Short Note: An approximate Formula for Selection Intensity

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Summary

A formula for selection intensity following truncation selection of a certain proportion in a normal distribution is suggested. The deviation from the true values is less than .004.

Key words: Gain calculation, standardised selection differential, desk top calculator algorithm.

Zusammenfassung

Es wird eine Näherungsformel für die Selektionsintensität nach der Schwellenauswahl für bestimmte Teilflächen in einer Normalverteilung vorgeschlagen. Die Abweichung von den tatsächlichen Werten beträgt weniger als 0.004.

Selection intensity (i) is an important element of genetic gain predictions. Breeders often utilize the mean of a truncated standardised normal distribution to estimate the selection intensity, where selected proportion (P) corresponds to the area above the truncation point. Tables of this function are available (e.g. LINDGREN and NILSSON 1985). In some research however, computations must be made in which the selected proportions appear as an integrated part of the calculations. Neither tables nor the exact algorithms are easily used in that situation. Thus there is a need for algorithms which are easy to handle in a computer or desk top programmable calculator which give i as a function of P. For this use I suggest the following formula:

$$i(P) = (1-P)\,[1.452\,\sqrt{\ln\,(1/(P(1-P)))} - 0.45 + 1.122\,(1-P)^{9.0}\,P^{0.84}],$$

where

$i(P)$ is an approximation for the selection intensity,
and
P is the proportion selected

The formula has been tested and the deviations from the true values are less than 0.004 for P larger than 0.000000001. For smaller P the fit is not as good, but this should not be a concern for breeding applications.

Breeders are often concerned with finite populations comprising small numbers. Here a correction suggested by BURROWS (1972) may be helpful:

$$i(j,n) = i(P) - (n-j)/(2j(n+1)\,i(P))$$

The formula is an approximation of the expected mean of the j topranking values from a sample of n values from a standardised normal distribution. The approximation of $i(P)$ suggested above could be used with $P = j/n$. The whole calculation is still rather simple to feed into a programmmable calculator. The accuracy of this approximation is discussed by LINDGREN and NILSSON (1985). For $j > 2$ and $n > 50$, the error added is below 0.0033. However, for $j = 1$ the second decimal will be of limited significance.

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References

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Short Note: Storage of Forest Tree Germplasm in Liquid Nitrogen (–196° C)*

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Abstract

Seeds from a number of forest tree species. including silver fir (*Abies alba*), Norway spruce (*Picea abies*), scots pine (*Pinus sylvestris*), larch (*Larix decidua*), beech (*Fagus sylvatica*), and hybrid aspen (*Populus tremula* × *Populus tremuloides*) were stored for 1 and 6 days in liquid nitrogen (−196° C). Seed germination data indicate that in 5 of these 6 forest tree species investigated, there was practically no loss of viability in seed stored at −196° C for 1 or 6 days. Beech seeds did not germinate following storage in liquid nitrogen. It appears that relatively large seeds, such as those of beech, may be more prone to freezing-thawing injury than small seeded forest tree species as aspen, scots pine, Norway spruce, larch, and silver fir.

Key words: Seed storage, liquid nitrogen, gene banks.

Zusammenfassung

Saatgut einer Reihe von Forstbaumarten wie Weißtanne (*Abies alba*), Fichte (*Picea abies*), Kiefer (*Pinus sylvestris*),

*) Dedicated to Dr. G. H. MELCHIOR on his 60th birthday.

Lärche *(Larix decidua)*, Buche *(Fagus sylvatica)* und Hybridaspe *(Populus tremula × P. tremuloides)* wurde für 1 und 6 Tage in flüssigem Stickstoff (−196° C) gelagert. Die Keimprüfung ergab, daß bei 5 von 6 Forstbaumarten praktisch kein Verlust an Keimkraft bei den für 1 oder 6 Tage in flüssigem Stickstoff gelagerten Samen festgestellt wurde. Nur die Bucheckern keimten nach Lagerung in flüssigem Stickstoff nicht. Es scheint, daß relativ große Samen wie die Bucheckern mehr zu Gefrier-Auftau-Schäden neigen als kleine Samen, wie die von Aspe, Kiefer, Fichte, Lärche und Weißtanne.

