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RANGE MANAGEMENT — SEED AND GERMINABILITY OF ELEVEN ECOTYPES OF *CENCHRUS CILIARIS* UNDER DIFFERENT AGRONOMIC CONDITIONS

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Cenchrus ciliaris (buffel or anjan grass) belongs to arid and semiarid tracts of India and elsewhere. Earlier, the authors have distinguished 11 edaphic ecotypes (named RM 1...11) in the grass at Ahmedabad. Seed and germinability (under various agronomic conditions) of the ecotypes are presented in the paper.

Seeds are light and the weight varies in the ecotypes as also the seed output. Seeds are not dormant but show variations in germinability. Higher temperatures were found to promote germination, whereas lower temperatures and alternate low and high temperatures retarded it. Continuous light promoted germination in all the ecotypes. Storing for various periods was observed to enhance germination.

Germination of dechaffed seeds was found to be much higher than that of intact spikelets. Glume-extract showed clear retarding effect on exposed seed germination.

Lower to medium concentrations of ascorbic acid, gibberellic acid, streptomycin, streptomycin penicillin, sodium chloride and copper sulphate promoted germination of both seeds and spikelets. All results have been statistically examined for their significance.

Percentage germination differed in the ecotypes under all the treatments, making germinability a specific physiological character. Further, the results give useful information for range management practices for the grass.

INTRODUCTION

Cenchrus ciliaris belongs to arid and semiarid tracts of India and elsewhere. In these areas, extensive grasslands dominated by the species occur on sandy to silty situations exhibiting great morphological variations. Based on morphological characters, transplant experiments, cytology, culture experiments and organic productivity studies, 11 edaphic ecotypes of the grass were initially established in the grazing lands in Gujarat (at Ahmedabad, Pandeya and Jayan 1969, 1970). The ecotypes have been named RM1 to 11 (in honour of Prof. R. Misra of Varanasi) and arranged in decreasing order of length of bristles.

Seeds of *Cenchrus ciliaris* are enclosed within glumes in spikelets. Spikelets vary in number per spike and each spikelet encloses varying number of seeds (1 to 5). Mature spikelets get detached easily and are dispersed intact. Two types of seed and germination studies were made, one with intact spikelets — will be called 'spikelets' only; and the other with seeds — will be called as 'seed'.

Seed and germinability of the eleven ecotypes are interesting and specific for any range management practice in arid and semiarid tracts of India.

SEED STUDIES

Seeds of all the 11 ecotypes are dimorphic (cf. Lahiri & Kharabanda, 1961) and oval in shape. Weight of spikelet and seed varies in the 11 ecotypes. The weight of spikelet was maximum in RM6 (7.98 mg) and minimum in RM4 (2.80 mg); and for seed, it was maximum in RM3 (1.21 mg) and minimum in RM4 (0.71 mg) (Table I). Values are from plants grown in the garden transplant experiment.

TABLE I

Mean weight of spikelet and seed of the eleven ecotypes along with standard deviation SD (I)

Ecotype/ Weight	RM1	RM2	RM3	RM4	RM5	RM6	RM7	RM8	RM9	RM10	RM11
Mean weight of one spikelet (in mg) & SD	4.31 ±0.17	4.05 ±0.15	3.67 ±0.15	2.80 ±0.12	3.47 ±0.10	7.98 ±0.16	4.82 ±0.10	6.45 ±0.16	2.93 ±0.10	5.60 ±0.12	4.99 ±0.11
Mean weight of one seed (in mg) & SD	1.06 ±0.01	0.72 ±0.08	1.21 ±0.05	0.71 ±0.10	0.97 ±0.02	1.01 ±0.05	0.79 ±0.03	0.74 ±0.02	1.08 ±0.03	1.09 ±0.03	1.10 ±0.03

Seed output

Seed output of the 11 ecotypes was studied from the garden-raised plants during the months of July to October, 1968, i.e., during the first active growth after transplantation. The values greatly differ in the eleven ecotypes. Maximum seed output was recorded for RM10, followed by RM4, 3 and 2. Minimum number of seeds produced per year per plant (Table II) was in case of RM9.

TABLE II

Seed output of the eleven ecotypes in garden-raised plants

Ecotype	Average number of spikes per plant	Average number of spikelets per spike	Average number of seeds per spikelet	Average seed output per plant	SD
RM 1	182	96	2	34.944	± 2,315
RM 2	138	82	3	33,948	± 2,590
RM 3	148	68	3	30,192	± 1,848
RM 4	142	86	3	36,636	± 3,078
RM 5	122	82	2	20,008	± 1,549
RM 6	198	90	2	35,640	± 3,289
RM 7	176	72	2	25,344	± 2,407
RM 8	192	52	3	29,952	± 3,193
RM 9	86	92	2	15,824	± 2,345
RM 10	152	84	3	38,304	± 3,609
RM 11	164	62	2	20,336	± 2,528

Germinability

Germination study was undertaken with the view to:

(i) Observe dormancy, if any, and record differences in the degree of germinability of the ecotypes under natural conditions;

(ii) Observe the effect of various physical and chemical treatments (agronomic conditions) on germinability of the ecotypes.

