ken in die Praxis nicht nur hierzulande, sondern auch auf einem anderen Kontinent an der Stelle, wo die Probleme der Praxis mit Händen zu greifen sind und pragmatisch angepackt werden müssen.

Die Arbeitsgemeinschaft für Forstgenetik und Forstpflanzenzüchtung ist Melchior zu Dank verpflichtet, auf seine besonnene und menschlich verbindliche Art die durch sachfremde Einwirkungen leicht zu störende Diskussion bei wiederholten Anlässen wieder versachlicht zu haben. Zwei Tagungen dieser Arbeitsgemeinschaft hat Melchior ausgerichtet. Die Angehörigen des Schmalenbecker Instituts wissen sehr wohl, was sie an Melchior als stets gegenwärtigem und gesprächsbereitem Direktor verlieren und werden ihn in dankbarer Erinnerung behalten.

Noch immer und in wachsender Anzahl identifizieren sich Forstwissenschaftler auf der großen weiten Welt mit unserem Fachgebiet, indem sie die von Langner gegründete Zeitschrift Silvae Genetica lesen, welche nach wie vor unsere wichtigste Fachzeitschrift darstellt. Die Leser, die Co-Editoren und der Verlag danken Melchior für seine redaktionelle Tätigkeit als verantwortlicher Herausgeber.

Verläßt jemand den aktiven Dienst an der Wissenschaft, bevor er die hierfür bestimmte Altersgrenze erreicht hat, so mag ihn eine gewisse Wehmut beschleichen. Diese wird aber wohl verscheucht durch das Vergnügen, einmal etwas frei entscheiden und planen zu können, anstatt immer nur auf Anlässe, Anstöße und von anderen gesetzte Termine reagieren zu müssen! Der große Kreis der Forstgenetiker und Forstpflanzenzüchter und die Leser dieser Zeitschrift wünschen Melchior geruhsame Jahre im Kreis seiner Familie mit viel Freude an seiner geliebten hessischen Heimat!

Hans H. Hattemer

Genetic Analysis of Traits Related to Seed Germination among Provenances of Date Palm (Phoenix dactylifera, L.)

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Abstract

The materials used in this study were obtained from a genetic resources survey of the date palm conducted in 1980 in a region lying between 10° to 14° N latitude covering an area of approximately 262 000 sq. km. of the 'Sudan' and 'Sahel' types of ecological zones in northern Nigeria. Out of 174 provenances that were evaluated for fruit and seed traits, further studies were made at the University Farm, Samaru, Nigeria, from 1980—82 on seed material derived from twelve randomly selected provenances, which were representative of a broad spectrum of genotypes grown under similar environmental conditions, in order to obtain genetic information on some traits related to seed germination in date palm.

Significant differences (P = 0.05, 0.01) were observed among provenances for all traits, indicating that a significant amount of genetic variation exists among provenances for each trait. Wide ranges in the means were exhibited by sprouting or germination capacity (57.6—95.2), and leaf emergence (35.6—81.6). In all cases, the standard errors were lower than their respective means.

All estimates of variance components were positive, and their standard errors were lower than their respective estimates except in two cases.

Leaf emergence showed a positive, and highly significant (P = .01) phenotypic correlation with sprouting $r_{ph} = 0.44$), but did not show significant phenotypic correlations with any of the other traits. In all cases the genotypic correlations were larger than the phenotypic correlations. Leaf emergence showed a strongly positive genotypic correlation with sprouting ($r_g = 0.86$).

The heritability estimates for all traits were generally low. The highest values were obtained for seed weight (58%), leaf emergence (41%) and sprouting (20%). Although seed weight gave the highest estimate of heritability, its low genetic correlation with leaf emergence ($r_g = 0.11$), together with its unfavourable correlation with sprouting ($r_g = -0.39$), would tend to negate its usefulness as a desirable trait for selection.

In view of the fact that leaf emergence and sprouting showed a highly significant phenotypic correlation and a strong positive genotypic correlation, and also exhibited a significant amount of genetic variation; the comparatively low heritabilities for these two traits may to some extent be offset by the large variation, to make the traits responsive to selection. Hence, direct selection for sprouting or germination capacity seems promising, because it would indirectly improve leaf emergence.

Key words: Genetic analysis, Traits, Seed germination, Provenances, Date palm.

