I.

SEED-SETTING AND GERMINATION.

Seed-setting ability.

Methods and materials.

Discussion.

Germination.

Methods employed in the germination tests.

Even and alternating temperatures.

Low temperatures.

Light.

Light and KNO_3.

Light and other salts.

The influence of seed coverings on germination.

Summary.

A large number of native grasses have for years been assembled at the Prinshof and Rietondale stations, at Pretoria. Since it was believed that a majority of these types were low seed-setters and germinated unsatisfactorily, vegetative means were in the first instance employed in their propagation.

Slow progress was shown with this method of propagation and it became evident that it was not destined to play an important role in the development of artificial pastures, particularly when a number of promising grasses did not lend themselves to this method of propagation. As a consequence, vegetative propagation was condemned by many, an attitude which should, however, be challenged, since the slow progress was perhaps not entirely due to the non-availability of seed but to a lack of knowledge regarding the correct methods of vegetative propagation.

Thus / ..

Thus far only about 10% of the indigenous genera have proved of value, or have exhibited potential economic value. These are : *Digitaria* '), *Panicum* '), *Setaria*, *Themeda*, *Cenchrus*, *Urochloa*, *Chloris*, *Paspalum*, *Brachiaria*, *Acroceras*, *Echinochloa*, *Cynodon*, *Melinis*, *Hemarthria* and *Ehrharta*. In each of the genera *Cenchrus*, *Acroceras*, *Themeda*, *Echinochloa*, *Cynodon*, *Melinis*, *Ehrharta*, *Hemarthria* and *Chloris* only about one species is concerned, whereas in each of the others several species are involved.

Seed-Setting Ability.

A good indication of the extent and variation in seed setting was first secured in a study on self-fertilization, open-fertilization and seed-setting of a number of *Digitaria* selections. In these studies, muslin sleeves were employed to cover individual heads with, these (just after flowering and before shedding) being enclosed by wire, the whole being held in a position by a dropper driven into the ground. The results are summarized in table 1.

Seed-setting, expressed as a % of total florets, varied in the 26 selections, as shown in Table 1, from 0.16% to 37.4% and showed wide variations for the individuals of the same open-fertilized progeny. Thus, for three individuals of the progeny of Inkruip 24-3, one of the best *Digitaria* selections, the % seed setting were ± 11%, 15.9% and 37.4% under open-fertilized conditions. In the second case, however, ergot was recorded. In several instances the average number of seeds per head was larger for the self-fertilized than in the case

of / ..

') These genera require revision and as a consequence the species involved cannot be precisely defined.

of the open-fertilized heads of the same selection.

The low values for seed-setting are rather striking even though some of the best seeding ecotypes were under observation. Possibly it was too late in the season to obtain an indication of normal seed-setting because it appears to be markedly influenced by seasonal conditions, even if the disease factor be ignored. The majority of digitarias are attacked by a *Claviceps* sp. (Ergot) and they generally suffer severely towards the end of the growing season. A *Cerebella* sp. often inflicts heavy losses on *Urochloa* while another fungus ') may be responsible for a high percentage of seed infection in *Cenchrus ciliaris*.

In the 1940-41 season further studies were undertaken on the seed-yielding ability of some ~~AR xxx~~ grasses in which were included certain selections of a *Panicum* sp. and of *Digitaria Smutsii*; of a number of ecotypes of *Digitaria*, (mainly from the N'Gamiland region), of *Chloris gayana* and of *Cenchrus ciliaris*.

TABLE 1: THE % SEED SETTING IN CERTAIN *Digitaria* SELECTIONS UNDER OPEN-FERTILIZED CONDITIONS : END 1936-37 SEASON.

Strain	No. of heads under observation	Total hermaphrodite fls. on all heads	Total seeds on enclosed heads	% seed-setting.	Average No. of seeds per head.
"Port Elizabeth" 45 - 1	4	4331	511	12.8	138
D. Smutsii 3 - 8	2	2802	55	1.96	27
do. 2 - 2	4	4167	153	3.7	38
do. 2 - 1	5	-	56	-	11
"Umflozi" 1 - 1	1	1358	16	1.2	16
do. 3 - 5	3	4189	103	2.5	34
do. 3 - 6	5	5615	252	4.60	50

"Inkruip" / ..

') The *Sphaeralcia* stage of a *Claviceps* sp.

