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STUDIES ON THE BIOLOGY OF *EUCALYPTUS MICROTHECA* F. MUELL IN THE GEZIRA, SUDAN I. THE BEHAVIOUR OF THE SEED

By

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ABSTRACT

Eucalyptus microtheca has proved to be a success on the heavy clay soils of the Gezira. This tree species not only seeds regularly and prolifically during the summer, but also, though rarely, seeds during the winter. The germination behaviour of the seeds of this species is satisfactory, and the poorest stock gives an adequate number of seedlings for planting out. The germination behaviour was found to be largely affected by the locality and negatively correlated with the storage period. Seed index was not found to affect the final percentage gemination.

INTRODUCTION

The fast growth, wide adaptability, lack of palatability of the foliage to browsing animals and the suitability of the high density wood for fuel have made the eucalypts attractive crop plants (Turnbull and Boland 1984) .

When the Gezira scheme was started, almost all the natural vegetation (*Acaia*-Short Grass Scrub) was cleared. The growing stock in the riverain forests was felled, without, control, for supplying the large pumps with wood for fuel during the period of construction. This resulted in an acute shortage of fuelwood and building poles-a situation which was further aggravated by the adoption of the practice of burning the cotton stalks as a sanitary measure. As the indigenous tree species are extremely slow in growth, e.g. *Dalbergia sisso.* Roxb. and *Balanites*

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aegyptiaca L., the introduction of an exotic tree species was inevitable. *E. microtheca* (Myrtacaea), a native of Australia but with limited introduction elsewhere, was introduced to the Gezira, Sudan.

This part of the study on the biology of *E. microtheca* deals with the seed characteristics and the germination behaviour of various seed stocks in an endeavour to recommend the stocks to be used.

PHENOLOGY OF *EUCALYPTUS MICROTHECA*

Leaf growth starts in July and attains a peak during August to April; leaf area declines during May and June, but the species is never completely leafless (Houri 1977).

There are two rhythms of flowering, fruiting and seeding : a first cycle in the winter and a second in the summer. The latter occurs with unfailing regularity year afrer year. The first is not only milder in intensity but also accurs periodically and not annually. Sometimes the flowering phase my be completely arrested with no subsequent fruiting and seeding. The winter cycle of flowering may occur once or twice each four years. In the summer eycle the reproductive phase lasts from February to July. Flowering occurs from February to June (peak during March to May), fruiting from April to June (peak during May); and seeding from May to July (peak during June).

The winter reproductive cycle extends from October to February. Flowering occurs from October to December (peak in November); fruiting from November to January (peak in December); and seeding from December to February (peak in January).

According to Houri (1977). the occurrence of the winter reproductive cycle seems to be influenced by the total rainfall and cloud amounts.

MATERIALS AND METHODS

General

Seeds of eucalypts are very small in comparison with the seeds of other forest trees of the world. When collected and sold commercially, eucalypt seeds are mixed with the remnants of the unfertilized ovules known as " chaff" This " chaff" is not separated from the seed in normal commercial collections. For the series of experiments described here the general commercial method of collection was followed. Twenty three samples were collected from different localities in the

Gezira. From each sample, five 1 g sub-samples were taken and the seeds were separated from the other impurities. Seeds thus cleaned, were re-weighed and their number counted. From the data obtained, the average number of seeds per gramme and the percentage purity were calculated. From each of the weighed and cleaned samples, five lots, each of 1000 seeds, were weighed to give the seed index. Seeds were also stored at room temperature in the laboratory for different periods of time prior to testing.

The Experiment

The seed samples were tested to find their germinability, and to determine whether this had any correlation with the locality from where the seeds were collected, and with seed weight or srorage period. Germination tests were undertaken in a growth cabinet alternating between 12-h light at 30° C and 12-h dark at 20°C to simulate similar conditions prevailing in the Gezira during November and December. For each sample 5 replicates, each of 100 seeds were used. Seeds were placed on moistened flter paper and covered with another moistened filter paper inside 15 cm diameter petri-dishes. The filter papers were subsequently moistened when necessary with distilled water. The progress of germination was recorded daily for four weeks. Germination was taken as the emergence of the radicle. The results are expressed as germination per cent and germination speed, the latter defined as the number of days by which 50 % of the seeds had germinated.

