VOL. 8, NO. 5, MAY 2013 ISSN 1990-6145
ARPN Journal of Agricultural and Biological Science


www.arpnjournals.com

DORMANCY BREAKING AND GERMINATION OF CASTOR (*Ricinus Communis* L.) SEED

Msaakpa T. S.[1], Obasi M. O.[2] and Kortse P. A.[1]
[1]Department of Plant Breeding and Seed Science, University of Agriculture, Makurdi, Nigeria
[2]Department of Crop Production, University of Agriculture, Makurdi, Nigeria
E-Mail: msaakpat@yahoo.com

ABSTRACT

A study was conducted at the Crop Science Laboratory of University of Agriculture, Makurdi in 2007 and 2008 to determine dormancy-breaking methods to overcome dormancy in castor seeds. The water uptake curves of non-scarified and scarified seeds were determined by fresh weight increase among four replications of ten seeds each. Fresh weight increase of control seeds was negligible compared to that of scarified seeds indicating seed coat impermeability to water (evidence of dormancy). Different methods to overcome seed dormancy were compared: seeds soaked in cold water for 24 hours; seeds soaked in hot water (75^{o}C) and cooled for 24 hours; seeds (caruncle removed) soaked in cold water for 24 hours; seeds with caruncle removed; seeds with testa removed at caruncle; seeds soaked in 1M, 2M, 3M, 4M sulphuric acid for 5 minutes and washed for 10 minutes; seeds soaked for 24 hours in 1% of hydrogen peroxide, 20% of coconut milk, 15% of potassium nitrate, 200mg/L of fusicoccin, and 200mg/L of aluminium tetraflouride. Thereafter, seeds were subjected to germination tests at 28^{o}C and 12-hour photoperiod. First count of germination, final germination, percentage germination, total mortality, and germination speed index were recorded. Mechanical scarification: caruncle removal and soaking in cold water for 24 hours and testa removal at caruncle were efficient in promoting germination. Chemical scarification with sulphuric acid was completely unsuccessful. Scarification with 20% of coconut milk, 15% of potassium nitrate, 200mg/L of fusicoccin and 200mg/L of aluminium tetraflouride produced unsatisfactory results.

Keywords: castor seeds, dormancy, germination, scarification.

INTRODUCTION

Castor (*Ricinus communis* L.) is an industrial crop grown for its economic seeds exploited mainly for producing castor oil (Onwueme and Sinha, 1991). Freshly harvested seeds of castor exhibit some degree of dormancy manifested in slow, erratic and low germination probably caused by seed coat impermeability to water (Carvalho, 1994). Although it is an efficient mechanism to guarantee the survival and perpetuation of the species, seed dormancy is an important limiting factor for seed germination. In Nigeria, castor plant is grown as a minor crop and seed yield is low in the range of 500-650kg/ha due to poor germination which is attributed to seed dormancy. Thus, it contributes very little as a foreign exchange earner in Nigeria and its production is below optimum level for industrial uses.

In addition to poor germination, difficulties in seed germination tests of *R. communis* may also be caused by the growth of fungi and bacteria. Removal of the caruncle from seeds can reduce fungal and bacteria growth during germination tests as well as the delay to germination and can increases the proportion of seeds germinating (Hidayati *et al*., 2000a). Impermeable seed coats to water, or oxygen, mechanical restrictions or combinations of these with presence of chemical inhibitors are often found in tropical seeds with hard seed coat (Malvasi, 1988). Castor seed has hard seed coat which is impermeable to water. Treatments like scarification and stratification are needed to overcome external and internal dormancy (Baskin Baskin, 2000b). Studies on pre-sowing treatments to break dormancy in castor seeds have not received desired attention.

This study therefore, intends to identify the best pre-sowing treatment to break seed dormancy and to promote germination of castor seeds.

MATERIALS AND METHODS

Seeds of four accessions of castor (LAF-4, LAF-11, AKW-5, AKW-7) were collected from National Seed Service, Makurdi, Nigeria. The water uptake curves of control and scarified seeds were determined by fresh weight increase among four replications of ten seeds each. Seeds were immersed in distilled water under ambient condition (28^{o}C) and weighed every 6 hours for the first 24 hours. Thereafter, seeds were weighed every 12 hours for 108 hours. Results were expressed as percent of fresh weight increase.