Strain	No. of heads under obser-vation	Total herma-phrodite fls. on all heads	Total seeds on enclosed heads	% seed-set - ting.	Average No.of seeds per head.
"Inkruip" 1 - 7	4	2431	24	0.85	6
do.	4	1574	38	2.1	9
31- 5 / 2 - 4	3	1294	21	1.6	7
do. 2 - 8	4	4296	21	0.5	5
do. 2 -10	3	1370	49	3.6	16
D 24 / 1	2	1796	37	2.1	18
31- 2 / 1 - 4	3	1735	40	2.3	13
15- 7 / 1 - 9	2	1436	227	15.8	113
15- 7 / 1 - 2	4	2150	244	11.6	61
15- 7 / 1 - 5	1	ca.600	119	ca.20	119
31-16 / 1 - 5	2	1253	60	0.5	30
31-16 / 1 - 3	4	2071	17	0.8	4
"Port Elizabeth" 39 - 14	7	4507	107	2.4	15
do. 45 - 2	3	1233	3	0.2	1
do. 37 - 10	4	4052	594	14.7	148
24- 3 / 2 - 1	1	1082	405	37.4	405
do. 2 - 4	2	1612	256	15.9	128
do. 2 - 12	4	1218	330	ca.11.2	82
D. 24 / 2	3	1574	57	3.6	19

Methods and Materials.

In the case of the panicums, which ordinarily shed their seeds long before the last flowers have opened, heads were enclosed as described above but soon after flowering had started and were shaken every day. This method was also adopted in the case of the D. Smutsii selections. In the remaining grasses small gauze bags were slipped over the heads after the last flowers had opened and before any shedding had occurred, the open ends being tied up to prevent the escape of seeds. The bags were not supported by wire; they were left on until the seeds were mature. This method worked very well with these

genera / ..

genera, allowing of the normal course of pollination and fertilization and facilitated normal development of caryopses.

All florets (spikelets in the case of Chloris and Cenchrus) and all seeds were counted and the number of seeds expressed as a percentage of the florets in Digitaria and Panicum and as a percentage of the spikelets in Cenchrus and Chloris as in the latter two the spikelet is composed of 2 or more florets which makes calculations on a "floret" basis impracticable. The results of these studies are recorded in table 2.

TABLE 2: THE PERCENTAGE SEED-SETTING OF A NUMBER OF ECOTYPES AND SELECTIONS OF GRASSES: 1940-41 Season

Kind of Grass and/ or no (ecotype or selection).	No. of heads covered.	Range (in %) of seed-setting ability	Ave. % seed setting	Stand. Deviation.	Coeff. of variation.
Panicum Sp. ("makarikari") selections :					
14 - 17	4	45.7 - 54.8	50.0	3.98	7.88
1 - 6	4	56.8 - 84.0	71.2	11.86	16,67
2 - 14	3	21.6 - 36.0	31.3	4.87	15.55
14 - 11	5	9.8 - 18.4	13.7	4.3	31.43
2 - 23	5	60.8 - 79.3	69.3	6.75	9.73
13 - 12	4	26.7 - 42.8	35.2	7.25	20.61
11 - 4	2	41.8 - 46.6	44.2	3.39	7.68
11 - 11	5	8.0 - 22.8	15.9	5.31	33.37
15 - 5	5	15.5 - 21.6	17.6	2.44	13.88
15 - 9	4	5.0 - 12.1	7.4	3.19	42.94
12 - 6	5	0.5 - 1.6	0.8	-	-
12 - 1	1	-	48.7	-	-
Digitaria Smutsii selections :					
1 - 5/7	16	9.9 - 37.6	24.0 ')	10.75	44.75 ')
1 - 5/2		17.5 - 37.9	30.9 ')	6.27	20.27 ')

Digitaria Smutsii / ..

') These values represent results from two separate individuals in the same clone.