MATERIAL AND METHODS

Mature spikelets of the eleven ecotypes of *Cenchrus ciliaris,* collected from the garden-raised plants during August-October, 1968, and stored in polythene bags at room temperature ranging from 20° to 24° C, were used for the germination experiments. Germination was effected in petri dishes.

Germinability of both spikelets and seeds was examined. For counting purpose, a spikelet which may have 1–5 radicles was taken as one unit.

Following germination experiments were conducted:

1. For dormancy—freshly collected spikelets were used during September 1968.
2. *Physical Treatments*
   (i) *Radiant energy — temperature:* The seeds and spikelets were subjected to continuous and alternate temperatures of 15° and 38° C. The experiment was set during September, 1968.
   (ii) *Radiant energy — light:* Spikelets/seeds were germinated under continuous light and continuous darkness during September, 1968.
   (iii) *Effect of storage:* Freshly collected spikelets were stored separately in polythene bags and tested for germinability at 3 monthly interval for one year (i.e., during September and December, 1968, March and June, 1969).
   (iv) *Effect of glume-extract on percentage germination:* Glumes of 1000 spikelets each of the eleven ecotypes were removed and ground to powder, and then soaked in 50 ml distilled water to form suspension. The suspension was stirred well and kept overnight, then filtered and the filtrate was used as stock solution (Standard Inhibitor).
      (*a*) In one set, standard inhibitor was diluted in proportions of 1:2, 1:5 and 1:10 with distilled water and given as media for the seeds during germination. The experiment was conducted during August/September, 1968.
      (*b*) In another set, standard inhibitor was warmed up in an oven at 46° C for 10 hr. This solution was then diluted in proportions of 1:2, 1:5 and 1:10 and given as media for seed germination.
      (*c*) In the third set, standard inhibitor was kept under continuous light (100 watt bulb at 30 cm distance) for 24, 30 and 72 hours, before using it as culture medium.
3. *Chemical Treatments*

   Seeds and spikelets of all the 11 ecotypes were separately pretreated with 25, 50 and 100 ppm of the following solutions as per the standard method of soaking and drying: Ascorbic acid (AA), gibberellic acid (GA), streptomycin, streptomycin pencillin, sodium chloride and copper sulphate ($CuSO_4$).

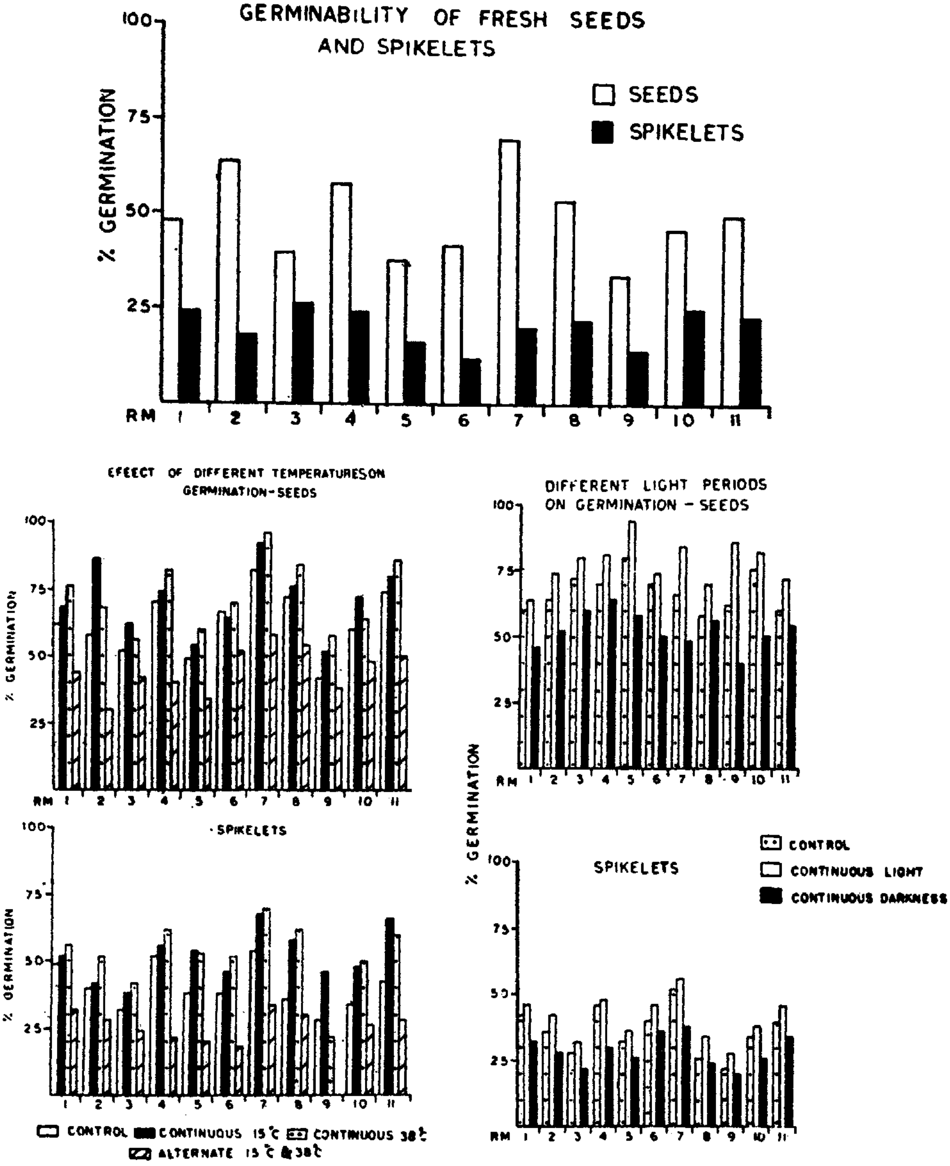

FIG. 1

A separate distilled water pretreated set along with an untreated control was also kept. The experiment was performed during March/April, 1969.