RESULTS

Table 1 gives the locality and position from which the seeds were colleced, date of collection, storage period, purity percentage, number of seeds per gramme and seed index. The averages of the three latter parameters with their standard deviations are also given in the table, it can be seen that all of the three parameters show a great variability.

The Experiment

Germination speed and locality

The average number of seeds that had germinated were calculated, and the day on which each sample reached 50 % germination was recorded. From these data the samples were classified into 3 groups (Table 2): Group A (limit 15 days)

Table 1

Locality, position, date of collection, storage period, purity %, number of seeds / g and seed index of the seed of *Eucalyptus microtheca* collected from the Gezira area.

Serial No.	Locality	Position in Gezira	Date of Collection	Storage (months)	Purity %	Seed No. / g	Seed Index (g / 1000)
1	Medani	Central	June, 76	5.0	30.4	1789	0.56
2	Medani	Central	June, 75	14.0	43.6	1595	0.63
3	Medani	Central	June, 73	40.0	41.2	1662	0.60
5	Medani	Central	June, 73	40.0	48.8	1384	0.72
6	Medani	Central	June, 76	4.5	22.8	1713	0.58
7	Touris	Northern	July, 76	4.0	32.0	2125	0.47
8	Fawar	Northern	Sept., 76	1.0	36.4	1643	0.61
9	G. Naga	Northern	Aug., 76	2.0	43.2	937	1.70
10	Medani	Central	June, 73	40.0	48.4	1547	0.65
11	Medani	Central	June, 75	16.0	53.0	1246	0.80
12	Medani	Central	June, 76	4.5	46.0	1735	0.80
13	Medani	Central	June, 76	4.5	35.6	1887	0.53
14	Medani	Central	June, 76	4.5	35.6	1856	0.54
15	Medani	Central	June, 75	16.0	33.2	1723	0.58
16	Medani	Central	June, 75	16.0	54.4	1472	0.68
17	A' Gaili	Southern	Nov., 76	0.5	29.6	1395	0.72
18	Medani	Central	Aug., 76	2.0	30.4	1475	0.68
19	Medani	Central	June, 76	4.5	28.0	1909	0.52
20	Guneid	Central	Nov., 75	0.5	7.2	2153	0.47
21	Gonomab	Central	Sept., 75	14.0	58.4	1711	0.59
22	Heglig	Central	Sept., 75	14.0	82.0	1872	0.53
23	A'Magid	Northern	Sept., 75	14.0	31.2	2140	0.47
24	A'Magid	Northern	July, 75	16.0	28.8	2254	0.44
			Mean		39.1	1705	0.64
			Standard deviation		16.1	312	0.25

constitutes 39.1 % of the total number of samles, Group B (limit 28 days) contains 26.1 % of the samples, and Group C (> 28 days to 50 % germination) forms 34.8 % of the total samples. Table 3 shows that the two samples from central Gezira reached 50 % germination in 10 and 15 days, whereas the two samples from northern Gezira did not reach 50 % germination after 28 days.

Germination speed and storage period

The data in Tables 1 and 2 show that the three samples which were stored for a period of two months or less reached 50 % germination within 15 days; the majority of the samples stored for a period of 4–5 months reached 50 % germination within 28 days; whereas two of the three samples stored for 40 months did not reach 50 % germination speed in 28 days. Samples 6, 11 and 5 all collected from Wad Medani, were stored for 4.5, 16 and 40 months, respectively. It can be seen that samples 6 and 11 reached 50 % germination in 27 days, whereas sample 5 did not reach germination within 28 days.

Germination speed and seed index

There is no definite relationship between the seed indices given in Table 1 and the germination speed of the various samples given in Table 2. It can be seen that samples 13,6 and 12 having, respectively, seed indices of 0.53, 0.58 and 0.80 g had reached 50 % germination in 27 days.

The cumulative germination percentages

The germination percentages (arc sin scale) for the various samples afrer 1, 2, 3 and 4 weeks were calculated and the analysis of variance of the data is given in Table 4. The table shows that throughout the experiment a consistently significant difference ($p < 0.01$) existed between the germination percentages of the various samples.