Pre-sowing treatments (methods to break dormancy) included: 1-untreated seeds (control); 2-seeds soaked in cold water for 24 hours; 3-seeds soaked in hot water (70^{o}C) and cooled for 24 hours; 4-caruncle removed and seeds soaked in cold water for 24 hours; 5-caruncle removed only; 6-testa removed at caruncle; 7-seeds soaked in 1M, 8-2M, 9-3M, 10-4M sulphuric acid for 5 minutes each and washed for 10 minutes; 11-seeds soaked in 1% of hydrogen peroxide for 24 hours; 12-seeds soaked in 20% of coconut milk for 24 hours; 13-seeds soaked in 15% of potassium nitrate for 24 hours; 14-seeds soaked in 200mg/L of fusicoccin for 24 hours; 15-seeds soaked in 200mg/L of aluminium tetraflouride for 24 hours. Chemicals involved in treatments 7 u 15 are considered as plant growth regulators.

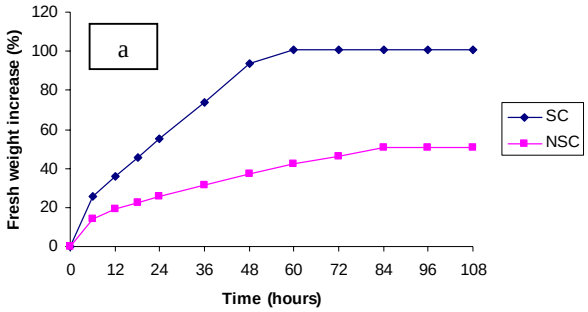
Germination tests immediately followed treatments to overcome seed dormancy. Seeds were

pressed in moist soil, 2 cm deep and placed in plastic containers at 28°C for 12-hour photoperiod. First count of germination, germination speed index, final count of germination, percentage germination, and total mortality of seeds were recorded. The evaluations started the fourth day after seeding. Radicle emergence was used as a reference to consider a seed germinated. The analysis followed a Completely Randomized Design followed by Fisher's Least Significant test at 5% for mean comparisons.

RESULTS

Figure-1 shows that fresh weight increase of control seeds was negligible compared to that of scarified seeds. Results also showed that mechanical scarification (T_4 and T_6) yielded significantly higher number of first germination count, final germination and higher germination speed index than all other treatments used (Tables 1 to 4). The response of all the four castor accessions followed the same trend. Mechanical scarification (T_4): caruncle removal and soaking in water for 24 hours followed closely to mechanical scarification (T6): testa removal at caruncle. Water soaking of seeds of *R.communis* for 24 hours was not effective to overcome seed dormancy.

Chemical scarification treatments using 1M, 2M, 3M and 4M sulphuric acid (T_7 to T_{10}) did not support germination of seeds of all castor accessions (Tables 1 to 4). Other dormancy breaking treatments involving: 1% of hydrogen peroxide, 20% of coconut milk, 15% of potassium nitrate, 200mg/L of fusicoccin, and 200mg/L of aluminium tetraflouride did not differ significantly with the control in first germination count, final count of germination and in mortality of the seeds. Table-5 shows that dormancy breaking treatments significantly influenced all parameters in both years of study combined. In this study, mechanical scarification turned out to be the best pre-sowing treatment to overcome *R. communis* seed dormancy.



