GERMINATION RESPONSES OF SOME COMMON EUCALYPTS

by

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Abstract:—Some species of Eucalypts are considered the best amongst the fast growing broad-leaved trees and have been selected for large scale afforestation in West Pakistan. This prompted a studyon the germination behaviour of these species. Seeds of *Eucalyptus camaldulensis*, Dehn., *E. melanophloia*. F. v. M., *E. microtheca*, F. V. M., and *E. tereticornis*, Sm. have been used in this study. Both laboratory and field experiments have shown a marked trend from high germinative capacity and germinative energy index for large seeds to low capacity and energy for small seeds. It has further been indicated that temperature has a pronounced effect on germinative capacity, germinative energy index and germination period.

Introductions—Although the Eucalypt seeds are of very small size, yet in a given seedlot different size ranges can be distinguished. Work on this subject was carried out by Grose and Zimmer and they found that the size of the seed determined the absolute growth of the seedling at least 16 weeks after emergence. Similar studies were needed for the species which had been selected for large scale affore station in West Pakistan. Seeds were abtained from the selected stands of *E. camaldulensis*, *E. melanophloia*, *E. microtheca* and *E. tereticornis*, and a study was made to determine the germination responses of seeds of various sizes under controlled temperature as well as in the field. An attempt was also made to determine the optimum termperature required for germination of these species.

Statement of the Problem:—

It is a routine practice with the Forest Deparnment to collect tree seeds from what ever source available irrespective of its quality. This has been specially *true* in the case of Eucalypts. The result was that the nursery stock thus produced was generally weak and malformed. There used to be preponderance of stragglers. It was therefore decided to study as to how far the size of seed was responsible in production of good or poor plants. Seed was collected from naturally occurring stands and not from isolated trees. As in a seedlot various size ranges can be distinguished, there fore, the seed of different sizes was germinated both under controlled and natural conditions to determine the best suitable seed source and the germination conditions for each species.

Review of Liberature:—

Work on this subject was carried out by Grose and Zimmer (1958). The species studied by them were *Eucalyptus maculata*, Hook f. and *E. sieberiana* F. v. M. *Seeds*

of four distinct size ranges from a seedlot of each species were germinated at constant temperature on moist filter paper and in soil. In all cases, large seed germinated faster than the small and in soil cultures also gave a larger percentage of germination. After seven weeks, percentage survival of seedlings from the smallest seeds of both the species was lower than that for seedlings grown from three large sized ranges of seed. Size of the seed also determined the absolute growth of the seedlings atleast sixteen weeks after emergence, probably owing to the influence of coyledon area accordingto the authors, it is probable that seed size has a similar influence on germination and early growth of seedlings of all eucalypts.

These research workers have further rooted that *E. camaldulensis* will germinate both at constant and alternating temperatures. It germinates best at 95° F. They studied thirty one different lots of seeds and found that no relationship existed between environmental condition of the locality of collection and optimum conditions for germination.

The seeds of eucalypts vary greatly in size. The most comprehensive range of measurements of Eucalyptus seed is due to Maiden (1903-33), who quotes the measurements of 198 different species, and who states that eucalyptus seeds vary in size from about 0.5 mm. to 16 mm. long and from about 0.5 mm. to 7 mm. broad. *E. calophylla* seeds are probably the largest in the genus and measure from 5-16 mm. long and from 5 to 7 mm. broad, while those from *E. dealbata*, among the smallest of all Eucalyptus seeds, vary from 0.5 mm. to 1 mm. long and 0.5 mm. to 0.7 mm. broad.

According to A. R. Penfold and J. L. Willis, (6) the germination of Euclyptus seed takes place from ten to twenty days after sowing in the warmer parts of Australia.

Material and Methods:—

Fertile seeds from each seedlot were separated from the chaff with the help of a dissecting microscope and an improvised micrometer for obtaining lots of various seed sizes, both length and breadth were measured. Since there was a direct relationship of length with breadth, only seed length was taken into consideration for the determination of size classes. Variation in seed size and their weights for each species is given below:—

Species	Seed size (inches)	Mean weight of 250 seeds (gm.)
E. camaldulensis ..	0.03	0.063
	0.04	0.083
	0.05	0.094
E. melanophloia ..	0.05	0.095
	0.06	0.121
	0.07	0.151
	0.08	0.177
E. microtheca ..	0.05	0.098
	0.06	0.114
	0.07	0.130
	0.08	0.142
E. tereticornis ..	0.03	0.055
	0.04	0.072
	0.05	0.081
	0.06	0.104

GERMINATION METHOD.

(a) In the laboratory:—

The technique suggested by Grose and Zimmer was adopted for germination. It consisted of using a 4-inch petridish containing two filter papers placed together over an inverted 3½ inch watch glass. Before placing the filter papers over the watch glass, four red and one blue line were drawn radially with a pencil to divide the filter paper into five equal sectors. One radial cut was made close to the blue line extending almost to the centre. Overlapping portions of the filter papers were folded under the edge of the watch glass. These filter papers were kept moist with water through a folded gauze wick placed at the base of the petridish and supplied with approximately 1/10-inch of water. The red and blue lines served as markers, thus permitting germination of five sub-samples in each petridish.