The associations of the 23 means were tested using Duncan's method of the shortest significant range to segregate the similar groups, and, accordingly samples were classified as excellent, good, and poor germinators. The results of this grouping for the cumulative germination percentage in 4 weeks are given in Table 5. It should be mentioned that poor germination, here, is used in a relative sense. The lowest germination recorded was 34 % for sample 7 which could be considered satisfactory for practical purposes for a plant species that seeds prolifically and whose seeds are easy to collect.

Table 2

The germination speed of the seed samples

Group A		Group B		Group C	
Sample No.	Days to 50 % Germination	Sample No.	Days to 50 % Germination	Sample No.	Days to 50 % Germination
16	7	6	27	1	–
18	7	10	27	2	–
15	8	11	27	3	–
17	8	12	27	5	–
19	8	13	27	7	–
20	9	14	27	8	–
21	10			23	–
9	11			24	–
22	15				

Table 3

The germination speed of seeds from different localities and comparable storage periods

Sample No.	Storage Period (months)	Days to 50 % Germination	Locality
21	14	10	Central Gezira
22	14	15	Central Gezira
23	14	–	Northern Gezira
24	16	–	Northern Gezira

Table 4

Analysis of variance of data of germination progress.

Time	source of variation	Sum of Squares	Degrees of Freedom	Mean Square	F	Significance
1 st Week	Between samples	14899.81	22	677.26	10.275	***
	Between replicates	160.16	4	40.04	0.607	N. S.
	Residual	5799.80	88	65.91		
	Total	20859.77	114	——		
2 nd Week	Between samples	22297.17	22	1013.51	14.360	***
	Between replicates	245.21	4	61.30	0.09	N. S.
	Residual	6210.15	88	70.57		
	Total	28752.53	114	——		
3 rd Week	Between samples	23392.29	22	1063.29	16.770	***
	Between replicates	172.95	4	43.24	0.068	N. S.
	Residual	5578.48	88	63.39		
	Total	29143.72	114	——		
4th Week	Between samples	10748.35	22	488.56	10.280	***
	Between replicates	87.56	4	21.89	0.460	N. S.
	Residual	4138.69	88	47.54		
	Total	14974.60	114	——		

*** $P < 0.01$

Table 5
Grouping of the means of germination percentages
of the samples after 4 weeks from sowing

EXCELLENT		GOOD		POOR	
Sample No.	**Germination%**	**Sample No.**	**Germination%**	**Sample No.**	**Germination%**
16	89	14	71	24	46
15	83	19	67	08	46
21	75	10	66	03	46
18	74	13	66	05	45
11	73	20	64	02	39
17	73	06	60	23	38
		12	61	01	36
		09	59	07	34
		22	56		

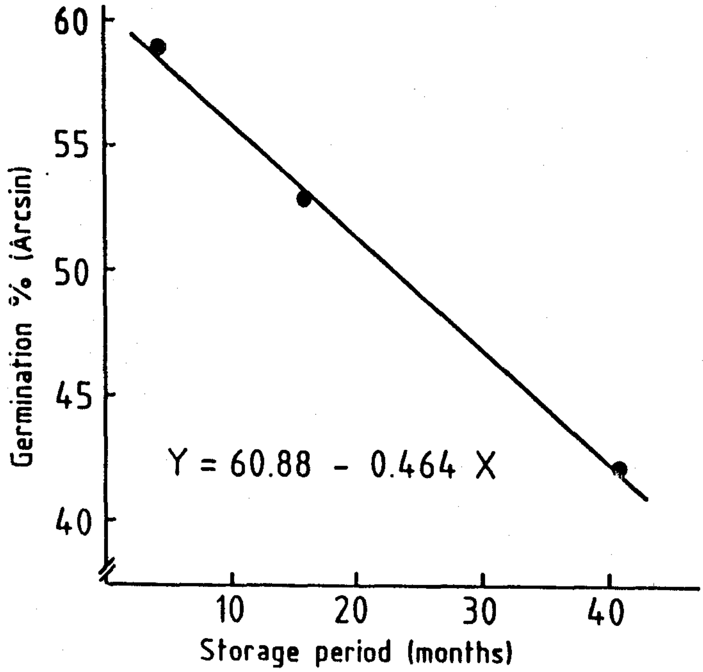

Fig. 1 The effect of storage period on cumulatvie germination percentage.