RESULTS

(1) *Germinability*

Germination studies in the freshly fallen seeds and spikelets have proved that there is no dormancy, but the germinability varies in the eleven ecotypes (Fig. 1). Germinability was found to be higher in case of seeds than in spikelets.

Seeds showed variation in germinability, which was highest in RM7 (70%), and lowest in RM9 (34%). Germinability of spikelets also showed variation within the eleven ecotypes. Maximum percentage germination of spikelet units was obtained in case of RM3 (26%) and minimum was obtained in case of RM6 (12%). Mean monthly maximum and minimum laboratory temperatures then were 31.12° C and 24.44° C, respectively.

(2) *Physical Treatments*

(i) *Radiant energy—Temperature*

(*a*) *Seeds*: It was observed that seeds, when subjected to different temperature treatments, exhibit varied germinability among the ecotypes (Fig. 1). Under continuous 38° C temperature, germination was promoted in all the ecotypes. The germination was maximum in case of RM7 (96%), and minimum in RM3 (56%).

Under continuous 15° C temperature there was no germination even up to 20 days in any of the ecotypes; but after this treatment when they were brought back to laboratory conditions (mean maximum and minimum temperatures were 31° and 24° C, respectively) the seeds started germination. Germination under initial lower temperature followed by laboratory conditions, was maximum (92%) in case of RM7 and minimum in case of RM9 (52%).

Under alternate 15° and 38° C temperatures germination was retarded in all the ecotypes. Under control (laboratory conditions) maximum seed germination was in RM7 (82%) and minimum in RM10 (42%).

(*b*) *Spikelets* : As mentioned earlier, germination percentage was lesser in case of spikelets than in seeds (Fig. 1). Thus under continuous 38° C there was maximum germination in the spikelets of all the ecotypes. Here RM7 showed highest germination (70%) and RM9 had the lowest germination (38%).

Under continuous lower temperature of 15° C there was no germination for 20 days, but when brought back to laboratory condition the spikelets germinated with otherwise maximum percentage in RM3 (38%). Under alternate 15° and 38°C temperature, germination was retarded. Here the maximum percentage was in case of RM7 (34%) and minimum in case of RM6 (18%).

Under control (laboratory conditions), maximum percentage germination of spikelets was in case of RM7 (57%) and minimum in case of RM9 (28%).

Analysis of variance: Analysis of variance was done for determining the significance of the various temperature treatments on seeds and spikelets. (Table III).

TABLE III

Analysis of variance for effect of temperature on seed and spikelet germination

Characters	Factors	DF	SS	MSS	*F* value
Effect of temperature on seeds	Ecotypes	10	4324.19	432.42	11.26**
	Temperature	3	5473.82	1824.61	47.51**
	Error	30	1152.18	38.41	
Effect of temperature on spikelets	Ecotypes	10	1962.00	196.20	7.86**
	Temperature	3	5549.45	1849.82	74.14**
	Error	30	748.55	24.95	

**denotes significance at 1% point level.

Thus temperature has a decisive effect on the ecotypes with respect to germinability. Higher temperature promotes germination.

(ii) *Radiant energy—light*

(*a*) *Seeds*: Germinability of 11 ecotypes was found to be greatly influenced by light (Fig. 1). Continuous light promoted germination. Here maximum germination was obtained in RM5 (94%) and minimum in RM1 (64%). Continuous darkness retarded germination with its maximum in RM4 (64%) and minimum in case of RM9 (40%).

Under control in laboratory conditions maximum percentage of germination was in case of RM5 (80%) and minimum in both RM1 and 11 (60%).

(*b*) *Spikelets*: Here also, the maximum germination was obtained under continuous light. Highest percentage was in RM7 (56%) and lowest in RM9 (28%). Continuous darkness retarded germination. The highest recorded under the treatment was in RM7 (38%) and lowest in RM9 (20%).

Under control, germination was again highest in RM7 (52%) and lowest in RM9 (22%).

Analysis of variance—See Table below.

TABLE IV

Analysis of variance for light periods and the ecotypes

Characters	Factors	DF	SS	MSS	*F* value
Effect of	Ecotypes	10	1712.00	171.00	30.37**
light on	Light periods	2	852.60	426.30	75.63**
seeds	Error	20	112.73	5 64	
Effect of	Ecotypes	10	1079.52	107.95	3.29*
light on	Light periods	2	3785.70	1892.85	57.86**
spikelets	Error	20	654.30	32.72	

**denotes significance at 1% point level.

*denotes significance at 5% point level.