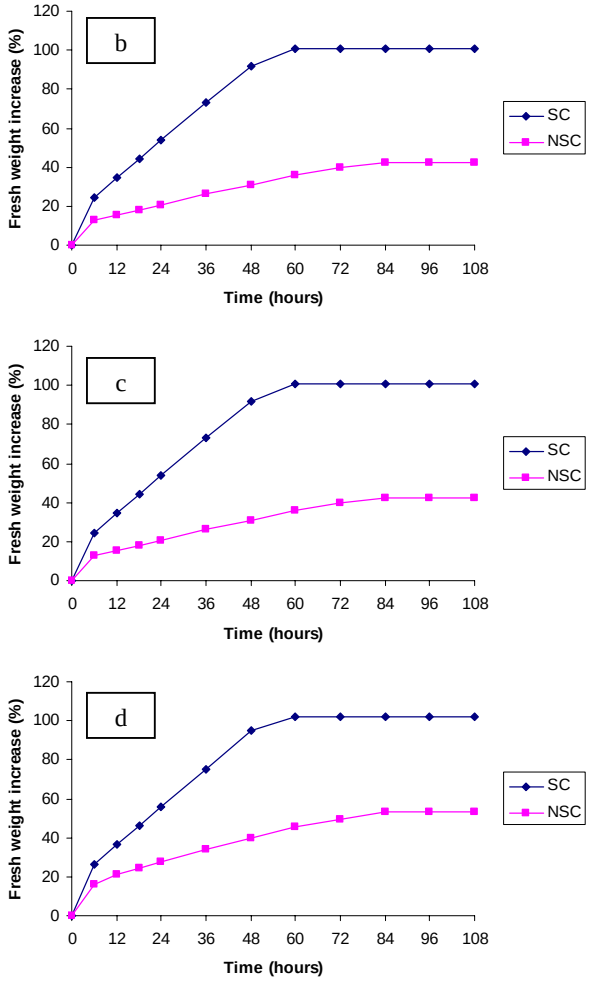


Figure-1. Water uptake curves for non-scarified and scarified seeds of LAF-4 (a), LAF-11 (b), AKW-5 (c) and AKW-7 (d) castor accessions in 2007 and 2008.

Where

SC = Scarified castor seeds
NSC = Non-scarified castor seeds

Table-1. Effects of different dormancy-breaking treatments on LAF-4 castor accession in 2007 and 2008 (Combined data).

Treatments		First germination count, 7days after planting	Final germination count, 14 days after planting	Pre-emergence mortality of seeds	Post-emergence mortality of seeds	Total mortality of seeds
$T_{1=}$	Control (untreated seeds)	2.00	4.33	5.67	0.00	5.67
$T_{2=}$	Seeds soaked in cold H_2O for 24 hours	2.33	4.33	5.67	0.00	5.67
$T_{3=}$	Seeds soaked in hot H_2O at 70^0C and cooled for 24 hours	2.33	5.00	5.00	0.00	5.00
$T_{4=}$	MS_1: Caruncle removal + soaking in cold H_2O for 24hrs	5.00	8.00	2.00	0.00	2.00
$T_{5=}$	MS_2: caruncle removal	4.33	7.00	3.00	0.00	3.00
$T_{6=}$	MS_3: testa removal at caruncle	5.33	9.33	0.67	0.00	0.67
$T_{7=}$	CS_1: seeds soaked in 1M H_2SO_4 for 5minutes	0.00	0.00	10.00	0.00	10.00
$T_{8=}$	CS_2: seeds soaked in 2M H_2SO_4 for 5minutes	0.00	0.00	10.00	0.00	10.00
$T_{9=}$	CS_3: seeds soaked in 3M H_2SO_4 for 5minutes	0.00	0.00	10.00	0.00	10.00
$T_{10=}$	CS_4: seeds soaked in 4M H_2SO_4 for 5minutes	0.00	0.00	10.00	0.00	10.00
$T_{11=}$	Seeds soaked in 1% H_2O_2 for 24 hours	2.00	3.33	6.67	0.00	6.67
$T_{12=}$	Seeds soaked in 20% of coconut milk for 24 hrs	3.33	4.33	5.67	0.00	5.67
$T_{13=}$	Seeds soaked in 15% of KNO_3 for 24 hours	2.33	4.33	5.67	0.00	5.67
$T_{14=}$	Seeds soaked in 200mg/L of fusicoccin for 24hours	3.33	5.33	4.67	0.00	4.67
$T_{15=}$	Seeds soaked in 200mg/L of ALF_4 for 24hours	3.33	5.33	4.67	0.00	4.67
	$LSD_{(0.05)}$	0.824	1.025	1.025	NS	1.025
	CV (%)	20.8	15.5	18.3	0.0	18.3

Where

MS	=	Mechanical scarification
CS	=	Chemical scarification
KNO_3	=	Potassium nitrate
ALF_4	=	Aluminum tetraflouride
H_2O_2	=	Hydrogen peroxide
H_2SO_4	=	Sulphuric acid

Table-2. Effects of different dormancy-breaking treatments on LAF-11 castor accession in 2007 and 2008 (Combined data).