For each seed size, ten sub-samples were germinated under constant temperature incubator.Separate tests were carried out under 32°.36° and 38° centigrade. In order to facilitate statistical analysis of germination, 25 seeds were tested in each sub-sample.

Seeds were considered germinated. when the radicle after emergence attained a length of $\frac{1}{8}$-inch. The criterian of hypocotly length suggested by Grose and Zimmer (1958) was found impracticable, hence elongation of radicle was used.

Daily counts of germination were reeorded on test sheets of each sub-sample. When the total daily count of germination fell below ten percent, the remaining seeds were squashed to note their viability. Seeds with firm white embryos were considered viable and the rest nonviable.

(b) *In the Field*:—

Seeds of various sizes of all the four species were separated in the same manner as described above and were germinated at temperature ranging 18°-36° centigrade according to the standard nursery techhiques. The seeds were spread over small ear-then troughs filled with river sand and covered with a thin soil layer. Required moisture was mad availaple with mist sprayers.

The number of seeds which germinated in the laboratory and field were recorded daily and the germination capacities* of se ds of various sizes compared. For the comparison of germinative energies** germinative energy indices were determined by summing up the figures of progressive percentage germination. Grose Modified Germi nativeEnergy Index can be calculated by the following formula.

$$\text{Modified G. E. I.} = \frac{\text{G. E. I.}}{\text{(No. of days) (Germinative Capacity).}}$$

Mean germination percent (germinative capacity) and germinative energy indices are given in table 1-4.

Results and Discussion:—

Analysis of the data from the petridish experiments shows a marked trend from high germinative capacity and energy for large seeds to low capacity and energy for small seeds as shown in fig. 1 and 2. Similar results were obtained when the seeds of all four species were germinated in the field as shown in fig. 3.

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*Germinative capacity: The total number of seeds that germinate as a perecentage of total viable seeds.

**Germinative Engery: The percentage of seeds in a sample of viable seeds that have germinated up to the time when the daily germination rate reaches its peak.