Introduction

In the Federal Republic of Germany 'Waldsterben" (dying forests) is taking its toll. About 52% of the forest trees are damaged or are dying. The extent of damage is based on the following classification: 0 (normal or undamaged), 1 (slightly damaged), 2 (moderately damaged), 3 (heavily damaged), and 4 (already dead). In this context, class 0 or normal represents 48 % of the forest trees, and damaged trees (52%) is sum of the classes 1 to 4. The magnitude of 'Waldsterben' in the Federal Republic is as follows: 87% in silver fir *(Abies alba)*, 57% in scots pine *(Pinus sylvestris)*, 52% in Norway spruce *(Picea abies)*, 55% in beech *(Fagus sylvatica)*, 55% in oak *(Quercus robur, Q. petraea)*, and 31% in other forest tree species (Breloh und Dieterle 1985). These figures are alarming. They point out that the existence of a number of forest tree species is endangered unless something is done about this problem immediately. If 'Waldsterben' is mainly caused by environmental pollution (from air, water, and soil), then perhaps the best approach to combat 'Waldsterben' might be to control the pollution at the sources (factories, automobiles, etc). In the meanwhile, it seems necessary to investigate the causal agents (and there might be several) in 'Waldsterben' and plan strategies to save the forest trees (Melchior *et al.* 1986). One immediate approach to the problem would be to preserve whatever can be preserved of the genetically viable existing germplasm in genebanks by storage of seed, and vegetative material either in clonal banks or tissue banks. At this Institute a programme for conservation of forest tree germplasm has been underway, exploiting recent technologies for seed and tissue storage. Seeds of the forest tree species are generally stored at temperatures ranging from 4° C to −18° C. In this report results are presented on storage of seed from the forest tree species at super low temperature of liquid nitrogen (−196° C).

Materials and Methods

The storage potential of several forest tree species, both broadleaved and conifers, was explored. These included:

Table 1. — Germination data on seed stored for 24 hours at control (0° C) and super low temperature (−196° C).

species / hybrids	No. of seeds sown	No. of seeds germinated 0°C	No. of seeds germinated -196°C	% seed germination 0°C	% seed germination -196°C
Abies alba (lot 1)	60	16	15	26.6	25
Abies alba (lot 2)	60	15	18	25	30
Fagus sylvatica	60	31	0	51.6	0
Larix decidua	60	26	28	43.3	46.6
Picea abies	60	53	56	88.3	93.3
Pinus sylvestris	30	21	21	70	70
Populus tremula x Populus tremuloides	60	59	60	98.3	100

Table 2. — Germination data on seed stored for 6 days at control (0° C) and super low temperature (−196° C).

species / hybrids	0°C No. of seeds sown	0°C No. of seeds germinated	-196°C No. of seeds sown	-196°C No. of seeds germinated	% seed germination 0°C	% seed germination -196°C
Abies alba (lot 1)	50	11	100	16	22	16
Abies alba (lot 2)	50	13	100	27	26	27
Fagus sylvatica	60	31	100	0	51.6	0
Larix decidua	100	39	100	34	39	34
Picea abies	100	92	100	91	92	91
Pinus sylvestris	100	79	100	80	79	80
Populus tremula x Populus tremuloides	100	100	100	99	100	99

silver fir *(Abies alba* Mill.), Norway spruce *(Picea abies* (L.) Karst.), scots pine *(Pinus sylvestris* L.), European larch *(Larix decidua* Mill.), European beech *(Fagus sylvatica* L.), and hybrid aspen *(Populus tremula* L. × *Populus tremuloides* Michx.). Seeds stored at 0° C served as controls. Seeds were stored for one day (24 hours) and 6 days in screw cap glass bottles in liquid nitrogen (−196° C). After these treatments, the glass bottles containing seed were dipped in a water bath maintained at 40° C for about 2 minutes, and then kept at room temperature for half an hour before sowing. The control and super cold storage seeds from silver fir, Scots pine, Norway spruce, and larch were sowed in peat-perlite substrate for the germination test. Seeds from beech were cold stratified for germination, and germination test in hybrid aspen was performed on moist filter paper in petri plates.