Treatments		First germination count, 7days after planting	Final germination count, 14 days after planting	Pre-emergence mortality of seeds	Post-emergence mortality of seeds	Total mortality of seeds
$T_{1=}$	Control (untreated seeds)	2.33	4.00	6.00	0.00	6.00
$T_{2=}$	Seeds soaked in cold H_2O for 24 hours	3.00	5.33	4.67	0.00	4.67
$T_{3=}$	Seeds soaked in hot H_2O at 70^0C and cooled for 24 hrs	3.00	5.33	5.00	0.00	5.00
$T_{4=}$	MS_1:Caruncle removal + soaking in cold H_2O for 24hrs	4.33	8.00	2.00	0.00	2.00
$T_{5=}$	MS_2: caruncle removal	3.33	7.33	2.67	0.00	2.67
$T_{6=}$	MS_3: testa removal at caruncle	6.33	9.33	1.00	0.00	1.00
$T_{7=}$	CS_1: seeds soaked in 1M H_2SO_4 for 5minutes	0.00	0.00	10.00	0.00	10.00
$T_{8=}$	CS_2: seeds soaked in 2M H_2SO_4 for 5minutes	0.00	0.00	10.00	0.00	10.00
$T_{9=}$	CS_3: seeds soaked in 3M H_2SO_4 for 5minutes	0.00	0.00	10.00	0.00	10.00
$T_{10=}$	CS_4: seeds soaked in 4M H_2SO_4 for 5minutes	0.00	0.00	10.00	0.00	10.00
$T_{11=}$	Seeds soaked in 1% H_2O_2 for 24 hours	2.33	3.33	6.67	0.00	6.67
$T_{12=}$	Seeds soaked in 20% of coconut milk for 24 hrs	2.33	5.33	4.67	0.00	4.67
$T_{13=}$	Seeds soaked in 15% of KNO_3 for 24 hours	2.33	5.33	4.67	0.00	4.67
$T_{14=}$	Seeds soaked in 200mg/L of fusicoccin for 24hours	3.33	5.67	4.33	0.00	4.33
$T_{15=}$	Seeds soaked in 200mg/L of ALF_4 for 24hours	3.33	6.33	3.67	0.00	3.67
	$LSD_{(0.05)}$	0.786	2.35	0.896	NS	0.896
	CV (%)	10.5	19.0	9.4	0.0	9.4

Where

MS	=	Mechanical scarification
CS	=	Chemical scarification
KNO_3	=	Potassium nitrate
ALF_4	=	Aluminum tetraflouride
H_2O_2	=	Hydrogen peroxide
H_2SO_4	=	Sulphuric acid

Table-3. Effects of different dormancy-breaking treatments on AKW-5 castor accession in 2007 and 2008 (Combined data).

Treatments		First germination count ,7days after planting	Final germination count, 14 days after planting	Pre-emergence mortality of seeds	Post-emergence mortality of seeds	Total Mortality of seeds
T_{1} =	Control (untreated seeds)	2.00	3.67	6.33	0.00	6.33
T_{2} =	Seeds soaked in cold H_2O for 24 hours	3.33	5.33	4.67	0.00	4.67
T_{3} =	Seeds soaked in hot H_2O at 70^0C and cooled for 24 hrs	3.00	5.33	4.67	0.00	4.67
T_{4} =	MS_1:Caruncle removal + soaking in cold H_2O for 24hrs	4.00	8.00	2.00	0.00	2.00
T_{5} =	MS_2: caruncle removal	3.33	7.33	2.67	0.00	2.67
T_{6} =	MS_3: testa removal at caruncle	5.33	10.00	0.00	0.00	0.00
T_{7} =	CS_1: seeds soaked in 1M H_2SO_4 for 5minutes	0.00	0.00	10.00	0.00	10.00
T_{8} =	CS_2: seeds soaked in 2M H_2SO_4 for 5minutes	0.00	0.00	10.00	0.00	10.00
T_{9} =	CS_3: seeds soaked in 3M H_2SO_4 for 5minutes	0.00	0.00	10.00	0.00	10.00
T_{10} =	CS_4: seeds soaked in 4M H_2SO_4 for 5minutes	0.00	0.00	10.00	0.00	10.00
T_{11} =	Seeds soaked in 1% H_2O_2 for 24 hours	1.33	3.00	7.00	0.00	7.00
T_{12} =	Seeds soaked in 20% of coconut milk for 24 hrs	3.67	5.67	4.33	0.00	4.33
T_{13} =	Seeds soaked in 15% of KNO_3 for 24 hours	2.67	6.00	4.00	0.00	4.00
T_{14} =	Seeds soaked in 200mg/L of fusicoccin for 24hours	2.67	4.67	5.33	0.00	5.33
T_{15} =	Seeds soaked in 200mg/L of ALF_4 for 24hours	3.33	6.33	3.67	0.00	3.67
	$LSD_{(0.05)}$	1.025	1.084	1.084	Ns	1.084
	CV (%)	20.6	15.2	11.4	0.0	11.4

Where

MS = Mechanical scarification
CS = Chemical scarification
KNO_3 = Potassium nitrate
ALF_4 = Aluminum tetraflouride
H_2O_2 = Hydrogen peroxide
H_2SO_4 = Sulphuric acid

Table-4. Effects of different dormancy-breaking treatments on AKW-7 castor accession in 2007 and 2008 (Combined data).