Kind of Grass and/ or no (ecotype or selection).		No. of heads covered.	Range (in %) of seed-setting ability	Ave. % seed setting	Stand. Deviation	Coeff. of variation.
Digitaria Smutsii selections: (cont.)						
1 - 6		14	9.8 - 38.5	21.6	-	-
1 - 9 ")		14	13.9 - 36.6	27.5	-	-
3 - 3 ")		21	19.0 - 46.6	31.7	-	-
7 - 4 ")		9	27.7 - 39.2	32.7	-	-
13 - 14 ")		12	16.7 - 51.1	31.7	-	-
13 - 12 ")		13	22.4 - 59.6	33.8	-	-
15 - 12 ")		19	20.3 - 54.4	37.9	-	-
16 - 6 ")		16	39.5 - 54.3	47.1	-	-
16 - 12 ")		14	29.2 - 55.7	44.6	-	-
8 - 7 ")		12	25.1 - 46.7	34.7	-	-
Digitaria spp.:						
Mobabi Flats	A.708	6	0.9 - 12.4	5.7	4.07	71.4
Zanghunpan	A.616	6	63.0 - 83.8	76.5	7.29	9.52
Gomoti R. No.1	A.615	6	26.1 - 50.3	42.4	10.63	25.07
Kwaai No. 11	A.598	6	47.6 - 83.0	65.5	11.66	17.80
Nkoana Pits 5	A.594	6	5.6 - 13.3	8.3	3.46	41.68
Ngami Lake	A.687	7	4.5 - 72.6	39.8	30.23	75.9
Molopo No.1	A. 38	6	10.5 - 57.3	30.1	16.73	55.58
Mobabi Flats	A.717	6	19.0 - 44.6	30.8	8.88	28.83
Chobi R.	A.701	7	21.4 - 84.7	49.9	22.73	45.55
Gomoti R.	A.699	6	25.1 - 72.2	41.2	18.16	44.07
Gomoti No.23	A.685	5	52.3 - 90.1	68.7	16.97	24.70
Zanghunpan	A.720	6	42.8 - 63.6	48.8	8.42	17.25
Rakops No.6	A.597	4	55.3 - 94.7	82.4	18.16	22.03
Kwaai No.23	A.601	6	45.2 - 81.7	68.4	12.6	18.42
Zanghunpan	A.730	6	37.7 - 62.6	46.4	8.42	17.68
Rakops No. 5	A.591	6	55.9 - 82.6	71.7	9.8	13.99
Zanghunpan No.2	A.614	6	33.1 - 71.3	52.9	15.03	28.41
Umflozi, seln.	3/5	7	7.2 - 22.8	15.4	10.77	69.93
do.	3/6	6	5.1 - 14.6	11.1	10.86	97.83
do.	1/1	8	9.8 - 40.4	19.8	9.11	46.01

Chloris gayana / ..

") In all these selections anything from 1 to 6 heads were enclosed in the same bag, the material from each such bag being counted together. Standard deviations could therefore not be computed for individual heads.

Kind of Grass and/ or no (ecotype or selection).		No. of heads covered.	Range (in %) of seed-setting ability	Ave. % seed setting	Stand. Deviation.	Coeff. of variation
Chloris gayana : "')						
Et.Elim Hospital	A.367	9	10.4 - 39.8	18.1	9.16	50.6
R. No. 1 seln.	A.172	9	44.1 - 98.3	68.9	17.37	25.21
Olifants Riv.	A.202	9	61.4 - 91.7	78.6	9.79	12.45
R. No. 2 Seln.	A.174	10	40.2 - 93.2	79.4	16.5	20.88
Zebediela	A.167	9	48.1 - 90.8	73.8	19.31	26.16
"Commercial"	A.168	9	74.7 - 99.1	88.2	7.87	8.92
Greytown	A.224	10	22.2 - 72.2	52.1	17.01	32.62
Umflozi	A.245	6	44.1 - 76.3	60.0	16.01	26.66
Lorenzo Marques	A.169	8	69.1 -104.3	89.9	12.56	20.93
Nursery	A. 83	9	75.4 - 91.4	84.48	5.56	6.58
Cenchrus ciliaris : "')						
Hartjies Veld	A.456	9	5.1 - 41.7	20.6	12.72	61.75
Mt. Elgon	119	7	14.8 - 82.4	54.8	30.64	55.9
Groot Marico	A.557	12	37.7 - 72.4	52.5	10.72	20.41
Nursery No.12		9	12.2 - 75.4	34.7	16.85	48.55
" " 334		10	14.0 - 50.8	29.7	15.68	52.83
" " 338		10	24.2 - 73.4	39.6	15.09	38.1
" " 388		9	19.0 - 76.7	46.9	22.49	47.99
" " 339		15	1.9 - 45.2	15.4	13.52	87.79
Dodoma " 118		8	26.9 -123.0	61.5	33.45	54.39
"	A.291	7	45.2 - 94.4	68.2	17.69	25.93
Hartjies Veld	A.265	9	6.9 - 23.9	13.2	7,07	53.6
Wylliespoort	A.467	9	35.5 -129.0	64.2	31.38	48.87
Springbok Vlakte	A.211	9	14.6 - 53.2	29.0	15.49	53.26
Marico		8	49.7 -105.2	85.1	19.28	22.66
Nursery 344		8	0.0 - 19.3	8.0	7.93	99.12
" 325		9	9.1 - 40.0	21.0	17.26	82.19
" 76		8	31.0 - 86.2	58.3	19.77	33.91
Marico Seln.		7	56.8 -138.5	88.5	25.23	28.51
Nursery No.75		8	43.0 - 96.4	63.0	21.09	33.47
" " 292		8	71.6 - 95.4	80.5	7.60	9.44
Brachiaria brizantha :						
Weenen	A.495	9	27.3 - 47.2	37.0	7.47	20.17
Rustenburg	A.246	6	11.8 - 45.7	31.5	12.52	39.80

Discussion / ..

