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Quality analysis of seeds of *Cupressus* Linn. species for seed testing and plus tree selection

Abstract: *Cupressus* Linn., commonly known as 'cypress', belongs to the family *Cupressaceae*. It consists of 20 species with a wide and discontinuous distribution in the Northern Hemisphere. In the present study, three species, namely *C. torulosa* Don., *C. arizonica* Greene and *C. glabra* Sudw., growing in the western Himalayan region of India at an altitude of 1760 m. have been studied. This is a preliminary attempt where embryology is used in estimating seed quality and in seed testing. Seed quality was analysed according to five (0–IV) seed classes based on the presence of the embryo and endosperm and their nature of development in the seed-cutting test. Seeds having neither embryo nor endosperm belong to class '0'. In class 'I' seeds contain the endosperm but a shrivelled embryo or sometimes no embryo. Class 'II' contains seeds with an embryo of half-length of the embryo cavity and class 'III' seeds containing an embryo of at least three-quarter length of the embryo cavity. Seeds with completely developed full embryo were assigned to class 'IV'. However a high percentage of seeds of classes 0–III present in seed lots from particular trees of a species decrease the quality of seeds. Similarly a high percentage of seeds of class 'IV' improves the seed quality of a given tree selected as plus tree for germplasm collection.

Additional Keywords: embryo, endosperm, sterility, germplasm

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Introduction

Cupressus Linn., commonly known as 'cypress, an ancient Latin name derived from Greek 'Kuparissos' is one of the important genus of family *Cupressaceae*. The genus has a wide and discontinuous distribution in the Northern Hemisphere. It consists of about 20 species growing at different altitudes, three of which i.e. *C. torulosa* Don., *C. arizonica* Greene and *C. glabra* Sudw. were investigated in this study. Many workers (Chamberlain 1935, Doak 1937, Li 1953a, Konar and Banerjee 1963, Dallimore and Jackson 1966, Florin 1967, Eckenwalder 1976, Miller 1977, Dogra 1983, 1984, Sahai 1990, 1993) discussed different aspects of the genus. Very little attention was paid to embryological details significant in the seed analysis of *Cupressus* species. Although in other conifer like *Pinus,* seed testing was taken into consideration by several workers (Kujala 1927, Wibeck 1929 b) and was supplemented by X-ray radiography (Šimak & Gustafsson 1953 a, b, 1980) and micro-technique (Hakansson 1960, Sarvas 1962) in *Cupressus,* this type of study is not done so far. However it is a preliminary study in this direction.

It is not always true that trees with good vegetative performance will certainly show good reproductive performance or high fertility in respect of fruit and seed-set. To get rid off these doubts, analysis of seed based on embryo and endosperm development is most probably a good parameter for determining seed quality and seed testing. Here, this parameter was adopted for three species of *Cupressus* growing in the western Himalayan region of India.

In the present study analysis of seed quality was done according to the modification of Simak and Gustafsson's classification, which is based on the presence of five seed classes. These classes were further analysed and the highest positive results were used for plus tree selection.

A general introduction of the three *Cupressus* species is as follows:

1. *Cupressus arizonica* Greene, popularly known as Rough Bark Arizona Pine, occurs wild in the mountains of Arizona, New Mexico and Mexico. It is planted wild in northwest Himalayas near several hill stations.
2. *C. glabra* Sudworth, also known as Smooth Arizona Cypress, is confined to central Arizona. It is also planted wildly in northwest Himalayas.
3. *C. torulosa* Don., commonly known as Bhutan Cypress, is indigenous to the outer ranges of west Himalayas and also occurs in west Szechwan and China.

Material and methods

One indigenous i.e. *C. torulosa* and two introduced species i.e. *C. glabra* and *C. arizonica* growing at altitudes of 1750–1980 m. were selected for this study. Selection was based on their good reproductive performance.

Mature seed samples were collected by randomized collection of 10 cones per tree as well as from randomly chosen four trees of three species and were extracted from the mature cones by using little mechanical pressure. For each species a fixed i.e. 100 seeds of each tree was taken from the bulk of the seeds of 40 cones. They were soaked in 25% alcohol for 24 hours and then sectioned with a sharp razor. Seeds were examined under Zoom Stereomicroscope to classify seed classes on the basis of the embryo and endosperm development determining the seed quality.