Treatments		First germination count, 7days after planting	Final germination count, 14 days after planting	Pre-emergence mortality of seeds	Post-emergence mortality of seeds	Total mortality of seeds
$T_{1=}$	Control (untreated seeds)	1.67	3.67	6.33	0.00	6.33
$T_{2=}$	Seeds soaked in cold H_2O for 24 hours	2.67	5.00	5.00	0.00	5.00
$T_{3=}$	Seeds soaked in hot H_2O at 70^0C and cooled for 24 hrs	2.33	5.00	5.00	0.00	5.00
$T_{4=}$	MS_1:Caruncle removal + soaking in cold H_2O for 24hrs	4.00	8.33	1.67	0.00	1.67
$T_{5=}$	MS_2: caruncle removal	3.33	7.33	2.67	0.00	2.67
$T_{6=}$	MS_3: testa removal at caruncle	5.33	9.67	0.33	0.00	0.33
$T_{7=}$	CS_1: seeds soaked in 1M H_2so_4 for 5minutes	0.00	0.00	10.00	0.00	10.00
$T_{8=}$	CS_2: seeds soaked in 2M H_2SO_4 for 5minutes	0.00	0.00	10.00	0.00	10.00
$T_{9=}$	CS_3: seeds soaked in 3M H_2SO_4 for 5minutes	0.00	0.00	10.00	0.00	10.00
$T_{10=}$	CS_4: seeds soaked in 4M H_2SO_4 for 5minutes	0.00	0.00	10.00	0.00	10.00
$T_{11=}$	Seeds soaked in 1% H_2O_2 for 24 hours	1.33	2.67	7.33	0.00	7.33
$T_{12=}$	Seeds soaked in 20% of coconut milk for 24 hrs	2.33	5.67	4.33	0.00	4.33
$T_{13=}$	Seeds soaked in 15% of KNO_3 for 24 hours	2.33	5.33	4.67	0.00	4.67
$_{14=}$	Seeds soaked in 200mg/L of fusicoccin for 24hours	2.33	4.33	5.67	0.00	5.67
$T_{15=}$	Seeds soaked in 200mg/L of ALF_4 for 24hours	3.33	6.33	3.67	0.00	3.67
	$LSD_{(0.05)}$	0.896	1.292	0.963	Ns	0.963
	CV (%)	20.0	18.6	11.3	0.0	10.0

Where

MS = Mechanical scarification
CS = Chemical scarification
KNO_3 = Potassium nitrate
ALF_4 = Aluminum tetraflouride
H_2O_2 = Hydrogen peroxide
H_2SO_4 = Sulphuric acid

Table-5. Mean squares for dormancy breaking treatments on LAF-4, LAF-11, AKW-5 and AKW-7 castor accessions in 2007 and 2008 (Combined data).

Sources of variation	First germination count (day 7)	Final germination count (day 14)	Total mortality	Percentage germination	Germination speed index
LAF-4					
Treatments	7.660**	20.994**	18.898**	20.994**	37.512**
Residual	1.178	1.298	1.689	1.298	1.167
LAF-11					
Treatments	9.879**	24.794**	27.613**	24.794**	48.036**
Residual	0.222	2.000	0.289	2.000	1.083
AKW-5					
Treatments	8.594**	23.127**	28.327**	23.127**	48.179**
Residual	0.378	0.289	0.422	0.289	1.083
AKW-7					
Treatments	7.724**	28.279**	31.746**	28.279**	39.711**
Residual	0.289	0.600	0.333	0.600	0.979