The cumulative germination percentage and locality

Comparing the results given in Table 5 with the localities from which the samples were collected (Table 1), it can be seen that all the 15 samples classified as excellent and good germinators were collected from centrl Gezira except samples 17 and 9 which were, respectively, collected from southern and northern Gezira. Half of the poor germinators came from northern Gezira.

The cumulative germination percentage and the storage period

Comparing the results given in Table 5 with the storage periods of the samples (Table 1), it can be seen that : (a) all the samples stored for a period of 2 months or less behaved as excellent or good germinators, (b) all samples stored for a period of 4–5 mounths appeared in the list of good germinators except for sample 1, (c) all the samples stored for a period of 14–16 months appeared in the group of excellent germinators except samples 22 and 2, and (d) all the samples stored for 40 months appeared in the list of poor germinators with the exception of sample 10. The data for samples 6, 11 and 5 all from central Gezira (Wad Medani) and stored for 4.5, 16 and 40 months respectively, were selected for further testing and analysis. Figure 1 shows a negative regression ($r = -0.46$) of germination percentage on storage period. Covariance analysis shows that germination percentage significantly ($p < 0.001$) decreased as storage period increased.

The cumulative germination percentage and seed index

The data of the cumulative germination percentage of the samples after one, two, three and four weeks were correlated with their seed indices. The correlation coefficients for these periods were respectively – 0.33, – 0.14, 0.36 and 0.33, and are not statistically significant. The data after the fourth week are presented in Figure 2. It can be seen that seed index does not seem to affect the germination performance of the seed of *E. microtheca.*

DISCUSSION

Germination is an event which marks the transition from the relatively safe state of the dormant embryo protected within the seed coat to the metabolically highly active and vulnerable form of the young seedling (Thompson 1973).

Amongst mechanisms responsible for coordinating germination with physical parameters of the environment, one of the most important is the temperature response (Thompson and Grime, 1983). Characteristics of the temperature response may be closely correlated with the geographical distribution of different species. Comparison between populations may reveal considerable variation from one part of a range to another, or only minor differences over similar geographical areas. It is evident from the results of this investigation that seeds collected from forests in central Gezira were superior in their germination performance, as measured by the germination speed and the cumulative germination percentage. Forest plantations in central and southern Gezira usually receive better irrigation and enjoy more favourable climatic conditions, as the rainfall increases generally from north to south. It is probably true that good forests give seeds of better germination performance. The most favourable time of the year for good germination vary from one geographical locality to another depending on the climatic parameters of the season prevailing in that area (Thompson 1973). This suggests that locality seems to have a profound effect on the germination speed of the seed of *E. microtheca.* Storage appears to affect the germination percentage of the seed of *E. microtheca* adversely. The latter was found to be negatively correlated with the former. It is not surprising that correlation did not occur between the germination responses of seeds stored in the laboratory and climatic features of the geographical localities in which *E. microtheca* plants are distributed, since storage conditions bear little resemblance to conditions experienced by these trees in their natural habitats.

For almost a century ecologists have examined the relationship between seed size and plant growth (intraspecific variation in seed size) but a consistent pattern has not emerged (Stanton 1984). While some studies report that larger seeds produce competitively superior seedlings (Black 1958), others conclude that the early growth advantage of large seeds is subsequently lost (Harper and obeid 1967). and Ismail (1983) experimenting with seeds of *Prosopis juliflora* found that the large seeds were non–dormant, while the small seeds were dormant. In contrast, demographic studies of natural plant populations revealed that attaining a large size early in life greatly reduces seedling susceptibility to water stress or shading by competitors (Harper, 1977; Stanton, 1984). In the present investigation seed index seems to have no effect on the germination percentage of the seed of *E. microtheca.* The variability in the number of seeds per unit weight (Table 1) seems to be a function of a number of complex factors including : time of collection, intraspecific competition and the climatic and edaphic conditions of the locality.