(iii) *Effect of storage*

(*a*) *Seeds:* Storing of seeds of *Cenchrus ciliaris* has an enhancing effect on % germination (Fig. 2). In seeds, germination after three months storage was highest in RM7 (80%) and lowest in RM9 (48%). Storage for 6 months further improved germination percentage in all the ecotypes. Maximum among the 11 ecotypes was in case of RM4 and 10 (86%) and minimum in case of RM9 (54%). Storage for a further period of three months still increased the % germination in all ecotypes; maximum being in case of RM4 (94%) and minimum in RM3 (70%). Storage for 12 months seemed to be most favourable for germination capacity. Here the maximum was obtained in RM7 (98%) and minimum in RM3 (80%). Thus with storage, germinability fluctuated in the eleven ecotypes, with a clear enhancement.

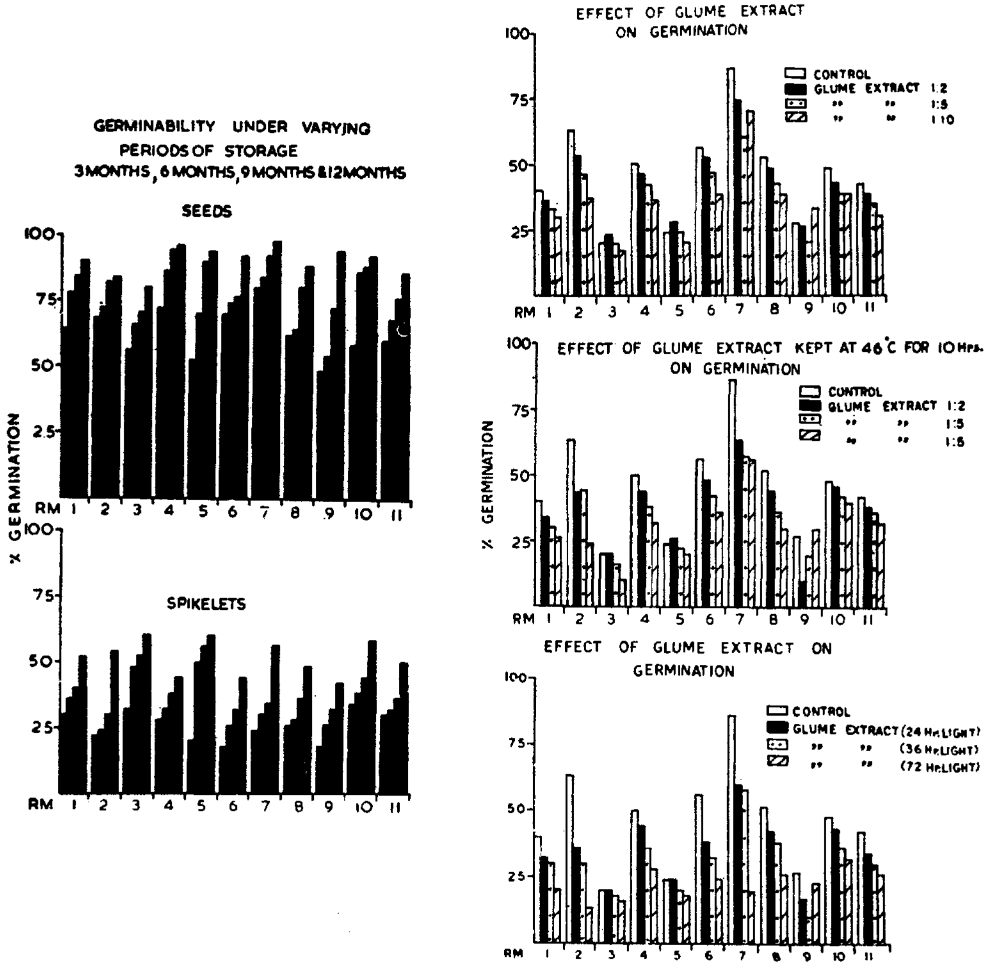

FIG. 2 Germinability of seeds and spikelets of the 11 ecotypes of *Cenchrus ciliaris* under varying periods of storage (*left*) and Effect of glume-extract on seed germination (*right*).

(*b*) *Spikelets:* In case of spikelets, in the first quarter, maximum germination was in RM10 (34%); in additional second quarter in RM5 (52%); in the third additional quarter in RM5 (56%); and in the last additional quarter in RM3 (60%). Likewise, minimum was in case of RM6 and 9 (18%)—first quarter; RM2 (24%)—second additional quarter; RM2 (30%)—third additional quarter, and RM9 (42%) in the last additional quarter.

Mean maximum and minimum temperatures inside the laboratory during the months of investigation were as follows:

September: 35.81, 25.09° C; December: 29.00, 13.00° C.;
March: 36.42, 20.00° C and June: 38.22, 26.60° C.

Analysis of variance—set Table V:

TABLE V

Character	Factors	DF	SS	MSS	*F* value
Effect of storage on seeds	Ecotypes	10	1868.91	186.89	5.73**
	Periods	3	4684.63	1561.54	47.88**
	Error	30	978.37	32.61	
Effect of storage on spikelets	Ecotypes	10	1604.91	160.49	7.09**
	Periods	3	3923.27	1307.75	57.80**
	Error	30	378.73	22.62	

**denotes significance at 1% point level.

(iv) *Effects of glume extract on percentage germination*

Since experiments on germinability clearly showed that spikelets had much lesser percentage germination than the excised seeds, investigations were directed towards finding out the glume-block in germination of the seeds, if any (Fig. 2). In the experiments it was observed that when seeds were put for germination in glume extract media, % germination in the three concentrations of the glume extract was much lower than untreated control. Further, it was observed that germinability in the glume extract media varied among ecotypes.

