IMPROVING SEED GERMINATION OF *DERRIS INDICA* BY VERTICAL SOWING

C. Swaminathan, R . S. Vinaya Rai, K . K . Suresh, & K . Sivaganam

Forestry Research Station, Tamil Nadu Agricultural University, Mettupalayam 641 301, India

Received May 1992

SWAMINATHAN, C., VINAYA RAI, R.S., SURESH, K.K. & SIVAGNANAM, K. 1993. Improving seed germination of *Derris indica* by vertical sowing. Seeds of *Derris indica* were sown by five different methods. Sowing the seeds vertically with the micropyle directed downwards gave the maximum germination of 92%. Vertical sowing with the micropyle oriented laterally and upwards recorded respectively germinability of 58 and 66%. Sowing the seeds flat gave germination of 72% indicating that micropyle orientation is more important than disposition of seed vertically or flat. Parameters like germination energy, germination value and emergence energy value were also high when seeds were sown vertically with the micropyle pointed downwards. The plausible reason for this is discussed. The study has failed to sustain the contention that germination is positively correlated with seed soil contact area. The study also indicates that presowing treatment with water is not necessary for maximising germination for this species.

Key words: Sowing - micropyle - germination energy - germination speed - value

SWAMINATHAN, C., VINAYA RAI, R.S., SURESH, K.K. AND SIVAGNANAM, K. 1993. Memperbaiki percambahan biji benih *Derris indica* dengan penyemaian menegak. Biji benih *Derris indica* di semai dengan lima cara yang berlainan. Biji benih yang di semai secara menegak dengan mikrofil menghadap ke bawah memberikan peratus percambahan yang maximum, sebanyak 92%. Penyemaian secara menegak di mana mikrofil di letakkan dalam keadaan melintang memberikan 58% percambahan manakala mikrofil yang menghadap keatas memberikan 66% percambahan. Penyemaian biji benih dengan mikrofil dalam keadaan terlentang memberikan 72% percambahan. Ini jelas menunjukkan yang orientasi mikrofil adalah lebih penting dari posisi biji benih sama ada secara menegak atau melintang. Parameter-parameter seperti tenaga percambahan, nilai percambahan dan nilai tenaga percambahan juga tinggi apabila biji benih di semai secara menegak dengan mikrofil menghadap ke bawah. Penjelasan tentang hasil kajian ini di bincangkan. Namun demikian hasil kajian ini gagal membuktikan korelasi positif antara percambahan dan kawasan sentuh tanah-biji benih. Kajian ini juga menunjukkan rawatan air sebelum penyemaian tidak memaksimakan peratus percambahan spesies ini.

Introduction

Indian forests are being denuded at an appalling rate of 1.5 million *ha* every year (Campbell 1987) and only one-tenth of the forest area so cleared is reforested (Anonymous 1986). This, coupled with the low productivity, in comparative global statistics, of Indian forests, has accentuated the mismatch between supply and demand of industrial and domestic wood. Seed management, an important factor for increased productivity, has so far received little attention for forest tree species. With the increasing demand for multipurpose tree seedlings dictated

by the expanding social and agroforestry programmes, emphasis has now been placed on the production and management of high quality planting material/ seeds. *Derris indica* (*Pongamia pinnata*) is a valuable oil-seed bearing tree with a seed oil content of 27 %. The major fatty acids present in the oil are oleic (44.5 - 71.3%), linoleic (10.8 - 18.3%) and eicosenoic acids (9.5 - 12.4%) (Nagarajan *et al.* 1984). Lipid associates present are karanjin and pongamol (Lakshmikanthan 1984). Undistilled oil can be used in the manufacture of laundry soap and distilled oil in soap manufacture. The oil is also used in leather tanning, lubrication and medicinal preparations for scabies and leucoderma. The press-cake left after oil extraction makes a useful poultry feed (Mandal & Banerjee 1979 a,b). The leaves serve as nutritious fodder and as green manure for rice crop (Rao & Purkayastha 1972). The leaves contain 17.6% crude protein, 2.2% calcium and 0.2% phosphorus (Gupta *et al.* 1975). The leaves also possess insecticidal properties (NAS 1980) and serve as a good fertilizer for sugarcane (Nagarajan *et al.* 1984). Pods are fed to cattle in Maharastra (Laurie 1945). Being an evergreen tree with a pleasing canopy, the tree finds favour for shade and ornament especially along avenues. Its flowers are used as manure for pot culture (Anonymous 1978). Studies were therefore carried out to determine the effect of sowing methods on germinability in this species of diverse utility.