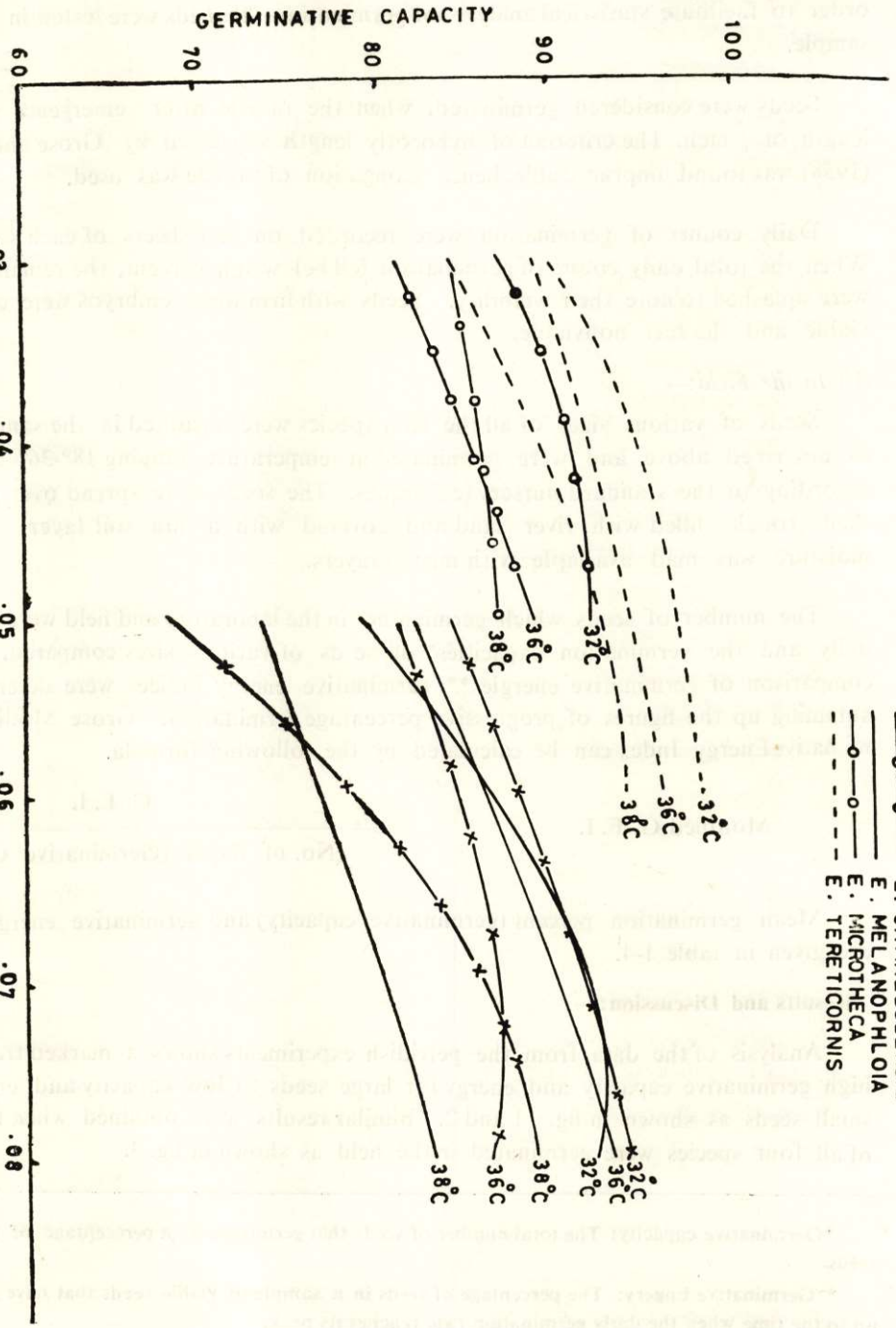

FIG: 1 EFFECT OF SEED SIZE ON GERMINATIVE CAPACITY

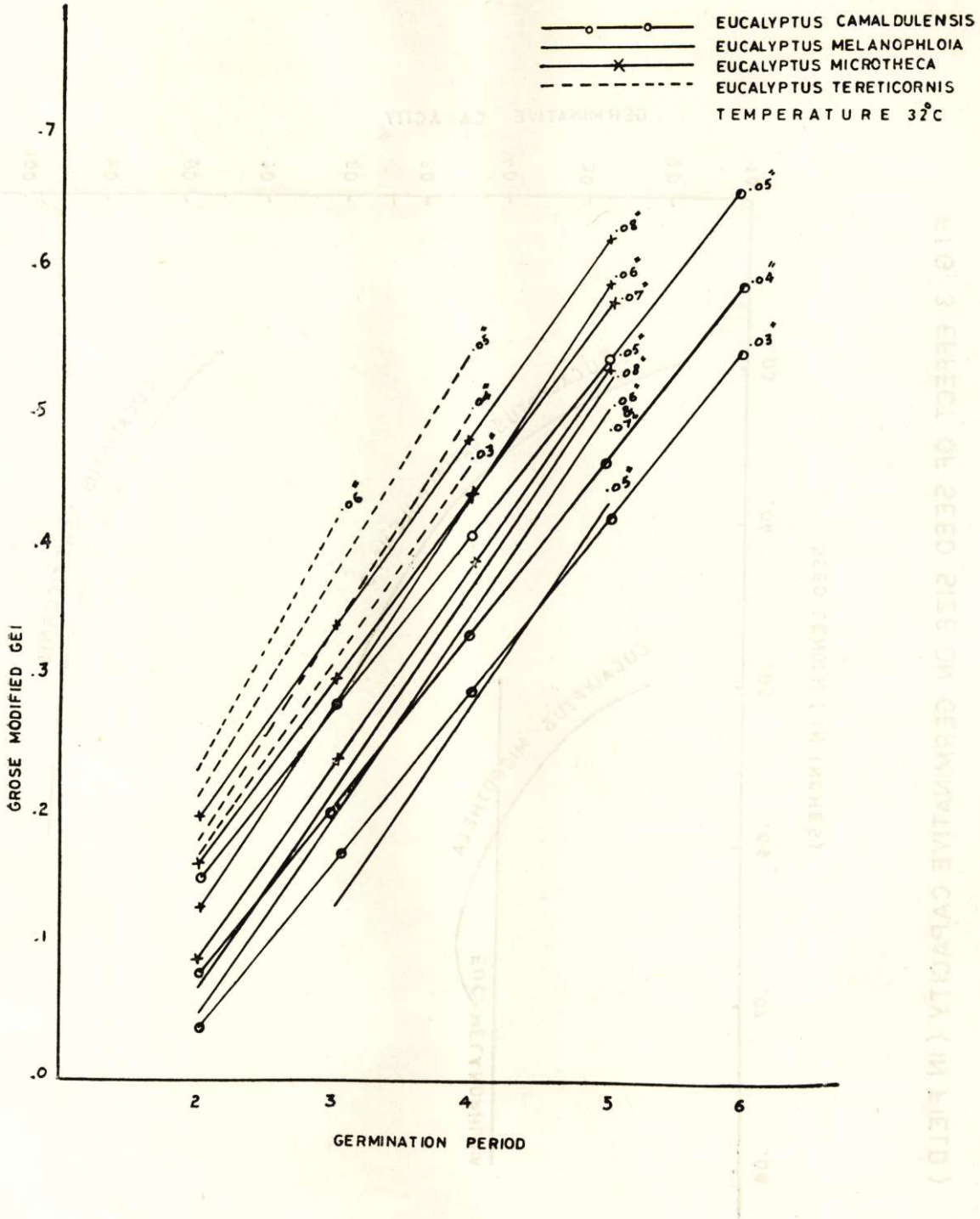

FIG: 2 EFFECT OF SEED SIZE ON GROSE MODIFIED GEI CORRESPONDING TO GERMINATION PERIOD.