In the medium of standard inhibitor which was heated at 46° C, germination was not improved in any of the three concentrations. But here also ecotypes showed variation within themselves in their germination capacity as effected by the standard inhibitor.

Standard inhibitor treated with three durations of light when given as media did not improve germination when compared with that of excised seeds. However, difference in germination percentage among ecotypes could easily be noticed (Mean monthly maximum and minimum laboratory temperatures were 34.21 and 24.12°C, respectively).

Analysis of variance—See Table VI.

TABLE VI

Characters	Factors	DF	SS	MSS	*F* value
Glume-extract in 3 concentrations	Ecotypes	20	5217.52	521.75	32.99**
	Concentrations	2	311.69	155.85	9.85**
	Error	20	316.30	15.82	
Glume-extract under temperature treatments	Ecotypes	10	4405.88	440.59	15.46**
	Concentrations	2	293.88	146.94	5.15*
	Error	20	570.12	28.51	
Glume-extract under light treatments	Ecotypes	10	2394.24	239.42	4.85**
	Concentrations	2	966.79	483.39	9.79**
	Error	20	987.21	49.36	

**denotes significance at 1% point level.
*denotes significance at 5% point level.

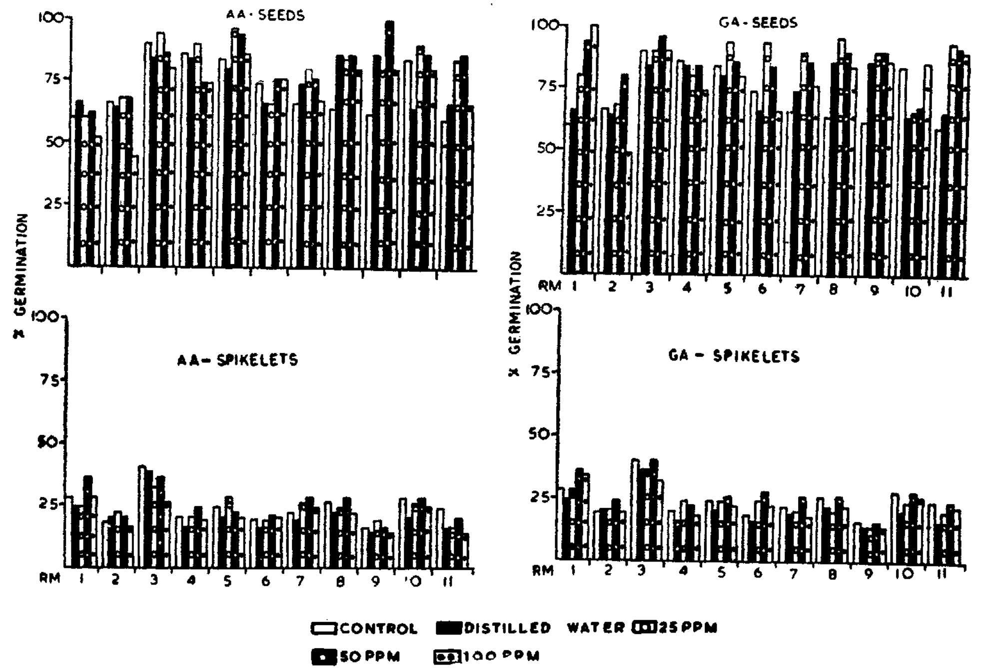

FIG. 3. Effect of different concentrations of ascorbic acid (AA) and gibberellic acid (GA) on germination percentage of seeds and spikelets of the 11 ecotypes of *Cenchrus ciliaris*.

(C) *Chemical pretreatments*

Chemical pretreatments were given to spikelets and seeds of the eleven ecotypes in order to see their effect on germinability for improving their agronomic status, and to differentiate the ecotypes on the basis of this physiological character also. It was observed that the germinability of 11 ecotypes differs in the three concentrations of respective chemical pretreatments, and distilled water-pretreated and untreated controls.

It is interesting to note the results of the two controls first as presented in Figs. 3 and 4 along with the respective chemical pretreatments. It is evident from the figures that with respect to two controls: (i) Spikelets had lesser germinability than seeds; (ii) Except in RM1, 7, 8, 9 and 11, germinability of seeds is less in distilled water pretreatment than in untreated control.

Mean monthly maximum and minimum laboratory temperatures recorded during the experimentation of chemical pretreatment were: 36.62° and 20.24° C, respectively.

(I) *Ascorbic acid* (*AA*)—Effects of AA on germinability of the 11 ecotypes, as shown in (Fig. 3), can be summarised as:

(i) 100% germination of the seeds was recorded in RM9 50 ppm. In spikelets it was highest in RM1 and 3 with the same concentration of the solution.

(ii) At 25 ppm, germinability was highest in case of seeds in RM5, and in spikelets in RM3.