Materials and methods

Mature pods were collected from a 15- *y* - old tree in the campus of the Tamil Nadu Agricultural University, Coimbatore (11° 02'N, 76° 57'E at 426 *m* a.s.l.) during November 1988, air-dried and seeds extracted by manual shelling. The seeds at the rate of 50 for each treatment method were sown in 200 gauge poly pots measuring 20 × 10 *cm* by five different sowing methods, *viz.* (i) seeds buried vertically with the micropyle directed upwards, (ii) seeds buried vertically with the micropyle disposed laterally, (iii) seeds buried vertically with the micropyle directed downwards, (iv) seeds half-buried with the micropyle disposed laterally, and (v) seeds buried horizontally (Figures 1.& 2). The experiment was set up in quadruplicate. The sowing was done on December 5, 1988. Number of germinants was counted daily from the onset of germination up to 15 days thereafter. Emergence of cotyledons above the soil was reckoned as germination (Bahuguna *et al.* 1987). From the daily count of germinants, the following parameters were computed: (i) germination per cent, (ii) germination energy, (iii) germination value (after Czabator 1962), (iv) germination value (after Djavanshir & Pourbeik 1976), (v) emergence energy value (EEV), and (vi) germination relative index (GRI). Germination energy was calculated after Maguire (1962) by the formula.

$$GE = \frac{X_1}{Y_1} + \frac{(X_2 - X_1)}{Y_2} + \ldots\ldots\ldots\ldots + \frac{(X_n - X_{n-1})}{Y_n}$$

Where X_n is the number of germinants on the nth counting date and Y_n, the number of days from sowing to the nth count. Germination value as defined by