"') The seed-setting was computed on a spikelet basis and not on a floret basis.

Discussion.:

The Panicum selections exhibited a very wide range of seed-setting, which is in great contrast to the values secured for their delayed germination, as recorded below. In the case of the D. Smutsii selections, however, the values ~~are~~ were much lower and consequently the scope for improvement of seed production seems to be more limited.

The Digitaria ecotypes, on the other hand, offer good possibilities for improvement in the direction of better seeding capacity. The C. gayana ecotypes are, with one exception, quite good seed-setters and are on the whole appreciably better than commercial seed obtained in the trade, as revealed by our analyses. Yet if one considers that the majority of the spikelets contain 2 - 3 fertile florets, there would appear to be ample room for improvement.

The C. ciliaris ecotypes are somewhat disappointing, though a few of them are fairly good.

A notable feature of the results is the great variability registered in the majority, particularly in the Cenchrus and Digitaria groups. This was anticipated as preliminary studies had revealed such a condition, though it is not very clear why it should be so unless it be due to the small size of the plots and the consequent poorer chances for effective pollination. However, anthesis often appeared to be somewhat irregular on individual plants. The results nevertheless indicate that great possibilities for improvement in this respect exist.

As regards the other panicums, in general, observations indicate that, on the whole, they shed their seeds very readily and seed-setting of the various species and ecotypes vary probably fully as much as obtained in the above selections. Disease may, however, cause much loss during the latter part of the season. In connection with the digitarias , on the other

hand / ..

hand, the position is a good deal less favourable than indicated by the N'Gamiland ecotypes, the performance of which, as a group, is quite unusual. The majority of the balance of the digitarias are poor seeders and from some ecotypes no seed have so far been obtained. A few have shown fair seed-setting, viz., "Port Elizabeth", "Inkruip", "Kuruman", "North Rhodesia", "Matabele Location" and Digitaria longiflora A65.

Though no actual studies were made on Acroceras macrum , the experience so far indicates that the available ecotypes of this species are very poor, with perhaps one exception and that shedding takes place soon, as with Ehrharta calycina . Similarly Paspalum scrobiculatum ecotypes appear to be fairly good seeders and this applies, on the whole, to the Urochloa spp. and ecotypes. Echinochloa and Setaria ecotypes in our possession are, in the main, very poor. Some Themeda ecotypes are fair seeders. Amongst the Sporobolus and Eragrostis spp., some of which are also attracting attention in conservation work, good seeders are to be found.

Some of the annuals, such as Urochloa helopus, Dactyloctenium aegypticum, Brachiaria isachne, Panicum laevifolium, which are pioneers under certain conditions, are quite good seeders.

G e r m i n a t i o n .

Investigations on any phase of germination are of little or no value unless the number of seeds used in the tests are known, as otherwise the percentage germination cannot be ascertained. A good deal of time was initially devoted to methods of cleaning seeds; that is, separating bracts (coverings) devoid of caryopses and/or removing the coverings themselves and so setting the caryopses free. An improvised blower, constructed for this purpose, proved very effective, but could only be

used / ..

used for the cleaning of seeds of grasses like <u>Panicum</u>, whereas seeds (fruit) of the digitarias, setarias etc., possessing hairs and setae could not be cleaned in this way and had therefore to be germinated in the uncleaned condition, the cleaning being accomplished on the completion of the germination test and after drying of the seeds. For this purpose a suitable method of cleaning (i.e. for removing the coverings) of the seeds had to be evolved, the procedure developed for this purpose consisting of the rubbing of the fruits between rubber surfaces to release the caryopses.

The use of transmitted light for the separation of fertile and unfertile spikelets appeared unserviceable. It was found that conc. H_2SO_4 could be used for removal of the hairs and that after washing and drying the separation of the spikelets devoid of caryopses could be effected by blower, but though this proved useful for certain work, it could hardly be considered safe for all purposes. Even if suitable means of removing the coverings (bracts) mechanically could be found, there would still be the possibility of injury to a percentage of the caryopses.