(iii) In all the ecotypes, germination percentage decreased at 100 ppm.

(iv) A comparison of the above results with the two controls shows that at 100 ppm concentration of AA actually there is a retardation in germinability in all the eleven ecotypes.

Analysis of variance—See Table VII.

(II) *Gibberellic acid* (*GA*)—Effects of GA on germinability of the eleven ecotypes (Fig. 3) are:

(i) 100% germination of the seeds was recorded in RM1 at 100 ppm. In spikelets it was highest in RM3 under treatment with 50 ppm concentration of GA.

(ii) At 25 ppm, germinability was highest in case of seeds of RM8 and in spikelets in RM3.

(iii) At 50 ppm, germinability was highest in case of seeds in RM3 and in spikelets in the same ecotypes.

(iv) At 100 ppm, germinability was highest in case of spikelets in RM1.

(v) A comparison of the above results with the two controls shows that at 50 ppm of GA there is acceleration in germinability in all the ecotypes, both for seeds and spikelets. At 25 ppm there was retardation in the seeds of RM4 and spikelets of RM2 and 8. At 100 ppm. seeds of RM2, 4, 5 and 6 and spikelets of RM2, 3 and 5 showed retardation in germinability.

Analysis of variance—See Table VII.

(III) *Streptomycin*—Results of germinability of streptomycin-pretreated seeds and spikelets of the eleven ecotypes (Fig. 4) show that:

(*a*) 100% germination of the seeds was recorded in RM5 under 50 ppm. In spikelets it was highest in RM1 and 3 under 50 ppm and 25 ppm, respectively.

(*b*) At 25 ppm germinability was highest in case of seeds of RM8.

(*c*) In 100 ppm germinability was highest in case of seeds of RM9 and in case of spikelets, it was highest in RM10.

(*d*) A comparison of the above results with the two controls shows that germinability of the seeds of RM4 and of spikelets of RM3 and 9 was retarded at 25 ppm of streptomycin. At 50 ppm seeds of RM6 and 7 and spikelets of RM3 and 9 showed retardation in germination.

At 100 ppm, germination of seeds of RM4,6 and 7 and spikelets of RM1, 2, 4, 6 and 9 was retarded.

Analysis of variance—See Table VII.

(IV) *Streptomycin penicillin*—The results of germinability of seeds and spikelets of the 11 ecotypes under streptomycin penicillin treatment (Fig. 4), show that:

(i) Highest germination percentage of seeds was recorded in RM5 and 8 at 25 and 50 ppm, respectively. In spikelets it was highest in RM3 at 50 ppm concentration.

(ii) At 25 ppm germination of spikelets was highest in RM3.

(iii) At 50 ppm, germinability was highest in case of seeds of RM11 and spikelets of RM3.