Zusammenfassung

Das in dieser Studie verwendete Material stammt aus überwachten Genressourcen der Dattelpalme, aus einer Region zwischen dem 10. und 14. Breitengrad sowie dem 4. und 12. Längengrad, die ungefähr 262 000 km^2 groß ist, und wurde 1980 eingesammelt. Die Region gehört ökologisch zum „Sudan" und zur „Sahelzone" in Nordnigeria. Aus 174 unterschiedlichen Herkünften, die auf Frucht- und Samenmerkmale hin untersucht wurden, wurden zufällig 12 Typen entnommen, an deren Samenmaterial 1980—1982 weitere Untersuchungen an der Universitätsfarm Samaru, Nigeria, durchgeführt wurden. Diese Typen waren für ein breites Spektrum von Genotypen repräsentativ, die unter gleichen Umweltbedingungen aufgewachsen sind. Ziel der Untersuchung war es, Informationen über einige Merkmale zu erhalten, die im Zusammenhang mit der Samenkeimung der Dattelpalme stehen.

Bei den Typen wurden signifikante Unterschiede (P = 0,05; 0,01) für alle Merkmale beobachtet, was daraufhin deutet, daß zwischen den Typen bei allen Merkmalen eine erhebliche genetische Variation besteht. Beim Keimen zeigte sich eine große Spannweite im Mittelwert (57,6—95,2), ebenso beim Auftreten der Blätter (35,6—81,6). In allen

Fällen war die Standardabweichung niedriger als der entsprechende Mittelwert. Alle Schätzwerte für die Varianzkomponenten waren positiv und ihre Standardabweichungen bis auf zwei Fälle niedriger als ihre entsprechenden Schätzwerte.

Das Auftreten der Blätter war mit der Keimung positiv und hoch signifikant korreliert ($r_{ph} = 0,44$), zeigte aber keine signifikante phänotypische Korrelation mit irgendeinem anderen Merkmal. In allen Fällen waren die genetischen Korrelationen höher als die phänotypischen. Das Auftreten der Blätter zeigte eine hohe, positive genotypische Korrelation mit der Keimung ($r_g = 0,86$).

Die Heritabilitätsschätzwerte waren im allgemeinen für alle Merkmale niedrig. Die höchsten Werte wurden für Samengewicht (58%), Auftreten der Blätter (41%), und die Keimung (20%) erhalten. Obwohl das Samengewicht den höchsten Heritabilitätswert hatte, ist es wegen seiner geringen genetischen Korrelation mit dem Auftreten der Blätter ($r_g = 0,11$) und seiner negativen Korrelation mit dem Keimen ($r_g = -0,39$) kein geeignetes Merkmal für die Selektion.

Das Auftreten der Blätter und die Keimung wiesen eine hoch signifikante phänotypische Korrelation sowie eine enge positive genotypische Korrelation auf und variierten sehr stark. Die relativ niedrige Heritabilität für diese zwei Merkmale wird bis zu einem gewissen Grad durch die große Variabilität ausgeglichen. Daher sind diese Merkmale für eine Selektion geeignet. Deshalb erscheint eine direkte Selektion auf die Keimfähigkeit vielversprechend, da sie indirekt das Auftreten der Blätter verbessern würde.

Introduction

The date palm is adapted to a xeric habitat and thrives well in desert environments unsuitable for most crops (Samarawira, 1983). However seed germination in date palm is slow and may take 1—6 months from planting to leaf emergence. Although viable seed may sprout in 1—2 weeks, leaf emergence may be delayed for several months; a time lag which is critical when soil moisture, pests and diseases are serious limiting factors in seedling establishment (Samarawira, 1981). However, the problem of slow seed germination can be overcome by using pre-germination techniques. The use of such techniques in date palm resulted in 64—95% seed germination in one week (Samarawira and Osuhor, 1981). This not with standing, selection for traits related to seed germination would be a desirable goal in breeding programmes of date palm because early leaf emergence is important in relation to the successful establishment of a seedling. The genetic relationship of traits related to seed germination in date palm have not previously been reported.

The objectives of the investigation reported in this paper were to estimate the genetic variability, heritability and expected genetic advance from selection in traits related to seed germination in provenances of date palm, and to determine the interrelationships between these traits through correlation studies. The term 'provenance', applied to forest tree cops, is used for the seed sources of date palm in this study.

In a strict sense, this is not a 'provenance' test where only the nuclear genetic effects are measured in our experimental plantings. Since some of the seed tissue is heavily affected by the maternal environment, those environmental effects are reflected in observations of provenances effects. However, the primary traits of interest, germination and leaf emergence, are considered to be substantially independent of different environmental effects exerted on the maternal parent. For these traits, the traditional concepts of heritability, selection gain, genetic variances and covariance, etc. are suitable.