Results and Discussion

The germination data on seeds stored for one day at −196° C show that there was no significant loss of viability in 5 of 6 forest tree species investigated *(Table 1)*. Beech seeds did not germinate after storage at −196° C, compared to controls at 0° C (51.6% germination). Seed lots from different forest tree species showed differences in their germination percentage after 0° C storage (control) *(Table 1, 2)*. Within a species the control value was compared with the cold storage treatment. The seeds stored for one day at −196° C gave germination values that were equal to or slightly higher than the controls *(Table 1)*. The latter was observed in one seed lot of silver fir, Norway spruce, larch, and hybrid aspen.

The germination data on seeds stored for 6 days at −196° C *(Table 2)* did not show any appreciable departure from that obtained for one day yold storage in liquid nitrogen. Slight lowering of germination percentages occurred in one seed lot of silver fir and larch stored at −196° C compared to the controls. Slight increases in the germination percentages observed in the forest tree species stored at −196° C for one day *(Table 1)* were not observed in the same tree species stored at −196° C for 6 days *(Table 2)*. However, chi square tests indicate that the differences between controls (0° C) and seeds stored at −196° C for one day are not significant ($X^2 = 0.05$; df = 1). That is also true for different periods of storage at −196° C ($X^2 = 0.86$; df = 1). On the other hand, chi squares values showed highly significant differences between the forest tree species in terms of their seed germination capacities ($X^2 = 839.6^{***}$; df = 5). At the temperature of liquid nitrogen

(−196° C), theoretically, the material could be stored for a very long time without an appreciable loss of viability. The aim of storage at super low temperature is to halt metabolic processes, so that the material remains genetically stable for a long time.

Seeds from the forest tree species are generally stored at temperatures ranging from 4° C to −18° C. At these temperatures, the seeds can be stored only for a limited period of time. In most cases the seeds start to lose viability after a few years. Beech, oak, and silver fir seeds can be stored at these temperatures only for 1 to 4 years.

It should be pointed out that all kinds of seeds can not be effectively stored in liquid nitrogen. Beech seeds did not germinate after storage at −196° C, whether for one day or 6 days. It would appear that relatively small seeds such as those of aspen, scots pine, Norway spruce, larch, and silver fir, which showed practically no loss of viability following storage at −196° C, are less prone to freezing-thawing injury as compared to large seeds of beech and perhaps oak. We are investigating whether freezing-thawing injury is incurred to embryo or cotyledon (storage organ) or both in the beech seeds.

The storage potential of large seeds, such as beech and oak, at low temperatures is further being investigated in our laboratory at Grosshansdorf by modifying the freezing-thawing procedures.

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References

Breloh, P. und Dieterle, G.: Ergebnisse der Waldschadenserhebung 1985. Allgemeine Forst-Zeitschrift **40**: 1377—1380 (1985). — Melchior, G. H., Muhs, H.-J. and Stephan, B. R.: Tactics for the conservation of forest gene resources in the Federal Republic of Germany. Forest Ecology and Management (in press) (1986).

Buchbesprechungen

Pines: Drawings and Descriptions of the Genus Pinus. By Aljos Farjon. E. J. Brill/Dr. W. Backhuys, Leiden, Netherlands. 1984. 219 pp. Hfl. 96.—. (ISBN 90-04-07068-0).

In this large format book nearly all known species of the genus *Pinus* are described by one page of line drawings and one page of detailed descriptions. The remarkable ink drawings by the author show the growth habit, a part of a twig, and needle and cone morphology. In a new edition, one should add to the illustrations scales for needle and cone size, to make the comparison between species easier. The descriptions provide the common English name, informations on morphology etc., on ecology and on the natural distribution with unfortunately very small maps. — In the introductory chapters of the book (24 pages) a detailed account of the inflorescences, morphology and development of cones, germination and growth, root system, bark and some characters of the trunk, and needles of pines is given. In final sections the classification of the genus *Pinus*, the phyllogeny and biogeography, contributed by J. van der Burgh, a glossary of botanical terms, and an index and a bibliography are presented. The attractive book is valuable to botanists, dendrologists and foresters, and can be highly recommended. B. R. Stephan

Plant Genetic Engineering. Edited by John H. Dodds. Cambridge University Press, Cambridge, 1985. 312 pages. £ 25.00/ US $ 39.50.