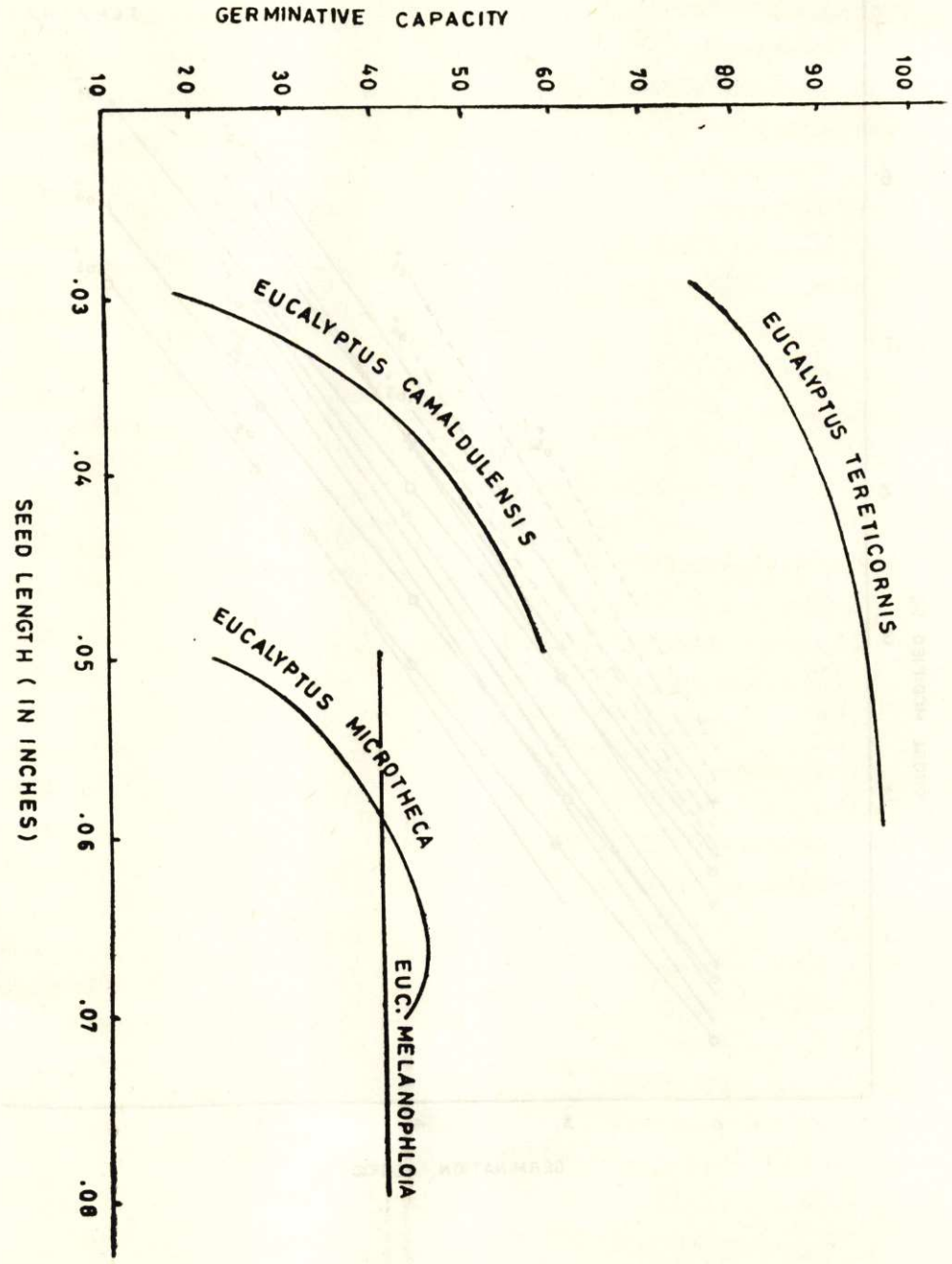

FIG: 3 EFFECT OF SEED SIZE ON GERMINATIVE CAPACITY (IN FIELD)