For seed size, the maternal environment can be assumed to substantially affect provenance differences, nevertheless, seed characteristics might be useful for discriminating among provenances, and, if seed traits are correlated with germination and leaf emergence might be at least temporarily useful to use as correlated traits for provenance selection in this generation. Therefore, in the following discussion, all taits are treated as if they were not influenced by the maternal environment, but at least for seed traits, the weakness of that assumption is recognised.

Materials and Methods

The source materials for this study were derived from a genetic resources survey of the date palm conducted in 1980 in a region lying between 10° to 14° N latitude and 4° to 12° E longitude covering an area of approximately 262 000 sq. km. of the Sudan and Sahel types of ecological zones in Northern Nigeria (Samarawira, 1982). Out of 174 provenances that were evaluatet for fruit and seed traits, further studies were made at the University Farm,Samaru, Nigeria, from 1980—1982 on twelve randomly selected provenances previously described (Samarawira and Osuhor, 1981) which were representative of a broad spectrum of genotypes grown under similar environmental conditions.

Measurements were taken on seed weight, length and circumference, on random samples of 200 seed replicated five times from each of the twelve provenances. The seed samples were then placed in polybags, soaked in water, and left in the dark according to the method described by Samarawira and Osuhor (1981). Percentage sprouting was recorded 10 days after the water treatment. Sprouted seed were planted in polybags and arranged in the field in a randomized complete block design with 5 blocks. Percentage of emergence was recorded at one month from planting when the mean leaf emergence was over 50%. Variance and covariance analyses for the different traits were performed according to Norman, Hull, Jenkins, Steinbrenner and Bent, (1970), in the forms given in *Tables 1* and *2*.

Table 1. — Form of analysis of variance with expected mean squares (E.M.S.) for each trait.

Source of Variance	d.f.	M.S.	E.M.S.
Blocks	r - 1	-	-
Provenances	g - 1	Mg	$\sigma^2e + r\sigma^2g$
Error	(r-1 g-1)	Me	σ^2e

r = number of blocks
g = number of provenances
m = observed mean square of subscript effect

Table 2. — Form of analysis of variance and covariance with observed and expected mean products for traits x and y.

Source of variance	d.f.	Trait x	Trait y	Mean product xy	Expected mean product
Blocks	r-1	-	-	-	-
Provenances	g-1	Mgx	Mgy	Mgx.gy	$\sigma xy + r\sigma gx.gy$
Error	(r-1)(g-1)	Mex	Mey	Mex.ey	σxy

Variance components (σ^2), and their standard errors (S. E.) were estimated by equating the observed mean squares with their expectations as follows:

Error variance = σ^2e = Me with S.E. =

$$\sqrt{\frac{2(Me)^2}{d.f. + 2}}$$

Genotypic variance = $\sigma^2 g = \frac{Mg - Me}{r}$ with S.E. =

$$\sqrt{\frac{(1)\ 2\ (2(Mg)^2 + 2(Me)^2)}{(r)\ \ (d.f. + 2)\ (d.f. + 2)}}$$

Phenotypic variance = $\sigma^2 ph = Me + \frac{Mg - Me}{r}$ with S.E. =

$$\sqrt{\frac{(1)\ 2\ (2(Mg)^2)}{(r)\ \ (d.f. + 2)}}$$

Phenotypic correlations (phxy), were obtained from mean squares and mean products according to the formula:

$$r_{phxy} = \frac{Mgx\,.\,gy}{\sqrt{Mgx\,.\,Mgy}}$$

Where, Mgx . gy = mean product of traits x and y, and, Mgx and Mgy = mean squares of traits x and y. Genotypic correlations (r_{gxy}), were estimated from components of variance and covariance (Mode and Robinson, 1959).

$$r_{gxy} = \frac{\sigma_{gxgy}}{\sqrt{\sigma^2_{gx}\,.\,\sigma^2_{gy}}}$$

where, σ_{gxgy} = genotypic covariance of traits x and y and, σ^2_{gx} and σ^2_{gy} = genotypic variances of traits x and y respectively.