Differences in germination response between seeds from different species have been reported, as have differences between seeds of the same species but from different habitats; also, differences have been observed between seeds from different plants of the same species of the same habitat and between seeds from different

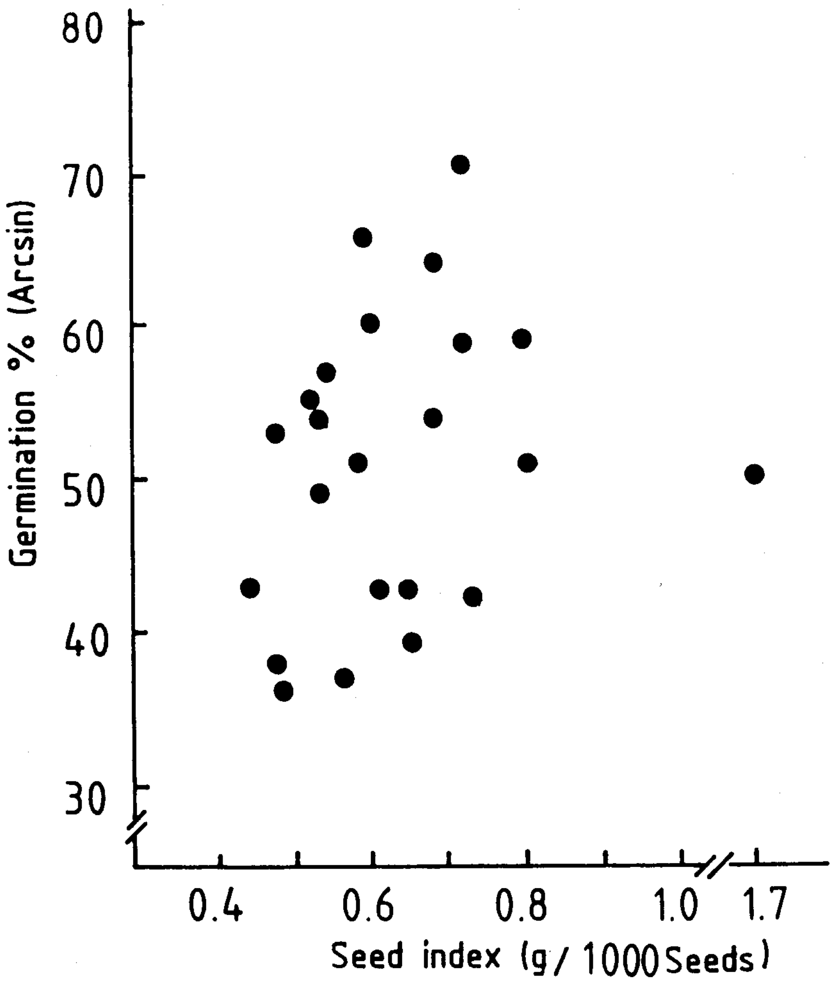

Fig. 2 The effect of seed weight on cumulative germination after four weeks

positions on the same plant (Cavers and Harper 1966). In this investigation, the samples, on the whole, showed a large variability in their germination performance. Nevertheless, the conclusions drawn are all useful from the applied point of veiw.

Within the limits of the Gezira and Managil extension, certain areas which have been either initially considered unsuitable for agricultural crops, or have proved so after repeated cultivation, have been assigned for planting *Eucalyptus microtheca.* To these infertile lands are also added those areas where inadequate irrigation is not possible because of topographical features, or where irrigation water is drained after its use in the agricultural fields. (Houri, 1977, Turnbull and Boland, 1984).

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دراســـة لتأثيـــر بعــض العوامـــل على إنبات بذرة الكافور (ايوكالبتس ميكروثيكا) في الجزيـــرة بالســـودان

أحمد محمد علي إسماعيل و محمـــد عبيـــد

و

أحمـد الحـوري أحمـد

أوضحت النتائج نجاح زراعة هذا النوع من أشجار الكافور في تربة الجزيرة ، كذلك أوضحت نتائج التجارب أن إنبات بذور الكافور يتأثر بمصدر البذرة وأن العلاقة بين نسبة الانبات وفترة التخزين كانت عكسية ، ولم يكن للدليل البذري (وزن الف بذرة) أثر جوهري على نسبة الإنبات النهائية .