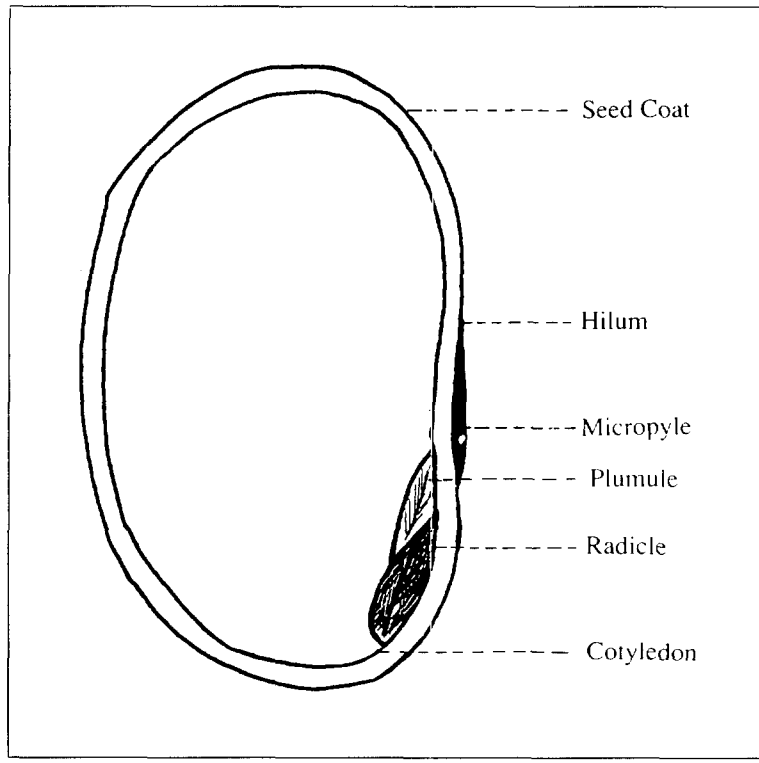

Figure 1. Cross section of *Derris indica* seed

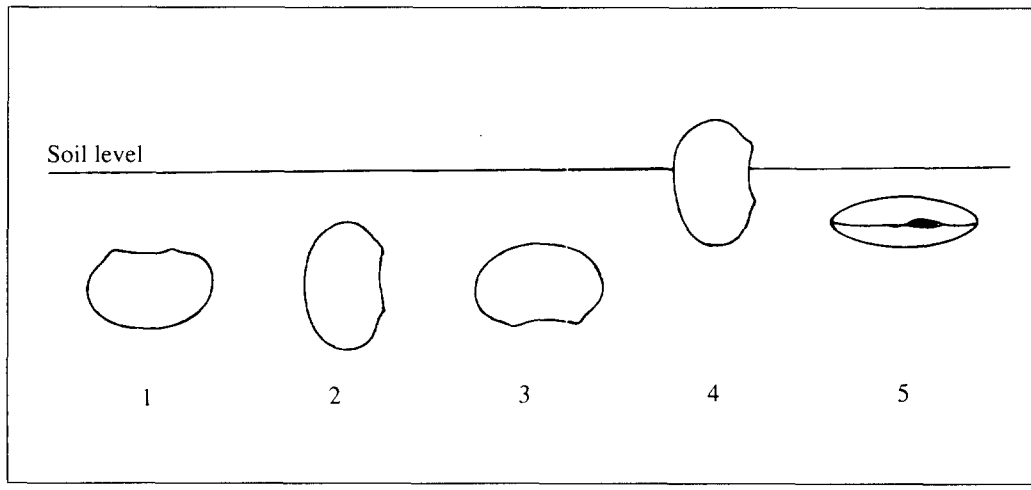

Figure 2. Position of sowing

Czabator (1962) is the integral of final mean daily germination percentage (MDG) and peak value (PV). Final MDG is the cumulative percentage of full seed germination at the end of the test divided by the number of days elapsed since sowing date. Peak value is the maximum mean daily germination obtained by dividing the maximum cumulative percentage reached at any time during the test period by the number of days from sowing when that maximum was reached. Germination value (GV) as proposed by Djavanshir and Pourbeik (1976) is given by the formula,

$$GV = (\sum DGS/N) \times \frac{GP}{10}$$

Where GV is germination value, GP is germination per cent at the end of the test, DGS is the daily germination speed obtained by dividing the cumulative germination per cent by the number of days since sowing. $\sum$ DGS is the summation of all DGS figures and N, the number of daily counts effective from the date of first germination. Emergence energy value is the highest value obtained when the germination percentage on a day is divided by the number of days since test when that germination percentage was reached (Bahuguna *et al.* 1987). Germination relative index was computed after Screevatsava and Sareen (1972) by the formula $[\sum X_n (h\text{-}n)]$ where X_n is the number of germinants at nth count; h, the total number of counts and n, the count number. The data recorded were subjected to analysis of variance (Panse & Suthatme 1967).

Results and discussion

The weight and dimensions of both pod and seed are given in Table 1. Pods were indehiscent, almost woody and pointed at both ends. Seeds were fairly large, compressed, wrinkled, longer than broader, more or less oval and biconvex. A single seed weighed 1.5 *g*. According to Mathauda (1955), a kilo contains 1200 to 1500 seeds (0.66 to 0.83 *g* per seed). The present study, however, indicates that trees with large seeds which number about 600 in a kilo do occur.

Table 1. Pod and seed attributes in *Derris indica*

Parameter	Pod	Seed
Length (*cm*)	5.17 ± 0.18	2.30 ± 0.26
Breadth (*cm*)	2.33 ± 0.20	1.56 ± 0.25
Width (*cm*)	1.01 ± 0.17	0.64 ± 0.01
Weight (*g*)	3.18 ± 0.29	1.52 ± 0.13