Estimates of broad sense heritability (h^2), were based on a replicated plot mean basis using formulae suggested by Burton (1952), Burton and De Vane (1953), and Johnson, Robinson and Constock (1955).

$$h^2 = \frac{\sigma^2_g}{\sigma^2_g + \sigma^2_e}$$

where, σ^2_g = genotypic variance
and, σ^2_e = environmental variance

Genetic coefficient of variability (G.C.V.%), was estimated according to Burton and De Vane (1953) and Hanson, Robinson and Comstock, (1956).

$$G.C.V.\% = \frac{\sqrt{\sigma^2_g}}{\bar{x}} \times 100$$

where, σ^2_g = genotypic variance
and $\bar{x}$ = population mean for each trait.

Estimates of expected genetic gain from selection (ΔG), were calculated according to Johnson *et al.* (1955).

$$\Delta G = \frac{\sigma^2_g\,.\,k\,.\,\sigma_{ph}}{\sigma^2_{ph}}$$

where ΔG = expected genetic gain
$\frac{\sigma^2_g}{\sigma^2_{ph}}$ = broad sense heritability
k = selection intensity. In this study k was given the value 2.06, which is its expectation in the case of 5% selection in large samples from a normally distributed population.
σ_{ph} = phenotypic standard deviation of the original population before selection.

Estimates of expected genetic gain as percentage of mean ($\Delta G\%$), were calculated according to Kaul and Bahn (1974).

$$\Delta G\% = \frac{\Delta G \times 100}{\bar{x}}$$

where $\bar{x}$ = original population mean before selection.

Results and Discussion

Significant differences (P = 0.05, 0.01), were observed among provenances for all traits studied (*Table 1*), indicating that a significant amount of "genetic" variation exists among the provenances for each trait. Wide ranges in the means were exhibited in sprouting (57.6—95.2), and leaf emergence (35.6—81.6). In all cases, the standard errors were lower than their respective means. The phenotypic coefficient of variation ranged from 8.26% for seed circumference to 22.65% for leaf emergence.

The time lag between sprouting and leaf emergence in the date palm may take 1—6 months. For most cultivars, 50% leaf emergence was obtained in one month from planting when the seed was subjected to pregermination treatment (Samarawira and Osuhor, 1981). In the experiments now reported, records were taken at wekly intervals and leaf emergence was analysed at one month from planting, when the mean leaf emergence was over 50% (*Table 1*).

Leaf emergence showed a positive and highly significant (P = .01), phenotypic correlation with sprouting (^{r}ph = 0.44), but did not show significant phenotypic correlations with any of the other traits (*Table 4*). Sprouting showed significant negative phenotypic correlations with seed weight (^{r}ph = 0.34, p = .01), and seed circumference ^{r}ph = −0.29, p = .05), respectively. Positive and highly significant phenotypic correlations were observed between seed weight and seed length (^{r}ph = 0.45, p = .01), and between seed weight and seed circumference (r_{ph} = 0.34, p = .01).

Leaf emergence showed a positive genotypic correlation with sprouting (^{r}g = 0.86), suggesting that direct selection for sprouting or germination capacity would indirectly increase leaf emergence. Negative genotypic correlations were obtained between leaf emergence and seed length (^{r}g = 0.53), and seed circumference (^{r}g = −0.28). The correlation of leaf emergence with seed weight was positive, though

Table 3. — Mean squares from analysis of variance, means, standard errors, ranges, and phenotypic coefficients of variation for different traits in data palm.

Source	d.f.	Sprouting %	leaf emergence %	Seed weight g	Seed length mm	Seed circumference mm
		MEAN SQUARES				
Blocks	4	287.41	225.47	0.02	14.24	4.91
Provenances	11	583.31*	977.48**	0.41**	18.06*	11.81*
Error	44	258.65	221.73	0.05	8.80	5.44
Means		77.10	65.73	1.23	24.22	28.22
Standard error (+)		7.19	6.66	0.10	1.33	1.04
Ranges	-	57.6-95.2	35.6-81.6	0.98-1.53	22.0-27.1	26.0-30.5
C.V. %	-	20.86	22.65	18.54	12.25	8.26

* Significant at .05 level
** Significant at .01 level

Table 4. — Estimates of phenotypic and genotypic correlations between different traits.

	Leaf emergence	Sprouting	Seed weight	Seed length	Seed circumference
Leaf emergence	1.00				
Sprouting	0.44 0.86	1.00			
Seed weight	0.08 0.11	−0.34 −0.39	1.00		
Seed length	−0.15 −0.53	−0.02 −0.13	0.45 0.57	1.00	
Seed circumference	−0.13 −0.28	−0.29 −0.89	0.34 0.71	0.12 0.14	1.00

(Upper correlation in each cell is phenotypic and lower correlation is genotypic. For the phenotypic correlation, the correlation coefficient must exceed 0.26 and 0.33 to be significant at the .05 and .01 levels of probability, respectively).

low. Sprouting showed negative genotypic correlations with seed weight ($^{r}g = -0.39$), seed length ($^{r}g = -0.53$), and seed circumference ($^{r}g = -0.28$).