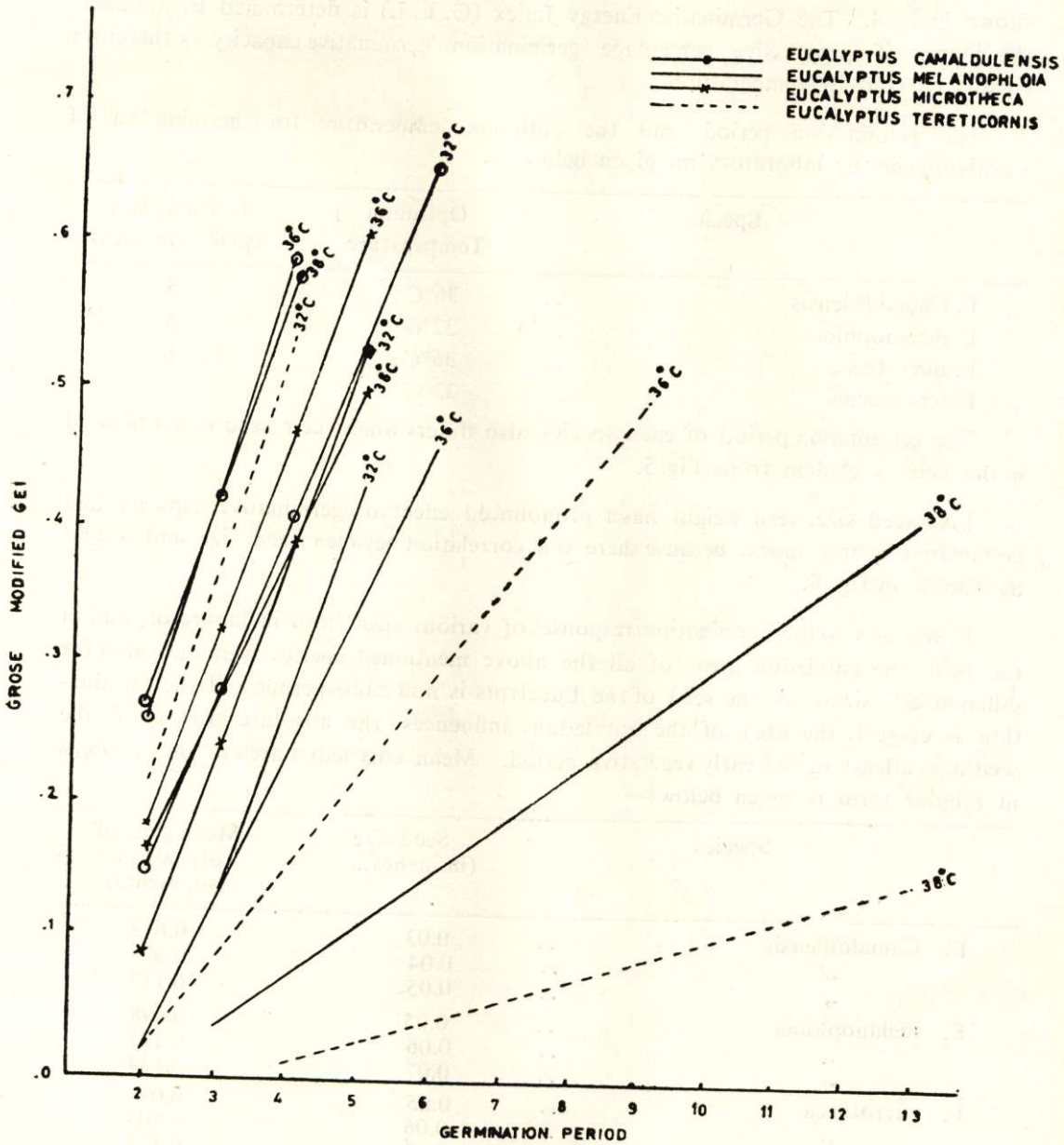

FIG:4 EFFECT OF TEMPERATURE ON GROSE MODIFIED GEI CORRESPONDING TO GERMINATION PERIOD

The temperature has also a pronounced effect on germinative energy index as shown in fig. 4. The Germinative Energy Index (G. E. I.) is determined by summing the figures of progressive percentage germination, germinative capacity is therefore equally effected by temperature.

The germination period and the optimum temperature for germination of Eucalyptus in the laboratory are given below:—

Species	Optimum Temperature	Germination Period (in days)
E. Camaldulensis ..	36°C	5
E. melanophloia ..	32°C	6
E. microtheca ..	36°C ..	6
E. tereticornis ..	32°C	7

The germination period of each species also differs when their seed is germinated in the field as evident from Fig. 5.

Like seed size, seed weight has a pronounced effect on germinative capacity and germinative energy index, because there is a correlation between seed size and weight as shown in fig. 6.

In addition to the germination responses of various sizes both in laboratory and in the field, the cotyledon area of all the above mentioned species were measured for different see sizes. As the seed of the Eucalypts is non-endospermic and the germination is epigeal, the area of the cotyledons influences the absolute growth of the seedlings atleast in the early vegetative period. Mean coty ledon area of the seedlings in tabular form is given below:—

Species	Seed size (in inches).	Mean area of cotyledons (sq. inches)
E. Camaldulensis ..	0.03	0.072
,, ..	0.04	0.098
,, ..	0.05	0.113
E. melanophloia ..	0.05	0.098
,, ..	0.06	0.123
,, ..	0.07	0.134
E. microtheca ..	0.05	0.099
,, ..	0.06	0.108
,, ..	0.07	0.128
,, ..	0.08	0.141
E. tereticornis ..	0.03	0.081
,, ..	0.04	0.098
,, ..	0.05	0.105
,, ..	0.06	0.125

CONCLUSION:—

1. Seed collection in the Eucalypts must be carried out very carefully in order to obtain satisfactory results as the germination percentage increases with the increase in the seed size.

