42.8%. The seed from Grant County was dormant for 135 days and had a germination of 56.0%. The seed produced in Tillman, Canadian, and Major counties was dormant from 45 to 75 days with an average germination of 76.8%, 76.7%, and 72.3%, respectively. The two lots of seed with the highest percent of dormancy were

grown without supplemental irrigation and were from the lowest seed yielding fields.

In 1958, switchgrass seed was harvested at weekly intervals, from two weeks after date of bloom to six weeks after blooming, to investigate the effect of seed maturity on germination. The same germinator design used in the 1957 study was used, and again there was no statistical difference between replications.

There were not enough germination tests conducted on each of the maturity stages, but it was evident that the seed taken from two weeks after pollination showed a greater percentage of dormancy. The more mature stages, five and six weeks from date of bloom, had the greatest germination capacity but shattered badly before they were hand-harvested and were infested with Helminthosporium fungus spores. Four weeks from pollination appeared to be the best time to harvest switchgrass seed for quality, appearance, and yield.

Future studies should be conducted to determine the effects of various growing conditions upon seed dormancy and the germination capacity. In any future germination studies the seed should be placed in the germination chambers following some design that will reduce, as much as possible, differences in temperature and light.

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