Results:

Five classes of seeds were observed in three species of *Cupressus*:

1. Class '0'. Empty seeds having neither embryo nor endosperm (Fig. 1A) or sometimes the embryo cavity filled with dark brown masses of embryo/endosperm. The average percentage of the seeds of this class was highest (45%) in trees No.1 and 4 of *C. torulosa* (Table 1).
2. Class 'I'. Endosperm present, embryo cavity developed but no embryo or sometimes a shrivelled embryo was observed (Fig. 1B). The highest averagepe rcentage (25%) of the seeds of this class was observed in tree No.2 of *C. arizonica* (Table 1).
3. Class 'II'. Seeds with endosperm and small embryo filling half of the length of the embryo cavity were observed (Fig.1C). The highest average percentage of seeds of this class was recorded in the tree No.3 of *C. torulosa* (Table 1).
4. Class 'III'. Seeds with endosperm and embryo filling the length of three-quarter of the embryo cavity were observed (Fig.1D). The highest average percentage of the seeds of this class was in tree No.2 of *C. torulosa* (Table 1).
5. Class 'IV'. Seeds with completely developed embryo or covering the total length of embryo cavity were observed (Fig.1E). The highest average percentage of the seeds of this class was present in the tree No.3 of *C. glabra* (Table 1).

There were also some seeds with sterile rusty brownish mass filling the whole embryo cavity in all the three species. These types of seeds were put under class 'I' and treated as sterile seeds.

According to all observations, it was reported that tree No.3 for *C. torulosa, C. glabra* and tree No.4 for *C. arizonica* have been selected as plus trees and can be included in the germplasm collection (Table 1).

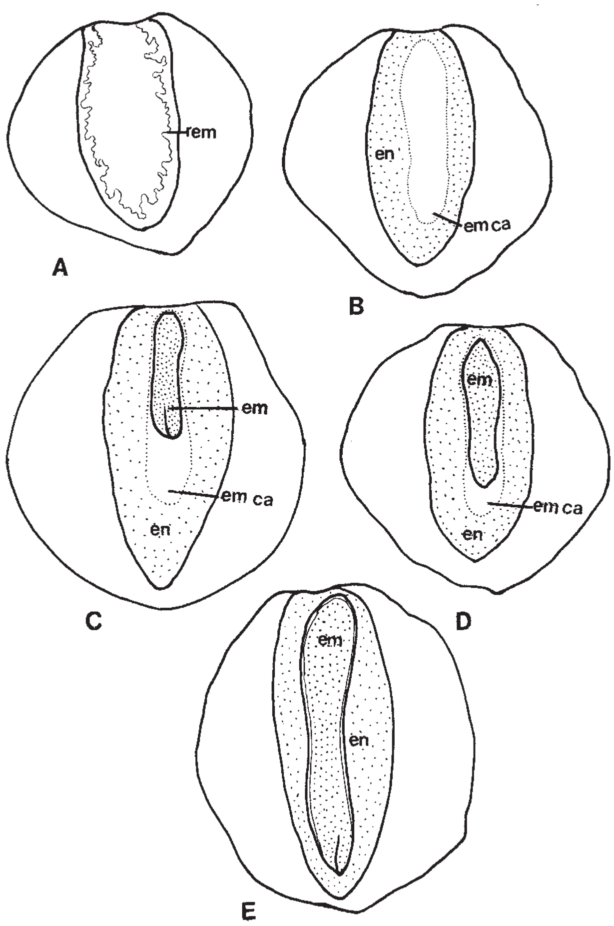

Fig. 1 A–E. L.S. of seeds showing five classes in *Cupressus* species. A. class '0', B. class 'I', C. class 'II', D. class 'III', E. class 'IV'. (em = embryo, en = endosperm, em ca = embryo cavity, ren = remains of endosperm). A–E 100×

Table 1. Average percentage of seed quality shown by five seed classes in *Cupressus* species (average based on randomized samples of 100 seeds of each bulk of 10 cones)

S.N.	Species	Tree No.	Class '0'	Class 'I'	Class 'II'	Class 'III'	Class 'IV'
1	*C. torulosa*	1	45	00	05	05	45
		2	35	15	04	00	46
		3	20	06	10	06	58
		4	45	15	05	00	35
2	*C. glabra*	1	40	00	01	00	59
		2	30	18	04	01	47
		3	20	02	02	00	76
		4	39	09	02	01	49
3	*C. arizonica*	1	30	08	08	00	54
		2	23	25	05	00	47
		3	36	20	04	02	38
		4	25	11	04	00	60

Discussion

Quality of seeds depends on the position of embryo/endosperm in the seeds. The proportion of full and empty seeds affects seed quality of a species. The trees/species having high percentage of class 'IV' type (completely developed) seeds were regarded as highly fertile trees/species e.g. tree No.3 of *C. glabra* (Table 1). Similarly species/trees having high percentage of class '0' and class 'I' seeds, were regarded as highly sterile species/trees e.g. tree No.4 of *C. torulosa* (Table 1).