The negative association of both leaf emergence and sprouting with seed length and circumference, would indicate that selection of trees on their seed traits would imply selecting for small seeds in order to improve germination and leaf emergence.

This would be true even if the negative correlation was caused by maternal environmental effects. On the other hand, only if the correlations reflect nuclear genetic effects, would selecting for either leaf emergence or sprouting result in reduced seed size in the trees which ultimately mature. If the correlation is truly genetic, and is due to pleiotropic genes, simultaneous selection for two traits in the same direction may cause a negative change (Lush, 1984; Leoner, 1950). If the unfavourable association of leaf emergence and sprouting with seed length and circumference is genetic and is due to linkage, improvement could be effected through recurrent selection involving the intercrossing of selected progenies as suggested by Al-Jibbouri, Miller and Robinson, 1958.

Estimates of phenotypic, genotypic and environment variance components are shown in *Table 5*. All estimates were positive. With the exception of two cases, the standard errors of all estimates were lower than the estimates. The variances for leaf emergence and sprouting were larger than those for seed weight, length and circumference. Although the environmental components of variance for leaf emergence and sprouting were relatively high, the genotypic components of variance, accounted for 41% and 20% of the total phenotypic variance for these two traits respectively.

Table 5. — Estimates of phenotypic, genotypic and environmental variance components for different traits.

Traits	Variance Phenotypic	Genotypic	Environmental
Leaf emergence	372.88 ± 171.46	151.15 ± 102.70	221.73 ± 46.23
Sprouting	323.58 ± 102.32	64.93 ± 105.12	258.65 ± 53.93
Seed weight	0.12 ± 0.02	0.07 ± 0.03	0.05 ± 0.01
Seed length	10.65 ± 0.07	1.85 ± 0.82	8.80 ± 1.83
Seed circumference	6.71 ± 2.07	1.27 ± 2.13	5.44 ± 1.33

Partitioning the total phenotypic variance of each trait into heritable and non-heritable components is helpful in determining the proportion of heritable variation that is exploitable for selection of superior individuals. For this purpose, estimates of heritability are necessary. However, heritability estimates have to be related to the particular population growing under particular environmental conditions. Hence, heritability values are at best useful as gross indicators of the possibility of selection for one or more traits (Hanson, 1963; Campbell, 1964; Namkoong *et al.*, 1966). Although narrow sense heritability is more meaningful, it has been reported (Nanson, 1968), that broad sense heritability in the first generation from provenance selec tion. However, since broad sense heritability represents the upper limit that can be achieved through selection, such estimates should be used judiciously. Estimates of broad sense heritability showed (*Table 6*) that the highest values were obtained for seed weight (58.33%), leaf emergence (40.54%), and sprouting (20.07%).

The genetic coefficients of variation for leaf emergence, seed weight, and sprouting were 18.07%, 21.51% and 10.45% respectively (*Table 6*).

Table 6. — Estimates of broad sense heritability (h^2 %), genetic coefficient of variation (G.C.V. %), expected genetic advance (Δ G), and expected genetic advance in percent of mean for different traits in data palm.

Traits	h^2 %	G.C.V. %	Δ G	Δ G %
Leaf emergence	40.54	18.70	16.13	24.54
Sprouting	20.07	10.45	7.44	9.65
Seed weight	58.33	21.51	0.42	34.15
Seed length	17.37	5.62	1.17	4.13
Seed circumference	18.93	3.99	1.01	3.58

Genetic advance is commonly predicted as the product of the heritability ratio and the selection intensity, or selection differential (Johnson *et al.* 1955; Falconer, 1960). The expected genetic advance in percent of the mean of the original population for leaf emergence, sprouting and seed weight were 24.5%, 9.7%, and 34.2% respectively, in comparison to the other traits which ranged from 3.58% to 4.13% (*Table 6*).

Although seed weight gave the highest estimate of heritability, its low genetic correlation with leaf emergence ($^{r}g = 0.11$), coupled with its unfavourable correlation with sprouting ($^{r}g = -0.39$), would tend to negate its usefulness as a trait for selection.

In this study, the heritability estimates obtained for traits related to seed germination were low. The low values may partly be explained by the generally high environmental components of variance shown for most traits. Similar low heritability estimates of traits related to seed germination have been reported for soybean (Green and Pinnel, 1968).