<u>Methods employed in the germination tests.</u>

It is customary in germination tests to count out the seeds for a test, beforehand and then to place these on the particular substratum for germination. As explained immediately above, however, no satisfactory means of precleaning the seed of many of ~~the~~ these grasses has until now been evolved. For this reason the general procedure adopted was to take a quantity of "seed" to furnish at least about 400 caryopses per test. This necessitated that a rough estimation of the seed content of every sample of seed employed should be made. On the whole, the number of caryopses used was in excess of 500. Germination tests were not replicated for the majority of the studies reported; recently, however, replication was introduced. It is appreciated that without replication one has no real check on the uniformity of germination but under the circumstances this appeared to be impracticable, and, moreover, large numbers of seeds were employed. Throughout the germination tests were made in petridishes, using clean, heat-sterilized quartz sand, distilled water and filter paper as the substrate. The quantities of sand and water were measured, in order to control the moisture contents at the start. The petridishes were always placed together in the same incubator held at a constant temperature of 28°C (initially 30°C). Counts were made daily* and the moisture content adjusted at this occasion, when necessary. Before entering the tests, all lots of seed were treated with Tillitine R. Electrically controlled incubators were used throughout and for all temperatures reported a fluctuation of about 1°C above or below is to be understood. The abbreviation ca. for "circa" is therefore prefixed. Results were always based on short-period germination tests of about 10 - 14 days, according to the kind of seed employed. This was done to eliminate, as far as possible, secondary influences arising out of an extended stay on the seed-bed.

Temperatures of 28 - 30°C were employed, because too low or too high temperatures often are unfit for the majority of seeds, whilst alternating temperatures stimulate germination. Moreover, preliminary tests indicated that this range was quite satisfactory which subsequent studies have confirmed, as discussed elsewhere.

The influence of various conditions or treatments on the germination of seeds in a state of delayed germination is discussed below.

Even / ..

* This provided a reasonable check on the uniformity of germination

control?

Even and alternating temperatures.

In 1936 tests were carried out with even and alternating temperatures on about 30 kinds of seed. After employing 7 - 8 days of even temperature at ca. 30°C, the combination of 6 hours at 40°C + 17-18 hours at 30°C was introduced for 4 days. In comparison with the former conditions, the latter produced marked stimulation (table W in appendix) in the case of Sporobolus sp. G37, Dig. milanjiana D36 and Panicum sp. "makarikari" C79. Of the balance, 18 kinds showed no stimulation and the others varying amounts. After introducing the combination 6 hours at room temperature plus 18 hours at 30°C, Panicum "Makarikari" C80 showed more stimulation than C79; the rest of the kinds exhibited little or no response. After a further 4 days the combination was altered to room temperature during the day and 40 - 42°C during the night, under which conditions C80 again showed more stimulation. C79 and P. minus F14, derived more benefit than at any previous occasion. This was true of also a few other Panicum ecotypes which had not shown any stimulation previously. When, after 4 days under these conditions, 6 hours at room temperature (daytime) and 18 hours at 40°C were substituted, only D36 yielded a very distinct response.

In the following test, 6 weeks afterwards, the same combination as previously was introduced after 8 days of even temperature, giving the same response as previously, except that D36, which had now registered a much higher germination during the even temperature period (table X, appendix), did not yield the same amount of stimulation as in the previous test. For the rest, the responses were essentially the same as in the previous test and this was also true when 6 hours at room (during the day) plus 18 hours at 30°C was thereafter substituted. When, after 4 days, this was replaced by 6 hours

at / ..

at room and 18 hours at 40°, D36 did not, as in the previous monthly test, show stimulation, but F14 and G37 were now slightly benefited.

In the subsequent test, 6 weeks afterwards, C80 showed no stimulation (table Y, appendix), where in the previous tests it had shown a fair increase after substitution of the first combination of alternating temperatures. Otherwise the responses were essentially the same with this combination.

Favourable alternating temperatures during germination often yield a very marked stimulation as compared with even temperatures. Thus, for example, 1½ months after harvesting Panicum sp. C80 showed a 70% increase over the germination at even temperature, whereas about 6 months after harvesting the increase under the same conditions was 95%. Apparently the effect of any combination of temperatures will vary according to the stage of delayed germination. Paspalum virgatum, on the other hand, gave no germination during the even temperature period at 30° or the subsequent 4 days at 6 hours laboratory temperature plus 18 hours at 30°, but when this was followed by the combination 6 hours in laboratory (daytime) plus 18 hours at 40°, the delayed germination was broken to the extent of 97% within a few days.

At other times, however, little or no stimulation can be secured by alternating temperatures. Thus, for example, Urochloa A.182 (of 4/3/41), when set out at 20°, at 40° and at 20 - 40°, 3 months after harvesting, gave no germination. Also, Digitaria "Kwaai" 11 (of 30/1/41) subjected to the same conditions, 5 months after harvesting, could not be stimulated at all even though at least 50% of the embryos in the latter were ready for germination. In the former, apparently, no embryos were ready for germination, as will be observed below. It would then seem that the application of alternating temperatures, like in the case of soil, is capable of overcoming, to some extent at least,

the / ..

the seed-coat and "embryo" restrictions of only certain kinds of seed.