2. The investigation has indicated that *E. melanophloia* and *E. tereticornis* require low temperature while *E. camaldulensis* and *E. microtheca* require high temperature for germination.

3. The period of germination for the Eucalypts in the field is from ten to twenty days Provided it is adequately warm and necessary moisture is available.

Acknowledgement.

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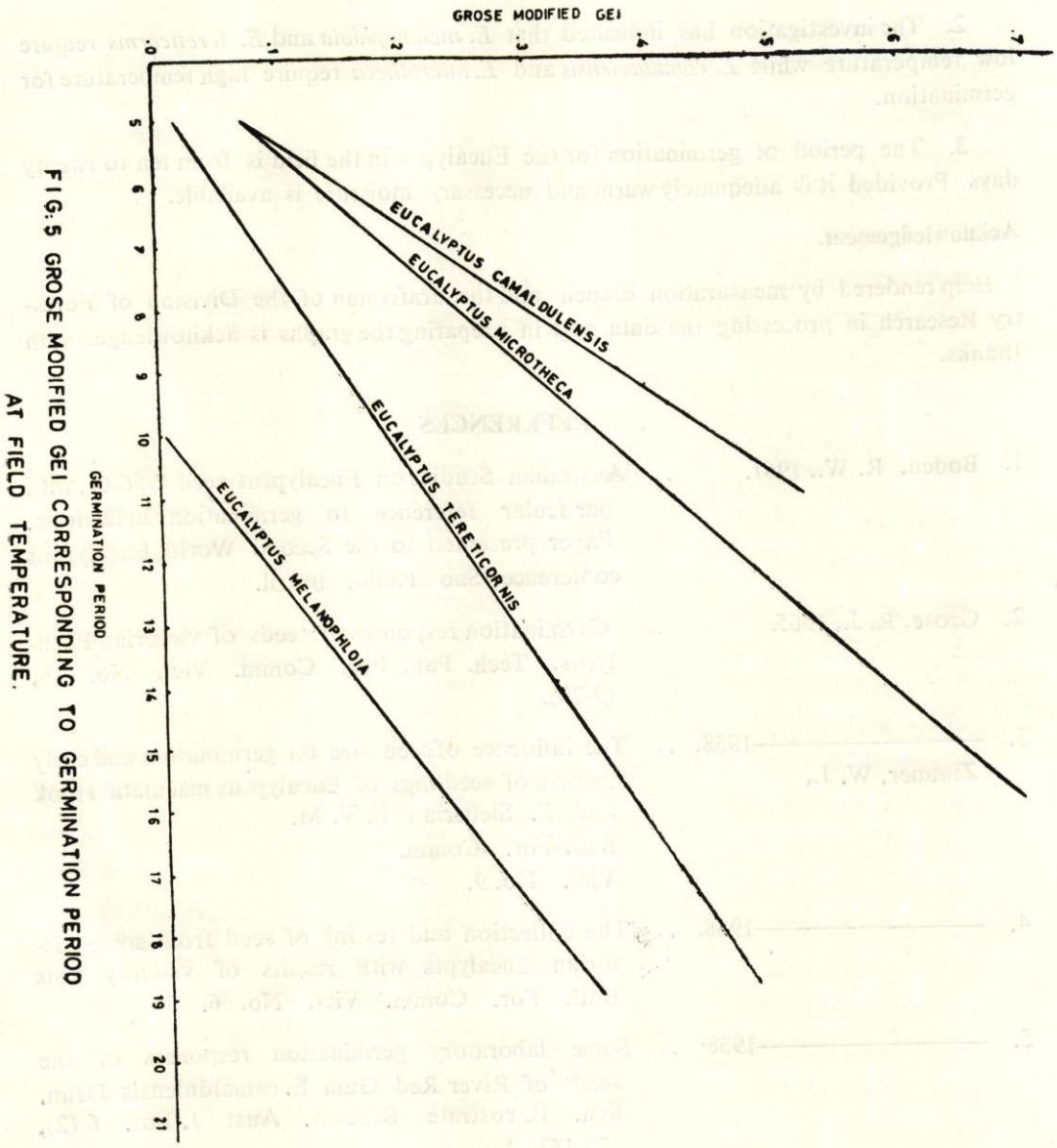

FIG: 5 GROSE MODIFIED GEI CORRESPONDING TO GERMINATION PERIOD AT FIELD TEMPERATURE.