Regarding method of sowing, the orientation of the micropyle rather than the dispostion of the seed was indicated to be the overriding factor in determining germination in this species. Downward orientation of the micropyle proved distinctly superior to either upward or lateral orientations from the standpoint of all

parameters evaluated with the exception of GRI (Table 2). In respect of GRI, it showed parity with half-buried seed combining lateral orientation of micropyle. Germination energy is a measure of the speed of germination and hence supposedly of the vigour of the seed and of the seedling which it produces. The interest in germinative energy stems from the theory, despite the lack of much experimental evidence, that only seeds which germinate rapidly in the laboratory will produce vigorous seedlings in the field (Aldhous 1972). This parameter was distinctly high when seed was sown vertically with the micropyle pointed downwards. Germination value combines as it does both total germination capacity and germination energy, and hence is a better measure of seed performance. In terms of this germination value also, sowing vertically with the micropyle down is indicated to be superior where the germination value, as an intergrated measure of seed quality, has been used by several tropical seed workers (Okora 1976, Costales & Veracion 1978). Germination value alternatively proposed by Djavanshir and Pourbeik (1976) was found by some researchers to be more closely related to survival of plants in field nurseries than was Czabator's method.

Table 2. Effect of sowing method on germination and related attributes in *Derris indica*

Disposition of seeds and orientation of microphyle	Onset of germination (day after sowing)	Germination (%)	Germination energy	Germination value		EEV	GRI
				Czabator	Djavanshir & Pourbeik		
Vertical-upward	17	66	1.85	11.4	1.1	3.4	129
Vertical-lateral	11	58	2.18	9.3	1.4	3.2	859
Vertical downward	11	92	3.48	24.8	3.5	5.4	1198
Vertical-half buried-lateral	9	72	3.07	16.2	2.1	4.5	1356
Flat	11	72	2.43	12.9	2.1	3.6	595
CD 5%		9	0.24	4.7	0.5	0.8	262

In a number of seeds there is, at least initially, a greater uptake of water through the micropyle than through the rest of the testa (Hamly 1932). Distance over which water flows to a seed through soil often does not exceed 10 *mm* irrespective of the soil water content. Water uptake by the seed is determined by water content of the soil immediately surrounding the seed. As soil water content increases, the water uptake by seed and its germination also increase (Dasberg 1971). The better germination associated with the downward orientation of the micropyle may therefore be the outcome of greater water likely to be available at a depth slightly away from the soil surface than at the soil surface. For the same reason, GRI was the least when micropyle was directed upwards.

A positive correlation between percentage germination and the area of contact between seed and its soil substrate has been reported (Manohar & Heydecker, 1964). However, in the present study, partially buried seed performed better than fully buried one, despite having only half as much seed-soil contact as the fully

buried seed. The relative importance of seed-soil interface area is thus discounted. The study attests to the argument that soil matric potential is more important than the area of wetted contact between seed and its supporting medium (Collis-George & Hector 1966, Collis-George & Williams 1968).

Germination in the species has been reported to range between 60 and 80 % and to last for about a month (Chaturvedi 1957). But the current study clearly demonstrates that by adopting suitable sowing method, this parameter can not only be maximised to as high as 92% but also concomitantly hastened. Soaking seeds in cold water for 24 *h* prior to sowing has been reported to hasten and improve germination in the species (Raynor 1940). But, in the present study, germination even in the absence of aqueous soaking ranged between 58 and 92 %, suggesting that method of sowing is more important than pre-sowing treatment. Mathauda (1955) reported that cold or hot water treatment did not improve germination. It is concluded that germination in the species can be maximised to as high as 92% by sowing the seed vertically with the micropyle directed downwards.

References

ALDHOUS, J.R. 1972. Nursery practices. *Forestry Commission Bulletin* No. 43, London.

ANONYMOUS. 1978. *Tree borne oil seeds - a resource for gainful employment.* Directorate of Non-edible Oils and Soap Industry, Khadi and Village Industries Commission, Bombay : 42 - 43.

ANONYMOUS. 1986. Are *Eucalyptus* ecologically harmful? *Unasylva* 38: 19 - 22.

BAGUGUNA, V.K., PYARE LAL & DHAWAN, V.K. 1987. Standardisation of nursery techniques (seed sowing methods and watering schedules) of *Eucalyptus* FRI- 4 under North Indian moist tropical climatic conditions. *Indian Forester* 113 : 541 - 549.

CAMPBELL, J.Y. 1987. Tropical forestry and biological diversity in India and the role of USAID/New Delhi. (Mimeograph).

CHATURVEDI, M.D. 1957. The common karanja. *Indian Farming* 7(2): 8 - 9.