In view of the fact that leaf emergence and sprouting showed a positive, and strong genotypic relationship ($^{r}g = 0.86$), and the two traits also exhibited a significant amount of genetic variance among provenances (*Table 3*), the low heritability values may to some extent be offset by the large variation in these two traits, to make the traits responsive to selection. Direct selection for sprouting or germination capacity therefore seems promising because it would indirectly improve leaf emergence.

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Performance of Teak (Tectona grandis L. f.) Provenances Seventeen Years after Planting at Longuza, Tanzania

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Summary

A provenance trial for teak (*Tectona grandis* L.f.) containing seed sources from Tanzania (3), India (3), Java (1), New Britain (1), Nigeria (1), Sudan (1), Trinidad (1) and Vietnam (1) was established at Longuza, Tanzania, in December, 1965. Data has been compiled on survival, growth and stem characteristics for 17 years.

At 17 years, analysis of variance demonstrated fairly uniform survival and growth rates among the provenances. Height growth ranged from 22.4 to 26.4 m, with the Tanzania provenance (F) from Mtibwa showing the best growth. Similar values for DBH and volume production were 18.2 to 21.5 cm and 207.9 to 333.5 m³/ha respectively, with provenance (J) Coimbatore, India being the best for both parameters. All provenances grew remarkably well and gave yields comparable to site quality I and II reported in the literature for India, Central America and the Caribbean. Both stem straightness and self pruning were satisfactory for all provenances. Buttressing, forking and fluting were rare to non-existent. It is therefore recommended that selection for tree improvement be made from superior trees of all the provenances in order to maintain a broad genetic base for teak in Tanzania.

Key words: Teak provenances, growth and yield, Tanzania.

Zusammenfassung

Ein Herkunftsversuch für Teak (*Tectona grandis* L.f.) von Tanzania (3 Herkünfte), Indien (3), Java (1), Neu-Britanien (1), Nigerien (1), Sudan (1), Trinidas (1) und Vietnam (1) wurde im Dezember 1965 in Longuza, Tanzania begonnen. Wachstumsraten und Stammeigenschaften wurden nach siebzehn Jahren bewertet.

Überlebens- und Wachstumsraten waren ziemlich gleichartig in den verschiedenen Herkünften. Das Höhenwachstum bewegte sich zwischen 22,4 bis 26,4 m; die Herkunft von Mtibwa, Tanzanien hatte das beste Höhenwachstum. Der BHD variierte zwischen 18,2 und 21,5 cm, und die Volumenproduktion zwischen jeweils 207,8 und 333,5 m³/ha. Alle Herkünfte zeigten außerordentlich gute Wuchsleistungen, wobei die Herkunft Coimbatore, Indien, noch die besten Leistungen zeigte. Erträge waren vergleichbar mit jenen auf Standortsklassen I und II in Indien, Zentralamerika, und in den Karibischen Inseln. Stammform und natürliche Astreinigung waren ausreichend für alle Herkünfte. Brettwurzeln, Zwiesel und Spannrückigkeit kamen selten oder nie vor. Die Selektion für die Zuchtbaumauslese sollte aus Plusbäumen aller Herkünfte bestehen, um auf diese Weise eine breite genetische Basis für Teak in Tanzania zu gewährleisten.

Introduction

Teak (*Tectona grandis* L.f.) produces one of the world's most valuable timbers (BRYCE, 1966). Its natural range covers most of India, Burma, Thailand, Laos, Malaysia and Indonesia. Unlike many fine timber species of the tropics, the silviculture of teak is well understood (KADAMBI, 1972). Therefore, the species has been raised with success in plantations, both in its natural range and as an exotic in many countries (WOOD, 1967; KADAMBI, 1972; EGENTI, 1978; KEOGH, 1982).

The Germans introduced teak into Tanzania in the later part of the 19th century using seed from Calcutta, India. Later, trial plots were established in different parts of the country from 1905 to 1936 using seed sources from Burma, Java, India, and Thailand (WOOD, 1967). Good performance of teak in trial plots led to the establishment of teak plantations in Longuza, Mtibva and Rondo since 1952. Today, nearly 5000 ha have been planted with the species in Tanzania.

The plantation program in Tanzania generally uses three major seed sources. For long however, wide variations have been recognized in the performance of different teak ecotypes (BEARD, 1943; KEIDING, 1973; KEOGH, 1979). A provenance