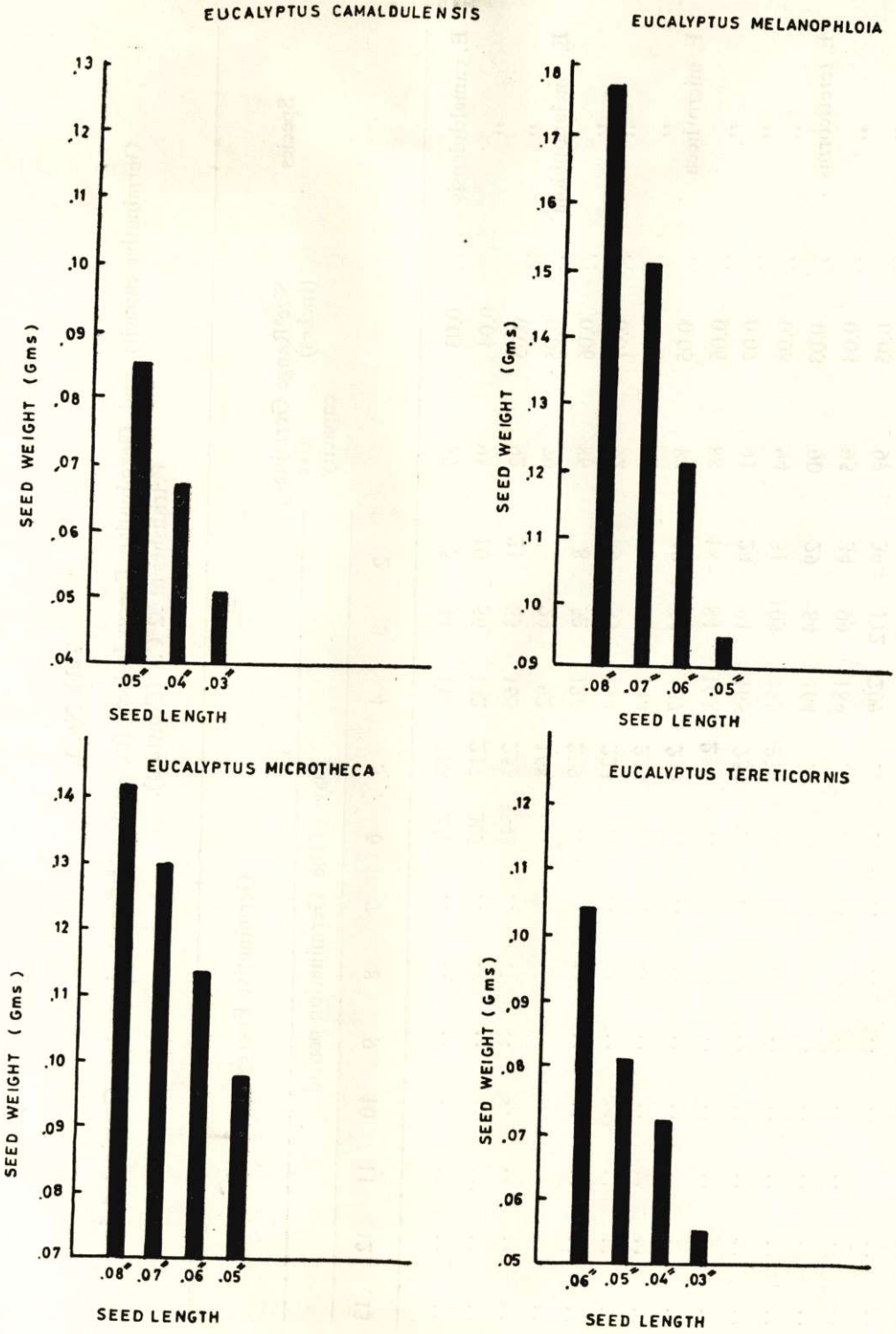

FIG.- 6 CORRELATION BETWEEN SEED SIZE AND WEIGHT.

Table No. 1.

Germinative capacity and Germinative Energy Indices for seeds of different sizes when Germinated in Petridishes at 32°C. (Constant).

Species	Size Range (inches)	Germinative capacity	Germinative Energy Index. Days of the Germination period										
			2	3	4	5	6	7	8	9	10	11	12	13
E. camaldulensis ..	0.03	87	5	44	110	188	270	..	..	..	..	..	..	..
,,	0.04	91	10	56	132	217	305	..	..	..	..	..	..	..
,, ..	0.05	92	21	83	165	253	343	..	..	..	..	..	..	..
E. melanophloia ..	0.05	79	..	29	92	168	..	..	..	..	..	..	..	..
,, ..	0.06	86	8	52	126	209	..	..	..	..	..	..	..	..
,, ..	0.07	92	9	53	134	224	..	..	..	..	..	..	..	..
,, ..	0.08	92	12	62	144	234	..	..	..	..	..	..	..	..
E. microtheca ..	0.05	84	12	64	137	215	..	..	..	..	..	..	..	..
,, ..	0.06	88	18	84	163	248	..	..	..	..	..	..	..	..
,, ..	0.07	91	24	91	165	254	..	..	..	..	..	..	..	..
,, ..	0.08	94	31	105	185	278	..	..	..	..	..	..	..	..
E. tereticornis ..	0.03	90	29	84	164	..	..	..	..	..	..	..	..	..
,, ..	0.04	95	34	99	189	..	..	..	..	..	..	..	..	..
,, ..	0.05	97	39	112	207	..	..	..	..	..	..	..	..	..
,, ..	0.06	98	46	124	..	..	..	..	..	..	..	..	..	..

Table No. 2.

Germinative capacity and Germinative Energy Indices for seeds of different sizes when Germinated in Petridishes at 36°C. (Constant).