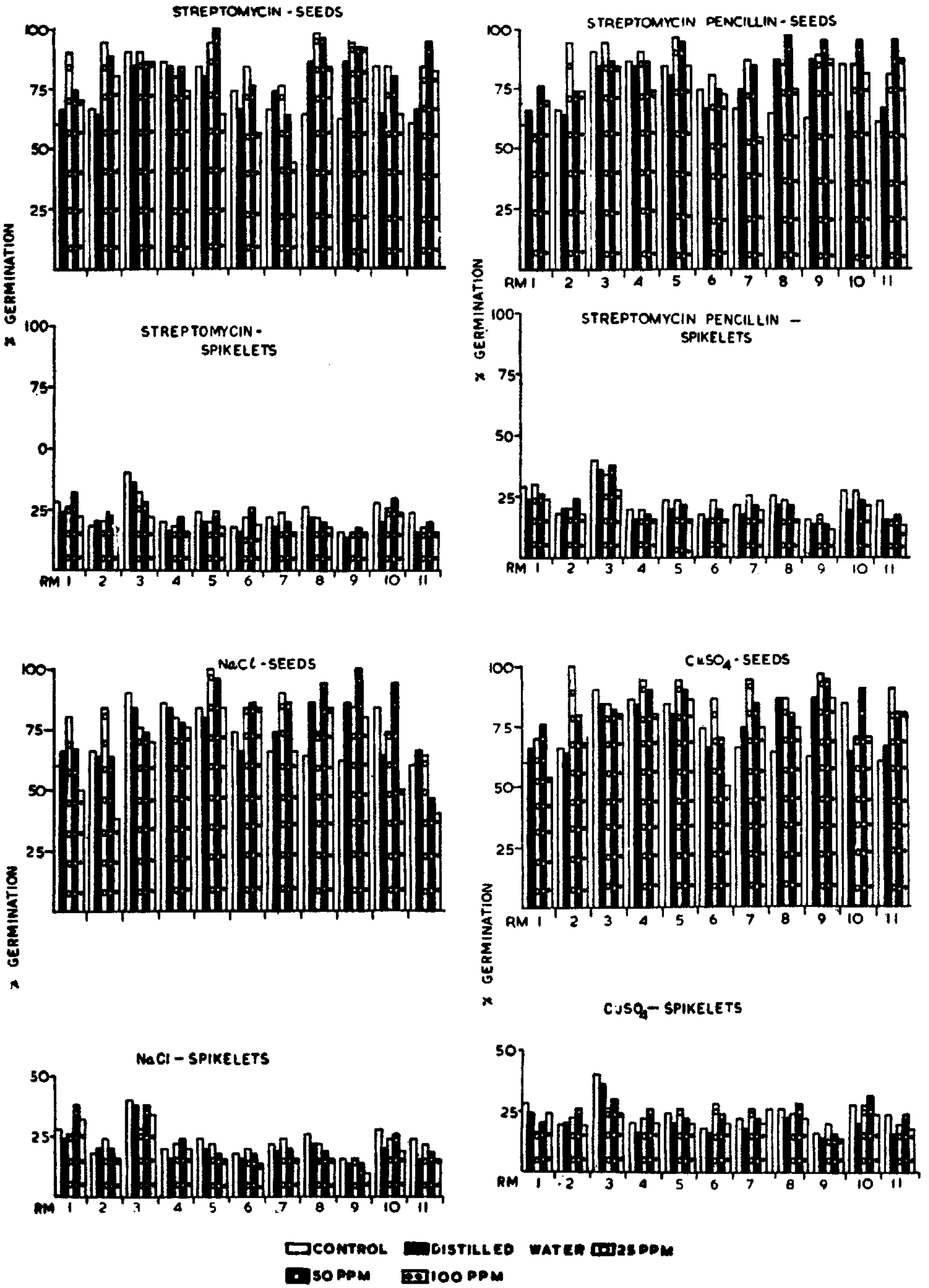

FIG. 4. Effect of different concentrations of Streptomycin, Streptomycin-pencillin, Sodium chloride (NaCl) and Copper sulphate ($CuSo_4$) on percentage germination of seeds and spikelets of the 11 ecotypes of *Cenchrus ciliaris*.

(iv) A comparison of the above results with the two controls shows that there is an overall acceleration in germination at 50 ppm concentration (both for seeds and spikelets) in all ecotypes. At 25 ppm there was slight retardation in germination of seeds in RM1 and spikelets of RM3. There was retardation in germination of spikelets under 100 ppm pretreatment in RM3, 5, 8, 9 and 11.

Analysis of variance—See Table VII.

(V) *Sodium chloride* (*NaCl*)—Results of germinability of seeds and spikelets under NaCl pretreatments (Fig. 4) show that:

(i) 100% germination of the seeds was recorded in RM5 and RM9 at 25 and 50 ppm, respectively. In spikelets, germinability was highest in RM1 and 3 with 50 ppm concentration of the solution.

(ii) At 25 ppm, germinability of spikelets was highest in RM3.

(iii) At 100 ppm, germination of seeds was highest in RM5, 6 and 8; in case of spikelets germination was highest in case of RM 3.

(iv) A comparison of the above results with the two controls shows that at 25 ppm of NaCl there was retardation in the seed germination of RM3 and 4; and in spikelets of RM3. At 50 ppm, germination of seeds was retarded in RM3 and 4 while germination of spikelets was retarded in RM5 and 8. In 100 ppm concentration of NaCl, seeds of RM 1, 2, 4,10 and 11 showed retardation in germination while spikelets of RM 2, 3, 5, 6, 7, 8, 9 and 10 showed retardation in this concentration.

Analysis of variance—See Table VII.

(VI) *Copper sulphate* (*$CuSO_4$*)—Results of germinability of seeds and spikelets of the eleven ecotypes under $CuSO_4$ pretreatment (Fig. 4) show that:

(i) 100% germination of seeds was recorded in RM 2 under 25 ppm. In spikelets germinability was highest in RM 10 with 50 ppm of the solution.

(ii) At 25 ppm, germinability of spikelets was highest in RM 6 and 10.

(iii) At 50 ppm germinability was highest in case of seeds in RM 9.

(iv) At 100 ppm, germination of seeds was highest in RM 5 and 9 and in case of spikelets, it was highest in RM1 and 3.

(v) A comparison of the above results with the two controls shows that there was retardation in germination of seeds in RM1 and 3. At 50 ppm there was retardation of germination in seeds (RM 3) and spikelets (RM1 and 3). In case of 100 ppm pretreatment, retardation was observed in seeds of RM1, 3, 4 and 6 and in spikelets of RM 3.

Analysis of variance—See Table VII.