In studies on suitable conditions for the testing of <u>Chloris gayana</u> seeds, it was found that the most favourable germination, in comparison with greenhouse soil tests, was realized with a combination of 20 - 30°C at the usual periods.

<u>Low temperatures.</u>

Though other workers have often found prechilling and low temperatures stratification or even low temperature germination effective or partly so, even with the Gramineae, the method has so far not proved to be of much use in the present studies thus far.

<u>Digitaria</u> Lake N'Gami of 11/2/41 was germinated in sterilized sand of three different moisture contents viz: 70%, 50%, 40% (expressed in terms of the waterholding capacity) at 10°C, but no definite response was realized even when the petri-dishes were subsequently transferred to the 28°C incubator.

Along the same lines as immediately above, an experiment was undertaken on 7 September, 1941 with <u>Panicum</u> NK36 of 27/1/41 and <u>Urochloa</u> N183 of 24/1/41. The seeds were kept at 5°C in moist sand of varying moisture-contents for different periods and thereafter germinated at 28°C. The moisture-contents employed were 75, 100 & 125% as expressed in terms of the water-holding capacity of the sand. The data are tabulated below.

TABLE 3: SHOWING THE EFFECT OF KEEPING SEEDS OF <u>Panicum</u> and <u>Urochloa</u> AT 5°C IN STERILIZED SAND OF DIFFERENT MOISTURE-CONTENTS AND FOR VARIOUS PERIODS ON THE COURSE OF THEIR DELAYED GERMINATION. GERMINATION TESTS TEN DAYS AT 28°C.

% Germination/..

	% Germination with various periods of treatment at 5°C							
	6hrs	12hrs	24hrs	2days	7dys	14dys	4wks	6wks
			75% moisture-content:					
Panicum N36	2	4	7	32	36	55	27	
Urochloa	0	0	1	0	0	1	0	
			100% moisture-content :					
Panicum N36	0	6	8	13	40	41	13	
Urochloa	2	0	0	1	1	0	0	
			125% moisture-content :					
Panicum N36	13	5	4	23	46	44	26	
Urochloa	1	1	3	0	3	3	1	

It would appear that moisture content between 75 and 125% had little, if any, effect on the course of delayed germination of either of the two kinds of seed used. The period of low temperature treatment was, however, an important factor and it would seem that a 14 days period was quite adequate to induce the greatest stimulation under these conditions. The controls for the *Panicum* and *Urochloa* were respectively 3.5 and 0%, thus giving a maximum stimulation of about 50% with the former.

Light.

The effect of light on germination has received much attention and that it may be an important factor in germination in isolated cases, is revealed by the undermentioned studies.

Panicum coloratum C99, was observed to respond well to conditions in front of a west-facing laboratory window, after the usual germination at ca.30°C in a dark incubator. As light seemed to be responsible for this favourable influence, seed of this ecotype was subjected to alternate light and dark treatments (where A = the petridish started off with light treatment and B = the petridish started off with dark treatment, black photographic paper being used to obtain darkness). The test

was / ..

was conducted in front of the same window, giving the following germination percentages :-

T A B L E 4 : THE EFFECT OF ALTERNATING LIGHT AND DARK TREATMENTS (DURING THE PERIOD OF GERMINATION) ON THE GERMINATION OF Panicum ECOTYPE C99 OF 6/3/36.

	First 12 days	subsequent 12 days	subsequent 16 days	Foll. 13 days	Next 5 days	Total %
in light:	A 6.2%	B 21.8%	1.8%	A 10.4%	B 0.5%	A65.7%
in dark :	B47.2%	A 40.5%	4.3%	B 2.1%	A 4.3%	B73.4%

Darkness was better than 'light' to the extent of approximately 40% (first 12 days results), the latter, almost completely inhibiting germination, contrary to expectation. Incidentally the control in the incubator also gave ca.40%, which would appear to indicate that the illumination received during the periods when daily counts were made, had little, if any, effect on the germination capacity. The original favourable response was most probably due to temperature fluctuations.

The results further show the sensitivity of seeds to such influence, particularly when on the seedbed and whilst in the condition of delayed germination. An attempt is always made to expose seeds (in the petridishes) as little as possible, when seedlings are counted out, in order to obviate light and temperature influences as much as possible.

Light and KNO_3.

Owing to the need for more information about light influence on the seed of native grasses, further tests with several kinds of seed were undertaken the results of which appear in the table below.

T A B L E 5 / ..