Species	Size Range (inches)	Germinative capacity	Germinative Energy Index. Days of the Germination period											
			2	3	4	5	6	7	8	9	10	11	12	13
E. camaldulensis ..	0.03	81	25	85	161	..	..	..	..	..	..	..	..	..
,, ..	0.04	85	39	105	187	..	..	..	..	..	..	..	..	..
,, ..	0.05	89	44	120	204	..	..	..	..	..	..	..	..	..
E. melanophloia ..	0.05	82	5	31	76	148	224	..	..	..	..	..	..	..
,, ..	0.6	86	8	44	95	173	254	..	..	..	..	..	..	..
,, ..	0.07	88	10	52	114	194	276	..	..	..	..	..	..	..
,, ..	0.08	93	17	72	151	240	..	..	..	..	..	..	..	..
E. mtocrtheca ..	0.05	81	26	83	159	239	..	..	..	..	..	..	..	..
,, ..	0.06	85	38	104	185	268	..	..	..	..	..	..	..	..
,, ..	0.07	85	39	103	177	258	..	..	..	..	..	..	..	..
,, ..	0.08	86	43	115	193	277	..	..	..	..	..	..	..	..
E. tereticornis ..	0.03	89	2	8	22	58	100	149	201	253	..	..	..	..
,, ..	0.04	92	2	12	32	74	124	..	..	..	..	..	..	..
,, ..	0.05	94	4	20	56	113	178	..	..	..	..	..	..	..
,, ..	0.06	96	8	31	67	105	170	..	..	..	..	..	..	

Table No. 3.

Germinative capacity and Germinative Energy Indices for seeds of different sizes when Germinated in Petridishes at 32°C. (Constant).

Species	Size Range (inches)	Germinative capacity	Germnative Energy Index. Days of the Germination period											
			2	3	4	5	6	7	8	9	10	11	12	13
E. camaldulensis ..	0.03	84	2	49	113	194	..	..	..	..	..	..	..	..
,, ..	0.04	85	23	77	151	..	..	..	..	..	..	..	..	..
,, ..	0.05	87	44	116	196	..	..	..	..	..	..	..	..	..
E. melanphloia ..	0.05	73	..	4	17	43	72	105	139	176	216	264	314	365
,, ..	0.06	76	..	9	27	56	92	131	172	217	265	317	372	429
,, ..	0.07	78	1	6	23	55	91	133	175	220	271	327	385	445
,, ..	0.08	83	2	12	40	82	130	184	238	294	357	426	497	569
E. microtheca ..	0.05	68	20	60	108	166	..	..	..	..	..	..	..	..
,, ..	0.06	80	20	74	133	201	..	..	..	..	..	..	..	..
,, ..	0.07	84	34	85	146	219	..	..	..	..	..	..	..	..
,, ..	0.08	89	39	99	169	253	..	..	..	..	..	..	..	..
E. teretocornis ..	0.03	84	..	1	2	4	8	13	18	24	30	37	46	55
,, ..	0.04	86	..	1	3	6	11	17	23	31	39	49	60	72
,, ..	0.05	94	..	2	6	14	27	42	58	75	94	116	140	165
,, ..	0.06	94	2	10	23	47	77	109	142	177	216	258	304	354

Table 4. Germinative capacity and Germinative Energy Index for seeds of different sizes when Germinated in the Field: Temperature Range:

36°C (Maximum)

18°C (Minimum)

Species	Seed size (inches)	Germinative capacity	Germinative Energy																
			Days of the Germination period																
			5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
E. camaldulensis ..	0.03	19	..	3	6	99	17	27	39	51	64	80	97	114	131	149	167	185	..
	0.04	48	..	15	37	63	97	133	171	209	249	292	335	379	424	469	514	559	..
	0.05	58	..	19	59	107	162	219	277	335	..	..	..	..	..	..	..	..	..
E. melanophilcia ..	0.05	40	..	..	..	..	..	..	8	18	40	63	94	127	163	199	..	..	..
	0.06	38	..	5	14	24	36	50	71	96	128	162	197	223	..	..	..	..	..
	0.07	26	..	2	4	7	10	14	20	30	48	71	94	119	..	..	..	..	..
	0.08	40	..	8	22	40	60	85	115	146	184	222	260	298	336	376	416	..	..
E. microtheca ..	0.05	22	3	17	34	51	69	88	108	128	148	168	189	210	..	..	..	..	..
	0.06	41	10	44	81	120	160	..	..	..	..	..	..	..	..	..	..	..	..
	0.07	42	9	45	84	126	168	210	..	..	..	..	..	..	..	..	..	..	..
E. tereticornis ..	0.03	75	1	10	24	40	58	78	99	137	193	253	315	377	440	507	574	645	719
	0.04	89	1	12	27	43	61	81	106	150	208	268	332	398	470	553	640	..	..
	0.05	94	5	26	53	86	122	164	220	281	359	438	517	596	676	767	859	952	1045
	0.06	92	7	49	107	179	256	334	418	504	593	683	773	863	953	1044	..	..	..