TABLE VII

Analysis of variance for various chemical pretreatments

Characters	Factors	DF	SS	MSS	*F* value
Effect of AA	Concentrations	2	643.16	321.58	8.04**
Seeds	Ecotypes	10	3561.22	356.12	8.91**
	Error	20	799.51	39.98	
Spikelets	Concentrations	2	154.42	71.20	11.59**
	Ecotypes	10	712.00	77.21	12.56**
	Error	20	122.91	6.15	
Effect of GA	Concentrations	2	266.91	133.46	1.80
Seeds	Ecotypes	10	2213.34	221.33	2.99*
	Error	20	1479.76	73.99	
Spikelets	Concentrations	2	124.36	62.18	15.88**
	Ecotypes	10	1024.24	102.42	26.16**
	Error	20	78.30	3.92	
Effect of Streptomycin	Concentrations	2	1508.61	754.31	15.36**
Seeds	Ecotypes	10	2723.40	272.34	5.55**
	Error	20	982 06	49.10	
Spikelets	Concentrations	2	158.06	79.03	15.71**
	Ecotypes	10	433.21	43.32	8.61**
	Error	20	100.61	5.03	
Effect of streptomycin penicillin	Concentrations	2	673.70	336.85	5.44
	Ecotypes	10	1608.24	160.82	2.59*
Seeds	Error	20	1238.31	61.92	
Spikelets	Concentrations	2	188.36	94.18	25.81**
	Ecotypes	10	814.30	81.43	22.32**
	Error	20	72.97	3.65	
Effect of NaCl	Concentrations	2	1614.79	807.39	7.65**
Seeds	Ecotypes	10	4922.91	492.29	4.67*
	Error	20	2110.55	105.53	
Spikelets	Concentrations	2	112.24	56.12	5.33*
	Ecotypes	10	1093.58	109.36	10.39**
	Error	20	210.42	10.52	
Effect of $CuSO_4$	Concentrations	2	1258.91	629.46	12.87**
seeds	Ecotypes	10	1937.21	193.72	3.96*
	Error	20	978.43	48.92	
Spikelets	Concentrations	2	103.52	51.76	6.67**
	Ecotypes	10	292.85	29.28	3.78**
	Error	20	155.15	7.76	

(Contd.)

TABLE VII (Contd.)

Characters	Factors	DF	SS	MSS	*F* value
Distilled water pretreatment Seeds	Ecotypes	10	2738.18	273.82	547636 00**
Spikelets	Ecotypes	10	4320.00	432 00	9599999.90**
Control Seeds	Ecotypes	10	4003.63	400.36	800726.00**
Spikelets	Ecotypes	10	5864.73	586.47	11729454.00**

**denotes significance at 1% point level
*denotes significance at 5% point level

DISCUSSION

In conformity with the work of Brzostowski and Owen (1965) none of the ecotypes of *Cenchrus ciliaris* was found to have dormancy, although the degree of germinability differed in the eleven ecotypes. Further, the germinability in spikelets was less than in seeds, even though the spikelets have 5 seeds each.

As recorded by Lahiri and Kharabanda (1962, 63) spikelets with intact glumes had deleterious effects on germination. When the seeds are watered with the respective glume extract inhibition was recorded as also observed by Lahiri and Kharabanda (1962). Interaction of light and high temperature on glume extract—a standard inhibitor could not remove the retarding effect. This will show that the inhibitor present in the glume is water soluble and heat stable organic substance.

Role of germination inhibitors is well known in literature (Evenari, 1949; Barton & Solt, 1948; Villiers & Wareing, 1960.) Seat of inhibitors may be anything from embryo to seed coat to glumes (Koller & Negbi, 1955). Inhibitors have been found to be regulatory to germination and thus there may be a inhibitor-promoter complex. It is essentially ecological in origin and function, regulating the critical stage of life cycle in germination (Koller, 1955). Whereas, Billings (1957) feels that while inhibitor in itself makes germination intermittent, it also creates 'ecological hurdles' which may be beneficial. In the view of Oppenheimer (1960) most of the inhibitors in arid and semiarid conditions are leached by rains and destroyed by high temperature . This is an adaptation to drought-xerophytism in plants under such conditions. Commenting on the role of such inhibitors, Libbert (1961) observes that production of inhibitors in seeds at germination time, i.e., when embryo is arranging all necessary endogenous set-up for germination, indicates gradual enrichment of inhibitor during entrance into dormancy and dry storage. During dry storage perhaps inhibitors are oxidised.

In the present studies the role of glume inhibitors in germinability was found significant and heating of the inhibitor extract up to 46° C could not destroy it. Of course the inhibitors are water soluble, simply because the inhibitors come out in the extract. It is possible that dry heat might be able to oxidise the inhibitor earlier. In any case the present inhibitors may be a regulatory mechanism so that the seeds can only germinate in the next monsoon rains.

Storage promoted germinability as also observed by Wareing (1963). He describes that the level of inhibitor present is related to rainfall succession which brings about thorough wetting of soil so that germination does not occur until the soil contains adequate moisture. Although Lahiri and Kharabanda (1962, 63) believe that these inhibitors are coumarin though their role in the process is not certainly known.

Higher temperatures increase germination of both seeds and spikelets which means a direct effect on germinability rather than via inhibitors.

Low temperature has been found to retard germination which again becomes a physiological character.

Continuous light promotes germination in all the eleven ecotypes. However, there was specificity with respect to the degree of effect in the eleven ecotypes.

In all cases storage promoted germinability which may either mean oxidation of inhibitor with time or as Brzostowski and Owen (1965) observe, the embryo is more prepared for better germination with time.

Pretreatment with chemicals promoted germinability of the eleven ecotypes. AA, GA and Streptomycin had stimulatory effects on germination of seeds and spikelets. NaCl had retarding effect, but copper sulphate again promoted germination in both seeds and spikelets.

The effect of pretreatment must be direct on the embryo because of high germinability of seeds and not via the glume. If that was so then the germinability should be more at higher concentrations of the pretreatment substances and not with the lower as seen in the cases.

The differences in germinability of seeds and spikelets of the eleven ecotypes and their analysis of variance clearly indicate that degree of germinability is an ecotypic character.

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