TABLE 5: THE EFFECT OF LIGHT AND KNO_3 (0.2%) ON THE GERMINATION OF VARIOUS KINDS OF SEED WHEN KEPT AT ROOM TEMPERATURE IN FRONT OF A SOUTH-FACING WINDOW. "DARK" DISHES WERE NOT OPENED UNTIL COMPLETION OF THE TEST. (The values in brackets are those obtained a fortnight earlier when the seeds were germinated in the greenhouse and the "dark" dishes were opened 3 times for counting during the test). 2 x 100 SEEDS PER TEST WERE USED ; DATE OF TEST 4/10/41.

Kind of grass; plot no; date of harvesting	Control at 28°C	Light plus Water	Dark plus Water	Light plus KNO_3	Dark plus KNO_3
Panicum leavifolium	- 4	18.5	36.0	63.3	20.5
N.K. 36; 3/2/41		(22.3)	(41.3)	(68.3)	(14.6)
Panicum sp.	- 6	18.8	43.0	14.5	31.3
A 146; 24/1/41		(21.3)	(44.8)	(41.5)	(24.6)
P. scrobiculatum	- 0	1.31	23.3	19.0	29.3
A 275; 25/1/41		(1.8)	(26.6)	(19.0)	(25.3)
P. notatum	1 -	-	-	-	-
A 240; 27/1/41		(0)	(0)	(3.0)	(10.[illegible])
Brachiaria brizantha	0.5	-	-	-	-
A 259; 24/1/41		(0)	(0)	(0)	(0)
Urochloa sp.	0.75	-	-	-	-
N.K. 85; 24/1/41		(0)	(2.8)	(8.3)	(2.5)

The above results obtained under room and glasshouse conditions indicate that illumination may play an important role, in the germination of seeds which exhibit delayed germination...On a sand-water seedbed (in petridishes), darkness increases the germination of three out of the six kinds very appreciably or, in other words, light reduces or partly inhibits germination. It is, therefore, not unlikely that the phenomenon is widespread in the seed of our native grasses. The more

extreme/ ..

extreme conditions in the greenhouse, in respect to temperature range, have apparently slightly increased germination, even for the dark treatments, which, if anything, should have shown lower values because they were opened three times for counting.

With a sand - KNO_3 seedbed the position is very different and the response no longer consistent. P. laevifolium now shows about the same germination in the dark as with water in light, whereas with light the germinability rises over 43%. That means, KNO_3 is harmful in dark and stimulating in light. With the Panicum A146, KNO_3 is harmful in both light and dark but more so with the former, though not so harmful as with light and water. With P. scrobiculatum , on the other hand, KNO_3 in dark is about equal to water plus dark, but with light it is not as harmful as is water plus light. The above differences obtained for P.laevifolium and Panicum sp.A146 were later (three months afterwards) found to be largely obliterated when the seed-coats were broken before the application of the same treatment.

In order to find out whether soaking in water and subsequent germination in KNO_3, or soaking in KNO_3 and germination in water will have any value for seeds which are in the condition of delayed germination, 2 ecotypes of Digitaria were soaked for 2, 6, 12 and 24 hours in both of the above series and thereafter germinated in the two respective media. The outcome of this experiment was that there was little in favour of any of the treatments for the promotion of germination of either of the ecotypes.

The breaking of seed-coats was studied in relation to light-, darkness-, water-, KNO_3- treatment, using P. maximum N.K.122 of 18/1/41 and P. laevifolium N.K.36 of 3/2/41. The comparison was made in October 1941 and January 1942 respectively. The controls at 28°C were 8.5% and 11.5% respectively.

TABLE 6/ ..

T A B L E 6 : THE EFFECT OF BREAKING OF SEED-COATS ON THE GERMINATION OF <u>P. maximum</u> N.K.122 AND <u>P. laevifolium</u>, N.K.36 WITH LIGHT-DARK AND KNO_3-WATER TREATMENTS.

		Light Water	Dark Water	Light KNO_3	Dark KNO_3
<u>P. maximum</u>;	seed-coats broken	15.0	8.0	4.5	23.0
do	normal fruits	18.5	25.0	19.0	11.0
<u>P. laevifolium</u>;	seed-coats broken	78.0	82.0	90.0	74.0
do.	normal fruits	10.0	10.0	40.0	26.0

With the seed of the N.K.122 ecotype, tested at room temperature, breaking of the seed-coats was apparently harmful with dark plus water and light plus KNO_3; but favourable with dark plus KNO_3. On the other hand, with the seed of the N.K.36 ecotype, tested at 28°C, all treatments were favourable with breaking of the seed-coats, the best one appearing to be light plus KNO_3. In the latter line of seed there was a tendency for the differences shown with the germination of normal fruits to become obliterated by the breaking of the seed-coats. In this case the delayed germination was largely due to the restrictions imposed by the seed-coats. In the other line of seed, however, the 'embryo' factor was the main cause of the delay and here the responses were not in the same direction.