* Significant at P = 0.05
** Significant at P = 0.01

DISCUSSIONS

The results of this study in which fresh weight increase of control seeds was negligible compared to that of scarified seeds indicates coat impermeability to water and agrees with the findings of Carvalho (1994) in *Enterolobium contortisiliquum*, ledo (1977) in *Schizolobium parahybum*. In this study, mechanical scarification turned out to be an excellent treatment to overcome seed dormancy in *Ricinus communis*. This agrees with results from several authors: Bianchetti and Ramos (1981) in *Petophorum dubium*; Carvalho *et al*. (1980) in *Erythrina speciosa*; Nassif and perez (1997) in *Pterogyne nitens*; Jeller and Perez (1999) in *Cassia excelsa*; and Lopes *et al*. (1998) in *Caesalpinea ferrea*. The authors explained that seeds tested have hard seed coat and mechanical scarification of the seed coat promoted water imbibitions and germination. Water soaking of seeds of *R. communis* for 24 hours was not effective to overcome seed dormancy because of the hard seed coat which is impermeable to water.

Due to unsatisfactory results, the use of boiling water to break dormancy in castor seeds should be discoursed. The heat generated affects the embryo of the seed. Chemical scarification treatments with sulphuric acid produced unsuccessful results. Because sulphuric acid is corrosive, it softens and penetrates the hard seed coat and kills the embryo. This result agrees with the findings of Lago *et al*. (1978) in castorbean cultivars. After ripening at room temperature for four, nine or several months was reported to avoid the problem of poor germination in castor seeds. The seed covering structures (testa and caruncle) are reported to be the major cause of poor germination in seeds of *R. communis*.

REFERENCES

Baskin J. M. and Baskin C. C. 2000 b. Dormancy-breaking and germination requirements of seeds of four Lonicera species (Caprifoliaceae) with underdeveloped spatulate embryos. Seed Science Research. 10: 459-469.

Bianchetti A and Ramos A. 1981. Quebra de dormancia de sementes de canafistula peltopherum dubium (spreng). Taubert. Resultados preliminares. Pesquisa Florestal. 3: 87-95.

Carvalho N. M., Filho J. F. S., Graziano T. T. and Aguiar I. B. 1980. Maturacao fisiologica de sementes de amendoim-do-campo. Revista Brasileira de Sementes. 2(2): 23-27.

Carvalho P. E. R. 1994. Especies floretais: recommendacoes silviculturais, Potencialidadese e uso da Madeira. Colombo: EMBRAPA-CNPF; Brasilia: EMBRAPA-SPI. p. 640.

Hidayati S. N., Baskin J. M. and Baskin C. C. 2000a. Morphological dormancy in seeds of two North American and one Eurasian Species of *Sambucus* (Caprifoliaceae) with underdeveloped spatulate embryos. American Journal of Botany. 87: 1669-1669.

Jeller H. and Perez S. C. J. G. A. 1999. Estudo da superacao da dormencia e da temperature em sementes de *Cassia excelsa* Schrad. Revista Brasileira de Sementes. 21(1): 32-40.

Lago A. A., Zink E., Banzatto N. V. and Savy-Filho A. 1978. Seed dormancy of three castorbean cultivars. Bragantia. 38: 41-44.

Ledo A. A. M. 1977. Estudo da causa da dormancia em sementes de guapuruva (*Schizolobium parahybum* (Vell.) Blake) e orelha-de-negro (*Enterolobium contortisiliquum* (Vell.) Morong.) e metodos para sua quebra. M.Sc. Thesis, Vigosa, UFV. p. 57.

Lopes J. C., Capucho M. T., Krohling B. and Zanotti P. 1998. Germinacao de sementes de especies florestais de *Caesalpinea ferea* Mart. Ex Tul. Var. Ieiostachya Benth., *Cassia grandis* L. e *Samanea saman* Merrill, apos tratamentos para superar a dormencia. Revista Brasileira de Sementes. 20(1): 80-86.

Malavasi M. M. 1988. Germinacao de sementes. In: Pina-Rodrigues, F. C. (Coord.). Manual de Analise de sementes Florestais. Campinas: Fundacao Cargill. pp. 25-40.

Nassif S. M. L. and Perez S. C. J. G. A. 1997. Germinacao de sementes de amendoim-do-campo (*Pterogyne nitens* Tul.): Influencia e profundidade de semeadura. Revista Brasileira de Sementes. 19(2): 172-179.

Omwueme I.C. and Sinha T. D. 1991. Field Crop Production in Tropical Africa. Tech. Centre Agric. of Rural Crops. ACP-EEC Lome Convention. pp. 159-175.