Šimak and Gustafsson's (1953a, b, 1980) X-ray radiography technique for embryo and endosperm analysis could be successfully applied without harm to seeds for their quality analysis and seed testing, even though it can not be implemented in the case of *Cupressus* species as in some cases presence of rusty dead mass of a full embryo can be confused with fully developed viable embryo under X-ray radiography.

In conifer species, taking into consideration such characteristics as good vegetative performance of the tree and adequate seed setting commonly does selection of plus trees for seed or germplasm collection. Actually these parameters can not be successfully employed in plus tree and germplasm collection work. The position of embryo and endosperm in a seed is determines the fate of healthy seeds as well as their quality as it was observed during the investigation presented here.

Information on annual flowering and seed production is necessary for the assessment of possibility to regeneration naturally and for the prediction of good seed year as reported by Dogra (1983). In conifers flowering period vary species to species and even tree to tree which ultimately affects seed production and the seed quality.

In conclusion examination of seed classes based on the development of embryo and endosperm in the seed is an important method for determining seed quality, that can be used for seed testing and plus tree selection programme.

References

Chamberlain C.J. 1935. Gymnosperms structure evolution. University Chicago Press. Chicago.

Dallimore W. and A.B. Jackson 1966. A Handbook of *Coniferae* and *Ginkgoaceae*. Revised by S.T. Harrison. Edward Arnold, London.

Doak C.C. 1937. Morphology of *Cupressus arizonica* gametophytes and embryogeny. Botanical Gazette 98: 808–815.

Dogra P.D. 1967. Seed sterility and disturbances in embryogeny in conifers with particular reference to seed testing and tree breeding in *Pinaceae* Studia Forestalia Suecica. N.45, 1–97.

Dogra P.D. 1983. Reproductive biology of conifers and its application in forestry and forest genetics. Phytomorphology. 33: 142–156.

Dogra, P.D. 1984. The embryology, breeding system an seed sterility in *Cupressaceae* – A Monograph 1–124.

Eckenwalder J.E. 1976. Re-evaluation of *Cupressaceae* and *Taxodiaceae* a proposed merger. Madrono. 23: 237–256.

Hakansson A. 1956. Seed development of *Picea abies* and *Pinus sylvestris* Meddeland. Statens Skogs-Forskningsinst.46: 1–23.

Hakansson A. 1959. Seed development of pine grafts. Botanical Notiser,112: 65–72.

Konar R.N. and Banerjee, S.K. 1963. The morphology and embryology of *Cupressus funebris* Endl. Phytomorphology 13: 321–328.

Kujala V. 1927. Untersuchungen uber den Bau und die Keimfahigkeit von Kiefern und Fichtensamen in Finnland. Common Institute of Forest Finland, 12:1–106

Li H.L. 1953b. A reclassification of *Libocedrus* and *Cupressus*.Journal Arnold Arboratum.34: 17–36.

Miller C.N. 1977. Mesozoic conifers. Botanical Review. 43: 217–280.

Sahai K. 1990. Seed-set in some *Cupressus* species growing in Kumaon Himalayas. Himalayan Research and Development.Vol. 9: 31.

Sahai K. 1993. Possibilities of seed sterility in Western Himalayan Cypress (*Cupressus torulosa* D. Don). XV International Botanical Congress. Yokohama, Japan. 439.

Sarvas R. 1962. Investigations of the flowering and seed crop of *Pinus sylvestris* Common Institute of Forest Finland, 53: 1–198.

Šimak M. and Gustafsson A. 1953a. Rontgenfotografering av skogstradsfro. – Skogen 5: 1–4.

Šimak M. and Gustafsson A. 1953b. X-ray photography and sensitivity in forestry species. Hereditas, 39: 458–468.

Šimak M. 1980. X-ray Radiography in research and testing of forest tree seeds.

Swedish University of Agricultural Science Dept. of Silviculture, Umea Rapporter, 3: 1–39.

Wibeck E. 1929 b. Die forstliche Saatgutversorgung Sechwedens und einschlagige Probleme. – Proceedings of International Congress. Forest Experiment Station Stockholm: 412–426.