From the above it would appear that illumination employed in these studies, may be an important factor in the germination of the seed of indigenous grasses, and is a factor to be reckoned with in any studies on the problem and condition of delayed germination, in order to obviate any unwarranted conclusions.

<u>Light and other salts.</u>

The value of $MgCl_2$, $MgSO_4$ and $NaNO_3$ as media in

concentrations /

concentrations of 0.2% (solutions) was studied with seed of Brachiaria brizantha A.259 of 24/1/41, and Urochloa A.183 of 27/1/41. In all but the Setaria, the controls with water in dark registered under 1%. The Setaria showed in the dark with water, $MgSO_4$, $NaNO_3$ and $MgCl_2$ resp. 52.5, 49.75, 34.0 and 51.5%, whilst in light the values were resp. 68.0, 60.75, 69.5 and 69.25%. These results would tend to indicate that light was more favourable than dark, for this kind of seed, not only when water was used as a medium, but also in the case of the salts employed, but that in light $NaNO_3$ was distinctly harmful. The salts are therefore no better than water. The experiment was conducted over the period October-November 1941.

The influence of seed-coverings on germination.

In Chapter 2 the influence of coverings in relation to the breaking of the seed-coats will receive attention and it only remains to note the effects of the removal of the coverings (paleae, etc.) on the immediate course of germination. As the caryopses of Chloris gayana are not tightly enclosed by their coverings and therefore easily removed without injury, the experiment was conducted with seeds of this species, the result being that the immediate effect brought an increase in germination of about 11% with this ecotype.

The removal of coverings was also attempted for other genera, but owing to the difficulty of removing caryopses without injuring the seed-coats, these results cannot be considered as reliable, although large increases were registered in a few cases. However, at other occasions, Chloris gayana ecotypes showed differences of 23% in favour of the removal of caryopses, whilst Sporobolus ecotypes, in which caryopses are readily set free without injury, 4% was the maximum difference registered.

S u m m a r y .

The following is a summary of the above studies :-

1. Seed-setting was studied in a number of ecotypes and selections by enclosing individual heads and not by harvesting of individual plots, as the latter was impracticable It was computed as a percentage of the number of spikelets per head, so that where there is only one floret per spikelet (e.g. Digitaria), the values are on a floret basis.

2. Great variation in seed-setting ~~is~~ was exhibited (in certain groups studied,more than in others) not only within the same exotype, but also within the same species and within the genus (between spp. of the same genus). Climatological influences would appear to be important in seed-setting.

3. Excellent seed-setting ~~is~~ was exhibited by certain of the Digitaria ecotypes studied, as also by certain of the selections of the 'Makarikari' ecotype of Panicum coloratum (?) and by certain ecotypes of Chloris gayana and Cenchrus ciliaris.

4. Good seed-setting ~~is~~ was not always associated with the best growth habits, but from a practical standpoint, there is, on the whole, good scope for improvement. [of what?]

5. The effects of various treatments and conditions on the germination of non-afterripened seed were studied.

6. All even [constant] temperatures so far studied, were ineffective to bring about anywhere near complete germination of seed in the condition of delayed germination and at best only presented an evaluation of the condition of delayed germination. [See Table X. Chloris gayana 94% in first few days at 30°C]

7. On the other hand, alternating temperatures may bring about

a marked / ..

- 24 -

a marked increase in germination of such seed, in some cases almost amounting to complete germination. The requirements in this respect varied for different kinds of seed.

8. Low temperatures of 15 or 20°C were so far not found to be effective for inducing germination, though it may be useful for cereals, etc. Even when the moisture content of the seed-bed (sand) was varied at the former temperature, the conditions were ineffective.

9. Precooling at 5°C, for definite periods, appeared to be a much more effective method of inducing germination, though that may only be true of the seed of certain lines. The moisture content of the seed-bed between 75% and 125% would appear to have little or no effect on the course of germination.

10. Light has a very important effect on the germination of, apparently, an appreciable percentage of the seeds of indigenous grasses, the majority, however, appearing not to be much affected by light or darkness. The sensitivity varied according to the ecotype, some being sensitive to light, others to dark.

11. KNO_3 and, to some extent, other salts, may have a very favourable effect on germination, but such effects may be influenced by light and dark.

12. Breaking of the seed-coats tended to obliterate the differential effects of light-dark and KNO_3-water treatments in the one line of seed used, but not in the other.

13. The influence of seed-coverings (bracts) on the course of germination is reported, it being shown that this may bring about appreciable differences.

4–11%

II. / ..