COLLIS - GEORGE, N. & HECTOR, J.B. 1966. Germination of seeds as influenced by matric potential and by area of contact between seed and soil water. *Australian Journal of Soil Research* 4: 145 -164.

COLLIS - GEORGE, N. & WILLIAMS, J. 1968. Comparison of the effects of soil matric potential and isotropic effective areas on the germination of *Lactuca sativa. Australian Journal of Soil Research* 6 : 179 - 192.

COSTALES, A.B. & VERACION, V.P. 1978. Germination of benguet pine seeds at various intervals of watering. *Sylvatrop* 3(4): 243 - 245.

CZABATOR F. J. 1962. Germination value - an index combining speed and completeness of pine seed germination. *Forest Science* 8: 386 - 396.

DASBERG, S. 1971. *Journal of Experimental Botany* 22 : 999 -1008.

DJAVANSHIR, K. & POURBEIK, H. 1976. Germination value - a new formula. *Silvae Genetica* 25: 79 - 83.

GUPTA, P. C. SINGH, R., SANGWAN, D. C. & PRADHAN, K. 1975. Chemical composition and *in vitro* nutrient digestibility of some of the tree leaves. *Indian Forester* 101: 674 - 680.

HAMLY, D. H. 1932. Softening of the seeds of *Melilotus alba. Botanical Gazette* 93: 345 - 375.

LAKSHMIKANTHAN, V. 1984. Chemistry and industry of tree-borne oil seeds in service to citizen. Pp. 1-12 in Suri, R. K. & Mathur, K.C. (Eds.) *Recent Trends in Forest Utilization.* International Book Distributors, Dehra Dun.

LAURIE, M.V. 1945. *Fodder trees in India.* Indian Forestry Leaf 1.82 (Silviculture). Forest Research Institute, Dehra Dun. 17 pp.

MANDAL, L. & BANERJEE, G.C. 1979a. Studies on the utilization of karanja (*Pongamia glabra* Vent) cake in layer diet. *Indian Journal of Poultry Science* 14 (2): 105 - 109.

MANDAL, L. & BANERJEE, G. C. 1979 b. Studies on the utilization of karanja (*Pongamia glabra* Vent) cake in broiler ration. *Indian Journal of Poultry Science* 14 (2): 110 - 113.

MATHAUDA, C. S . 1955. *Pongamia pinnata* (L) Pierre (Syn. *Pongamia glabra* Vent). Family Leguminosae - Papiloneae. *Indian Forester* 81: 563 - 565.

MAGUIRE, J. D. 1962. Speed of germination - aid in selection and evaluation for seedling emergence and vigour. *Crop Science* 2: 176 -177.

MANOHAR, M. S. & HEYDECKER, W. 1964. Effects of water potential on germination of pea seeds. *Nature* 202 : 22 - 24.

NAGARAJAN, S., JAIN, H.C. & CHADHA, Y.R. 1984. Industrial exploitation of forest based minor oil seeds. Pp. 50-58 in Suri, R.K. & Mathur, K.C. (Eds.) *Recent Trends in Forest Utilization.* International Book Distributors, Dehra Dun.

NAS. 1980. *Firewood Crops - Shrub and Tree species for Energy Production.* National Academy of Sciences, Washington DC.

OKORA, O.O. 1976. Germination of *Terminalia ivorensis* seeds sown under various conditions of germination. In *Seed Problems. Proceedings of the 2nd International Symposium on Physiology of Seed Germination.* October, 1976. IUFRO, Fuji, Japan,

PANSE, V. G. & SUKHATME, P.V. 1967. *Statistical Methods for Agricultural Workers.* Indian Council of Agricultural Research, New Delhi.

RAO, R. K. & PURKAYASTHA, S. K. 1972. *Indian Woods - their Identification, Properties and Uses.* Volume III. Manager of Publications, Government of India, New Delhi : 121-122.

RAYNOR, E.W. 1940. A preliminary guide to the germinative capacity of seeds of certain common species in the United Provinces and a few exotics together with estimates of quantities of seeds required for 100 plants. *UP Forest Department Bulletin* 14 : 20 pp.

SREEVATSAVA, A. K. & SAREEN, K. 1972. Germination of soybean seeds as affected by different storage conditions. *Bulletin of Grain Technology* 10: 390 - 396.