Plant genetic engineering holds great promise for genetic modification and improvement of agricultural crop plants. The book contains 9 chapters. Following a short intructory chapter (Dodds), the next two chapters deal with isolation, culture and fusion of plant protoplasts (Dodds). Chapter 4 covers isolated cell organelles and subprotoplasts and their role in somatic cell genetics (Lörz). The next two chapters deal with Agrobacterium (Herrera-Estrella *et al.*) and viruses (Hull) as vectors systems for introduction of genes into plant cells. Chapter 7 discusses possibilities for genetic engineering of Rubisco, a soluble protein in the chloroplast involved in photosynthesis. The next chapter discusses genetic engineering of seed proteins: current and potential applications (Croy and Gatehouse). The last chapter reviews applications of genetic engineering to agriculture (Jones).

This book covers essentially two important aspects that are relevant to genetic engineering. In the first part tissue culture techniques, more specifically protoplast culture and its potential in the future is discussed. The second part of the book deals with molecular biology covering vector systems for gene transfers, and genetic modifications of Rubisco, and enzyme involved in photosynthesis, and an important storage protein. Although most of the recent techniques of genetic engineering are still in the experimental stages, their potential application to crop plants are enormous. For those working in molecular biology, this book describes the latest techniques of genetic engineering. M. R. Ahuja

Genetic improvement strategies in tropical forest trees. By R. D. Barnes and G. L. Gibson, (eds). Proceedings of a Joint Work Conference held in Mutare, Zimbabwe, April 1984 by IUFRO Working Parties, Tropical species provenances, breeding tropical species, breeding southern pines. 663 p.

The conference with the theme of rational use of materials and informations from provenance trials in afforestation and tree breeding programmes — was complemented by a preceding training course on various aspects in experiments in provenance and progeny testing and, a post conference tour which visited experimental and breeding work on forest species in plantations and natural forest in high and low rain fall zones. Pre- and post conference meetings were considered very appropriate for the venue because of the excellent planning and execution of field trials on the provenance and breeding work in Zimbabwe.

In the conference there were 60 registered participants from 28 countries and a varying number of observers. Eigthy-six voluntary papers presented the latest results on provenance research and their use for planning breeding strategies. Six position-papers of specialists covered the most contentious issues and discussion centred around these.

A summary covered the subject matter and outcome of most of the discussion at the conference and includes species and provenance, pest resistance, conservation, inbreeding, multiple population strategy, vegetative propagation, genotypic environment interaction research needs and others.

Other significant aspects were discussed during the conference tour and summarized as for example industrial versus non industrial species and other topics. So the volume presents the recent results, ideas and strategies on provenance research, and improvement in tropical forest trees. G. H. Melchior

Handbuch für Pilzfreunde. In 6 Bänden. Begründet von E. Michael, neubearbeitet von B. Hennig, weitergeführt und herausgegeben von H. Kreisel, Greifswald.

Band 2: Nichtblätterpilze (Basidiomyzeten ohne Blätter, Ascomyzeten). Herausgegeben und bearbeitet von H. Kreisel. Mit Beiträgen von D. Benkert. 3., neubearbeitete Auflage. G. Fischer Verlag, Stuttgart. 1986. 448 S.- mit farb. Abb. von rund 290 Pilzarten auf 125 Taf. sowie 30 Abb. im Allg. und Systemat. Teil. Geb. DM 58,—. ISBN 3-437-30347-3 (Lizenzausgabe).

Im Rahmen der Neubarbeitung des sechsbändigen Handbuches für Pilzfreunde erschien jetzt der 2. Band in 3. Auflage. Der Band ist, wie auch in anderen Bänden des Handbuches üblich, in einen allgemeinen, einen systematischen und einen speziellen Teil ge-